**TEXAS INSTRUMENTS**

LM66100-Q1 具有输入极性保护功能的 5.5V、1.5A、79mΩ、汽车类低 IQ 理想二极管

1 特性

- 符合面向汽车应用的 AEC-Q100 标准：
  - 器件温度等级 1：-40°C 至 125°C 环境工作温度范围
- 宽工作电压范围：1.5V 至 5.5V
- VIN 反向关断电压：绝对最大值为 –6V
- 最大持续电流 (I_{MAX})：1.5A
- 导通电阻 (R_{ON})：
  - 5V V_{IN} = 79mΩ（典型值）
  - 3.6V V_{IN} = 91mΩ（典型值）
  - 1.8V V_{IN} = 141mΩ（典型值）
- 启用比较器芯片 ($\overline{CE}$)
- 通道状态指示 (ST)
- 低电流消耗：
  - 3.6V V_{IN} 关断电流 ($I_{SD,VIN}$)：120nA（典型值）
  - 3.6V V_{IN} 静态电流 ($I_{Q, VIN}$)：150nA（典型值）

2 应用

- 信息娱乐系统、仪表组和音响主机
- 汽车仪表组显示器
- ADAS 环视系统 ECU
- 车身控制模块和网关
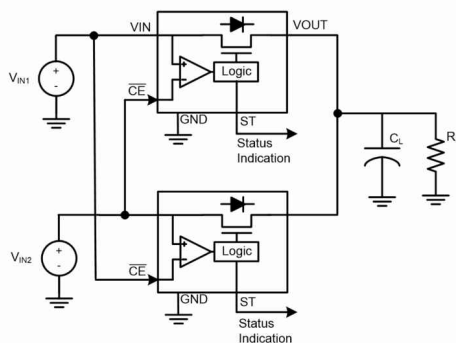
典型应用

3 说明

LM66100-Q1 是一款单输入单输出 (SISO) 集成式理想二极管，是各种应用的理想之选。该器件包含一个可在 1.5V 至 5.5V 输入电压范围内运行的 P 沟道 MOSFET，并且支持 1.5A 的最大持续电流。

该芯片通过比较 $\overline{CE}$ 引脚电压和输入电压来提供支持。当 $\overline{CE}$ 引脚电压高于输入电压时，该器件被禁用并且 MOSFET 关断。当 $\overline{CE}$ 引脚电压比较低时，MOSFET 开启。LM66100-Q1 还具有反极性保护 (RPP) 功能，可保护器件不受输入接线错误的影响，例如电池装反。

可在 ORing 配置中使用两个 LM66100-Q1 器件，其实施方法与双二极管 ORing 相似。在此配置中，该器件将最高输入电压传递到输出端，同时阻断反向电流流入输入电源。这些器件可比较输入和输出电压，从而确保内部电压比较器成功阻断反向电流。

LM66100-Q1 采用标准 SC-70 封装，工作结温范围为 –40°C 至 150°C。

器件信息[1]

器件型号	封装	封装尺寸（标称值）
LM66100-Q1	SC-70 (6)	2.1mm × 2.0mm

(1) 如需了解所有可用封装，请参阅数据表末尾的可订购产品附录。

Table of Contents

4 Revision History

注：以前版本的页码可能与当前版本的页码不同

5 Pin Configuration and Functions

(Top View)

VIN	1		6	VOUT
GND	2		5	ST
$\overline{\text{CE}}$	3		4	N/C
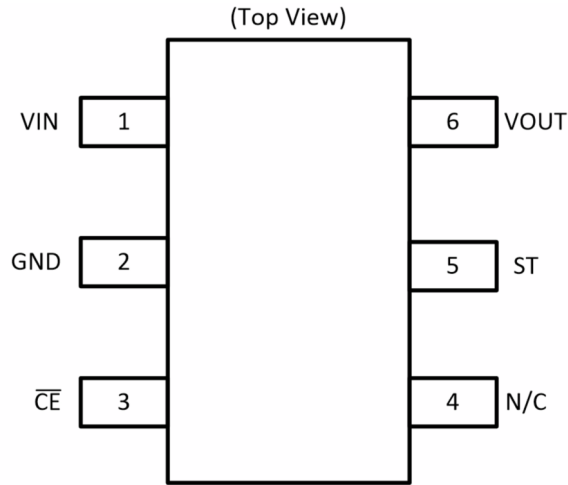
图 5-1. DCK Package 6-Pin SC-70 Top View

表 5-1. Pin Functions

PIN		I/O	DESCRIPTION
NO.	NAME		
1	VIN	I	Device input
2	GND	—	Device ground
3	$\overline{\text{CE}}$	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

Product Folder Links: *LM66100-Q1*

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
$V_{\overline{CE}}$	Maximum $\overline{CE}$ Pin Voltage	-0.3	6	V
V_{ST}	Maximum ST Pin Voltage	-0.3	6	V
$I_{SW, MAX}$	Maximum Continuous Switch Current		1.5	A
$I_{SW, PLS}$	Maximum Pulsed Switch Current ($\leqslant$120 ms, 2% Duty Cycle)		2.5	A
$I_{D, PLS}$	Maximum Pulsed Body Diode Current ($\leqslant$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		mA
T_J	Junction temperature	-40	150	°C
T_{STG}	Storage temperature	-65	150	°C
T_{LEAD}	Maximum Lead Temperature (10 s soldering time)		300	°C

(1) Operation outside the Absolute Maximum Ratings may cause permanent device damage. Absolute Maximum Ratings do not imply functional operation of the device at these or any other conditions beyond those listed under Recommended Operating Conditions. If used outside the Recommended Operating Conditions but within the Absolute Maximum Ratings, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per AEC Q100-002[1] HBM ESD classification level 2	±2000	V
		Charged device model (CDM), per AEC Q100-011 CDM ESD classification level C4A	±500	

(1) AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

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

		LM66100	UNIT
	THERMAL METRIC[1]	DCK (SC-70)	
		6 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	192	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	124	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	52	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	34	°C/W

THERMAL METRIC[1]		LM66100	UNIT
		DCK (SC-70)	
		6 PINS	
Ψ_{JB}	Junction-to-board characterization parameter	52	°C/W

(1) For more information about traditional and new thermal metrics, see the Semiconductor and IC Package Thermal Metrics application report.

