TPS27081A 1.2-V to 8-V, 3-A PFET High-Side Load Switch With Level Shift and Adjustable Slew Rate Control

1 Features

- Low ON-Resistance, High-Current PFET
  - $R_{DS(on)}$ = 32 mΩ at V_{GS} = –4.5 V
  - $R_{DS(on)}$ = 44 mΩ at V_{GS} = –3 V
  - $R_{DS(on)}$ = 82 mΩ at V_{GS} = –1.8 V
  - $R_{DS(on)}$ = 93 mΩ at V_{GS} = –1.5 V
  - $R_{DS(on)}$ = 155 mΩ at V_{GS} = –1.2 V
- Adjustable Turnon and Turnoff Slew Rate Control Through External R1, R2, and C1
- Supports a Wide Range of 1.2-V to 8-V Supply Inputs
- Integrated NMOS for PFET Control
- NMOS ON/OFF Supports a Wide Range of 1-V to 8-V Control Logic Interface
- Full ESD Protection (All Pins)
  - HBM 2 kV, CDM 500 V
- Ultra-Low Leakage Current in Standby (Typical 100 nA)
- Available in Tiny 6-Pin Package
  - 2.9 mm × 2.8 mm × 0.75 mm SOT (DDC)

2 Applications

- High-Side Load Switches
- Inrush Current Control
- Power Sequencing and Control
- Standby Power Isolation
- Portable Power Switches

3 Description

The TPS27081A device is a high-side load switch that integrates a Power PFET and a Control NFET in a tiny package.

The TPS27081A features industry-standard ESD protection on all pins providing better ESD compatibility with other onboard components.

The TPS27081A level shifts ON/OFF logic signal to VIN levels and supports as low as 1-V CPU or MCU logic to control higher voltage power supplies without requiring an external level-shifter.

Switching a large value output capacitor CL through a fast ON/OFF logic signal may result in an excessive inrush current. To control the load inrush current, connect a resistor R2 and add an external capacitor C1 as shown in the *Simplified Schematic*. To configure the TPS27081A to achieve a specific slew rate, refer to the *Application and Implementation* section.

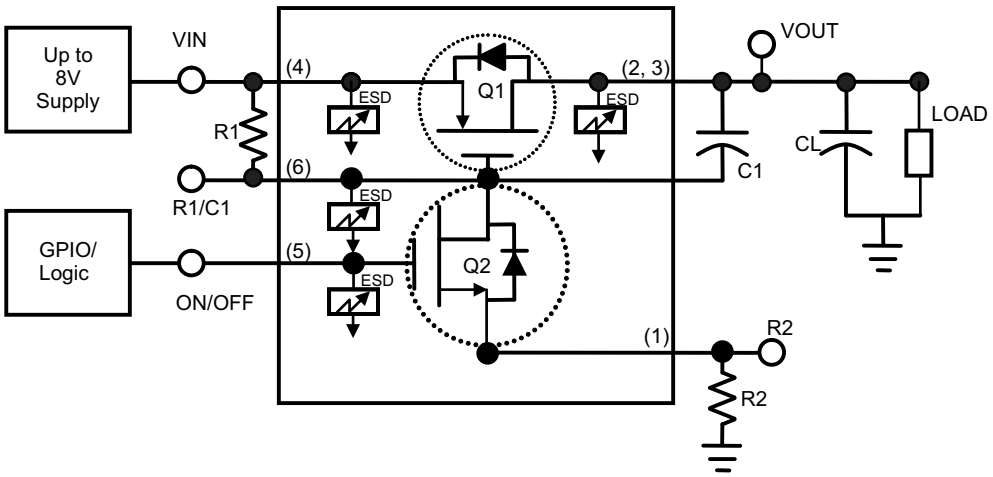
A single pullup resistor R1 is required in standby power switch applications. In such applications connect the R2 pin of the TPS27081A to the system ground when inrush current control is not required.

