LM66100 5.5-V, 1.5-A, 79-mΩ, Low IQ ideal diode with input polarity protection

1 Features

- Wide operating voltage range: 1.5 V – 5.5 V
- Reverse voltage standoff on VIN: –6-V absolute maximum
- Maximum continuous current (I_{MAX}): 1.5 A
- On-Resistance (R_{ON}):
  - 5-V V_{IN} = 79-mΩ (typical)
  - 3.3-V V_{IN} = 91-mΩ (typical)
  - 1.8-V V_{IN} = 159-mΩ (typical)
- Comparator chip enable ($\overline{CE}$)
- Channel status indication (ST)
- Low current consumption:
  - Shutdown current ($I_{SD,VIN}$): 120-nA (typical)
  - Quiescent current ($I_{Q,\ VIN}$): 150-nA (typical)

2 Applications

- Smart meters
- Building automation
- GPS and tracking
- Primary and backup batteries

3 Description

The LM66100 is a Single-Input, Single-Output (SISO) integrated ideal diode that is well suited for a variety of applications. The device contains a P-channel MOSFET that can operate over an input voltage range of 1.5 V to 5.5 V and can support a maximum continuous current of 1.5 A.

The chip enable works by comparing the $\overline{CE}$ pin voltage to the input voltage. When the $\overline{CE}$ pin voltage is higher than VIN, the device is disabled and the MOSFET is off. When the $\overline{CE}$ pin voltage is lower, the MOSFET is on. The LM66100 also comes with reverse voltage protection (RVP) that can protect the device from a miswired input, such as a reversed battery.

Two LM66100 devices can be used in an ORing configuration similar to a dual diode ORing implementation. These devices can compare input and output voltages to make sure that reverse current is blocked through an internal voltage comparator.

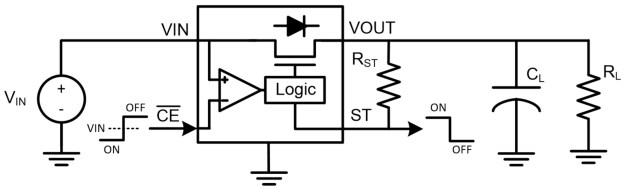
The LM66100 is available in a standard SC-70 package characterized for operation over a temperature range of –40°C to 125°C.

Device Information(1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
LM66100DCK	SC-70 (6)	2.1 mm x 2.0 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

Typical Application



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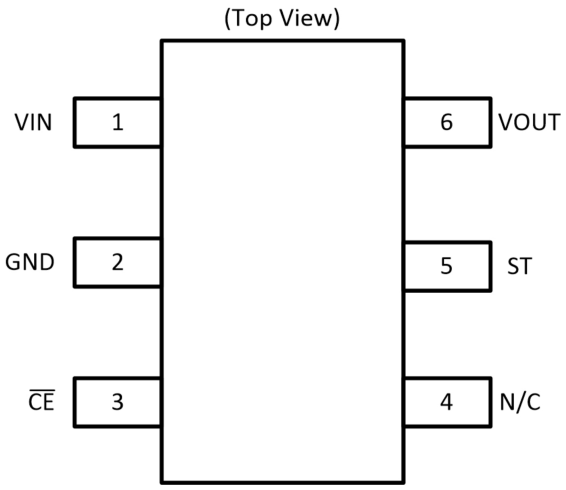
4 Revision History

DATE	REVISION	NOTES
March 2019	*	Initial release.

5 Pin Configuration and Functions

DCK Package
6 Pin SC-70
Top View



Pin Functions

PIN		I/O	DESCRIPTION
NO.	NAME		
1	VIN	I	Device input
2	GND	-	Device ground
3	$\overline{CE}$	I	Active-low chip enable. Can be connected to VOUT for reverse current protection. Do not leave floating.
4	N/C	-	Not internally connected, can be tied to GND or left floating.
5	ST	O	Active-low open-drain output, pulled low when the chip is disabled. Hi-Z when the chip is enabled. Connect to GND if not required.
6	VOUT	O	Device output

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6 Specifications

6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)

		MIN	MAX	UNIT
V_{IN}	Maximum Input Voltage Range	–6	6	V
V_{OUT}	Maximum Output Voltage Range	–0.3	6	V
$I_{SW, MAX}$	Maximum Continuous Switch Current		1.5	A
$I_{SW, PLS}$	Maximum Pulsed Switch Current (≤1 ms, 2% Duty Cycle)		2.5	A
$I_{D, PLS}$	Maximum Pulsed Body Diode Current (≤0.1 ms, 0.2% Duty Cycle)		2.5	A
$I_{\overline{CE}}$	Maximum $\overline{CE}$ Pin Current	–1		mA
I_{ST}	Maximum ST Pin Current	–1	1	mA
T_J	Junction temperature	–40	125	°C
T_{STG}	Storage temperature	–65	150	°C
T_{LEAD}	Maximum Lead Temperature (10 s soldering time)		300	°C

(1) Stresses beyond those listed under *Absolute Maximum Rating* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Condition*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, allpins(1)	±2000	V
		Charged device model (CDM), per JEDEC specificationJESD22-C101, all pins(2)	±500	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process. Manufacturing with less is possible with the necessary precautions. Pins listed may actually have higher performance.

