

PCIe 2.0 Clock Generator with 2 HCSL Outputs for Automotive Applications

Features

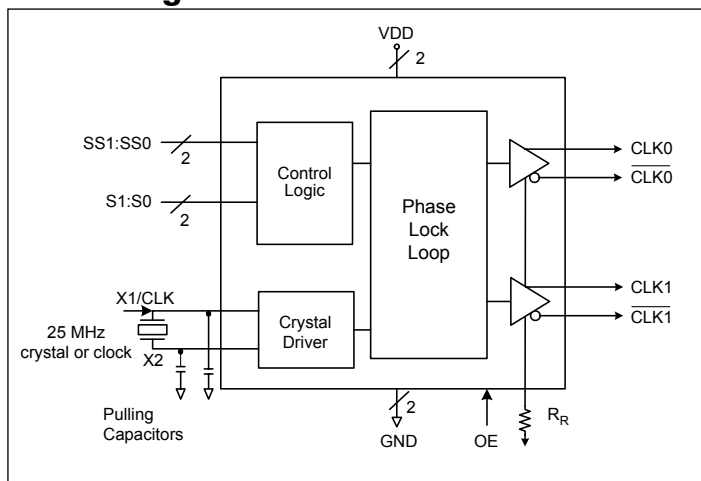
- PCIe® 2.0 compliant
 - Phase jitter - 2.1ps RMS (typ)
- LVDS compatible outputs
- Supply voltage of 3.3V ±10%
- 25MHz crystal or clock input frequency
- HCSL outputs, 0.8V Current mode differential pair
- Jitter 35ps cycle-to-cycle (typ)
- Spread of -0.5%, -0.75%, and no spread
- Spread Bypass option available
- Spread and frequency selection via external pins
- Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)
- Halogen and Antimony Free. "Green" Device (Note 3)
- The PI6C557-03AQ is suitable for automotive applications requiring specific change control; this part is AEC-Q 100 qualified, PPAP capable, and manufactured in IATF 16949 certified facilities.
<https://www.diodes.com/quality/product-definitions/>
- Packaging: (Pb-free and Green)
 - 16-pin, TSSOP (L)

Description

The PI6C557-03AQ is a spread spectrum clock generator compliant to PCI Express® 2.0 and Ethernet requirements. The device is used for PC or embedded systems to substantially reduce Electro-magnetic Interference (EMI).

The PI6C557-03AQ provides two differential (HCSL) or LVDS spread spectrum outputs. The PI6C557-03AQ is configured to select spread and clock selection. Using Diodes' patented Phase-Locked Loop (PLL) techniques, the device takes a 25MHz crystal input and produces two pairs of differential outputs (HCSL) at 25MHz, 100MHz, 125MHz and 200MHz clock frequencies. It also provides spread selection of -0.5%, -0.75%, and no spread.

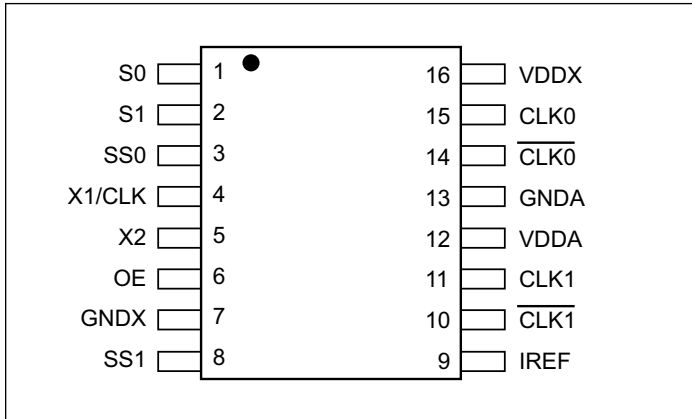
Block Diagram



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.

Pin Configuration



Pin Description

Pin #	Pin Name	I/O Type	Description
1	S0	Input	Select pin 0 (Internal pull-up resistor). See Table 1.
2	S1	Input	Select pin 1 (Internal pull-up resistor). See Table 1.
3	SS0	Input	Spread Select pin 0 (Internal pull-up resistor). See Table 2.
4	X1/CLK	Input	Crystal or clock input. Connect to a 25MHz crystal or single ended clock.
5	X2	Output	Crystal connection. Leave unconnected for clock input.
6	OE	Input	Output enable. Internal pull-up resistor.
7	GNDX	Power	Crystal ground pin.
8	SS1	Input	Spread Select pin 1 (Internal pull-up resistor). See Table 2.
9	IREF	Output	Precision resistor attached to this pin is connected to the internal current reference.
10	$\overline{\text{CLK1}}$	Output	HCSL compliment clock output
11	CLK1	Output	HCSL clock output
12	VDDA	Power	Connect to a +3.3V source.
13	GNDA	Power	Output and analog circuit ground.
14	$\overline{\text{CLK0}}$	Output	HCSL compliment clock output
15	CLK0	Output	HCSL clock output
16	VDDX	Power	Connect to a +3.3V source.

