

**PI3AUX221**

**AUX/DDC Interface IC**

## Description

The PI3AUX221 is an interface chip between the discrete Graphics Processing Unit (GPU) and the Display Port (DP) connector. The device is ideal for applications that require support of Dual-Mode Display Port. It integrates the support function for Display Data Channel (DDC) in HDMI mode and includes the functions of level translation, mux function, over-voltage protection, back-drive protection and inversion of Hot Plug Detect (HPD). The level translation function allows a wide range of voltage between 1V to 5V. The device eliminates the requirement of many discrete components, and it is available in a space-saving 12-pin ultra-thin 0.65mm high 2x2 mm QFN package.

## Application(s)

- Dual Mode Display Port in Graphics Cards

## Features

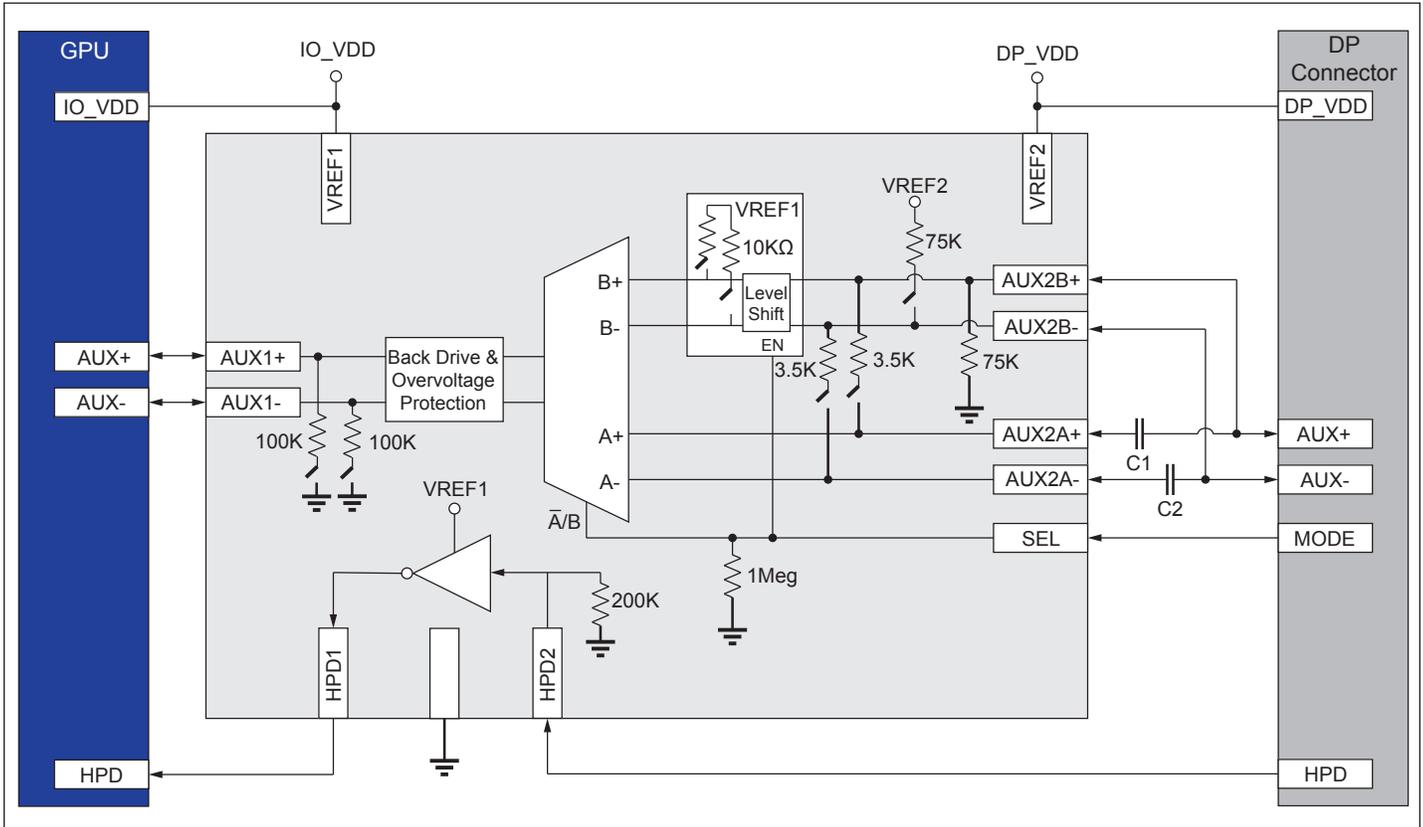
- AC-Coupling of AUX Signal or DC-Level Translated Display Data Channel (DDC) Signal Controlled by the SEL Pin
- Bi-Directional Level Translation of 100KHz DDC Signals
- Inverted Level Translation of HPD Signal from DisplayPort Connector to GPU
- Protection Function to Prevent Signal Propagation Across AUX1 and AUX2A/B when either VREF1 or VREF2 Voltage is Invalid
- Protection Function to Prevent Signal Propagation from HPD2 to HPD1 when VREF1 is Invalid
- Protection on AUX1 from Over-Voltage Condition of AUX2A and AUX2B
- Leakage Current Between VREF1 and VREF2 Limited to 100nA
- 10MHz, -3dB Bandwidth for AUX Switches
- Complies with DisplayPort 2.0
- Complies with HDMI 2.1
- Packaging (Pb-free & Green):
  - 12-Pin UQFN 2x2mm
- Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)
- Halogen and Antimony Free. "Green" Device (Note 3)
- For automotive applications requiring specific change control (i.e. parts qualified to AEC-Q100/101/104/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please [contact us](#) or your local Diodes representative.