6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

		MIN	TYP	MAX	UNIT
V_{IN}	Input Voltage Range	1.5		5.5	V
V_{OUT}	Output Voltage Range	1		5.5	V
$V_{\overline{CE}}$	$\overline{CE}$ Pin Voltage Range	0		5.5	V
V_{ST}	ST Pin Voltage Range	0		5.5	V

6.4 Thermal Information

THERMAL METRIC(1)(2)		LM66100 DCK (SC-70) 6 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	200	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	TBD	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	TBD	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	TBD	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	TBD	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	TBD	°C/W

(1) For more information about traditional and new thermal metrics, see the Semiconductor and IC Package Thermal Metrics application report.
(2) Preliminary Estimates Subject to Change

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6.5 Electrical Characteristics

over operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
Input Supply (VIN)								
$I_{SD,VIN}$	VIN Shutdown Current	VOUT = VIN $V\overline{CE}$ > VIN + 80mV I_{OUT} = 0 A (VOUT = open)		25°C		0.12	0.3	µA
				-40°C to 105°C			0.3	µA
$I_{Q,VIN}$	VIN Quiescent Current	VOUT = VIN $V\overline{CE}$ < VIN - 250mV I_{OUT} = 0 A (VOUT = open)		25°C		0.15	0.5	µA
				-40°C to 105°C			0.5	µA
$I_{OUT,\ OFF}$	OUT to IN Leakage Current (Current out of VIN)	VOUT - VIN ≤ 5.5 V $V\overline{CE}$ > VIN + 80mV		25°C		0.2	0.5	µA
				-40°C to 85°C			2.7	µA
				-40°C to 105°C			8	µA
		VOUT - VIN ≤ 4.5 V $V\overline{CE}$ > VIN + 80mV		-40°C to 85°C			1.7	µA
				-40°C to 105°C			5.1	µA
		VOUT - VIN ≤ 1.0 V $V\overline{CE}$ > VIN + 80mV		-40°C to 85°C			0.7	µA
				-40°C to 105°C			2.1	µA
ON-Resistance (RON)								
R_{ON}	ON-State Resistance	IOUT = -200 mA	VIN = 5 V	25°C		79	125	mΩ
				-40°C to 85°C			150	
				-40°C to 125°C			200	
R_{ON}	ON-State Resistance	IOUT = -200 mA	VIN = 3.6 V	25°C		91	150	mΩ
				-40°C to 85°C			200	
				-40°C to 125°C			250	
R_{ON}	ON-State Resistance	IOUT = -200 mA	VIN = 1.8 V	25°C		159	200	mΩ
				-40°C to 85°C			250	
				-40°C to 125°C			300	
Comparator Chip Enable (CE)								
V_{ON}	Turn ON Threshold	$V\overline{CE}$ - VIN		-40°C to 125°C	–250	–150	–80	mV
V_{OFF}	Turn OFF Threshold	$V\overline{CE}$ - VIN		-40°C to 125°C	0	35	80	mV
$I_{\overline{CE}}$	$\overline{CE}$ Pin Leakage Current	$V\overline{CE}$ > VIN + 80mV		-40°C to 125°C	0	400	650	nA
Reverse Current Blocking (RCB) and Body Diode Characteristics								
I_{RCB}	Reverse Activation Current	$V\overline{CE}$ = VOUT		-40°C to 125°C		0.5	1	A
V_{FWD}	Body Diode Forward Voltage	I_{OUT} = 10 mA $V\overline{CE}$ > VIN + 80mV		-40°C to 125°C	0.1	0.5	1.1	V
Status Indication (ST)								
$V_{OL,\ ST}$	Output Low Voltage	IST = 1 mA		-40°C to 125°C			0.2	V
t_{ST}	Status Delay Time	$V\overline{CE}$ transitions from low to high		-40°C to 125°C		1		µs
I_{ST}	ST Pin Leakage Current	$V\overline{CE}$ < VIN - 250mV		-40°C to 125°C	–100		100	nA

6.6 Switching Characteristics

Unless otherwise noted, the typical characteristics in the following table applies over the entire recommended operating voltage at an ambient temperature of 25°C and a load of C_L = 1 µF and R_L = 1kΩ

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{ON}	Turn ON Time	VIN = 1.5 V		120		µs
		VIN = 3.3 V		50		µs
		VIN = 5 V		30		µs
t_{OFF}	Turn OFF Time	VIN = 1.5 V		7		µs
		VIN = 3.3 V		9		µs
		VIN = 5 V		5		µs

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Switching Characteristics (continued)

Unless otherwise noted, the typical characteristics in the following table applies over the entire recommended operating voltage at an ambient temperature of 25°C and a load of C_L = 1 µF and R_L = 1kΩ

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{FALL}	Output Fall Time (1)	VIN = 1.5 V		220		µs
		VIN = 3.3 V		95		µs
		VIN = 5 V		65		µs

(1) See the *Timing Application* section for information on how R_L and $_L$ affect Fall Time.