6.5 Electrical Characteristics

Typical values are at 25°C with an input voltage of 3.6V. Maximum and minimum values are across the entire operating voltage range, from 1.5V to 5.5V. (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
Input Supply (VIN)								
$I_{SD,VIN}$	VIN Shutdown Current	VOUT = VIN $\overline{VCE}$ > VIN + 80 mV I_{OUT} = 0 A (VOUT = open)		25°C		0.12	0.3	µA
				−40°C to 125°C			0.3	µA
$I_{Q,VIN}$	VIN Quiescent Current	VOUT = VIN $\overline{VCE}$ < VIN − 250 mV I_{OUT} = 0 A (VOUT = open)		25°C		0.15	0.3	µA
				−40°C to 125°C			0.3	µA
$I_{OUT, OFF}$	OUT to IN Leakage Current (Current out of VIN)	VOUT − VIN ⩽ 5.5 V $\overline{VCE}$ > VIN + 80 mV		25°C		0.2	0.5	µA
				−40°C to 85°C			2.7	µA
				−40°C to 125°C			8	µA
		VOUT − VIN ⩽ 4.5 V $\overline{VCE}$ > VIN + 80 mV		−40°C to 85°C			1.7	µA
				−40°C to 125°C			5.1	µA
		VOUT − VIN ⩽ 1.0 V $\overline{VCE}$ > VIN + 80 mV		−40°C to 85°C			0.7	µA
				−40°C to 125°C			2.1	µA
ON-Resistance (RON)								
R_{ON}	ON-State Resistance	I_{OUT} = −200 mA	VIN = 5 V	25°C		79	95	mΩ
				−40°C to 85°C			110	
				−40°C to 125°C			120	
R_{ON}	ON-State Resistance	I_{OUT} = −200 mA	VIN = 3.6 V	25°C		91	110	mΩ
				−40°C to 85°C			125	
				−40°C to 125°C			140	
R_{ON}	ON-State Resistance	I_{OUT} = −200 mA	VIN = 1.8 V	25°C		141	180	mΩ
				−40°C to 85°C			210	
				−40°C to 125°C			230	
Comparator Chip Enable (CE)								
V_{ON}	Turn ON Threshold	$\overline{VCE}$ − VIN		−40°C to 125°C	−250	−150	−80	mV
V_{OFF}	Turn OFF Threshold	$\overline{VCE}$ − VIN		−40°C to 125°C	0	35	80	mV
$I_{\overline{CE}}$	$\overline{CE}$ Pin Leakage Current	VCE < VIN − 250 mV		−40°C to 125°C	0	160	300	nA
$I_{\overline{CE}}$	$\overline{CE}$ Pin Leakage Current	$\overline{VCE}$ > VIN + 80 mV		−40°C to 125°C	0	400	610	nA
Reverse Current Blocking (RCB) and Body Diode Characteristics								
I_{RCB}	Reverse Activation Current	$\overline{VCE}$ = VOUT		−40°C to 125°C		0.5	1	A
V_{FWD}	Body Diode Forward Voltage	I_{OUT} = 10 mA $\overline{VCE}$ > VIN + 80 mV		−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			0.1	V

Product Folder Links: LM66100-Q1

6.5 Electrical Characteristics (continued)

Typical values are at 25°C with an input voltage of 3.6V. Maximum and minimum values are across the entire operating voltage range, from 1.5V to 5.5V. (unless otherwise noted)

	PARAMETER	TEST CONDITIONS		MIN	TYP	MAX	UNIT
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 – 250 mV	–40°C to 125°C	–20		20	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 = 100 nF and R_L = 1 kΩ

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{ON}	Turn ON Time	VIN = 1.8 V		90		µs
		VIN = 3.6 V		40		µs
		VIN = 5 V		27		µs
t_{OFF}	Turn OFF Time	VIN = 1.8 V		2		µs
		VIN = 3.6 V		2		µs
		VIN = 5 V		2		µs
t_{FALL}	Output Fall Time	VIN = 1.8 V		20		µs
		VIN = 3.6 V		10		µs
		VIN = 5 V		7.5		µs

Product Folder Links: *LM66100-Q1*

6.7 Typical Characteristics
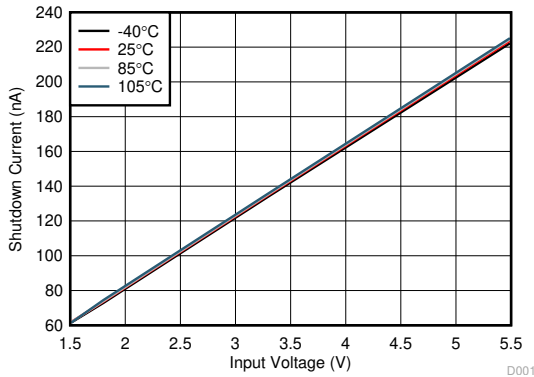
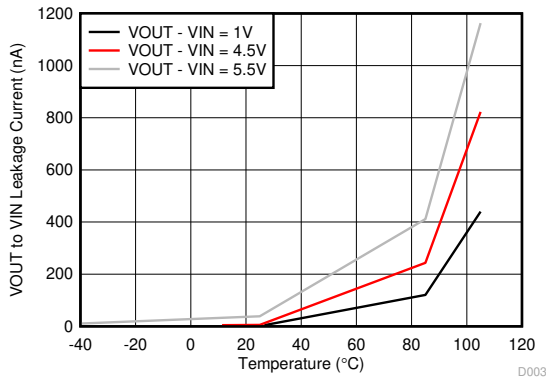$V_{\overline{CE}} > V_{IN}$

