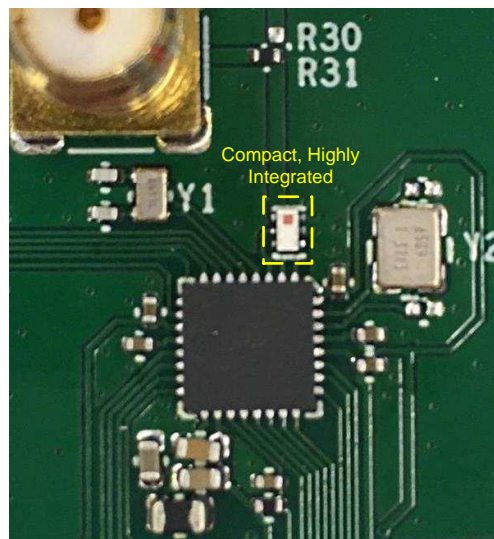


# Johanson Balun for the CC26xx Device Family

*Smart Connectivity Solutions*

## ABSTRACT

This application report describes the implementation, active measurements, schematics, and design files when pairing Johanson Technology Inc.'s 2450BM14G0011 impedance-matched integrated balun-filter with Texas Instruments' CC26xx family of cost-effective, ultra-low power, 2.4-GHz wireless MCUs.



## Contents

|   |  |   |
|---|--|---|
| 1 | Introduction .....                       | 2 |
| 2 | General Specifications .....             | 4 |
| 3 | Typical Electrical Characteristics ..... | 7 |

## List of Figures

|    |   |   |
|----|---|---|
| 1  | Schematic TI CC26XX With Impedance-Matched Filter 2450BM14G0011 .....               | 2 |
| 2  | PCB Layout Reference for TI CC26XX and Impedance Matched Filter 2450BM14G0011 ..... | 3 |
| 3  | 2450BM14G0011 .....   | 4 |
| 4  | Mechanical Dimensions .....   | 5 |
| 5  | Mechanical Dimensions .....   | 5 |
| 6  | Terminal Configuration .....  | 5 |
| 7  | Mounting Considerations .....   | 6 |
| 8  | Measuring Diagram .....   | 6 |
| 9  | Insertion and Return Loss .....   | 7 |
| 10 | Amplitude and Phase Balance .....   | 7 |

## List of Tables

|   |                                   |   |
|---|-----------------------------------|---|
| 1 | +5 dBm Measurements .....         | 3 |
| 2 | RX Sensitivity Measurements ..... | 3 |

|   |                               |   |
|---|-------------------------------|---|
| 3 | General Specifications .....  | 4 |
| 4 | Part Number Explanation ..... | 4 |
| 5 | Mechanical Dimensions.....    | 5 |
| 6 | Terminal Configuration .....  | 5 |

## Trademarks

All trademarks are the property of their respective owners.