Table 1: Output Select Table

S1	S0	CLK(MHz)
0	0	25
0	1	100
1	0	125
1	1	200

Table 2: Spread Selection Table

SS1	SS0	Spread
0	0	No Spread
0	1	Down -0.5
1	0	Down -0.75
1	1	No Spread

Application Information

Decoupling Capacitors

Decoupling capacitors of 0.01 μ F should be connected between each V_{DD} pin and the ground plane and placed as close to the V_{DD} pin as possible.

Crystal

Use a 25MHz fundamental mode parallel resonant crystal with less than 300PPM of error across temperature.

Crystal Capacitors

C_L = Crystals's load capacitance in pF

Crystal Capacitors (pF) = $(C_L - 8) * 2$

For example, for a crystal with 16pF load caps, the external effective crystal cap would be 16 pF. $(16-8)*2=16$.

Current Source (IREF) Reference Resistor - R_R

If board target trace impedance is 50 Ω ,

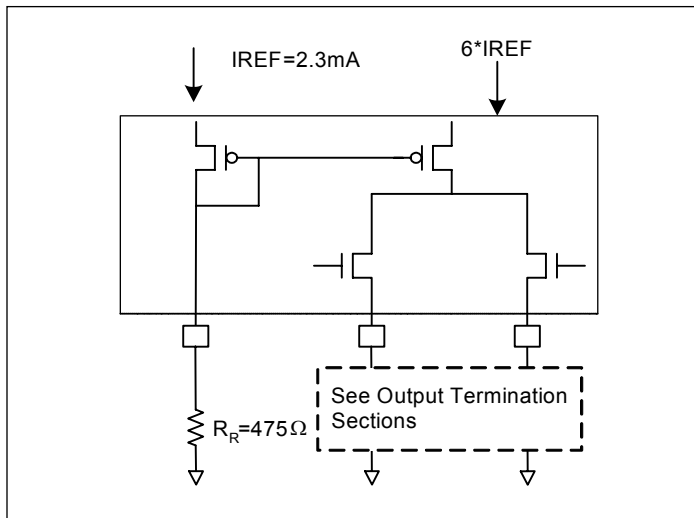
then $R_R = 475\Omega$ providing an IREF of 2.32 mA. The output current (I_{OH}) is 6*IREF.

Output Termination

The PCI Express differential clock outputs of the PI6C557-03AQ are open source drivers and require an external series resistor and a resistor to ground. These resistor values and their allowable locations are shown in detail in the PCI Express Layout Guidelines section.

The PI6C557-03AQ can be configured for LVDS compatible voltage levels. See the LVDS Compatible Layout Guidelines section.

Output Structures



PI6C557-03AQ

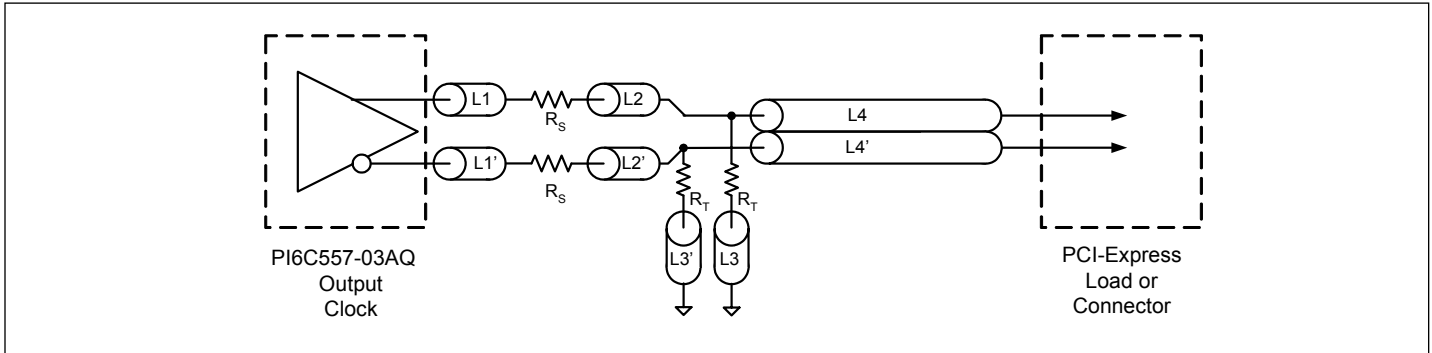
PCI Express Layout Guidelines

Common Recommendations for Differential Routing	Dimension or Value	Unit
L1 length, route as non-coupled 50Ω trace.	0.5 max	Inch
L2 length, route as non-coupled 50Ω trace.	0.2 max	Inch
L3 length, route as non-coupled 50Ω trace.	0.2 max	Inch
R _S	33	Ω
R _T	49.9	Ω