Device Information[1]

PART NUMBER	PACKAGE	BODY SIZE (NOM)
TPS27081A	SOT (6)	2.90 mm × 1.60 mm

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

Simplified Schematic



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4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision D (April 2013) to Revision E — **Page**

- Added *Pin Configuration and Functions* section, *ESD Ratings* table, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section ... 1

Changes from Revision C (January 2013) to Revision D — **Page**

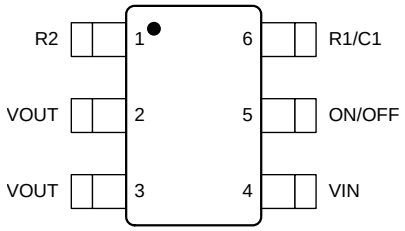
- Updated wording in document. ... 1

Changes from Revision B (September 2012) to Revision C — **Page**

- Removed DRV package preview from datasheet. ... 1

5 Pin Configuration and Functions

DDC Package
6-Pin SOT
Top View



Pin Functions

PIN		I/O(1)	DESCRIPTION
NAME	NO.		
ON/OFF	5	I	Active high enable. When driven with a high-impedance driver, connect an external pull down resistor to GND
R1/C1	6	I	Gate terminal of power PFET (Q1)
R2	1	O	Source terminal of NMOS (Q2) . Connect to system GND directly or through a slew rate control resistor
VIN	4	I	Source terminal of power PFET (Q1). Connect a pull-up resistor between the pins VIN/R1 and R1/C1
VOUT	2	O	Drain terminal of power PFET (Q1). Connect a slew control capacitor between pins VOUT and R1/C1
	3		

(1) I = Input, O = Output

6 Specifications

6.1 Absolute Maximum Ratings

Specified at T_J = –40°C to 105°C unless otherwise noted.(1)(2)

		MIN	MAX	UNIT
$V_{IN(max)}$	VIN pin maximum voltage with reference to pin R2	–0.1	8	V
$V_{OUT(max)}$	VOUT pin maximum voltage with reference to pin R2	–0.1	8	V
$V_{ON/OFF}$	ON/OFF in maximum voltage with respect to pin R2	–0.3	8	V
$I_{Q1(on)}$	Maximum continuous drain current of Q1 at T_J = 105°C		3	A
	Maximum pulsed drain current of Q1 (3) at T_J = 105°C		9.5	
P_D	Maximum power dissipation at T_A = 25°C, T_J = 150°C, $R_{\theta JA}$ = 105°C/W		1190	mW
T_A	Operating free-air ambient temperature	–40	85(4)	°C
$T_{J(max)}$(5)	Operating virtual junction temperature		150	°C
T_{stg}	Storage temperature	–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* 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 Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) Refer to TI's design support web page at www.ti.com/thermal for improving device thermal performance.
(3) Pulse width <300 µs, duty cycle < 2%
(4) $T_{J(max)}$ limits and other related conditions apply. Refer to SOA charts, Figure 8 through Figure 12.
(5) Operating at the absolute $T_{J(max)}$ = 150°C can affect reliability. For higher reliability,TI recommends maintaining T_J < 105°C.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins(1)	±2000	V
		Charged device model (CDM), per JEDEC specification JESD22-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.

6.3 Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
V_{IN}	Input voltage	1		8	V
T_A	Operating free-air ambient temperature	–40		85	°C
T_J	Junction temperature	–40		105	°C

6.4 Thermal Information

THERMAL METRIC(1)		TPS27081A DDC (SOT) 6 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	105	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	43	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	17.8	°C/W
ψ_{JT}	Junction-to-top characterization parameter	6.5	°C/W
ψ_{JB}	Junction-to-board characterization parameter	16.2	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	n/a	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, SPRA953.

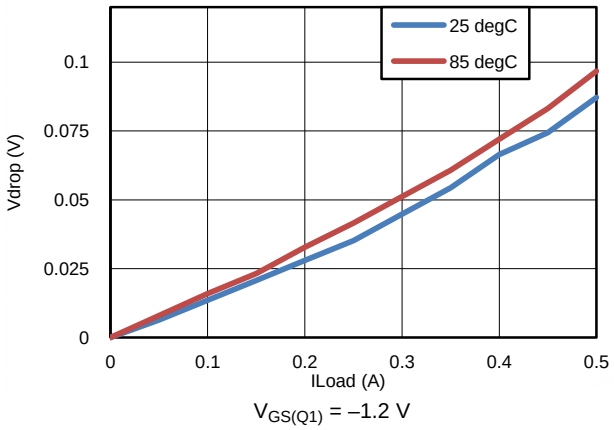
6.5 Electrical Characteristics

Specified over the recommended junction temperature range T_J = –40°C to 105°C unless otherwise noted. Typical values specified at $T_A = T_J$ = 25°C.