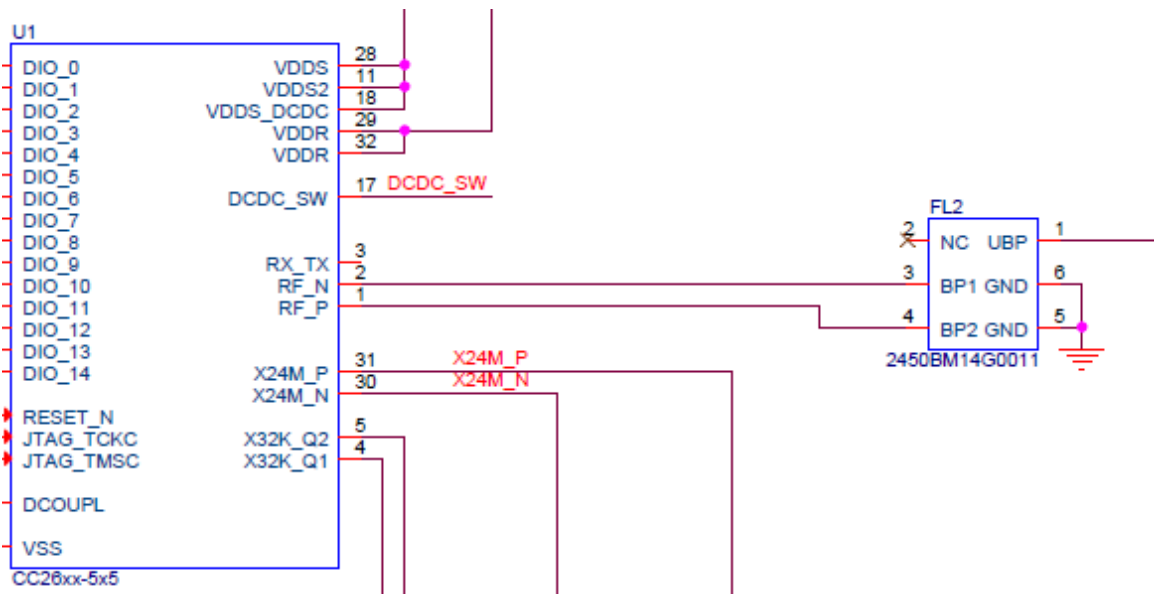
## 1 Introduction

The 2450BM14G0011 was developed in order to satisfy the space constraints of compact designs as well as layouts sensitive to assembly pick and place costs. This IPC provides the following benefits:

- Consolidates Texas Instruments' reference 9 discrete LC components into a single component
- Overall RF performance (insertion loss, return loss, output power, harmonic rejection) comparable to discrete LC solution at a fraction of the size
- Complex impedance matched to all variants of the CC26XX
- Provides harmonic rejection necessary for FCC and ETSI compliance

This front-end solution reduces implementation size area by using smaller effective PCB real estate while reducing component count, increasing performance consistency (100% RF tested before T&R), and offering excellent temperature stability (4ppm). AEC-Q200 qualification is available.

- Design/Layout Files: <http://www.ti.com/lit/zip/swrc326>
- Technical Support: <http://www.johansontechnology.com/ask-a-question>
- 2450BM14G0011 Datasheet: <https://www.johansontechnology.com/datasheets/baluns-matched/2450BM14G0011.pdf>
- 2450BM14G0011T-AEC Datasheet: <https://www.johansontechnology.com/downloads/2450BM14G0011T-AEC.pdf>



**Figure 1. Schematic TI CC26XX With Impedance-Matched Filter 2450BM14G0011**

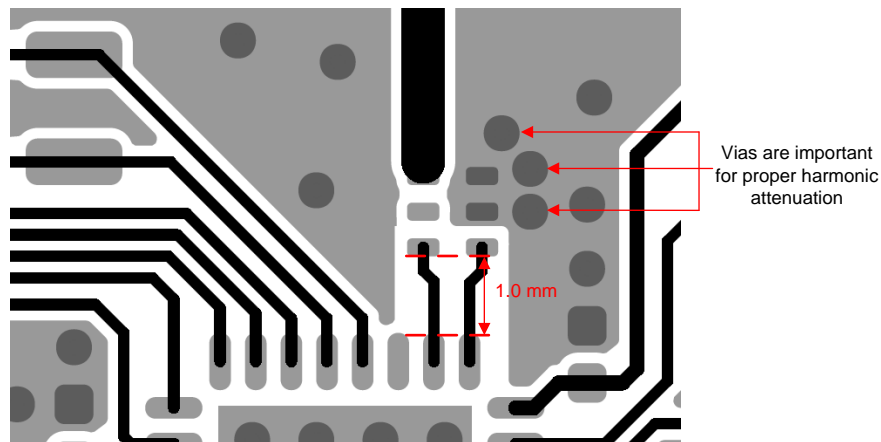


Figure 2. PCB Layout Reference for TI CC26XX and Impedance Matched Filter 2450BM14G0011

For more examples and alternative products see [www.johansontechnology.com/ti](http://www.johansontechnology.com/ti).