图 6-1. Shutdown Current vs Input Voltage
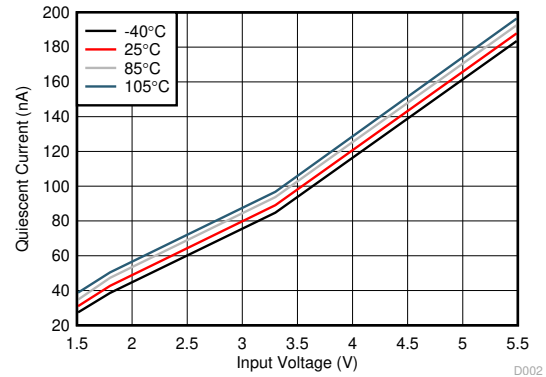
$V_{\overline{CE}} < V_{IN}$
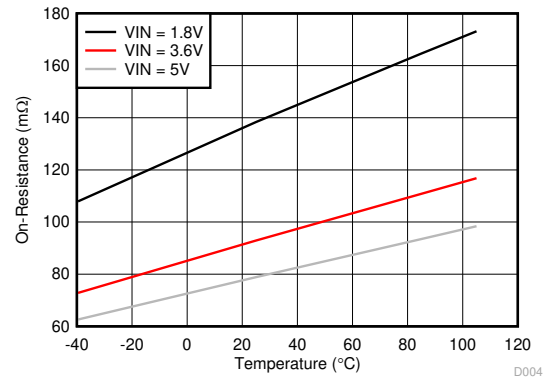
图 6-2. Quiescent Current vs Input Voltage

$V_{\overline{CE}} > V_{IN}$

图 6-3. Reverse Leakage Current vs Junction Temperature

$V_{\overline{CE}} < V_{IN}$ $I_{OUT} = 200\ mA$
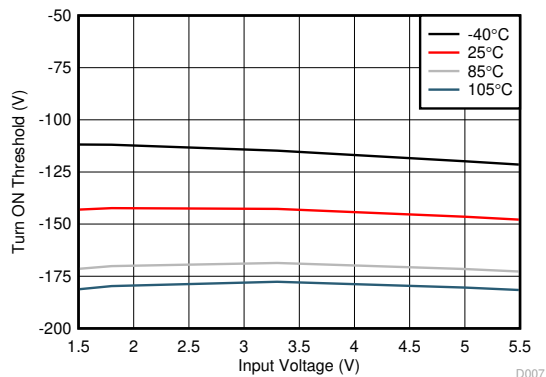
图 6-4. On-Resistance vs Junction Temperature
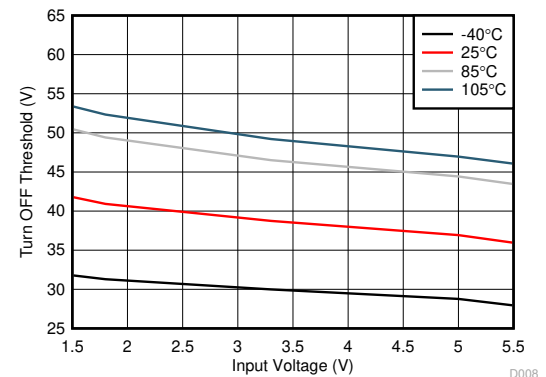
图 6-5. Turn ON Threshold vs Input Voltage

图 6-6. Turn OFF Threshold vs Input Voltage
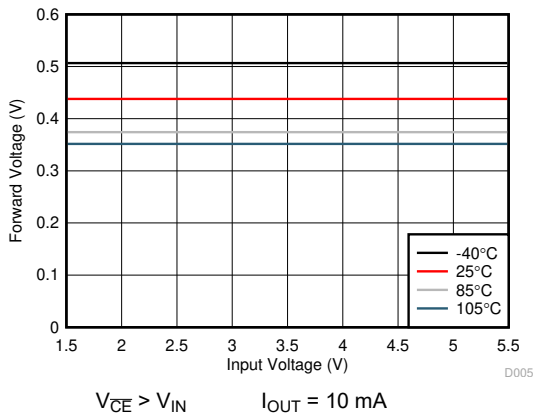
6.7 Typical Characteristics (continued)

$V_{\overline{CE}} > V_{IN}$ I_{OUT} = 10 mA

图 6-7. Body Diode Forward Voltage vs Input Voltage

C_L = 100 nF R_L = 1 kΩ
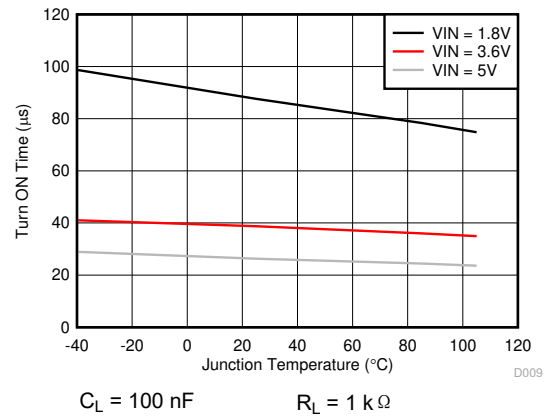
图 6-8. Turn ON Time vs Junction Temperature

C_L = 100nF R_L = 1 kΩ V_{IN} = 1.8 V to 5 V
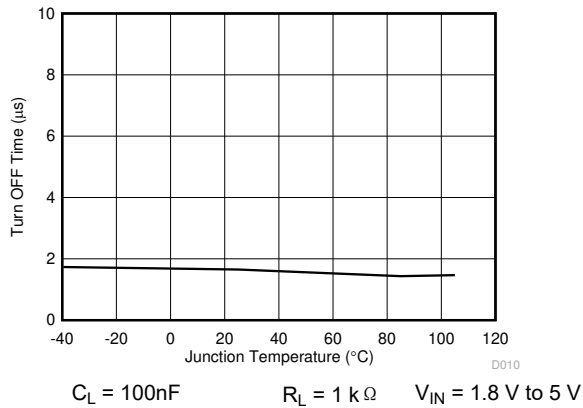
图 6-9. Turn OFF Time vs Junction Temperature

C_L = 100 nF R_L = 1 kΩ
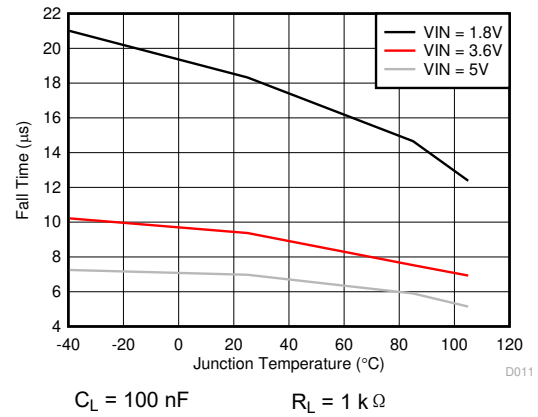
图 6-10. Fall Time vs Junction Temperature

