

LTC4372, LTC4373
Low Quiescent Current Dual
Ideal Diodes

DESCRIPTION

The DC2969A circuit board enables evaluation of the LTC[®]4372 and LTC4373 low quiescent current ideal diode controllers. The DC2969A-A option is assembled with the LTC4372 controller, whereas DC2969A-B is assembled with the LTC4373 controller. DC2969A includes two independent ideal diode circuits sharing a common ground, operating over a 2.5V to 33V range, and protecting the load against reverse inputs of up to -28V. One of these

circuits includes a high side load switch in series with the ideal diode allowing load on/off control with the SHDN/UV jumper. In addition, input dropouts are blocked from the output, permitting capacitors to hold up the load when input power fails. Each channel can carry up to 20A.

Design files for this circuit board are available.

All registered trademarks and trademarks are the property of their respective owners.

PERFORMANCE SUMMARY Specifications are at $T_A = 25^\circ\text{C}$

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Voltage Limits	VIN Operating	2.5		33	V
	VINA DC Survival	-28		50	V
	VINB DC Survival	-28		36	V
Undervoltage Threshold (DC2969A-B VINB Only)	VINB Rising	2.80	3	3.20	V
	VINB Falling	2.35	2.5	2.65	V
Output Current	2.5V \leq VIN \leq 5V			10	A
	5V $<$ VIN \leq 33V			20	A

DEMO MANUAL DC2969A

QUICK START PROCEDURE

There are exposed conductors on the bottom of the board, and any banana plugs present will protrude through the bottom of the board. Even though the board is equipped with standoffs, the underlying surface should be non-conductive and clear of any wire, solder, and other conductive debris.

A simple demonstration of DC2969A's operation is as follows:

1. Position the two SHDN/UV jumpers to enable both channels: LO for DC2969A-A, HI for DC2969A-B.
2. Connect two adjustable power supplies, initially turned off or set to 0V. Connect one supply to VINA and nearby GND, the second to VINB and its associated GND (see Figure 1). Join the outputs of VOUTA and VOUTB at the input of a 10A capable DC load, initially turned off or set to 0A.
3. Adjust one power supply to 12V. Set the DC load to 10A. Check that the output is roughly within 50mV of the input.
4. Slowly adjust the other power supply up and down relative to the first while monitoring the power supply currents. The higher supply will carry the load current, with a narrow transition region where the input voltages are nearly identical and the supplies droop share. If one supply is turned off or shorted, the output voltage will not collapse—the other supply will carry the load.
5. Each channel can be individually controlled by its associated SHDN/UV jumper. For example, if VINB is adjusted to 12V and VINA is set to 10V, VINB supply will source the entire load current. If SHDNB/UVB jumper is subsequently set to HI for DC2969A-A or LO for DC2969A-B, channel B will turn off and the full load current will be provided by channel A. Note that turning off channel A through the SHDNA/UVA jumper only turns off the M1A MOSFET channel; the M1A body diode always provides a parallel current path. Do not flow more than 2A through the MOSFET body diode, else M1A may heat up to destruction. Positioning channel B jumper at DIV (DC2969A-B only) provides a 3V rising and 2.5V falling undervoltage lockout threshold on VINB. Unless the SHDNB/UVB turret is being driven, do not use DIV position for DC2969A-A as it floats the SHDN pin.
6. Dial any supply below ground up to -28V and check that the output voltage is limited to roughly -1V.

BOARD DESCRIPTION

Overview

DC2969A features two independent LTC4372 or LTC4373 ideal diode circuits sharing a common ground. Each channel handles up to 20A at room temperature with no air flow. The board has 2oz copper on the outer layers. Reference designators are duplicated for the two sections of the board; the upper section is suffixed A while the lower section is suffixed B. Universal footprints have been provided (on both outer layers) for the MOSFETs to accommodate power SO8, DPAK, and D2PAK packages. Probe pads have been provided for circuit nodes without turrets.

Below is a brief description of the main components of DC2969A. Components without an A or B suffix refer to both channels.

U1 – Ideal Diode Controller

U1 is LTC4372 for DC2969A-A and LTC4373 for DC2969A-B, both in an 8-pin MSOP package. Please refer to the controller datasheets for details on their operation.