7 Parameter Measurement Information

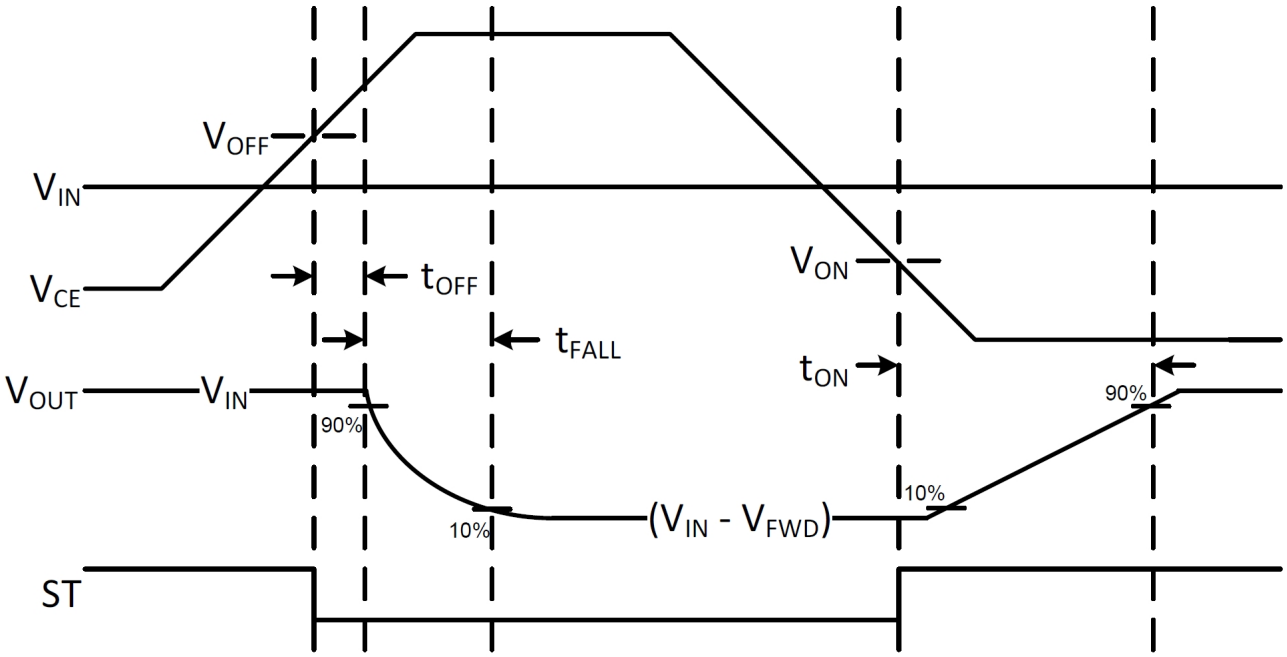

Figure 2. Timing Diagram

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8 Detailed Description

8.1 Overview

The LM66100 is a Single-Input, Single-Output (SISO) integrated ideal diode that is well suited for a variety of applications. The device contains a P-channel MOSFET that can operate over an input voltage range of 1.5 V to 5.5 V and can support a maximum continuous current of 1.5 A.

The chip enable works by comparing the $\overline{CE}$ pin voltage to the input voltage. When the $\overline{CE}$ pin voltage is higher than VIN, the device is disabled and the MOSFET is off. When the $\overline{CE}$ pin voltage is lower, the MOSFET is on. The LM66100 also comes with reverse voltage protection (RVP) that can protect the device from a miswired input, such as a reversed battery.