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
OFF-TIME CHARACTERISTICS							
BV_{IN1}	Q1 drain-to-source breakdown voltage	$V_{ON/OFF}$ = 0 V, $V_{GS(Q1)}$ = 0 V, $I_{D(Q1)}$ = 250 µA		–8			V
I_{LOAD} (1)	VIN pin total leakage current	V_{IN} = 8 V, $V_{ON/OFF}$ = 0 V, R_{R1} = 10 kΩ	T_J = 25°C		0.15	0.75	µA
			T_J = 85°C (2)		5	20	
		V_{IN} = 5 V, $V_{ON/OFF}$ = 0 V, R_{R1} = 10 kΩ	T_J = 25°C		0.05		
			T_J = 85°C (2)		2		
IF_{Q2}	Q2 drain-to-source leakage current	V_{IN} = 8 V, $V_{ON/OFF}$ = 0 V	T_J = 25°C		0.03	0.05	µA
			T_J = 85°C (2)		0.35	0.6	
		V_{IN} = 5 V, $V_{ON/OFF}$ = 0 V	T_J = 25°C		0.025		µA
			T_J = 85°C (2)		0.25		
ON-TIME CHARACTERISTICS (3)							
V_{IL}	ON/OFF pin low-level input voltage	V_{IN} = 5 V, $I_{D(Q1)}$ < 2 µA, R_{R1} = 10 kΩ, R_{R2} = RL = 0 Ω	T_J = 25°C			0.3	V
		V_{IN} = 5 V, $I_{D(Q1)}$ < 20 µA, R_{R1} = 10 kΩ, R_{R2} = RL = 0 Ω	T_J = 85°C (2)			0.2	
V_{IH}	ON/OFF pin high-level input voltage	V_{IN} = 5 V, R_{R1} = 10 kΩ		1			V
$R_{Q1(on)}$	Q1 Channel ON-resistance (4)	V_{GS} = –4.5 V, $I_{D(Q1)}$ = 3 A			32	55	mΩ
		V_{GS} = –3 V, $I_{D(Q1)}$ = 2.5 A			44	77	
		V_{GS} = –2.5 V, $I_{D(Q1)}$ = 2.5 A			50	85	
		V_{GS} = –1.8 V, $I_{D(Q1)}$ = 2 A			82	147	
		V_{GS} = –1.5 V, $I_{D(Q1)}$ = 1 A			93	166	
		V_{GS} = –1.2 V, $I_{D(Q1)}$ = 0.5 A			155	260	
$R_{Q2(on)}$	Q2 Channel ON-resistance	V_{GS} = 4.5 V, $I_{D(Q2)}$ = 0.4 A			1.8	3	Ω
		V_{GS} = 3.0 V, $I_{D(Q2)}$ = 0.3 A			2.3	6.2	
		V_{GS} = 2.5 V, $I_{D(Q2)}$ = 0.2 A			2.6	6.1	
		V_{GS} = 1.8 V, $I_{D(Q2)}$ = 0.1 A			3.8	10	
		V_{GS} = 1.5 V, $I_{D(Q2)}$ = 0.05 A			4.4	8.5	
		V_{GS} = 1.2 V, $I_{D(Q2)}$ = 0.03 A			6.25	13.5	
Q1 DRAIN-SOURCE DIODE PARAMETERS (3) (5)							
IF_{SD}	Source-drain diode peak forward current	VF_{SD} = 0.8 V, $V_{ON/OFF}$ = 0 V			1		A
VF_{SD}	Source-drain diode forward voltage	$V_{ON/OFF}$ = 0 V, IF_{SD} = –0.6 A				1	V