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Product Folder Links: *LM66100-Q1*
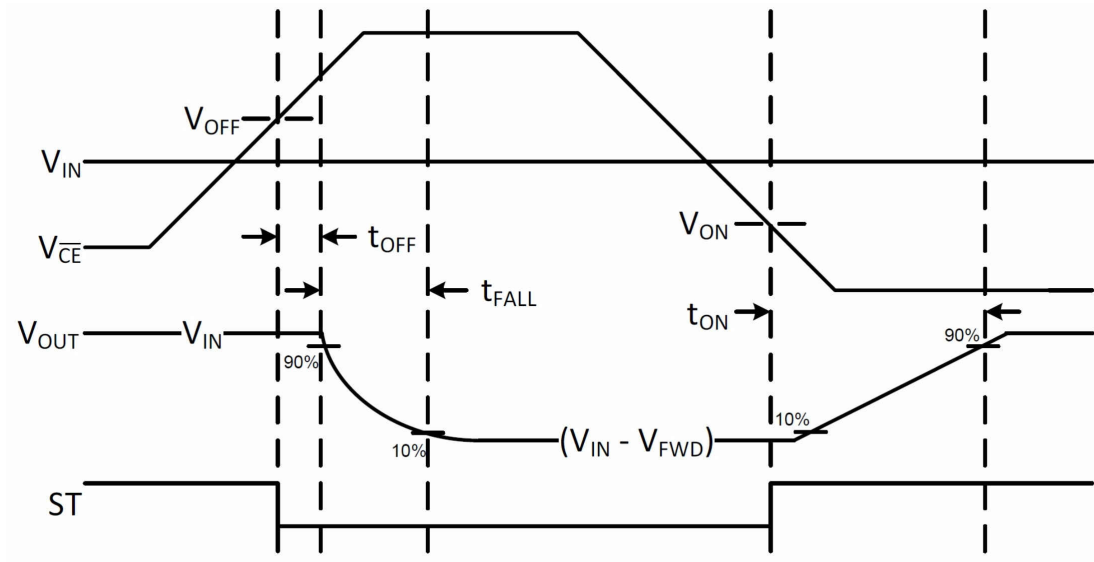
7 Parameter Measurement Information


图 **7-1. Timing Diagram**

8 Detailed Description

8.1 Overview

The LM66100-Q1 is a Single-Input, Single-Output (SISO) integrated ideal diode that contains a P-channel MOSFET to minimize the voltage drop from input to output. The LM66100-Q1 can operate over an input voltage range of 1.5 V to 5.5 V and 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 by 80 mV, the device is disabled and the MOSFET is off. When the $\overline{CE}$ pin voltage is lower than V_{IN} by 250 mV, the MOSFET is on. The LM66100-Q1 also comes with reverse polarity protection (RPP) that protects against events where the VIN and GND terminals are swapped.

8.2 Functional Block Diagram

Product Folder Links: *LM66100-Q1*
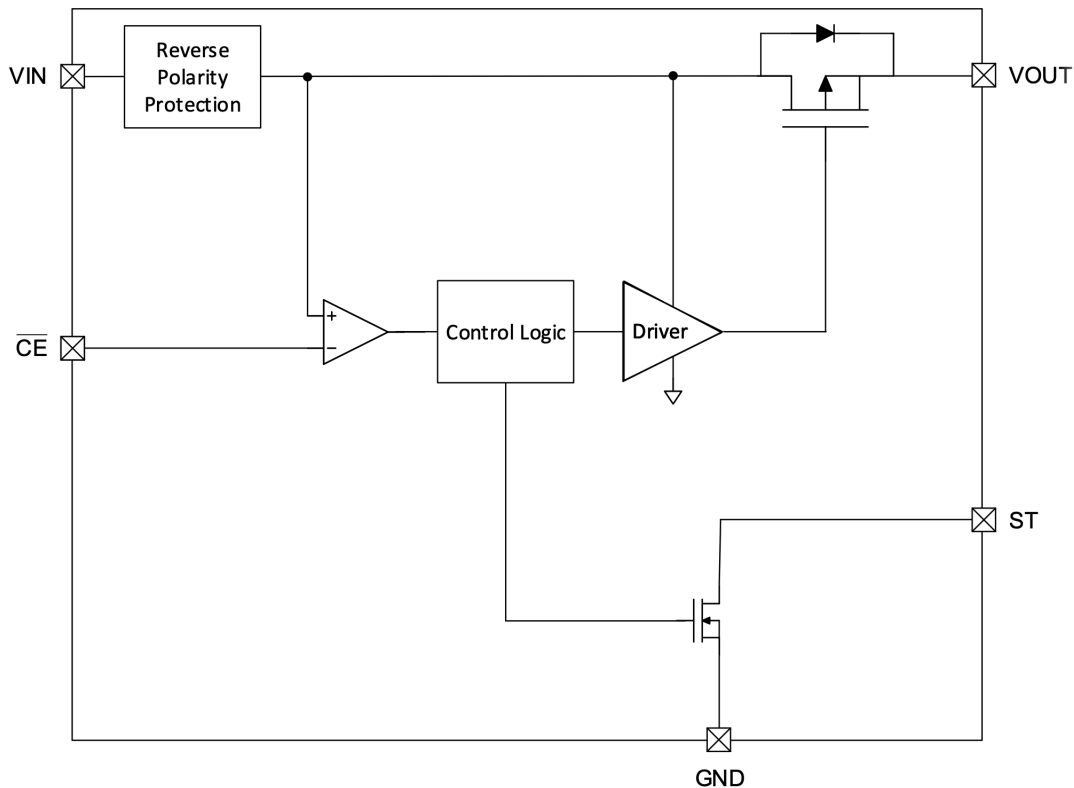
8.3 Feature Description