Table 1. +5 dBm Measurements

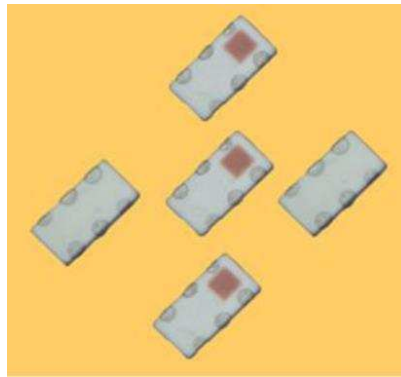
| Fundamental         | 2450BM14G0011 Sample 1 | 2450BM14G0011 Sample 2 | 2450BM14G0011 Sample 3 | 2450BM14G0011 Sample 4 |
|---------------------|------------------------|------------------------|------------------------|------------------------|
| MHz                 | dBm                    | dBm                    | dBm                    | dBm                    |
| 2402                | 4.1                    | 4.3                    | 4.6                    | 4.6                    |
| 2426                | 4.1                    | 4.2                    | 4.5                    | 4.5                    |
| 2440                | 3.9                    | 4.1                    | 4.3                    | 4.3                    |
| 2480                | 3.7                    | 3.8                    | 4.0                    | 4.2                    |
| <b>2nd Harmonic</b> |                        |                        |                        |                        |
| MHz                 | dBm                    | dBm                    | dBm                    | dBm                    |
| 2402                | -46.5                  | -44.8                  | -44.3                  | -44.2                  |
| 2426                | -46.2                  | -44.9                  | -43.7                  | -43.8                  |
| 2440                | -46.7                  | -44.6                  | -44.3                  | -44.2                  |
| 2480                | -46.5                  | -44.3                  | -44.6                  | -43.7                  |
| <b>3rd Harmonic</b> |                        |                        |                        |                        |
| MHz                 | dBm                    | dBm                    | dBm                    | dBm                    |
| 2402                | -48.8                  | -54.9                  | -53.1                  | -54.1                  |
| 2426                | -49.7                  | -55.0                  | -53.5                  | -54.6                  |
| 2440                | -51.1                  | -55.9                  | -54.1                  | -55.3                  |
| 2480                | -53.6                  | -54.9                  | -54.4                  | -54.9                  |

Table 2. RX Sensitivity Measurements

| MHz  | 2450BM14G0011 Sample 1/ 3 V DC | 2450BM14G0011 Sample 2/ 3 V DC | 2450BM14G0011 Sample 3/ 3 V DC | 2450BM14G0011 Sample 4/ 3 V DC |
|------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
| 2402 | -95.7                          | -95.5                          | -95.7                          | -95.7                          |
| 2426 | -95.7                          | -95.8                          | -96.0                          | -95.9                          |
| 2440 | -95.7                          | -95.7                          | -96.0                          | -95.9                          |
| 2480 | -96.0                          | -95.8                          | -96.1                          | -96.1                          |

To revise your layout, contact Johanson Technology's RF applications engineers at: [www.johansontechnology.com/ask-a-question](http://www.johansontechnology.com/ask-a-question).

## 2 General Specifications



**Figure 3. 2450BM14G0011**

**Table 3. General Specifications**

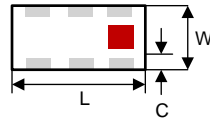
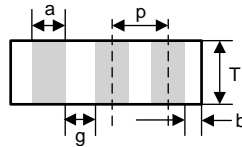
| Part Number  | 2450BM14G0011   |
|--|---|
| Frequency (MHz)  | 2400 - 2500   |
| Unbalanced Impedance   | 50 $\Omega$   |
| Balanced Differential Impedance  | Conjugate match to TI CC2620, CC2630, CC2640, CC2650, chipsets operated on INTERNAL BIAS MODE |
| Insertion Loss when component measured by itself (passive insertion loss)  | 1.5 Typ.<br>(1.8dB max. -40°C to+85°C)  |
| Return Loss (dB):  | 9.5 min.  |
| <ul style="list-style-type: none"> <li>• 25 typ. / 14dB min. @ 4800-5000 MHz</li> <li>• 20 typ. / 15dB min. @ 7200-7500 MHz</li> </ul> |   |
| Phase Difference (deg.)  | 180 $\pm$ 10  |
| Amplitude Difference   | 2.0 maximum   |
| Power Capacity   | 2W max (CW)   |
| Qty/Reel (pcs)   | 4,000   |
| Operating Temperature Range  | -40 ~ +85°C   |
| Storage Temperature Range  | -40 ~ +85°C   |
| Recommended Storage Conditions of Unused Product on T&R  | +5 ~ +35 °C,<br>5 ~ +35 °C, Humidity 45-75%   |
| Storage Period   | 18 months maximum   |

**Table 4. Part Number Explanation**

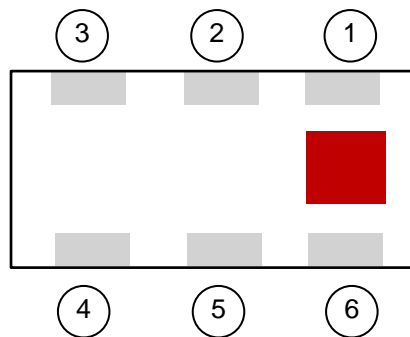
| P/N Suffix | Packaging Style   | Bulk     | Suffix = S    | 2450BM14G0011S        |
|------------|-------------------|----------|---------------|-----------------------|
|            |                   | T & R    | Suffix = T    | 2450BM14G0011T        |
|            | Termination Style | 100% Tin | Suffix = None | 2450BM14G0011(T or S) |

