**TI DLP® Pico™ Technology for Aftermarket Head-up Displays**

**Vivek Thakur and John Ferri**

**ABSTRACT**

Advances in consumer display technology present the opportunity to equip any automobile with aftermarket head-up display (AM-HUD) solutions. The objective of this application report is to help product developers design aftermarket head-up displays incorporating Texas Instruments DLP® Pico™ technology.

**Contents**

1. Introduction ................................................................. 2
2. Applicable Documents .................................................. 2
3. Terminology ..................................................................... 2
4. AM-HUD Key Requirements ............................................ 6
5. AM-HUD System ............................................................ 9
6. AM-HUD System Design Trade-Offs ............................... 10
7. Electronic System .......................................................... 15
8. Conclusions and Getting Started ....................................... 16

**List of Figures**

1. Projector HUD ................................................................. 3
2. Teleprompter HUD .......................................................... 4
3. Augmented HUD ............................................................ 4
4. HUD Diagram ................................................................. 5
5. HUD Eyebox and Field of View ......................................... 6
6. Field of View (FOV) .......................................................... 6
7. Number of Pixels Required Per FOV ................................. 7
8. Eyebox and Evaluation Point ............................................. 8
9. DLP AM-HUD System Simplified Block Diagram .............. 9
10. Virtual Image ................................................................... 9
11. Typical DLP AM-HUD System Block Diagram ................ 15

**List of Tables**

1. Interpupillary Distance (IPD) for Both Genders .................. 8
2. Typical AM-HUD Specifications ...................................... 10
3. Combiner and Diffuser Specification ................................. 10
4. Projection Unit Specification ............................................ 14
Introduction

A head-up display (HUD) is a transparent display that superimposes rich, configurable, real-time data in a driver's normal line of sight. The HUD concept first appeared in military aircraft, where it was increasingly necessary for the pilot to be able to monitor critical flight data without looking away from outside the aircraft to an instrument panel within the aircraft. As the capabilities of HUDs improved and dropped in price, HUDs found widespread application in commercial and even private aviation. In recent years, HUDs began appearing as a factory installed option in many high-end automobiles.

Recent advances in consumer display technology present the opportunity to equip any automobile with an aftermarket head-up display (AM-HUD) solution. The same powerful technology behind DLP Pico products can be used in the automobile for high-brightness, interactive display systems that enhance the driving experience. The small size, low power, economical cost, and proven reliability of DLP Pico technology provides the foundation for compelling AM-HUD products.

DLP Products offers a wide variety of digital micromirror devices (DMDs), including chips specifically designed for consumer, industrial, and automotive applications. Regardless of which DMD is selected, appropriate considerations should be made to meet the recommended operation conditions specified in the device datasheet. This document will explain key design requirements and trade-offs for aftermarket head-up display solutions based on DLP Pico technology.

Applicable Documents

The following TI Documents contain relevant information:

- Getting Started with DLP Pico Technology
- DLPC343X display controller datasheets: DLPC3430, DLPC3433, DLPC3435, DLPC3438 and DLPC3439.
- PMIC datasheets: DLPA2000, DLPA2005, DLPA3000 and DLPA3005
- DMD datasheets: DLP2010, DLP3010 and DLP4710
- Optical module manufacturers
- Application Note: Geometric Optics for DLP

Always refer to the latest revision of datasheets.

Terminology

3.1 Types of AM-HUD

There are several implementations of aftermarket HUD products. These different design approaches are broadly classified into the following categories:

Projector HUD

A Projector HUD creates an image on a diffuser screen with no additional optics after the projector (Figure 1).
Figure 1. Projector HUD
Teleprompter HUD

A Teleprompter HUD allows indirect viewing of an image through partial reflection from the car’s windshield, or a partially reflective screen in front of the windshield (Figure 2).

![Figure 2. Teleprompter HUD](image)

Augmented HUD

An augmented HUD uses mirror optics to create a virtual image floating beyond the windshield (Figure 3).

![Figure 3. Augmented HUD](image)

This document focuses on augmented HUD technology for AM-HUD applications.
3.2 **HUD Terminology**

Figure 4 and Figure 5 illustrate the terminology used in this document.