M1 – Ideal Diode MOSFET

M1 is the Infineon N-channel MOSFET BSC026N08NS5 in a SuperSO8 package. It was selected for its 80V drain-source breakdown voltage, $\pm 20V V_{GS(max)}$, and $2.2m\Omega$ drain-source on-state resistance (at $10V V_{GS}$). M1's $\pm 20V V_{GS(max)}$ is protected by the ideal diode controller's internal GATE-to-SOURCE 11.7V clamp. When input is at $-28V$ and output is at $33V$, M1's drain-source is at $61V$, safely below its 80V breakdown. During a supply short-circuit to ground with parasitic wire inductance to the IN/SOURCE pins, these pins can swing all the way down to $-40V$. If output is held up at $33V$ by load capacitors, M1 drain-source is subject to $73V$, which is also safely below its 80V breakdown.

At 20A load current and $VIN > 5V$, the forward drop across M1 will be $44mV$ and power dissipation will be $0.88W$. For $VIN \leq 5V$, the controller gate drive drops to $6.5V$ and M1 $R_{DS(ON)}$ increases to $3m\Omega$, yielding $30mV$ forward drop and $0.3W$ power dissipation at 10A. Note that these

calculations use typical on-resistance at $25^\circ C$ and do not consider MOSFET self-heating. Since MOSFET $R_{DS(ON)}$ rises sharply as gate drive falls to $4.5V$, be cautious while operating below 5V input since a combination of low U1 gate drive and high M1 threshold voltage may cause excessive MOSFET power dissipation.

M2B – Switch MOSFET

M2B is the Nexperia N-channel MOSFET PSMN1R7-60BS in a 3-lead D2PAK package. It was selected for its 60V drain-source breakdown voltage, $\pm 20V V_{GS(max)}$, large safe operating area (SOA), and $1.66m\Omega$ drain-source on-state resistance (at $10V V_{GS}$). M2B's $\pm 20V V_{GS(max)}$ is protected by the ideal diode controller's internal GATE-to-SOURCE 11.7V clamp. When input is at $33V$ and output is at $0V$, M2B's drain-source is at $33V$, safely below its 60V breakdown. Care should be taken when turning on into an output capacitor or load current that the M2B inrush power dissipation is within its SOA.

At 20A load current and $VIN > 5V$, the forward drop across M2B is $33mV$ and power dissipation is $0.66W$. For $VIN \leq 5V$, the controller gate drive drops to $6.5V$ and M2B $R_{DS(ON)}$ increases to $2m\Omega$, yielding $20mV$ forward drop and $0.2W$ power dissipation at 10A. Note that these calculations use typical on-resistance at $25^\circ C$ and do not consider MOSFET self-heating. Since MOSFET $R_{DS(ON)}$ rises sharply as gate drive falls to $4.5V$, be cautious while operating below 5V input since a combination of low U1 gate drive and high M2B threshold voltage may cause excessive MOSFET power dissipation.

CGB – Switch Gate Capacitor

A $10nF$ CGB capacitor is installed to slow down GATEB ramp up rate. This reduces the inrush current into the output load capacitor to $C_L \cdot I_{GATE(UP)} / C_{GATE}$, where $I_{GATE(UP)}$ is the GATE pull-up current provided by the ideal diode controller ($20\mu A$) and C_{GATE} is a combination of M2B's C_{RSS} ($0.6nF$) and the external CGB ($10nF$). GATEB ramp rate calculates to $1.9V/ms$, yielding $190mA$ inrush current per $100\mu F$ of output capacitance.

DEMO MANUAL DC2969A

BOARD DESCRIPTION

D1 to D3 – Input and Output TVS

D2B and D3B clamping voltages are chosen to accommodate normal operating voltage on the input and output while limiting any voltage transients below the controller's and MOSFET's absolute maximum ratings. D1, D2A, and D3A are not installed.

JP1 – Enable/Off Control

This jumper controls whether the MOSFET channel is forced off or the ideal diode control is enabled (see Table 1). Enabled doesn't imply MOSFET turn-on since that depends on VIN to VOUT differential voltage being above the controller's 30mV turn-on threshold. Note that when M1A is forced off, there is still a parallel current path through its inherent body diode. To avoid M1A damage, do not pass more than 2A through its body diode.