8.3.1 Reverse Polarity Protection (RPP)

In the event a negative input voltage is applied, the ideal diode stays 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 does not go negative with respect to GND. See 图 8-1.
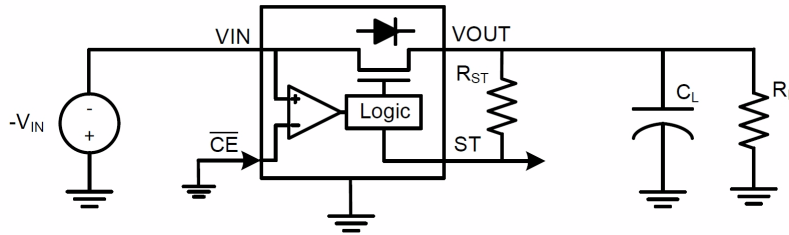

图 8-1. RPP Protection Circuit

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 switches off to stop the reverse current I_{RCB} within t_{OFF}. Once the output falls below V_{IN} by V_{ON}, the device turns back on.
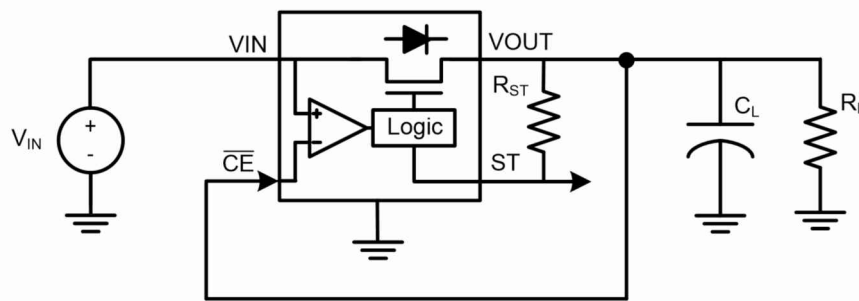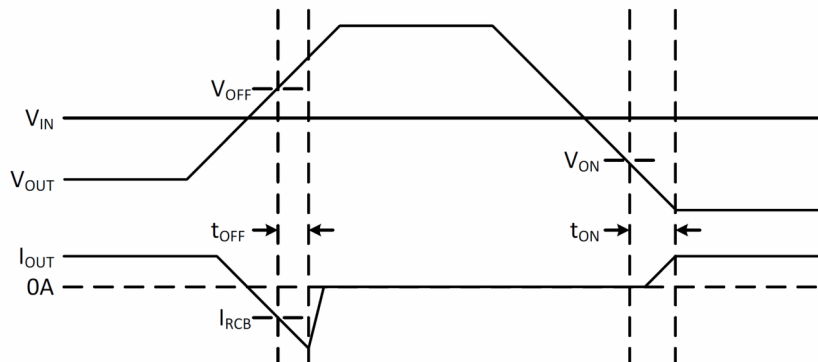

图 8-2. RCB Circuit

图 8-3. RCB Waveforms

8.4 Device Functional Modes

表 8-1 summarizes the Device Functional Modes:

表 8-1. Device Functional Modes

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

9 Application and Implementation

备注

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, as well as validating and testing their design implementation to confirm system functionality.

9.1 Application Information

The LM66100-Q1 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

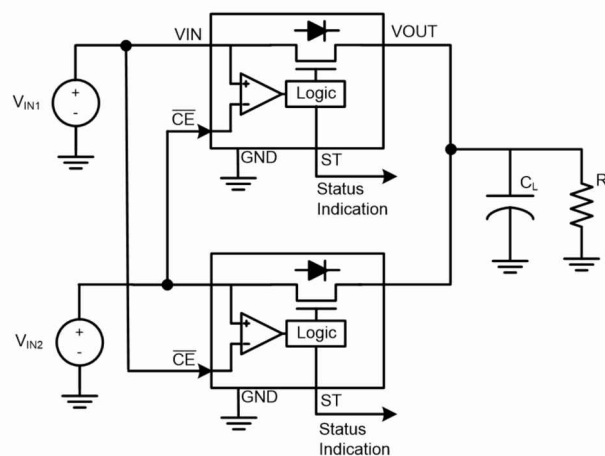Two LM66100-Q1 Ideal Diodes can be used together for ORing between two power supplies.

图 9-1. 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 is always selected using a make-before-break logic. This selection 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, TI recommends to use a series resistor ($R_{\overline{CE}}$) to limit the current into the $\overline{CE}$ pin during a negative voltage event.

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.
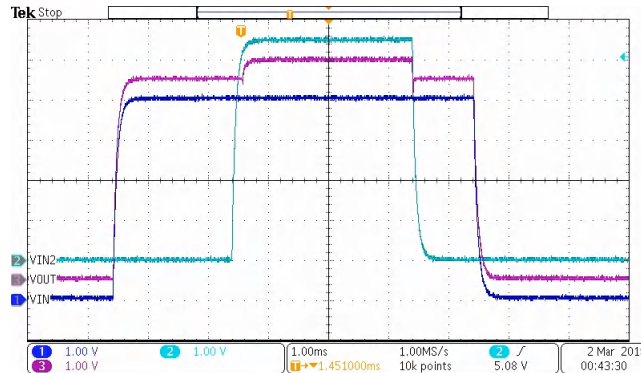