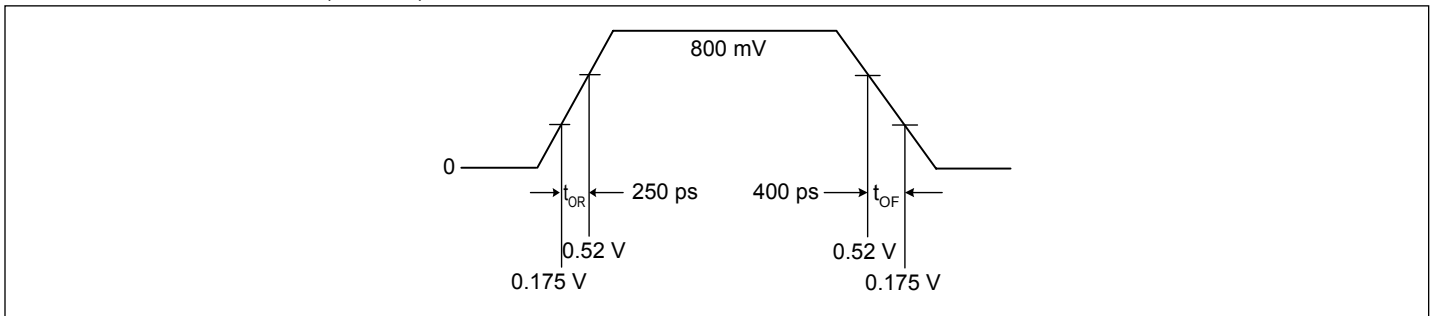
Differential Routing on a Single PCB	Dimension or Value	Unit
L4 length, route as coupled microstrip 100Ω differential trace.	2 min to 16 max	Inch
L4 length, route as coupled stripline 100Ω differential trace.	1.8 min to 14.4 max	Inch

Differential Routing to a PCI Express connector	Dimension or Value	Unit
L4 length, route as coupled microstrip 100Ω differential trace.	0.25 min to 14 max	Inch
L4 length, route as coupled stripline 100Ω differential trace.	0.225 min to 12.6 max	Inch

PCI Express Device Routing



Typical PCI Express (HCSL) Waveform

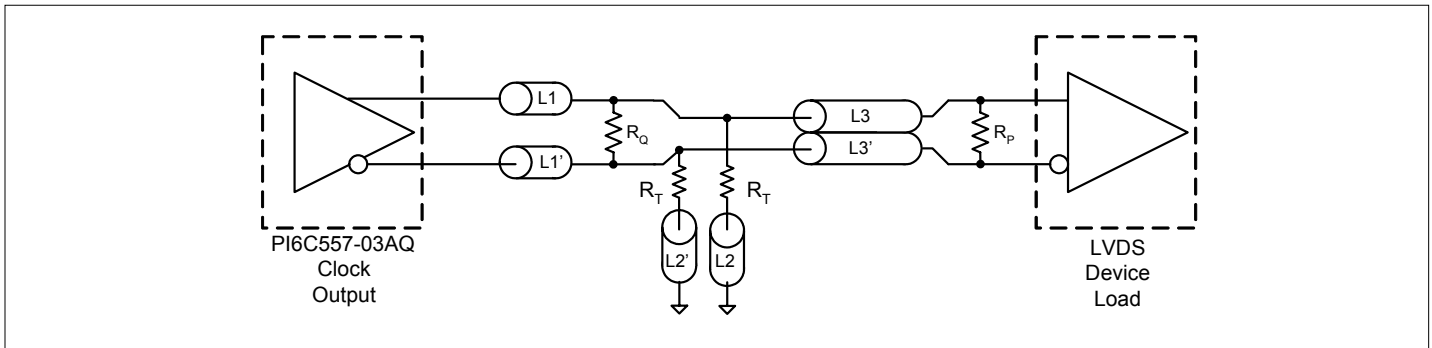


PI6C557-03AQ

Application Information

LVDS Recommendations for Differential Routing	Dimension or Value	Unit
L1 length, route as non-coupled 50Ω trace.	0.5 max	Inch
L2 length, route as non-coupled 50Ω trace.	0.2 max	Inch
R _P	100	Ω
R _Q	100	Ω
R _T	150	Ω
L3 length, route as 100Ω differential trace.		
L3 length, route as 100Ω differential trace.		