**Table 5. Mechanical Dimensions**

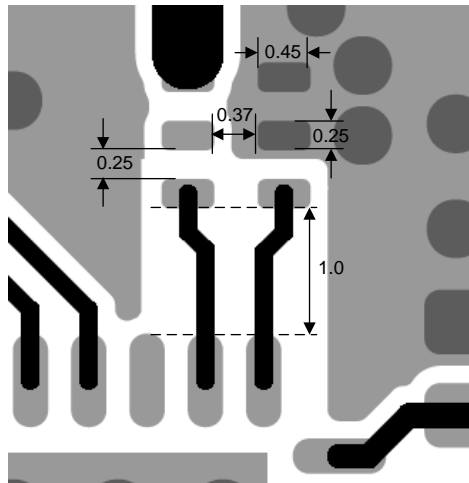
|   | Inches                 | Millimeter           |
|---|------------------------|----------------------|
| L | $0.063 \pm 0.004$      | $1.6 \pm 0.10$       |
| W | $0.031 \div 0.004$     | $0.8 \pm 0.10$       |
| T | $0.024 \pm 0.004$      | $0.6 \pm 0.10$       |
| a | $0.008 \pm 0.004$      | $0.2 \pm 0.10$       |
| b | $0.008 \pm +0.1/-0.15$ | $0.2 \pm +0.1/-0.15$ |
| c | $0.006 \pm 0.004$      | $0.15 \pm 0.10$      |
| g | $0.012 \pm 0.004$      | $0.3 \pm 0.10$       |
| p | $0.020 \pm 0.002$      | $0.5 \pm 0.05$       |


**Figure 4. Mechanical Dimensions**

**Figure 5. Mechanical Dimensions**
**Table 6. Terminal Configuration**

| No | Function             | No | Function            |
|----|----------------------|----|---------------------|
| 1  | Unbalanced Port (IN) | 4  | Balanced Port (OUT) |
| 2  | NC                   | 5  | GND                 |
| 3  | Balanced Port (OUT)  | 6  | GND                 |


**Figure 6. Terminal Configuration**

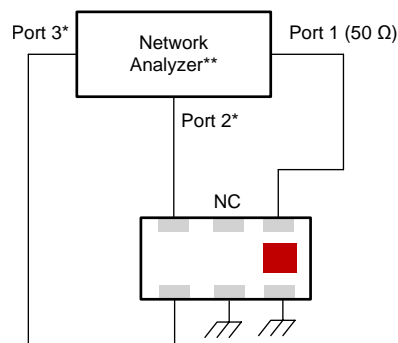
## 2.1 Mounting Considerations



**Figure 7. Mounting Considerations**

- Line width should be designed to match 50Ω characteristic impedance, depending on PCB material and thickness.
  - Land
  - Through-hole (0.3/0.2) vias to GND

## 2.2 Measuring Diagram



- (1) Impedance for ports 2 and 3 = Conjugate to Balanced Impedance/2
- (2) E5071C from Agilent

**Figure 8. Measuring Diagram**

- Port 1: Unbalanced Port
- Ports 2 and 3: Balanced Port
  - $IL = S_{ds21}$
  - $RL = S_{ss11}$
- Amp\_balance =  $\text{dB}(S(2,1)/S(3,1))$
- Phase\_balance =  $\text{Phase}(S(2,1)/S(3,1))$