8.2 Functional Block Diagram

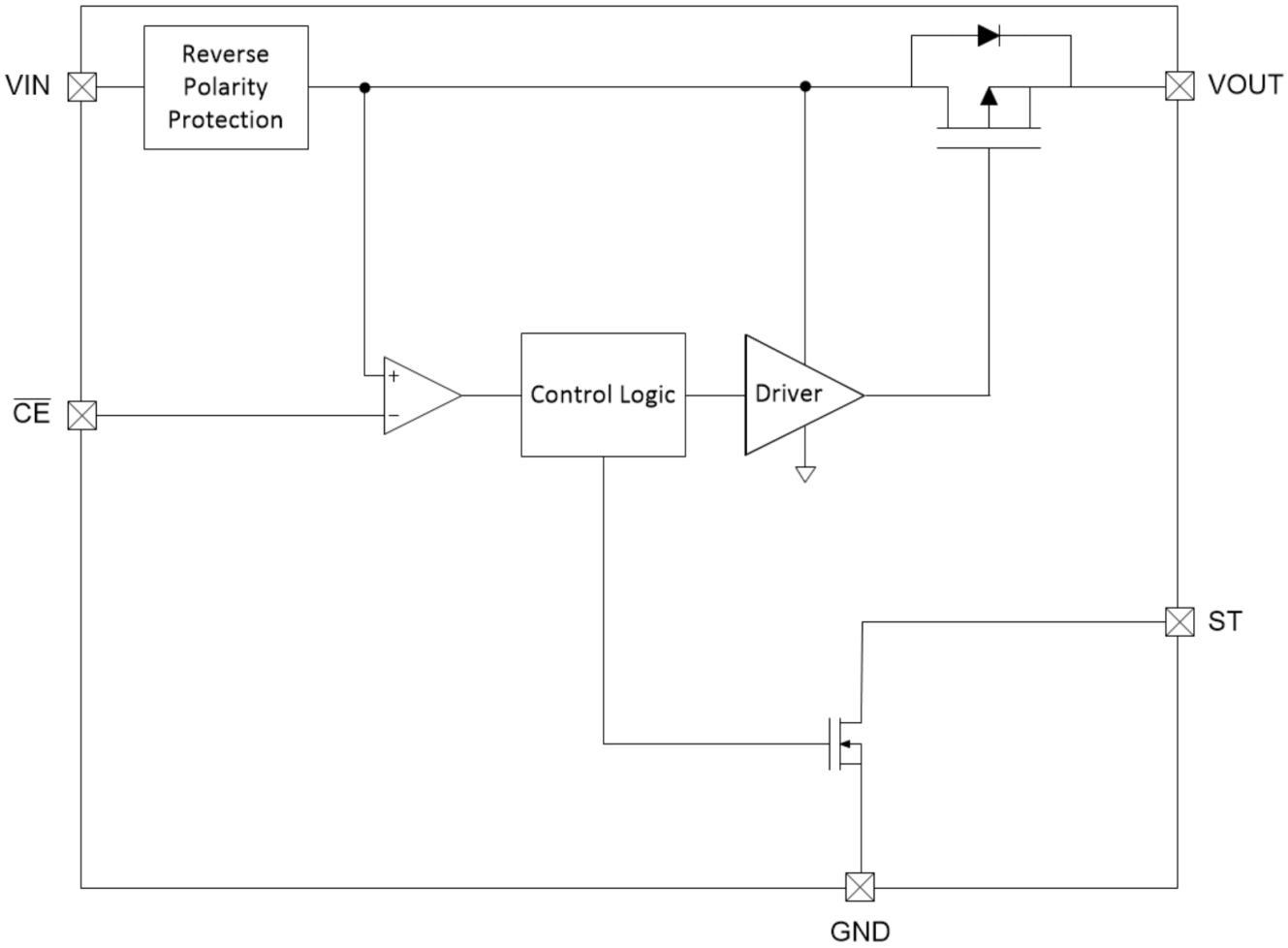

Figure 3. LM66100 Block Diagram

8.3 Feature Description

8.3.1 Reverse Polarity Protection (RPP)

In the event a negative input voltage is applied, the ideal diode will stay off and prevent current flow to protect the system load. For a stand-alone, always on application, $\overline{CE}$ can be tied to GND so it will not go negative with respect to GND see Figure 4.

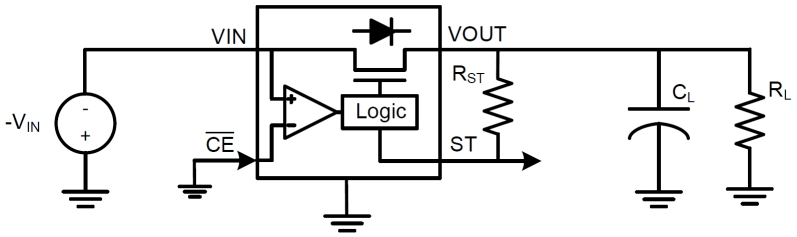

Figure 4. RPP Protection Circuit

8.3.2 Always-ON Reverse Current Blocking (RCB)

By connecting the $\overline{CE}$ pin to VOUT, this allows the comparator to detect reverse current flow through the switch. If the output is forced above the selected input by V_{OFF}, the channel will switch off to stop the reverse current I_{RCB} within t_{OFF}. Once the output falls to below V_{IN} by V_{ON}, the device will quickly turn back on.