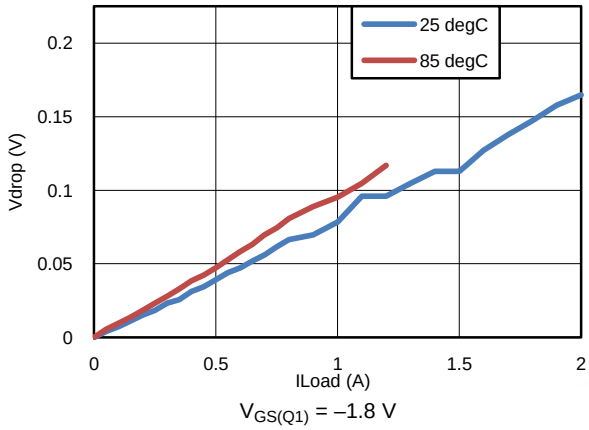
(1) Pullup resistor (R_{R1}) dependent.
(2) Specified by design. Not production tested.
(3) Pulse width < 300 µs, duty cycle < 2.0%
(4) Refer to *PFET Q1 Minimum Safe Operating Area (SOA)* section for current rating.
(5) Not rated for continuous current operation.

6.6 Typical Characteristics



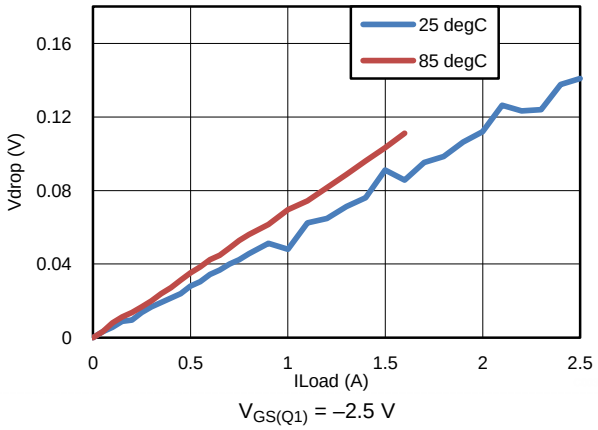
$V_{GS(Q1)}$ = –1.2 V

Figure 1. Drop Voltage vs Load Current



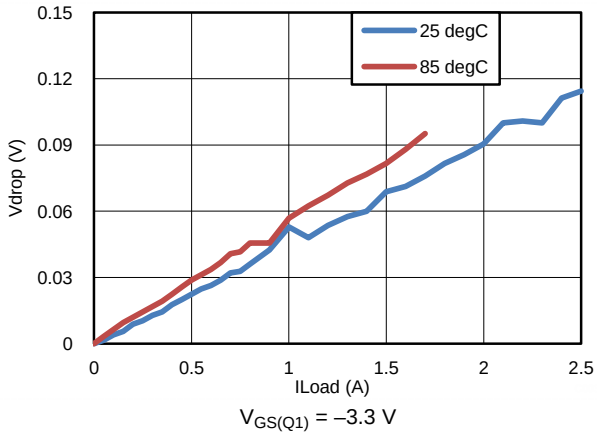
$V_{GS(Q1)}$ = –1.8 V

Figure 2. Drop Voltage vs Load Current