**Head-up Display (HUD)**
A transparent display that presents data in the driver's normal line of sight by creating a virtual image.

**Augmented Reality (AR)**
Superimposes a computer-generated image on a user's view of the real world, thus providing a composite view.

**Virtual Image (VI)**
An image that appears to “float” at some focal distance in space.

**Virtual Image Distance (VID)**
The focal distance where the virtual image appears to reside. The apparent distance between the viewer’s eyes and the virtual image created by the HUD optics. Typically, the virtual image is created well beyond the windshield of the car.

**Field of View (FOV)**
The angle subtended at the driver’s eyes by the virtual image presented by the HUD.

**Horizontal Field of View (HFOV)**
The horizontal angle (along x-axis) subtended from the driver’s eyes to the virtual image.

**Vertical Field of View (VFOV)**
The vertical angle (along y-axis) subtended from the driver’s eyes to the virtual image.

**Combiner**
A partially reflective element of the optical chain that reflects light towards the viewer and allows outside light to pass through.

**Eyebox**
The area in which the HUD virtual image is viewable by the driver.
4 AM-HUD Key Requirements

4.1 Field of View

The field of view (FOV) (Figure 6) is an important specification of an AM-HUD system. A wider field of view is desirable so that all required and useful information can be displayed without clutter, and in a way which is easily read by the driver. At the same time, the FOV should not be so wide that the driver is distracted from monitoring their car's current lane in the road. Ideally, the virtual image should be contained within the car's current lane width at a reasonable distance ahead.

Typically, lanes of US highways are 3.7 meters wide. A virtual image with a 12° FOV will span across a 3.7 meter lane at a distance of nearly 18 meters in front of the driver. The preferred horizontal field of view (HFOV) is between 6° to 12°, and a vertical field of view (VFOV) between 3° to 6°.

The total light output required from the HUD projection unit increases with FOV, so the increased power demand of a wider FOV should be taken into consideration.
4.2 Resolution

The resolution of a display determines the sharpness of the virtual image seen by the viewer (Figure 7). Resolution is determined by the combination of the FOV and the pixel density of the display. A typical human eye resolves about 1 arcminute per pixel. That means that a person with 20/20 vision can resolve a maximum of 60 pixels in a 1° FOV. A WVGA (854 x 480) resolution DLP chipset enables up to a 14° HFOV in which the viewer will be unable to discern the individual pixels in the virtual image.

![Figure 7. Number of Pixels Required Per FOV](image)

4.3 Virtual Image Distance

The desired virtual image distance (VID) is typically within the range of 2.4 meters to 30 meters (8 ft to 98 ft) so that the HUD presents information at the normal sight distance of vision during driving. A 3° down angle is also recommended for the virtual image so that the driver does not have to move their attention away from the lane of traffic in order to see information. The VID has no impact on the total light output from the projection unit, or the resolution required for the HUD. The virtual image position is determined by the HUD optical design.

4.4 Eyebox

The HUD “eyebox” (1) is a region within which the full virtual image can be viewed with at least one eye. A typical suggested eyebox dimension for AM-HUD is 140 mm x 60 mm. An AM-HUD offers more flexibility in the vertical dimension of the eyebox because the driver is able to adjust the vertical position of the eyebox, either by adjusting the tilt angle of the combiner, or the tilt of the entire HUD unit.

Interpupillary distance (IPD) is the distance between the center of the pupils of the two eyes. IPD is critical for the design of HUD systems, where both eyes' pupils need to be positioned within the eyebox.

---

(1) In optical systems, the eyebox is sometimes referred to as the exit pupil.
Table 1 gives a list of the IPD values for each gender from 1988 Anthropometric Survey of U.S. Army Personnel databases.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Sample Size</th>
<th>Mean (mm)</th>
<th>Standard Deviation</th>
<th>Minimum (mm)</th>
<th>Maximum (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>1771</td>
<td>64.7</td>
<td>3.7</td>
<td>52</td>
<td>78</td>
</tr>
<tr>
<td>Female</td>
<td>2205</td>
<td>62.3</td>
<td>3.6</td>
<td>52</td>
<td>76</td>
</tr>
</tbody>
</table>

A relatively small head movement ( > 1.5 inch / 40 mm lateral) will cause one eye to be outside of the eyebox. The optical design of the HUD should ensure that, under these conditions, the other eye can see the complete image. The performance evaluation points of an eyebox are highlighted by dots in Figure 8.