图 **9-2. Dual Ideal Diode ORing Behavior**

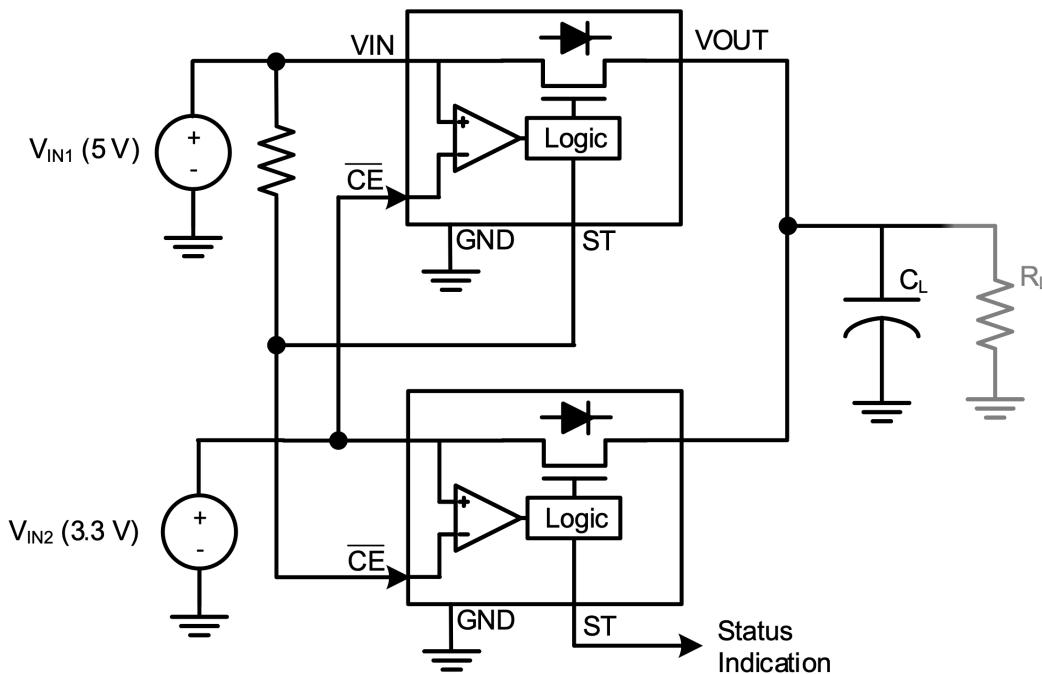### 9.2.2 Dual Ideal Diode ORing for Continuous Output Power

图 **9-3. 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 completely turn off, powering down the output load. To avoid this case, use the status output from the priority supply and a pullup resistor, causing both devices to switchover at the same time. For ORing applications that need RPP, TI recommends to use a series resistor ($R_{\overline{CE}}$) to limit the current into the $\overline{CE}$ pin during a negative voltage event.

Product Folder Links: *LM66100-Q1*

9.2.2.2 Application Curves

The figures below show the switchover performance between VIN1 and VIN2.
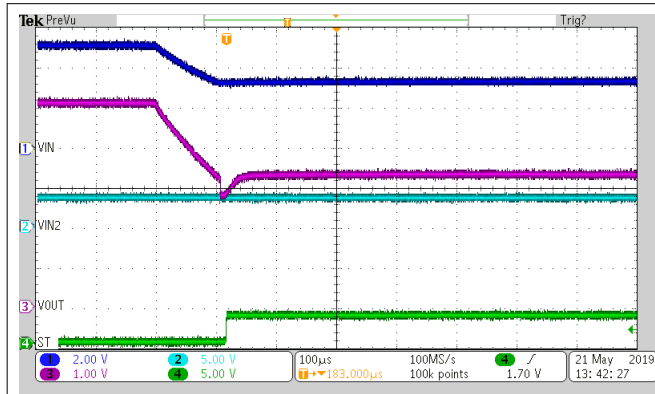

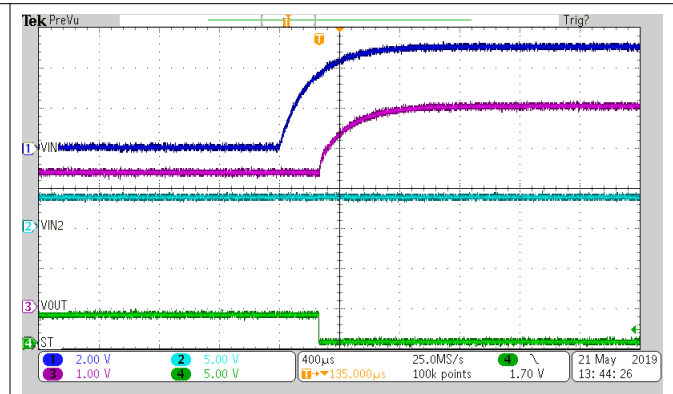图 9-4. Switchover From VIN1 (5 V) to VIN2 (3.3 V)

图 9-5. Switchover From VIN2 (3.3 V) to VIN1 (5 V)
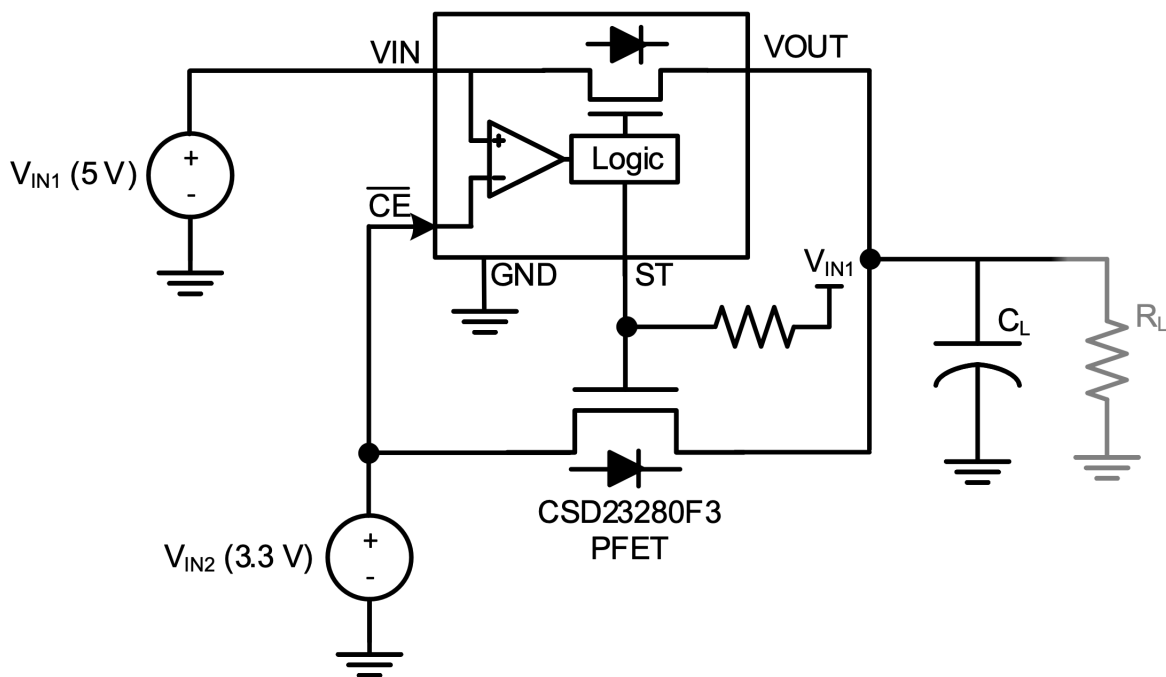
9.2.3 ORing with Discrete MOSFET

图 9-6. ORing with a Discrete MOSFET

9.2.3.1 Design Requirements

Similar to the Dual Ideal Diode circuit, the Status Output can also be used to control a discrete P-Channel MOSFET. This action can be useful in applications that want to minimize the leakage current on the secondary supply, such as battery backup systems. This configuration can also be used on systems that require a lower RON on the secondary rail, useful for higher current applications.