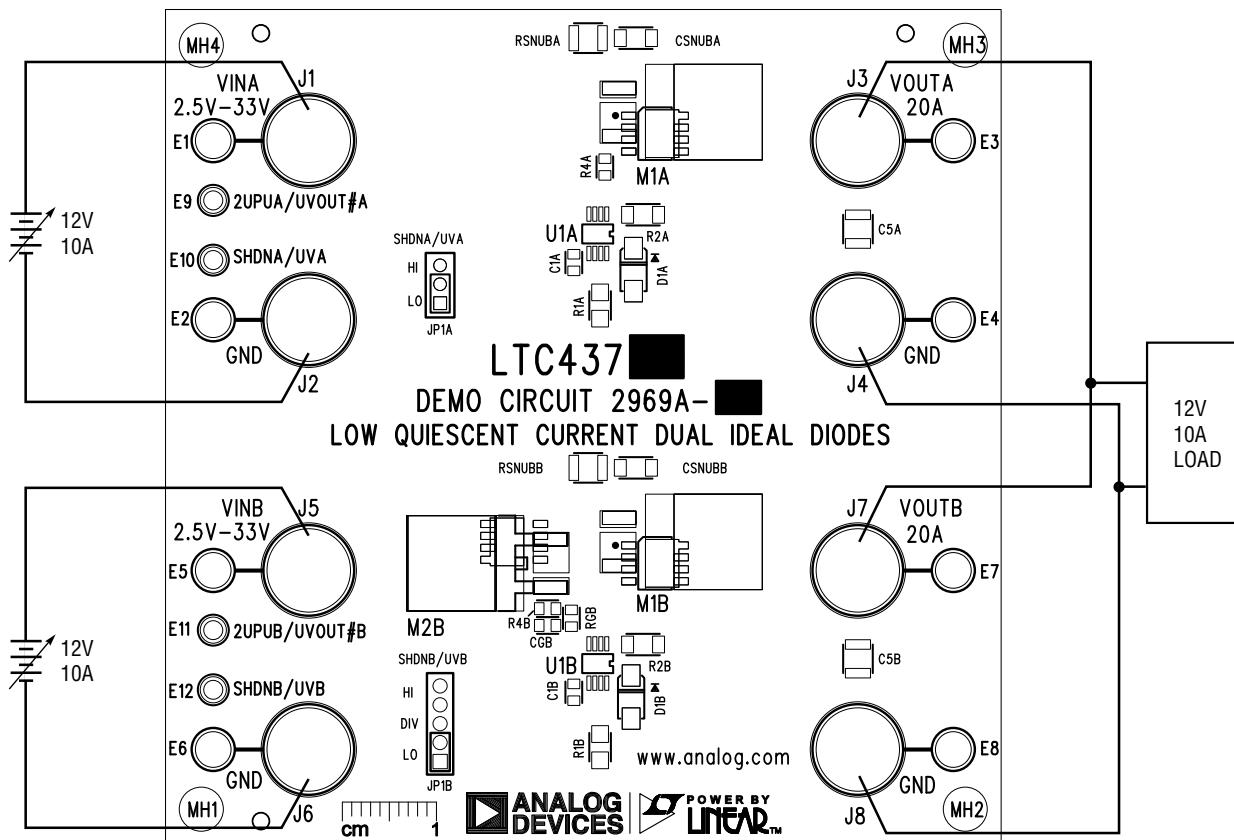
Table 1. Jumper Setting

Jumper Position	DC2969A-A (LTC4372 SHDN)	DC2969A-B (LTC4373 UV)
JP1A = HI = LO	M1A Off	M1A Enabled
	M1A Enabled	M1A Off
JP1B = HI = DIV = LO	M1B & M2B Off	M1B & M2B Enabled
	Floats SHDN!	VINB 2.5V/3V UV
	M1B & M2B Enabled	M1B & M2B Off

Optional Components

Pads for optional (or uninstalled) components have been provided on the board to try out other circuits from the controller datasheet.