<https://www.diodes.com/quality/product-definitions/>

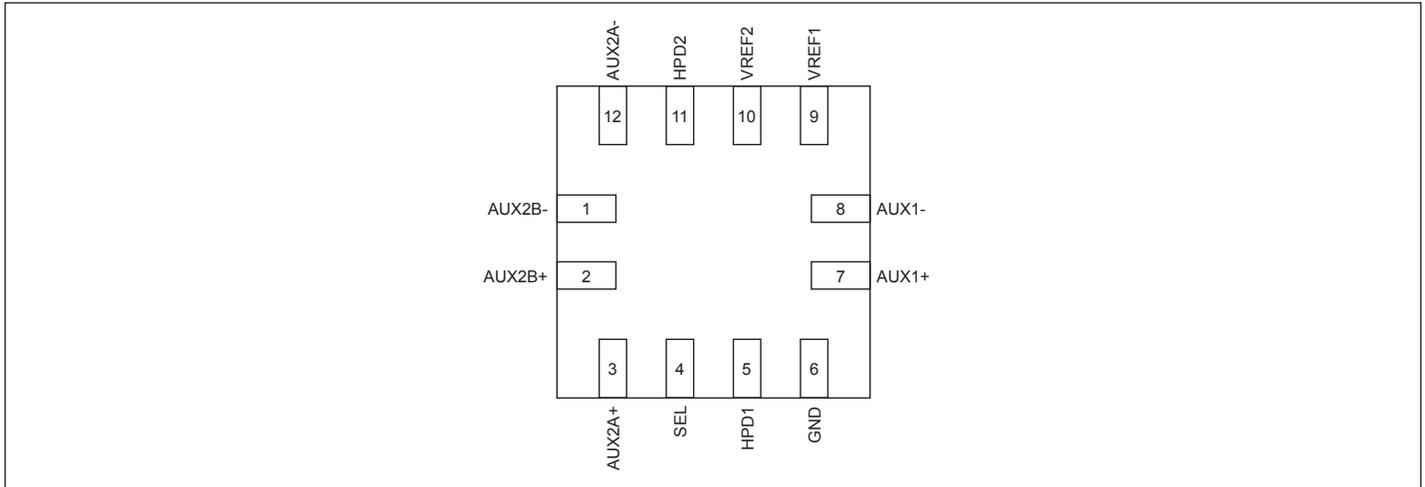
### Notes:

1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See <https://www.diodes.com/quality/lead-free/> for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

**Block Diagram**



## Pin Configuration



## Pin Description

| Pin Number | Pin Name | Type  | Description  |
|------------|----------|-------|--|
| 1          | AUX2B-   | I/O   | Connector side bi-directional AUX2B- signal.                   |
| 2          | AUX2B+   | I/O   | Connector side bi-directional AUX2B+ signal.                   |
| 3          | AUX2A+   | I/O   | Connector side bi-directional AUX2A+ signal                    |
| 4          | SEL      | I     | AUX2 A/B select input. (Low selects AUX2A, High selects AUX2B) |
| 5          | HPD1     | O     | HPD signal output to GPU.                                      |
| 6          | GND      | Power | Ground.  |
| 7          | AUX1+    | I/O   | GPU side bi-directional AUX1+ signal.                          |
| 8          | AUX1-    | I/O   | GPU side bi-directional AUX1- signal.                          |
| 9          | VREF1    | Power | GPU side reference voltage input.                              |
| 10         | VREF2    | Power | Connector side reference voltage input.                        |
| 11         | HPD2     | I     | HPD signal input from connector.                               |
| 12         | AUX2A-   | I/O   | Connector side bi-directional AUX2A- signal.                   |

## Maximum Ratings

(Above which useful life may be impaired. For user guidelines, not tested.)

|   |                            |
|---|----------------------------|
| $V_{REF1}, V_{REF2}$ .....                                | -0.5V to +6.0V             |
| AUX1+, AUX1-, AUX2A+, AUX2A-, AUX2B+, AUX2B- .....        | -0.5V to $V_{REF2} + 0.5V$ |
| HPD2, SEL, HPD1 .....                                     | -0.5V to +6.0V             |
| Channel Current .....                                     | $\pm 20mA$                 |
| Operation Temperature .....                               | -40 to +85°C               |
| Storage Temperature .....                                 | -65°C to +150°C            |
| Maximum Junction Temperature, $T_j(max)$ .....            | 125°C                      |
| ESD (HBM) .....   | 2kV                        |
| ESD at $V_{REF2}$ , AUX2A/B+/-, HPD2, SEL (Contact) ..... | 4kV                        |
| ESD at $V_{REF2}$ , AUX2A/B+/-, HPD2, SEL (Air) .....     | 8kV                        |

**Note:**

Stresses greater than those listed under MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

## Recommended Operating Conditions

| Symbol        | Parameter  | Conditions                            | Min.           | Typ. | Max.       | Units |
|---------------|--|---------------------------------------|----------------|------|------------|-------|
| $V_{REF1}$    | GPU reference voltage                                    |                                       | 1              | 1.8  | 5          | V     |
| $V_{REF2}$    | DP reference voltage                                     |                                       | $V_{REF1} + 1$ | 3.3  | 5          | V     |
| AUX1 $\pm$    | AUX1+ or - Single-ended swing                            | $V_{REF1}, V_{REF2} > \text{or} = 1V$ | 0              |      | $V_{REF1}$ | V     |
| AUX2A $\pm$   | AUX2A+ or - Single-ended swing                           | $V_{REF1}, V_{REF2} > \text{or} = 1V$ | 0              |      | 0.7        | V     |
| AUX2B $\pm$   | AUX2B+ or - Single-ended swing                           | $V_{REF1}, V_{REF2} > \text{or} = 1V$ | 0              |      | $V_{REF2}$ | V     |
| HPD2          | HPD2 swing   | $V_{REF2} > \text{or} = 1V$           | 0              |      | $V_{REF2}$ | V     |
| SEL           | SEL swing  | $V_{REF2} > \text{or} = 1V$           | 0              |      | $V_{REF2}$ | V     |
| $I_{channel}$ | Current to/from AUX1 $\pm$ , AUX2A $\pm$ and AUX2B $\pm$ |                                       |                |      | 10         | mA    |

## Electrical Characteristics

$V_{REF1} = 1.8V, V_{REF2} = 3.3V, \text{Temperature} = -40^\circ C \text{ to } +85^\circ C$ ; unless otherwise specified. Typical values are at Temperature = 25°C.