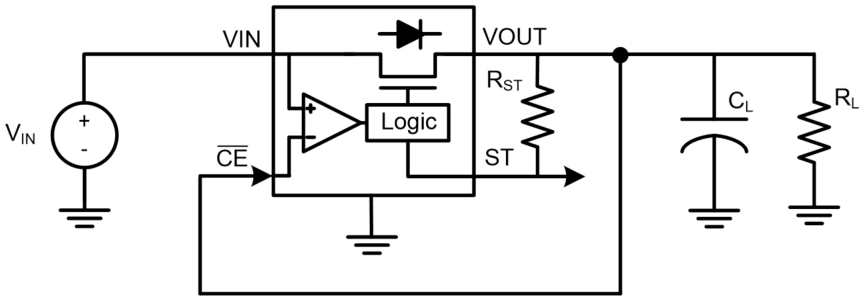

Figure 5. RCB Circuit

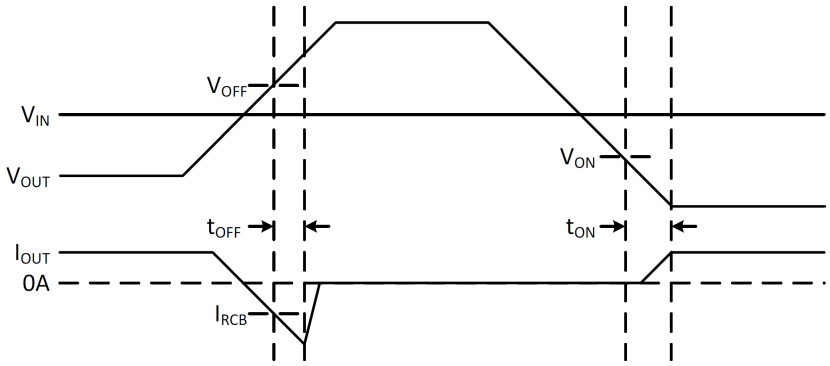

Figure 6. RCB Waveforms

8.4 Device Functional Modes

Table 1 summarizes the Device Functional Modes:

Table 1. Device Functional Modes

State	IN-to-OUT	Power Dissipation	ST State
OFF	Diode	$I_{OUT} \times V_{FWD}$	L
ON	Switch	$I_{OUT2}^2 \times R_{ON}$	H

9 Application and Implementation

NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

9.1 Application Information

The LM66100 Ideal Diode can be used in a variety of stand-alone and multi-channel applications.

9.2 Typical Applications

9.2.1 Dual Ideal Diode ORing

Two LM66100 Ideal Diodes can be used together for ORing between two power supplies.

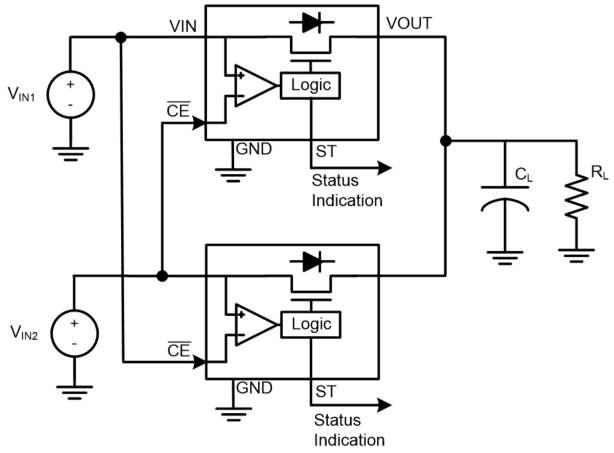

Figure 7. Dual Ideal Diode ORing

9.2.1.1 Design Requirements

Design a circuit that allows the highest input voltage to power a downstream system while providing reverse current protection.

9.2.1.2 Detailed Design Procedure

This circuit ties the $\overline{CE}$ of each device to the opposite power source. In this configuration, the highest supply will always be selected using a make-before-break logic. This prevents any reverse current flow between the supplies and avoids the need of a dedicated reverse current blocking comparator. For ORing applications that need RPP, it is recommended to use a series resistor ($R_{\overline{CE}}$) to limit the current into the $\overline{CE}$ pin during a negative voltage event.

ADVANCE INFORMATION

Typical Applications (continued)

9.2.1.3 Application Curves

The below scope shot shows the output voltage (VOUT) being initially powered by VIN1. When VIN2 is applied, it powers VOUT because it is a higher voltage. When VIN2 is removed, VOUT is once again powered by VIN1.