SCHEMATIC DIAGRAM



DEMO MANUAL DC2969A



ESD Caution

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

Legal Terms and Conditions

By using the evaluation board discussed herein (together with any tools, components documentation or support materials, the "Evaluation Board"), you are agreeing to be bound by the terms and conditions set forth below ("Agreement") unless you have purchased the Evaluation Board, in which case the Analog Devices Standard Terms and Conditions of Sale shall govern. Do not use the Evaluation Board until you have read and agreed to the Agreement. Your use of the Evaluation Board shall signify your acceptance of the Agreement. This Agreement is made by and between you ("Customer") and Analog Devices, Inc. ("ADI"), with its principal place of business at One Technology Way, Norwood, MA 02062, USA. Subject to the terms and conditions of the Agreement, ADI hereby grants to Customer a free, limited, personal, temporary, non-exclusive, non-sublicensable, non-transferable license to use the Evaluation Board FOR EVALUATION PURPOSES ONLY. Customer understands and agrees that the Evaluation Board is provided for the sole and exclusive purpose referenced above, and agrees not to use the Evaluation Board for any other purpose. Furthermore, the license granted is expressly made subject to the following additional limitations: Customer shall not (i) rent, lease, display, sell, transfer, assign, sublicense, or distribute the Evaluation Board; and (ii) permit any Third Party to access the Evaluation Board. As used herein, the term "Third Party" includes any entity other than ADI, Customer, their employees, affiliates and in-house consultants. The Evaluation Board is NOT sold to Customer; all rights not expressly granted herein, including ownership of the Evaluation Board, are reserved by ADI. CONFIDENTIALITY. This Agreement and the Evaluation Board shall all be considered the confidential and proprietary information of ADI. Customer may not disclose or transfer any portion of the Evaluation Board to any other party for any reason. Upon discontinuation of use of the Evaluation Board or termination of this Agreement, Customer agrees to promptly return the Evaluation Board to ADI. ADDITIONAL RESTRICTIONS. Customer may not disassemble, decompile or reverse engineer chips on the Evaluation Board. Customer shall inform ADI of any occurred damages or any modifications or alterations it makes to the Evaluation Board, including but not limited to soldering or any other activity that affects the material content of the Evaluation Board. Modifications to the Evaluation Board must comply with applicable law, including but not limited to the RoHS Directive. TERMINATION. ADI may terminate this Agreement at any time upon giving written notice to Customer. Customer agrees to return to ADI the Evaluation Board at that time. LIMITATION OF LIABILITY. THE EVALUATION BOARD PROVIDED HEREUNDER IS PROVIDED "AS IS" AND ADI MAKES NO WARRANTIES OR REPRESENTATIONS OF ANY KIND WITH RESPECT TO IT. ADI SPECIFICALLY DISCLAIMS ANY REPRESENTATIONS, ENDORSEMENTS, GUARANTEES, OR WARRANTIES, EXPRESS OR IMPLIED, RELATED TO THE EVALUATION BOARD INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY, TITLE, FITNESS FOR A PARTICULAR PURPOSE OR NONINFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS. IN NO EVENT WILL ADI AND ITS LICENSORS BE LIABLE FOR ANY INCIDENTAL, SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES RESULTING FROM CUSTOMER'S POSSESSION OR USE OF THE EVALUATION BOARD, INCLUDING BUT NOT LIMITED TO LOST PROFITS, DELAY COSTS, LABOR COSTS OR LOSS OF GOODWILL. ADI'S TOTAL LIABILITY FROM ANY AND ALL CAUSES SHALL BE LIMITED TO THE AMOUNT OF ONE HUNDRED US DOLLARS (\$100.00). EXPORT. Customer agrees that it will not directly or indirectly export the Evaluation Board to another country, and that it will comply with all applicable United States federal laws and regulations relating to exports. GOVERNING LAW. This Agreement shall be governed by and construed in accordance with the substantive laws of the Commonwealth of Massachusetts (excluding conflict of law rules). Any legal action regarding this Agreement will be heard in the state or federal courts having jurisdiction in Suffolk County, Massachusetts, and Customer hereby submits to the personal jurisdiction and venue of such courts. The United Nations Convention on Contracts for the International Sale of Goods shall not apply to this Agreement and is expressly disclaimed.

Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

[Analog Devices Inc.:](#)

[DC2969A-A](#) [DC2969A-B](#)