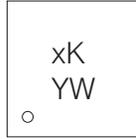
| Symbol                    | Parameter   | Conditions  | Min. | Typ. | Max. | Units      |
|---------------------------|---|---|------|------|------|------------|
| $V_{REF1}, V_{REF2}$      |   |   |      |      |      |            |
| $I_{DD}(V_{REF1})$        | Supply current ( $V_{REF1}$ )                     | SEL = 0, AUX1 $\pm$ , AUX2A/B $\pm$ are floating; SEL = 1, AUX1 $\pm$ , AUX2A $\pm$ are floating, AUX2B $\pm$ are pulled up to 3.3V |      |      | 40   | $\mu A$    |
| $I_{DD}(V_{REF2})$        | Supply current ( $V_{REF2}$ )                     |   |      |      | 80   | $\mu A$    |
| $I_{leakage}$             | Leakage current between $V_{REF1}$ and $V_{REF2}$ |   |      |      | 100  | nA         |
| <b>AUX1, AUX2A, AUX2B</b> |   |   |      |      |      |            |
| $R_{AUX1}$                | AUX1 $\pm$ pull-down resistance                   | SEL = 0   | 60   | 100  | 140  | K $\Omega$ |

**PI3AUX221**

| Symbol                  | Parameter  | Conditions  | Min.                    | Typ.              | Max.                    | Units |
|-------------------------|--|---|-------------------------|-------------------|-------------------------|-------|
|                         | AUX1± pull-up resistance                         | SEL = 1   | 6                       | 10                | 14                      | KΩ    |
| R <sub>AUX2B</sub>      | AUX2B+ pull-down resistance                      |   | 50                      | 75                | 100                     | KΩ    |
|                         | AUX2B- pull-up resistance                        | SEL = 0   | 50                      | 75                | 100                     | KΩ    |
| R <sub>onAUX2A</sub>    | AUX2A on resistance                              | SEL = 0, AUX1 = (0, 0.7V),<br>V <sub>REF1</sub> = 1V, V <sub>REF2</sub> = 2V,<br>10mA into AUX2A                |                         |                   | 10                      | Ω     |
| R <sub>onAUX2A_2B</sub> | AUX2A-to-AUX2B on resistance                     | SEL = 1, AUX2B = 3.3V   | 2.1                     | 3.5               | 4.9                     | KΩ    |
| R <sub>onAUX2B</sub>    | AUX2B on resistance                              | SEL = 1, AUX1 = 0.3 x V <sub>REF1</sub> ,<br>V <sub>REF1</sub> = 1V, V <sub>REF2</sub> = 2V,<br>10mA into AUX2B |                         |                   | 5                       | Ω     |
| R <sub>offAUX2B</sub>   | AUX2B off resistance                             | SEL = 0   | 10                      |                   |                         | MΩ    |
| C <sub>onAUX2B</sub>    | AUX2B on capacitance                             | SEL = 1, V <sub>REF2</sub> = 5V, 2.5Vdc<br>3.5Vpp 100kHz  |                         | 30                |                         | pF    |
| V <sub>CLAMP1</sub>     | Clamping voltage at V <sub>AUX1</sub> during OVP | V <sub>AUX2A/B</sub> = 3.3V, RL@ V <sub>AUX1</sub><br>= 10kΩ  | 0.8 x V <sub>REF1</sub> | V <sub>REF1</sub> | 1.2 x V <sub>REF1</sub> | V     |
| <b>SEL</b>              |  |   |                         |                   |                         |       |
| V <sub>IH</sub>         | Logic high input threshold                       |   | 70% V <sub>REF2</sub>   |                   |                         | V     |
| V <sub>IL</sub>         | Logic low input threshold                        |   |                         |                   | 30% V <sub>REF2</sub>   | V     |
| R <sub>PD</sub>         | Pull-down resistance                             |   | 600                     | 1000              | 1400                    | KΩ    |
| <b>HPD2</b>             |  |   |                         |                   |                         |       |
| V <sub>IH</sub>         | Logic high input threshold                       |   | 2.0                     |                   |                         | V     |
| V <sub>IL</sub>         | Logic low input threshold                        |   |                         |                   | 0.8                     | V     |
| R <sub>PD</sub>         | Pull-down resistance                             |   | 120                     | 200               | 280                     | KΩ    |
| <b>HPD1</b>             |  |   |                         |                   |                         |       |
| V <sub>OH</sub>         | Logic high output voltage                        | I <sub>Source</sub> = 300μA   | 90% V <sub>REF1</sub>   |                   |                         | V     |
| V <sub>OL</sub>         | Logic low output voltage                         | I <sub>Sink</sub> = 300μA   |                         |                   | 10% V <sub>REF1</sub>   | V     |