When the Ideal Diode path is enabled, the status is Hi-Z and pulls up the gate of the external PFET to keep it off. When the main supply (VIN1) drops such that backup supply (VIN2) is higher than VIN1, the ideal diode is disabled and pulls the ST pin and the PFET gate low to turn on the discrete MOSFET path.

9.2.3.2 Application Curves

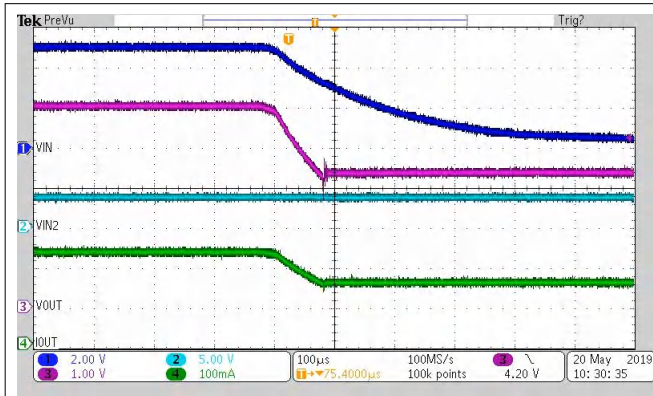The figures below show the switchover performance between VIN1 and VIN2.

图 9-7. Switchover From VIN1 5 V to VIN2 3.3 V
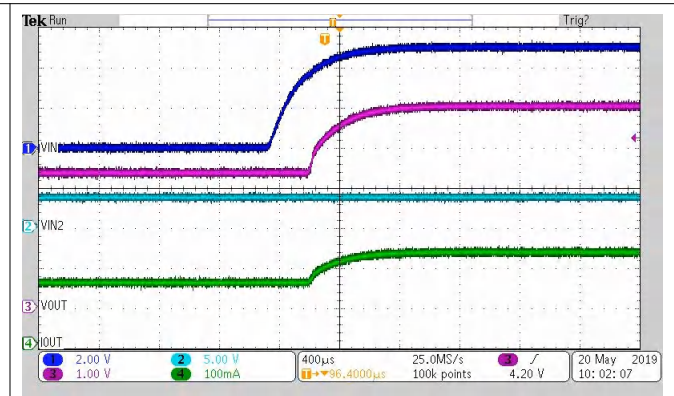
图 9-8. Switchover From VIN2 3.3 V to VIN1 5 V

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 can be required on the input.

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Product Folder Links: *LM66100-Q1*

11 Layout

11.1 Layout Guidelines

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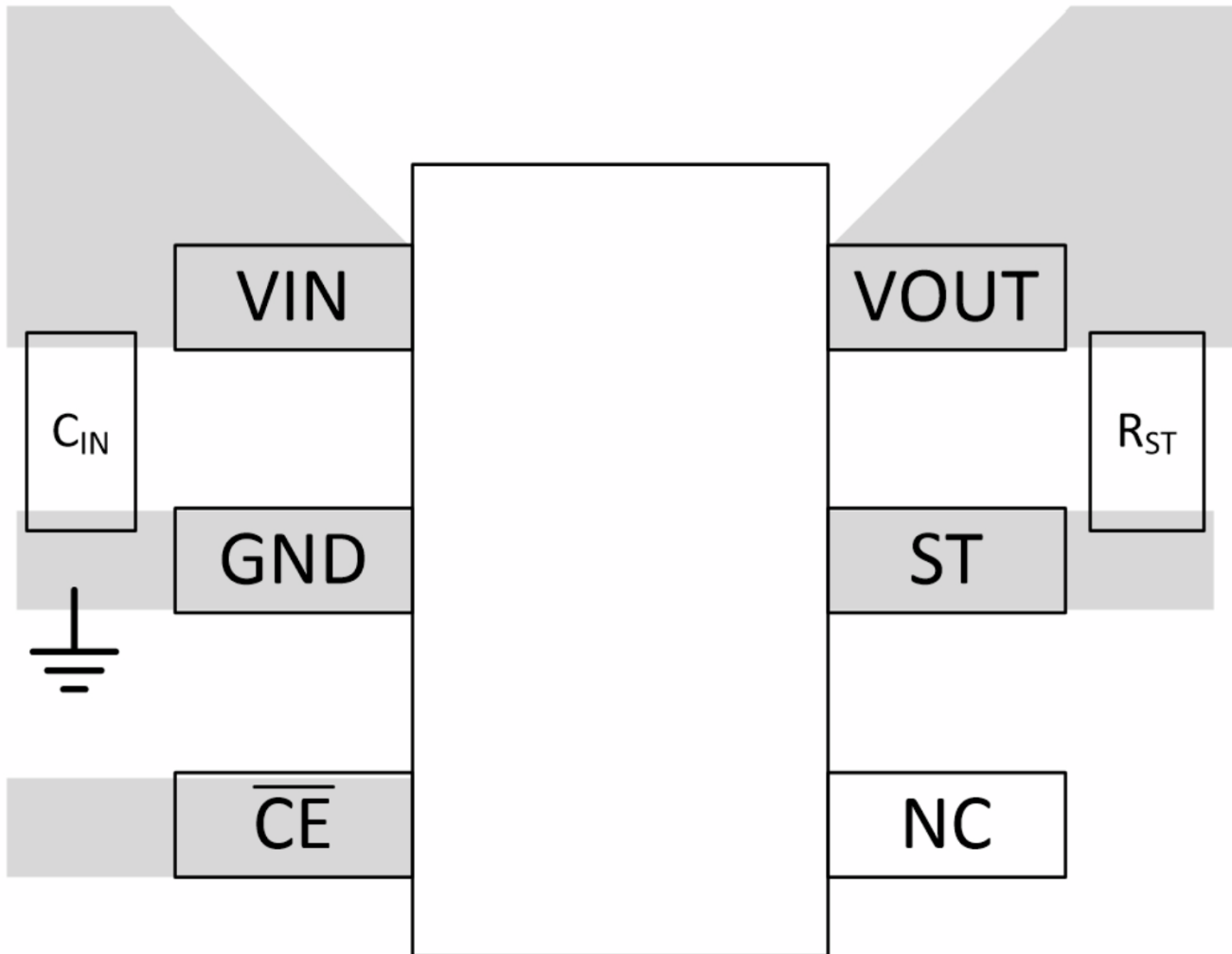
11.2 Layout Example