LVDS Device Routing



Maximum Ratings

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

Supply Voltage to Ground Potential	5.5V
All Inputs and Outputs	-0.5V to $V_{DD}+0.5V$
Ambient Operating Temperature	-40 to +85°C
Storage Temperature	-65 to +150°C
Junction Temperature	150°C
Soldering Temperature	260°C
EDS Protection (Input)	2000 V min (HBM)

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.

Electrical Specifications

Recommended Operation Conditions

Parameter	Min.	Typ.	Max.	Unit
Ambient Operating Temperature	-40		+85	°C
Power Supply Voltage (measured in respect to GND)	+3.0		+3.6	V

DC Characteristics ($V_{DD} = 3.3V \pm 10\%$, $T_A = -40^\circ C$ to $+85^\circ C$)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_{DD}	Supply Voltage		3.0	3.3	3.6	V
V_{IH}	Input High Voltage(1)	OE	2.0		$V_{DD} + 0.3$	V
V_{IL}	Input Low Voltage(1)	OE	GND - 0.3		0.8	V
I_{IL}	Input Leakage Current	$0 < V_{IN} < V_{DD}$	With input pull-up and pull-downs	-20	20	μA
			Without input pull-up and pull-downs	-5	5	
I_{DD}	Operating Supply Current	$R_L = 50\Omega$, $C_L = 2pF$			95	mA
I_{DDOE}		OE = LOW			50	mA
C_{IN}	Input Capacitance	@ 55MHz			7	pF
C_{OUT}	Output Capacitance	@ 55MHz			6	pF
L_{PIN}	Pin Inductance				5	nH
R_{OUT}	Output Resistance	CLK Outputs	3.0			k Ω

Notes:

1. Single edge is monotonic when transitioning through region.

HCSL Output AC Characteristics ($V_{DD} = 3.3V \pm 10\%$, $T_A = -40^\circ C$ to $+85^\circ C$)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
F_{IN}	Input Frequency			25		MHz
V_{OUT}	Output Frequency		25		200	MHz
V_{OH}	Output High Voltage ^(1,2)	100 MHz HCSL output @ $V_{DD} = 3.3V$	660	800	900	mV
V_{OL}	Output Low Voltage ^(1,2)		-150	0		mV
V_{CPA}	Crossing Point Voltage ^(1,2)	Absolute	250	350	550	mV
V_{CN}	Crossing Point Voltage ^(1,2,4)	Variation over all edges			140	mV
J_{CC}	Jitter, Cycle-to-Cycle ^(1,3)			35	60	ps
J_{RMS}	PCIe RMS Jitter	PCIe 2.0 Test Method @ 100MHz Output			3.1	ps
MF	Modulation Frequency	Spread Spectrum	30	31.5	33	kHz
t_{OR}	Rise Time ^(1,2)	From 0.175V to 0.525V	175		500	ps
t_{OF}	Fall Time ^(1,2)	From 0.525V to 0.175V	175		500	ps
T_{SKEW}	Skew between outputs	At Crossing Point Voltage			50	ps
$T_{DUTY-CYCLE}$	Duty Cycle ^(1,3)		45		55	%
T_{OE}	Output Enable Time ⁽⁵⁾	All outputs			10	μs
T_{OT}	Output Disable Time ⁽⁵⁾	All outputs			10	μs
t_{STABLE}	From power-up to $V_{DD}=3.3V$	From Power-up $V_{DD}=3.3V$		3.0		ms
t_{SPREAD}	Setting period after spread change	Setting period after spread change		3.0		ms

Notes:

1. $R_L = 50\text{-}\Omega$ with $C_L = 2\text{ pF}$
2. Single-ended waveform
3. Differential waveform
4. Measured at the crossing point
5. CLK pins are tri-stated when OE is LOW

Thermal Characteristics

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
θ_{JA}	Thermal Resistance Junction to Ambient	Still air			90	$^\circ C/W$
θ_{JC}	Thermal Resistance Junction to Case				24	$^\circ C/W$