![Figure 8. Eyebox and Evaluation Point](image)

### 4.5 Image Brightness

An AM-HUD needs to support a wide range of image brightness levels. During a bright sunny day, an image with 10,000 - 15,000 nits may be required. At night or during darkness (e.g. driving through a tunnel), 50 to 100 nits may be adequate. The brightness of an LED-illuminated DLP projection system can be easily adjusted by modulating the LED current intensity. LED current intensity is a software programmable feature in the DLP chipset, and can be changed during operation.
5 AM-HUD System

The system block diagram of an AM-HUD is shown in Figure 9. A standard optical engine incorporating DLP Pico projection display technology can be used for AM-HUD. A customer can make necessary system level trade-offs to leverage a wide range of optical engines available from suppliers and not require a custom development.

The projector incorporating DLP technology projects an image on the diffuser screen. A combination of mirror(s) and combiner create a virtual image in front of the viewer’s eyes, as shown in Figure 10. Normally the fold mirror(s) is a flat mirror, and the combiner is a free-form plastic with 20-25% reflectivity. Since the FOV is relatively small, one can use a diffuser screen with very high gain. This reduces the total light output required from the projection unit. A diffuser screen with 20× gain is recommended for AM-HUD applications.

The diffuser screen (in this example a transmissive screen) and one fold mirror can be replaced with a single "reflective diffuser" screen. This may help reduce the overall size of the AM-HUD product.

* These variables are defined in Table 3.
6 AM-HUD System Design Trade-Offs

In this section we will use the following specifications to discuss AM-HUD system design trade-offs.

### Table 2. Typical AM-HUD Specifications

<table>
<thead>
<tr>
<th>Features</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image Brightness intensity</td>
<td>15,000 nits or cd/m²</td>
</tr>
<tr>
<td>Virtual Image Distance</td>
<td>2,000 cm</td>
</tr>
<tr>
<td>Distance between Combiner and Eyebox</td>
<td>75 cm</td>
</tr>
<tr>
<td>Eyebox size</td>
<td>140 mm x 60 mm</td>
</tr>
<tr>
<td>Field of View</td>
<td></td>
</tr>
<tr>
<td>Horizontal</td>
<td>12°</td>
</tr>
<tr>
<td>Vertical</td>
<td>6°</td>
</tr>
<tr>
<td>Panel Resolution</td>
<td>WVGA (854 x 480 Pixel)</td>
</tr>
</tbody>
</table>

#### 6.1 Light Output vs. Eyebox and Field of View

The total light output (lumens) required to create the virtual image at the eyebox depends on the desired maximum brightness intensity of the virtual image, the area of the eyebox, and the FOV.

As stated before, virtual image distance (VID) has no impact on the total light required, even though the virtual image size grows with VID for a given FOV.

The following formula provides an approximation of the total light (lumens) required for a rectangular eyebox:

$$\text{Total Light} = 4 \times \text{EyeBox}_x \times \text{EyeBox}_y \times \text{Brightness}_{\text{intensity}} \times \tan\left(\frac{1}{2} \cdot \text{HFOV}\right) \times \tan\left(\frac{1}{2} \cdot \text{VFOV}\right)$$

Where

- Total Light — Total light at pupil in lumens
- EyeBox\(_x\) — X dimension of eyebox in meters
- EyeBox\(_y\) — Y dimension of eyebox in meters
- Brightness\(_{\text{intensity}}\) — Maximum brightness intensity of virtual image in nits or cd/m² (typically 10,000 nits to 15,000 nits)
- HFOV — Horizontal field of view
- VFOV — Vertical field of view

Estimated total light (reflected to driver’s eyebox) for

- 140 mm x 60 mm eyebox, 12° x 6° FOV and max virtual image brightness 15,000 nits ≈ 2.78 lumens

#### 6.2 Combiner and Diffuser Specification

Refer to Figure 10 for assumptions.