### 3 Typical Electrical Characteristics

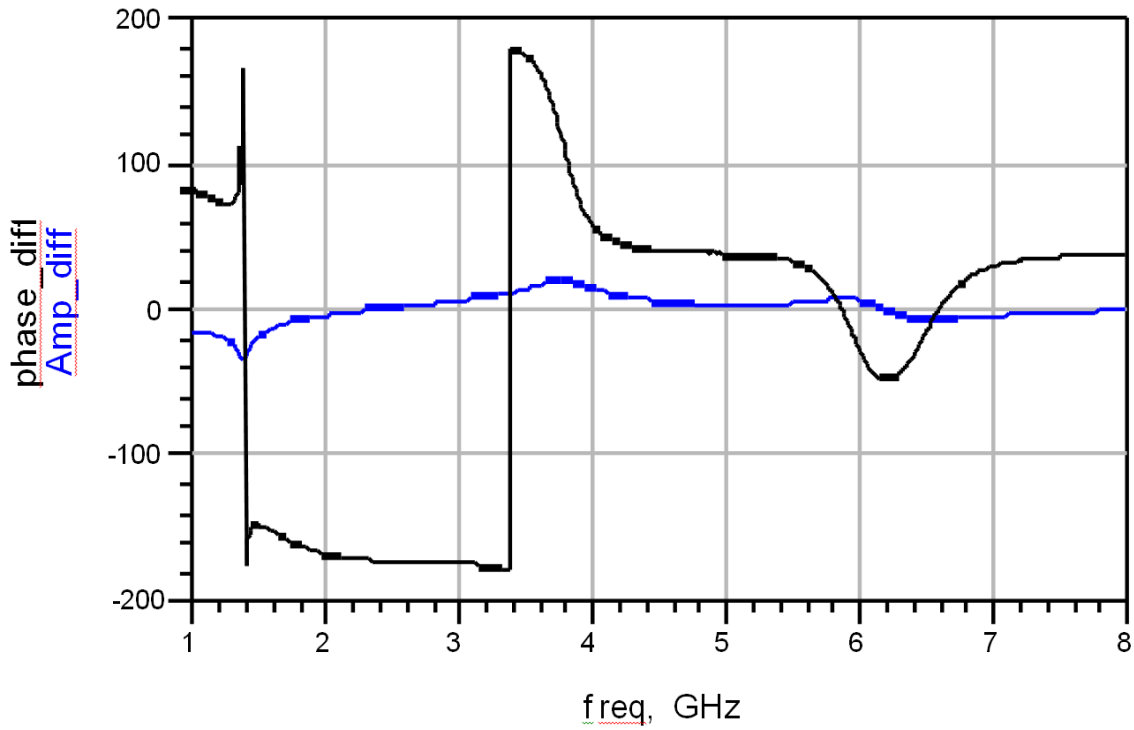


Figure 9. Insertion and Return Loss

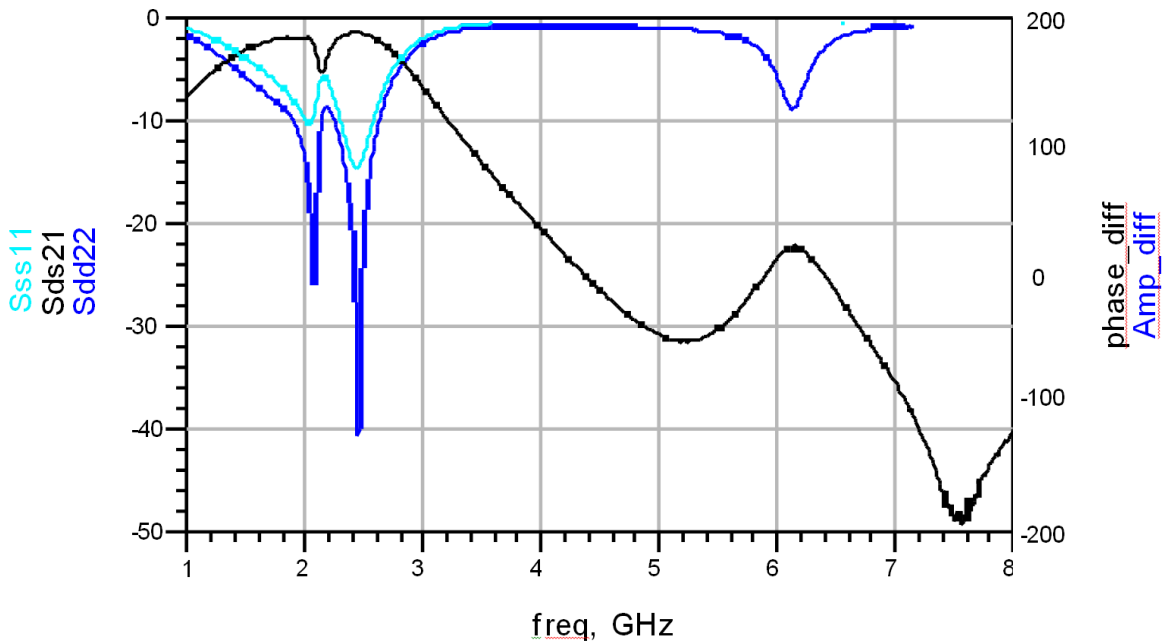


Figure 10. Amplitude and Phase Balance

## 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/sampterm.htm) (<http://www.ti.com/sc/docs/sampterm.htm>).

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2017, Texas Instruments Incorporated