PI3AUX221

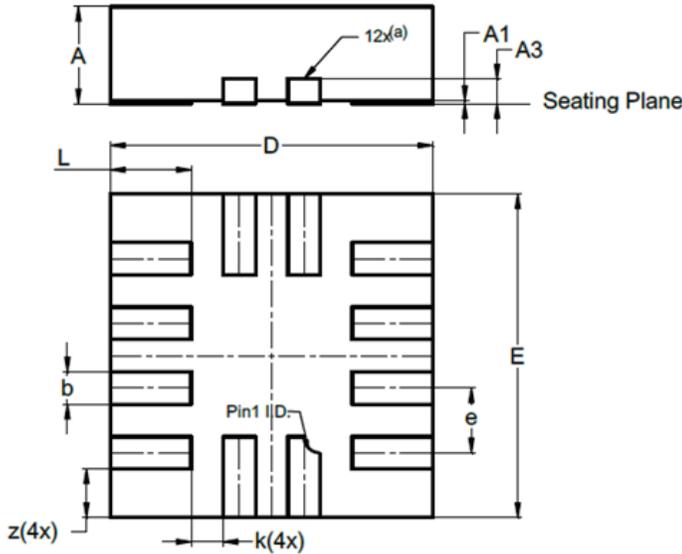
## Part Marking



xK = PI3AUX221ZTAE  
Y: Date Code (Year)  
W: Date Code (Workweek)

**Packaging Mechanical**

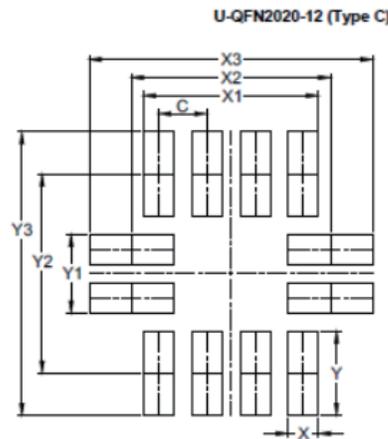
12-UQFN (ZTA)



| U-QFN2020-12<br>(Type C)    |          |      |       |
|-----------------------------|----------|------|-------|
| Dim                         | Min      | Max  | Typ   |
| A                           | 0.55     | 0.65 | 0.60  |
| A1                          | 0.00     | 0.05 | 0.02  |
| A3                          | --       | --   | 0.152 |
| b                           | 0.15     | 0.25 | 0.20  |
| D                           | 1.95     | 2.05 | 2.00  |
| E                           | 1.95     | 2.05 | 2.00  |
| e                           | 0.40 BSC |      |       |
| L                           | 0.45     | 0.55 | 0.50  |
| k                           | --       | --   | 0.20  |
| z                           | --       | --   | 0.30  |
| <b>All Dimensions in mm</b> |          |      |       |

Note (a) Actual shape dependent upon the manufacturing technology used.

**Suggested Pad Layout**



| Dimensions | Value<br>(in mm) |
|------------|------------------|
| C          | 0.400            |
| X          | 0.250            |
| X1         | 1.450            |
| X2         | 1.650            |
| X3         | 2.350            |
| Y          | 0.700            |
| Y1         | 0.650            |
| Y2         | 1.650            |
| Y3         | 2.350            |

For latest package information:

See <https://www.diodes.com/design/support/packaging/diodes-packaging/diodes-package-outlines-and-pad-layouts/>.