The values are chosen to design a compact size AM-HUD and typical use case.

### Table 3. Combiner and Diffuser Specification

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance from projection unit to diffuser screen</td>
<td>PD</td>
<td>To be calculated(^{(1)})</td>
</tr>
<tr>
<td>Distance between diffuser screen and fold mirror</td>
<td>DM</td>
<td>5 cm</td>
</tr>
<tr>
<td>Distance between fold mirror and combiner</td>
<td>MC</td>
<td>15 cm</td>
</tr>
<tr>
<td>Combiner to eyebox distance</td>
<td>CE</td>
<td>75 cm</td>
</tr>
<tr>
<td>Virtual image distance</td>
<td>VID</td>
<td>2,000 cm</td>
</tr>
</tbody>
</table>

\(^{(1)}\) Will match the throw ratio of the projector.
6.2.1 Diffuser Screen Dimensions

The following equation can be used to estimate the size of the diffuser screen:

$$\text{Diffuser Width} = \frac{2 \times \text{VID} \times (DM + MC) \times \tan\left(\frac{1}{2} \cdot HFOV\right)}{\text{VID} - CE}$$

$$\text{Diffuser Height} = \frac{2 \times \text{VID} \times (DM + MC) \times \tan\left(\frac{1}{2} \cdot VFOV\right)}{\text{VID} - CE}$$

Diffuser dimensions for reference design:

$$\text{Width} = \frac{2 \times \text{VID} \times (DM + MC) \times \tan\left(\frac{1}{2} \cdot HFOV\right)}{\text{VID} - CE} \text{ mm}$$

$$\text{Width} = \frac{2 \times 20,000 \times (50 + 150) \times \tan\left(\frac{1}{2} \cdot 12^\circ\right)}{(20,000 - 750)} \text{ mm}$$

Width = 44 mm

$$\text{Height} = \frac{2 \times \text{VID} \times (DM + MC) \times \tan\left(\frac{1}{2} \cdot VFOV\right)}{\text{VID} - CE} \text{ mm}$$

$$\text{Height} = \frac{2 \times 20,000 \times (50 + 150) \times \tan\left(\frac{1}{2} \cdot 6^\circ\right)}{(20,000 - 750)} \text{ mm}$$

Height = 22 mm

Diffuser Size = 44 \times 22 \text{ mm}
6.2.2 Combiner Specification

The combiner optical element can be made using injection molded plastic lens technology. It should be coated for 20-25% reflectivity.

There are two optical design choices for combiner and fold mirrors:

- Option 1 — The combiner is a free-form surface, with the fold mirror as a plane (flat) mirror.
- Option 2 — The combiner is a spherical surface, with the fold mirror as a free-form surface for the appropriate optical correction.

The following expressions can be used to estimate size of the combiner:

\[
\text{Combiner Width} = 2 \times CE \times \tan \left( \frac{1}{2} \cdot HFOV \right) + \text{EyeBox}_x \times \left( 1 - \frac{CE}{VID} \right)
\]

\[
\text{Combiner Height} = 2 \times CE \times \tan \left( \frac{1}{2} \cdot VFOV \right) + \text{EyeBox}_y \times \left( 1 - \frac{CE}{VID} \right)
\]

Combiner dimensions for reference design:

Width = \[2 \times CE \times \tan \left( \frac{1}{2} \cdot 12^\circ \right) + 140 \times \left( 1 - \frac{750}{20,000} \right) \text{ mm}\]

Width = 292 mm

Height = \[2 \times CE \times \tan \left( \frac{1}{2} \cdot 6^\circ \right) + 60 \times \left( 1 - \frac{750}{20,000} \right) \text{ mm}\]

Height = 136 mm

Combiner size = 292 × 136 mm

The optical specifications of the combiner will be a free-form surface. It will depend on the material and manufacturing process.
6.3 Projection Unit Specification

An existing DLP projection engine can be used in an AM-HUD design. The key specifications for projection units are brightness, throw ratio, resolution and minimum focus distance. In this section, these values are calculated.