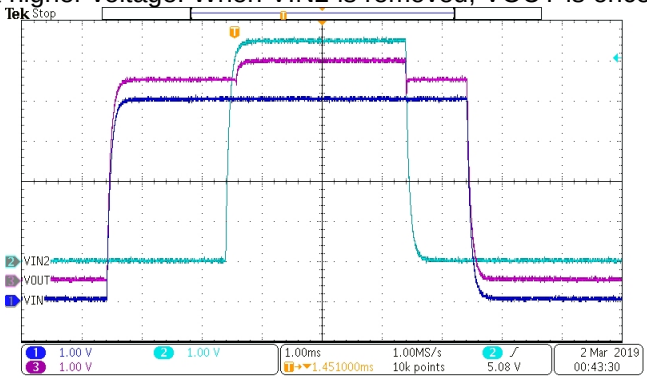

Figure 8. Dual Ideal Diode ORing Behavior

9.2.2 Dual Ideal Diode ORing for Continuous Output Power

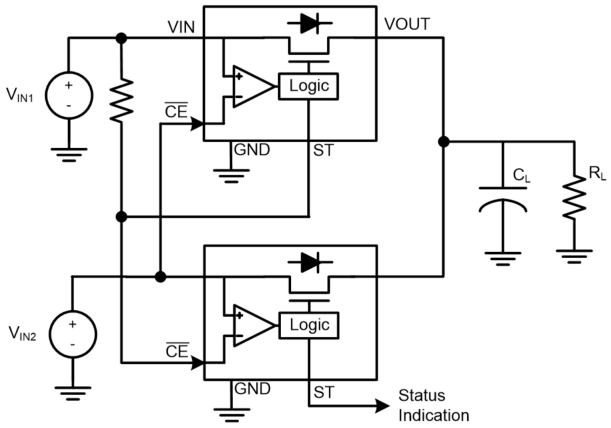

Figure 9. Dual Ideal Diode ORing for Continuous Output Power

9.2.2.1 Design Requirements

The shortcoming of the previous implementation happens when both input voltages are the same for a long period of time, then both devices will completely turn off, powering down the output load. To avoid this case, the status output from the priority supply and a pull up resistor can be used causing both devices to switchover at the same time. For ORing applications that need RPP, it is recommended to use a series resistor ($R_{\overline{CE}}$) to limit the current into the $\overline{CE}$ pin during a negative voltage event.

Figure 10 shows the expected behavior of the above circuit.

ADVANCE INFORMATION

Typical Applications (continued)

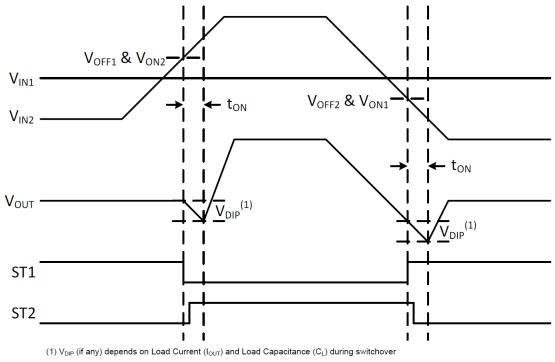

Figure 10. Dual Ideal Diode ORing for Continuous Output Power Behavior

10 Power Supply Recommendations

The device is designed to operate with a VIN range of 1.5 V to 5.5 V. The VIN power supply must be well regulated and placed as close to the device terminal as possible. The power supply must be able to withstand all transient load current steps. In most situations, using an input capacitance (CIN) of 1 μF is sufficient to prevent the supply voltage from dipping when the switch is turned on. In cases where the power supply is slow to respond to a large transient current or large load current step, additional bulk capacitance may be required on the input.

11 Layout

11.1 Layout Guidelines

For best performance, all traces must be as short as possible. To be most effective, the input and output capacitors must be placed close to the device to minimize the effects that parasitic trace inductances may have on normal operation. Using wide traces for VIN, VOUT and GND helps minimizr the parasitic electrical effects.