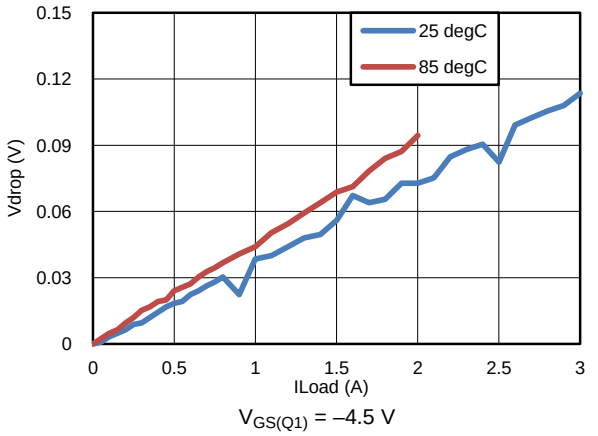
$V_{GS(Q1)}$ = –2.5 V

Figure 3. Drop Voltage vs Load Current



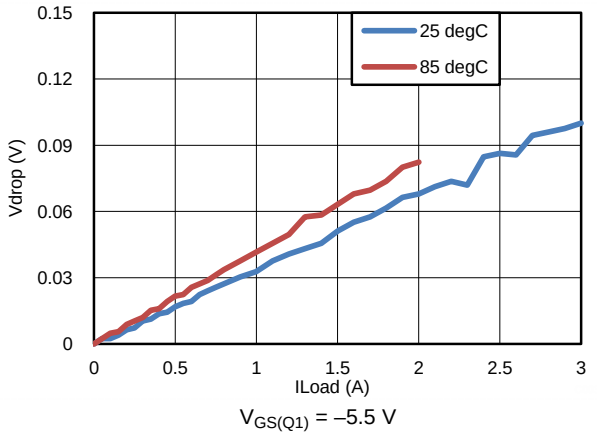
$V_{GS(Q1)}$ = –3.3 V

Figure 4. Drop Voltage vs Load Current



$V_{GS(Q1)}$ = –4.5 V

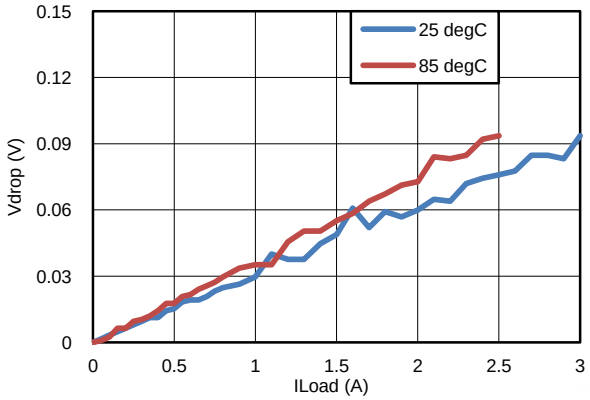
Figure 5. Drop Voltage vs Load Current



$V_{GS(Q1)}$ = –5.5 V

Figure 6. Drop Voltage vs Load Current

Typical Characteristics (continued)



$V_{GS(Q1)}$ = –7 V

Figure 7. Drop Voltage vs Load Current

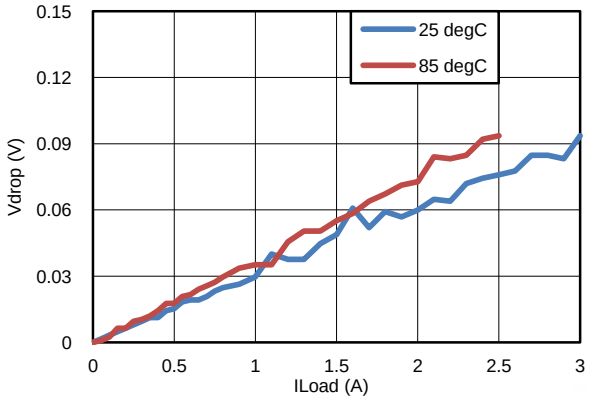
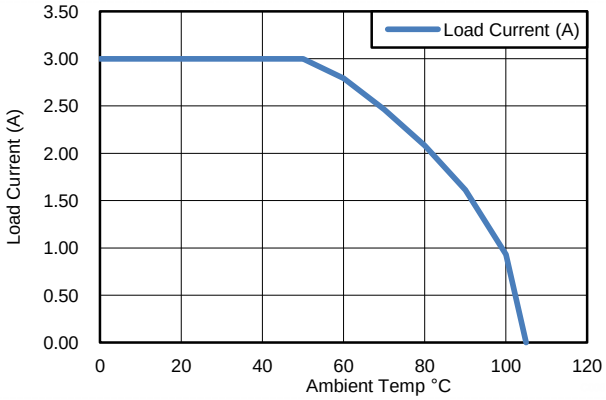