**Brightness**

The total light output from a projector is measured in lumens. The following factors need to be considered in estimating the required light output from the projector:

- Combiner reflectivity ~ 20%
- Diffuser transmission efficiency ~ 90%
- The diffuser's light scatter is normally larger than the eyebox. Only approximately 40-50% of light reaches the eyebox.
- Imaging Area Utilization

The aspect ratio of the HUD image in this example is 12:6 and the suggested DLP panel (WVGA) has an aspect ratio of 16:9. The resulting HUD image is formed by a subset of the panel's available area, according to the following equation:

\[
\frac{VFOV/HFOV}{DMD\ aspect\ ratio} = \frac{12}{16} = 89\% 
\]

Total required light at eyebox = 3.17 lumens

Required projection unit brightness

\[
= 2.78 \times (1/0.20) \times (1/0.90) \times (1/0.40) \times (1/0.89) 
\approx 45\ \text{lumens}
\]
Throw Ratio

The following equations can be used to calculate distance between projection unit and combiner:

\[
\frac{1}{f} = \frac{1}{DM + MC} - \frac{1}{VID - CE}
\]

\[
\frac{1}{\text{ProjectorDistance}} = \frac{1}{f} - \frac{1}{CE}
\]

Substituting values into the first equation:

\[
\frac{1}{f} = \frac{1}{2,000} - \frac{1}{19,250}
\]

\[f = 202.1 \text{ mm}\]

Substituting values into the second equation:

\[
\frac{1}{\text{ProjectorDistance}} = \frac{1}{202.1} - \frac{1}{750}
\]

\[\text{ProjectorDistance} = 277 \text{ mm}\]

Distance between projector and diffuser screen = \(277 - 200 = 77 \text{ mm}\)

\[\text{Projector Throw ratio} = \frac{\text{Distance}}{\text{Diffuser width}} = \frac{77}{44} = 1.74\]

Projection unit specification is shown in Table 4:

<table>
<thead>
<tr>
<th>Features</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brightness</td>
<td>~45 lumens</td>
</tr>
<tr>
<td>Resolution</td>
<td>WVGA (854x480)</td>
</tr>
<tr>
<td>Minimum focus distance</td>
<td>77 mm</td>
</tr>
<tr>
<td>Throw ratio</td>
<td>1.74</td>
</tr>
</tbody>
</table>
Electronic System

Figure 11 illustrates a typical block diagram for a DLP Pico projection system. The drive electronics consist of a DLP controller (DLPC3430/35) and a power management IC (DLPA2005). The DLP controller supports both parallel and DSI interface for connectivity to a processor. The DMD device (DLP2010) is integrated into the optical engine along with the LED illumination unit.

Figure 11. Typical DLP AM-HUD System Block Diagram
Conclusions and Getting Started

DLP technology can enable a wide field of view in a compact and small form factor aftermarket HUD system. The high optical efficiency of DLP Pico technology facilitates bright, vivid images and low power consumption. Furthermore, the high contrast ratio of DLP technology creates an excellent transparent see-through image without any gray background.

To get started with DLP Pico technology, we recommend the following actions:

- Learn more about DLP Pico technology.
  - Read the Getting Started with TI DLP Pico Technology white paper.
  - Browse DLP products and datasheets.
  - Experiment with the DLP throw ratio and brightness calculator.
- Evaluate DLP Pico technology with an easy to use evaluation module (EVM).
- Download TI Designs reference designs to speed product development, including schematics, layout files, bill of materials, and test reports.
  - DLP2010: Ultra Mobile, Ultra Low Power Display Reference Design using DLP Technology
  - DLP3010: Portable, Low Power HD Projection Display using DLP Technology
- Find optical modules and design support.
  - Buy TI DLP Pico optical modules.
  - Contact optical module manufacturers for high volume, production-ready optical modules.
  - Contact DLP design houses for custom solutions.
- Contact your local TI sales representative or TI distributor representative.
- Check out TI's E2E community to search for solutions, get help, share knowledge and solve problems with fellow engineers and TI experts.
Revision History