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11.2 Layout Example

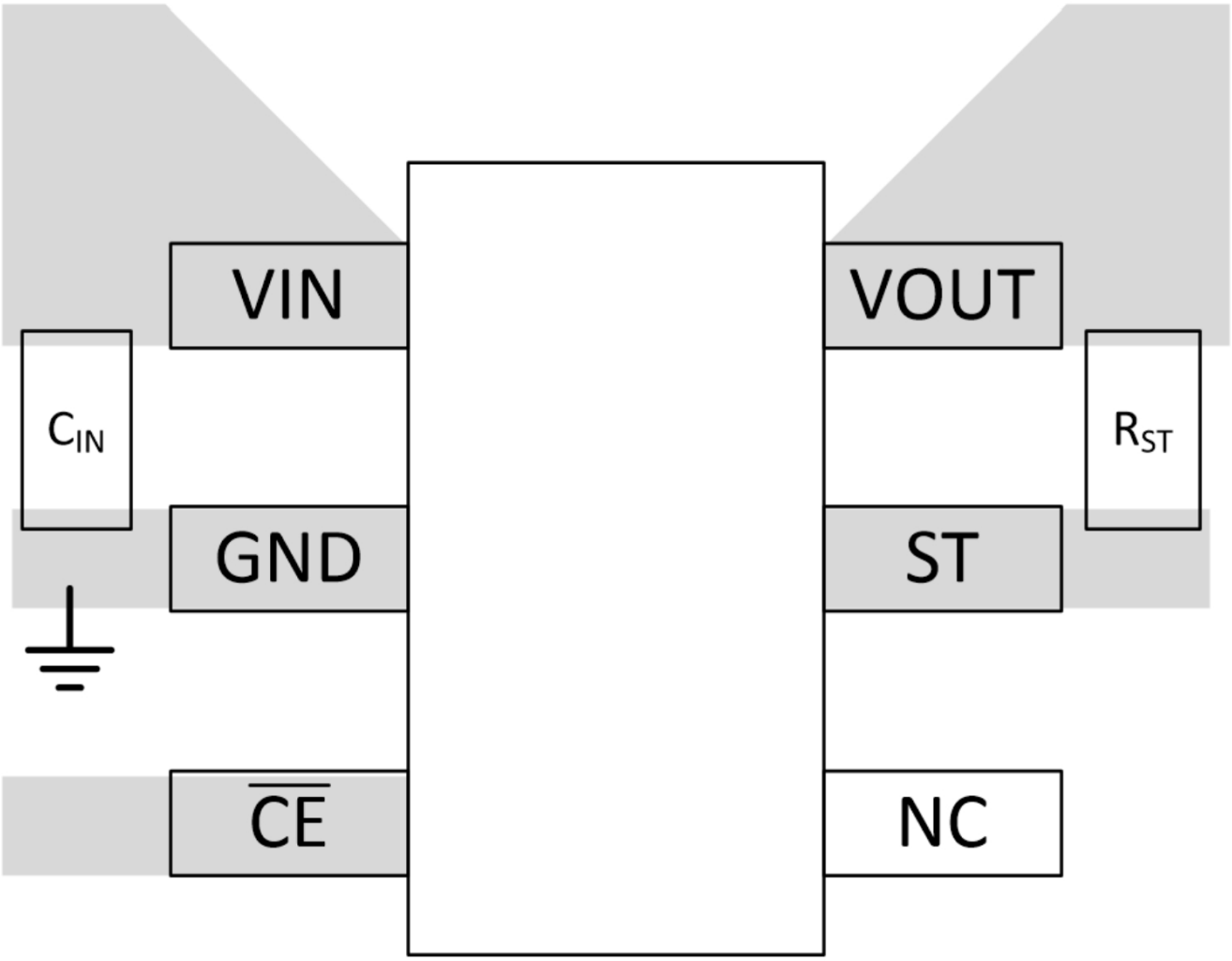


Figure 11. LM66100 Layout Example

12 Device and Documentation Support

12.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

12.2 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

TI E2E™ Online Community ***TI's Engineer-to-Engineer (E2E) Community.*** Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support ***TI's Design Support*** Quickly find helpful E2E forums along with design support tools and contact information for technical support.

12.3 Trademarks

E2E is a trademark of Texas Instruments.

12.4 Electrostatic Discharge Caution

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

12.5 Glossary

SLYZ022 — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

ADVANCE INFORMATION

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM66100DCKR	PREVIEW	SC70	DCK	6	3000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 105	1CU	
LM66100DCKT	PREVIEW	SC70	DCK	6	250	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 105	1CU	
PLM66100DCKR	ACTIVE	SC70	DCK	6	3000	TBD	Call TI	Call TI	-40 to 105		Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

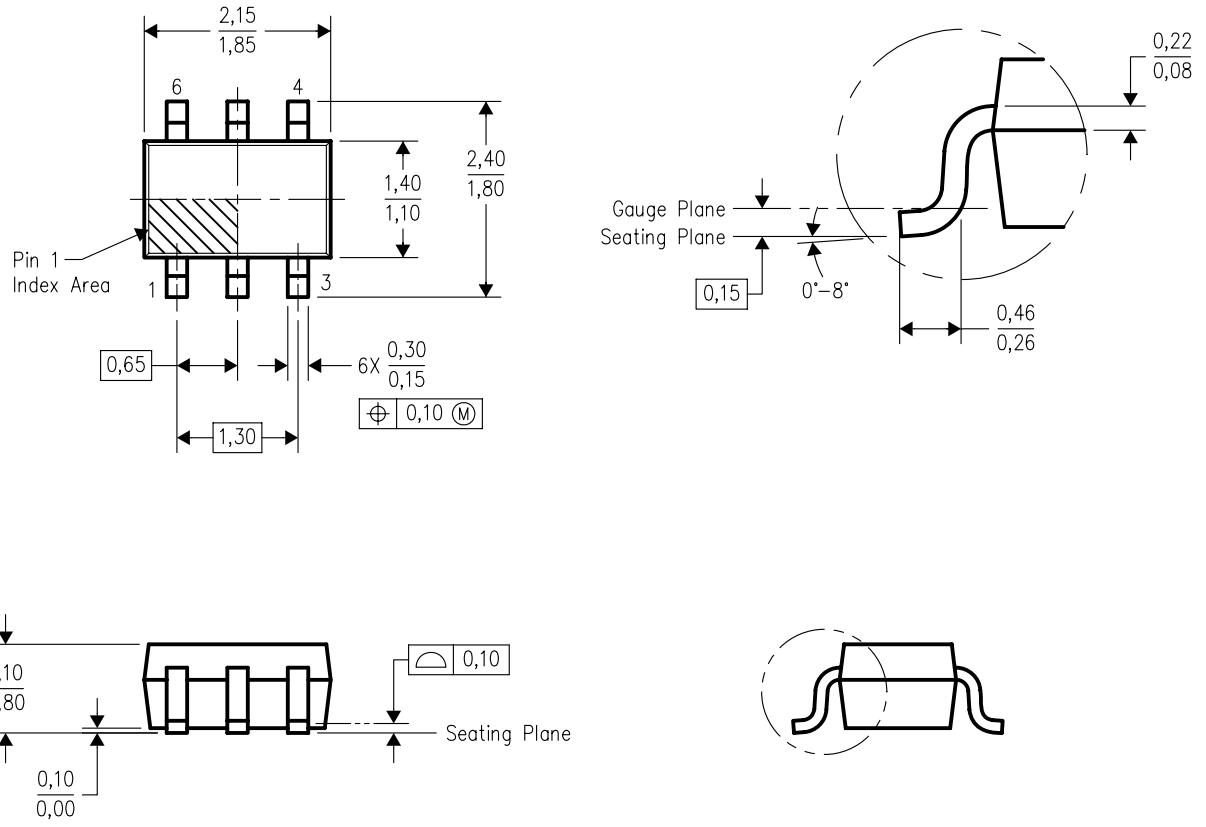
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