**Ordering Information**

| Orderable Part Number | Package Code | Package Description  |
|-----------------------|--------------|----------------------|
| PI3AUX221ZTAEX        | ZTA          | 12-Pin, 2x2mm (UQFN) |

**Notes:**

1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See <https://www.diodes.com/quality/lead-free/> for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.
4. E = Pb-free and Green
5. X suffix = Tape/Reel

**IMPORTANT NOTICE**

1. DIODES INCORPORATED (Diodes) AND ITS SUBSIDIARIES MAKE NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARDS TO ANY INFORMATION CONTAINED IN THIS DOCUMENT, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION).

2. The Information contained herein is for informational purpose only and is provided only to illustrate the operation of Diodes' products described herein and application examples. Diodes does not assume any liability arising out of the application or use of this document or any product described herein. This document is intended for skilled and technically trained engineering customers and users who design with Diodes' products. Diodes' products may be used to facilitate safety-related applications; however, in all instances customers and users are responsible for (a) selecting the appropriate Diodes products for their applications, (b) evaluating the suitability of Diodes' products for their intended applications, (c) ensuring their applications, which incorporate Diodes' products, comply the applicable legal and regulatory requirements as well as safety and functional-safety related standards, and (d) ensuring they design with appropriate safeguards (including testing, validation, quality control techniques, redundancy, malfunction prevention, and appropriate treatment for aging degradation) to minimize the risks associated with their applications.

3. Diodes assumes no liability for any application-related information, support, assistance or feedback that may be provided by Diodes from time to time. Any customer or user of this document or products described herein will assume all risks and liabilities associated with such use, and will hold Diodes and all companies whose products are represented herein or on Diodes' websites, harmless against all damages and liabilities.

4. Products described herein may be covered by one or more United States, international or foreign patents and pending patent applications. Product names and markings noted herein may also be covered by one or more United States, international or foreign trademarks and trademark applications. Diodes does not convey any license under any of its intellectual property rights or the rights of any third parties (including third parties whose products and services may be described in this document or on Diodes' website) under this document.

5. Diodes' products are provided subject to Diodes' Standard Terms and Conditions of Sale (<https://www.diodes.com/about/company/terms-and-conditions/terms-and-conditions-of-sales/>) or other applicable terms. This document does not alter or expand the applicable warranties provided by Diodes. Diodes does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel.

6. Diodes' products and technology may not be used for or incorporated into any products or systems whose manufacture, use or sale is prohibited under any applicable laws and regulations. Should customers or users use Diodes' products in contravention of any applicable laws or regulations, or for any unintended or unauthorized application, customers and users will (a) be solely responsible for any damages, losses or penalties arising in connection therewith or as a result thereof, and (b) indemnify and hold Diodes and its representatives and agents harmless against any and all claims, damages, expenses, and attorney fees arising out of, directly or indirectly, any claim relating to any noncompliance with the applicable laws and regulations, as well as any unintended or unauthorized application.

7. While efforts have been made to ensure the information contained in this document is accurate, complete and current, it may contain technical inaccuracies, omissions and typographical errors. Diodes does not warrant that information contained in this document is error-free and Diodes is under no obligation to update or otherwise correct this information. Notwithstanding the foregoing, Diodes reserves the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein. This document is written in English but may be translated into multiple languages for reference. Only the English version of this document is the final and determinative format released by Diodes.

8. Any unauthorized copying, modification, distribution, transmission, display or other use of this document (or any portion hereof) is prohibited. Diodes assumes no responsibility for any losses incurred by the customers or users or any third parties arising from any such unauthorized use.

9. This Notice may be periodically updated with the most recent version available at <https://www.diodes.com/about/company/terms-and-conditions/important-notice>

The Diodes logo is a registered trademark of Diodes Incorporated in the United States and other countries.

All other trademarks are the property of their respective owners.

© 2024 Diodes Incorporated. All Rights Reserved.

[www.diodes.com](http://www.diodes.com)