图 **11-1. LM66100-Q1 Layout Example**

Product Folder Links: *LM66100-Q1*

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 支持资源

TI E2E™ 支持论坛是工程师的重要参考资料，可直接从专家获得快速、经过验证的解答和设计帮助。搜索现有解答或提出自己的问题可获得所需的快速设计帮助。

链接的内容由各个贡献者"按原样"提供。这些内容并不构成 TI 技术规范，并且不一定反映 TI 的观点；请参阅 TI 的《使用条款》。

12.3 Trademarks

TI E2E™ is a trademark of Texas Instruments.

所有商标均为其各自所有者的财产。

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 术语表

TI 术语表　　　本术语表列出并解释了术语、首字母缩略词和定义。

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.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM66100QDCKRQ1	ACTIVE	SC70	DCK	6	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	1IW	Samples
PLM66100QDCKRQ1	ACTIVE	SC70	DCK	6	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PIW	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 finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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.

OTHER QUALIFIED VERSIONS OF LM66100-Q1 :

● Catalog : LM66100

NOTE: Qualified Version Definitions:

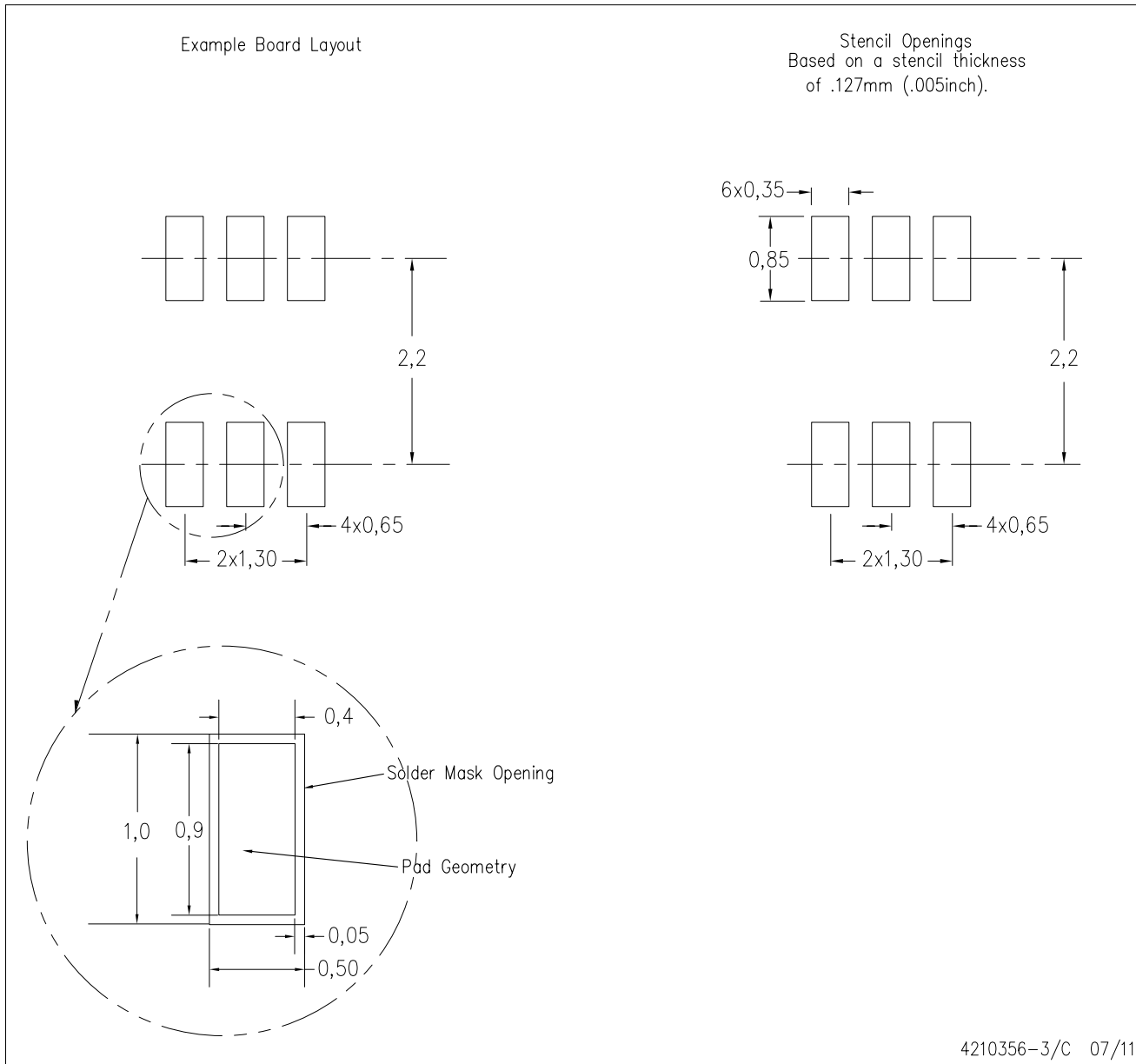　　　● Catalog - TI's standard catalog product

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

Example Board Layout

Stencil Openings
Based on a stencil thickness
of .127mm (.005inch).

6x0,35

0,85

2,2

2,2

4x0,65

2x1,30

4x0,65

2x1,30

0,4

Solder Mask Opening

1,0   0,9

Pad Geometry

0,05

0,50

4210356−3/C 07/11

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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