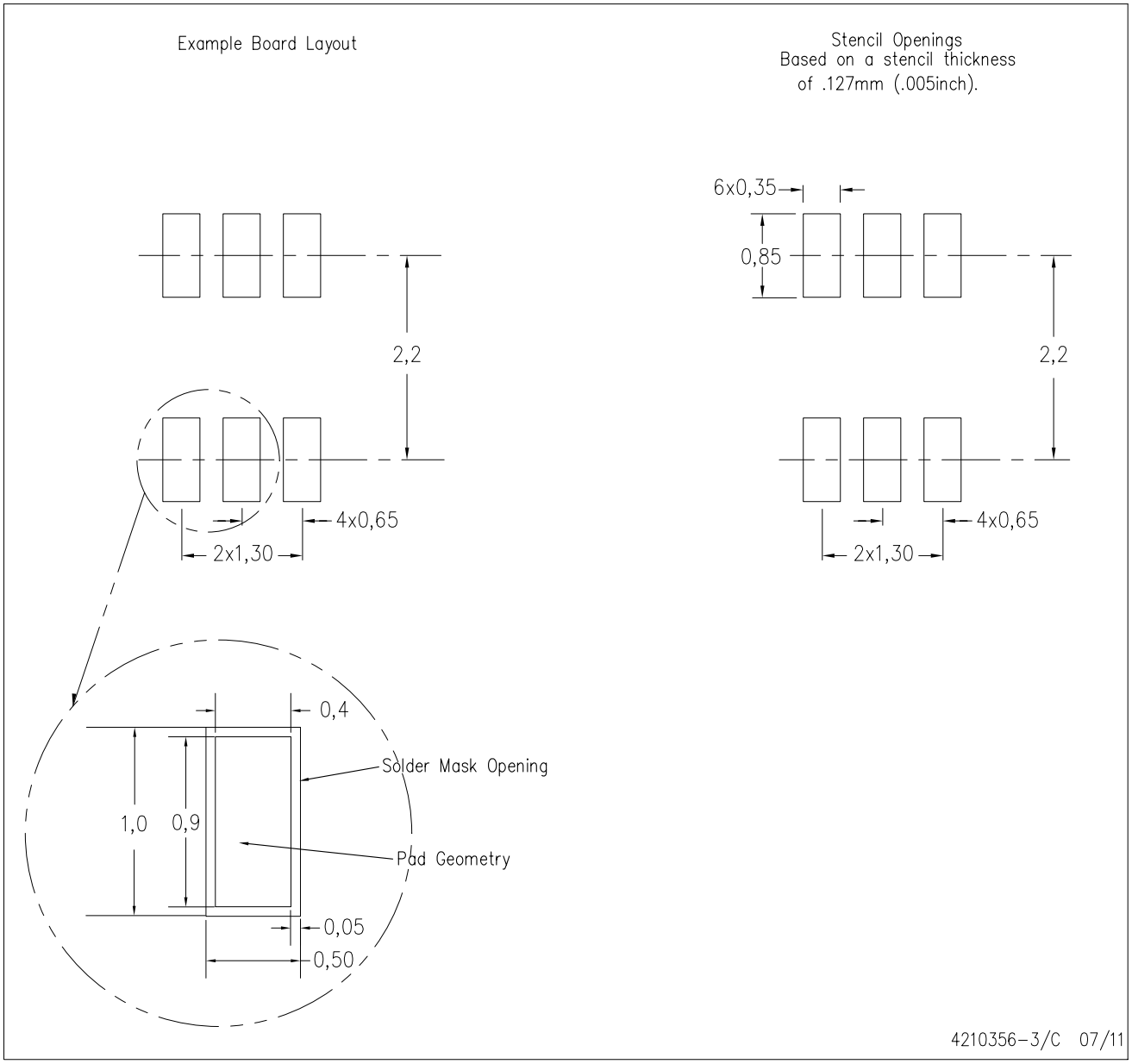
DCK (R–PDSO–G6) PLASTIC SMALL–OUTLINE PACKAGE



4093553–4/G 01/2007

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
D. Falls within JEDEC MO–203 variation AB.

DCK (R–PDSO–G6) PLASTIC SMALL OUTLINE



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
D. Publication IPC–7351 is recommended for alternate designs.
E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC–7525 for other stencil recommendations.

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