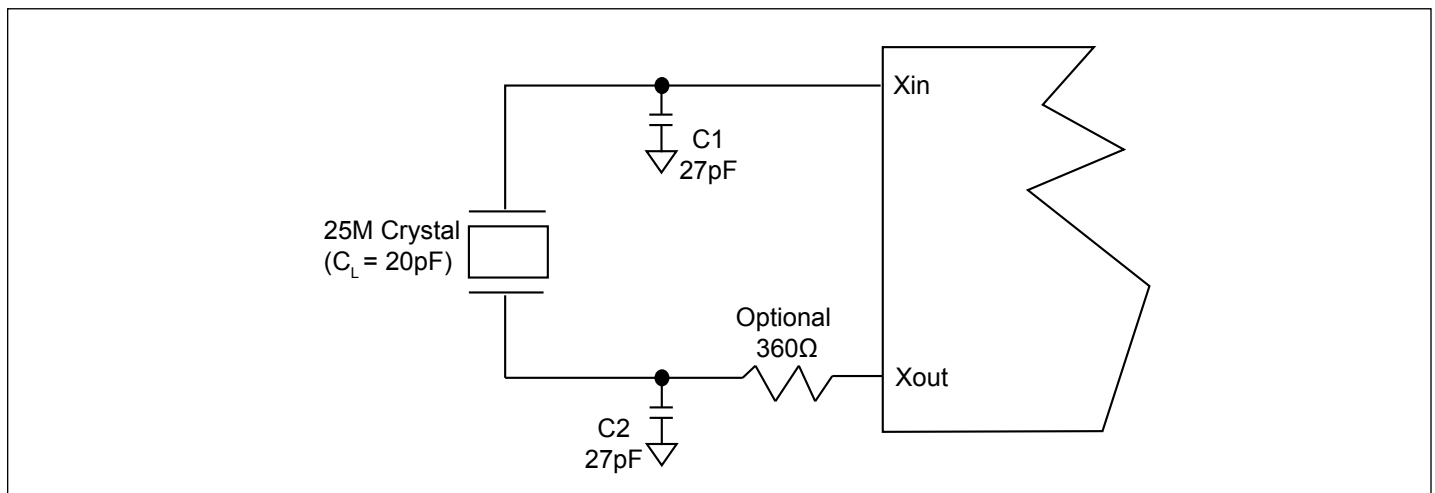
Recommended Crystal Specification

Diodes recommends:

a) FL2500184Q, SMD 3.2x2.5(4P), 25M, $C_L=20\text{pF}$, Frequency Tolerance $\pm 15\text{ppm}$, Stability $\pm 20\text{ppm}$
(<http://www.pericom.com/pdf/datasheets/se/FL.pdf>)

Recommended Crystal Circuit

The following diagram shows PI6C557-03AQ crystal circuit connection with a parallel crystal. For the $C_L=20\text{pF}$ parallel crystal, it is suggested to use $C_1=27\text{pF}$, $C_2=27\text{pF}$ in general. C_1 and C_2 can be adjusted to fine tune to the target ppm of crystal oscillation according to different board layouts. $R_1=360\text{ohm}$ is recommended in layout for smaller size crystal drive level adjustment.



Part Marking

Top mark not available at this time. To obtain advance information regarding the top mark, please contact your local sales representative.

PI6C557-03AQ

Packaging Mechanical: 16-TSSOP (L)

SYMBOLS	MIN.	NOM.	MAX.
A	–	–	1.20
A1	0.05	–	0.15
A2	0.80	1.00	1.05
b	0.19	–	0.30
c	0.09	–	0.20
D	4.90	5.00	5.10
E1	4.30	4.40	4.50
E	6.20	6.40	6.60
e	0.65 BSC		
L1	1.00 REF		
L	0.45	0.60	0.75
S	0.20	–	–
θ	0°	–	8°

NOTES:
 1. ALL DIMENSIONS IN MILLIMETERS. ANGLES IN DEGREES.
 2. JEDEC MO-153F
 3. DIMENSIONS DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.

		DATE: 03/24/16
DESCRIPTION: 16-Pin, 173mil Wide TSSOP		
PACKAGE CODE: L (L16)		
DOCUMENT CONTROL #: PD-1310	REVISION: G	

16-0061

For latest package info.

please check: <http://www.diodes.com/design/support/packaging/pericom-packaging/packaging-mechanicals-and-thermal-characteristics/>

Ordering Information

Ordering Code	Package Code	Description
PI6C557-03AQLEX	L	16-pin, 173mil Wide (TSSOP)

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 AND ITS SUBSIDIARIES (“DIODES”) 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 the 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.

Copyright © 2021 Diodes Incorporated

www.diodes.com