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

<table>
<thead>
<tr>
<th>Changes from Original (September 2016) to A Revision</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Corrected eyebox dimension from 160 mm × 60 mm to 140mm × 60mm and brightness from 3.17 to 2.78 lumens in estimated total light equation in Section 6.1</td>
<td>10</td>
</tr>
<tr>
<td>• Corrected equation from 'Width' to 'Height' and changed Eyebox y value from 140 to 60 in combiner dimensions for reference design in Section 6.2.2</td>
<td>12</td>
</tr>
<tr>
<td>• Corrected equation values from 3.17 to 2.78 and 50 lumens to 45 lumens in Section 6.3</td>
<td>13</td>
</tr>
<tr>
<td>• Corrected Brightness value from ~50 lumens to ~45 lumens in Table 4</td>
<td>14</td>
</tr>
</tbody>
</table>
IMPORTANT NOTICE FOR TI DESIGN INFORMATION AND RESOURCES

Texas Instruments Incorporated (‘TI’) technical, application or other design advice, services or information, including, but not limited to, reference designs and materials relating to evaluation modules, (collectively, “TI Resources”) are intended to assist designers who are developing applications that incorporate TI products; by downloading, accessing or using any particular TI Resource in any way, you (individually or, if you are acting on behalf of a company, your company) agree to use it solely for this purpose and subject to the terms of this Notice.

TI’s provision of TI Resources does not expand or otherwise alter TI’s applicable published warranties or warranty disclaimers for TI products, and no additional obligations or liabilities arise from TI providing such TI Resources. TI reserves the right to make corrections, enhancements, improvements and other changes to its TI Resources.

You understand and agree that you remain responsible for using your independent analysis, evaluation and judgment in designing your applications and that you have full and exclusive responsibility to assure the safety of your applications and compliance of your applications (and of all TI products used in or for your applications) with all applicable regulations, laws and other applicable requirements. You represent that, with respect to your applications, you have all the necessary expertise to create and implement safeguards that (1) anticipate dangerous consequences of failures, (2) monitor failures and their consequences, and (3) lessen the likelihood of failures that might cause harm and take appropriate actions. You agree that prior to using or distributing any applications that include TI products, you will thoroughly test such applications and the functionality of such TI products as used in such applications. TI has not conducted any testing other than that specifically described in the published documentation for a particular TI Resource.

You are authorized to use, copy and modify any individual TI Resource only in connection with the development of applications that include the TI product(s) identified in such TI Resource. NO OTHER LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE TO ANY OTHER TI INTELLECTUAL PROPERTY RIGHT. AND NO LICENSE TO ANY TECHNOLOGY OR INTELLECTUAL PROPERTY RIGHT OF TI OR ANY THIRD PARTY IS GRANTED HEREIN, including but not limited to any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information regarding or referencing third-party products or services does not constitute a license to use such products or services, or a warranty or endorsement thereof. Use of TI Resources may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

TI RESOURCES ARE PROVIDED “AS IS” AND WITH ALL FAULTS. TI DISCLAIMS ALL OTHER WARRANTIES OR REPRESENTATIONS, EXPRESS OR IMPLIED, REGARDING TI RESOURCES OR USE THEREOF, INCLUDING BUT NOT LIMITED TO ACCURACY OR COMPLETENESS, TITLE, ANY EPIDEMIC FAILURE WARRANTY AND ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF ANY THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

TI SHALL NOT BE LIABLE FOR AND SHALL NOT DEFEND OR INDEMNIFY YOU AGAINST ANY CLAIM, INCLUDING BUT NOT LIMITED TO ANY INFRINGEMENT CLAIM THAT RELATES TO OR IS BASED ON ANY COMBINATION OF PRODUCTS EVEN IF DESCRIBED IN TI RESOURCES OR OTHERWISE. IN NO EVENT SHALL TI BE LIABLE FOR ANY ACTUAL, DIRECT, SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF TI RESOURCES OR USE THEREOF, AND REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

You agree to fully indemnify TI and its representatives against any damages, costs, losses, and/or liabilities arising out of your non-compliance with the terms and provisions of this Notice.

This Notice applies to TI Resources. Additional terms apply to the use and purchase of certain types of materials, TI products and services. These include, without limitation, TI’s standard terms for semiconductor products http://www.ti.com/sc/docs/stdterms.htm), evaluation modules, and samples (http://www.ti.com/sc/docs/sampterms.htm).

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2018, Texas Instruments Incorporated