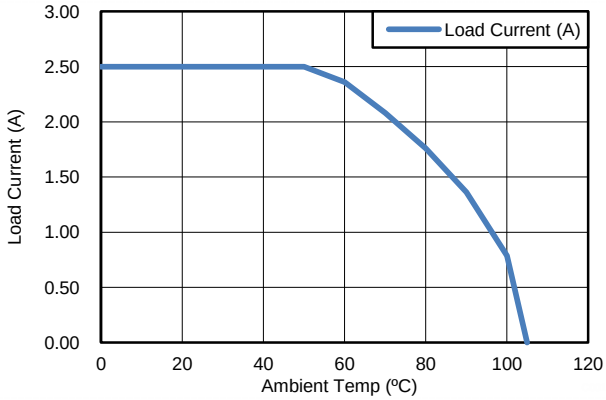
Figure 0. UNDEFINED

6.6.1 PFET Q1 Minimum Safe Operating Area (SOA)



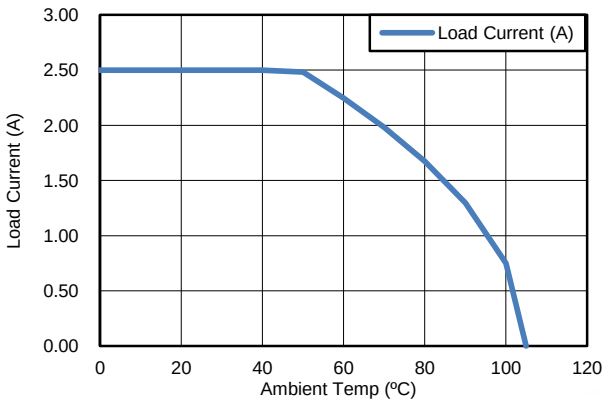
V_{GS}_Q1 = –4.5 V

Figure 8. Q1 Safe Operating Area



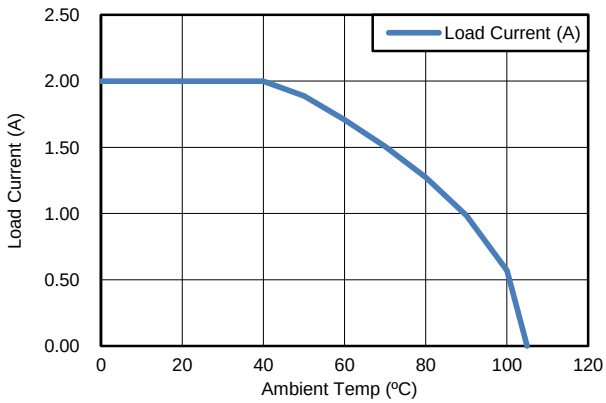
V_{GS}_Q1 = –3 V

Figure 9. Q1 Safe Operating Area



V_{GS}_Q1 = –2.5 V

Figure 10. Q1 Safe Operating Area



V_{GS}_Q1 = –1.8 V

Figure 11. Q1 Safe Operating Area

PFET Q1 Minimum Safe Operating Area (SOA) (continued)

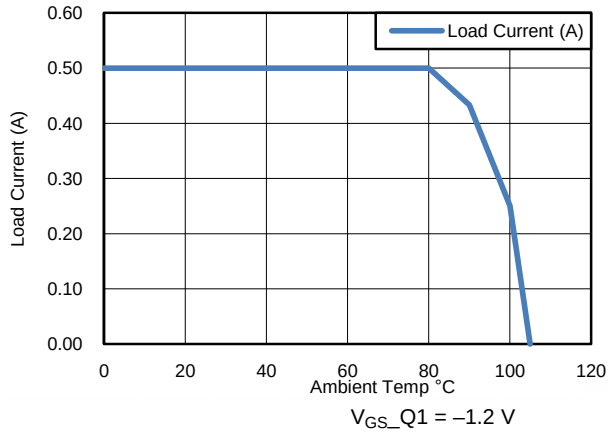


Figure 12. Q1 Safe Operating Area

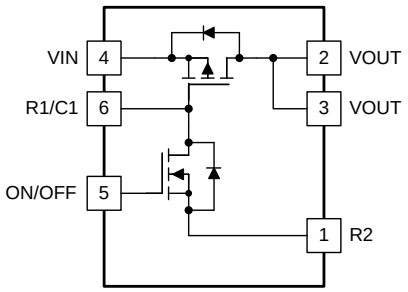
7 Detailed Description

7.1 Overview

The TPS27081A device is a load switch capable fo handing up to 8 V and 3 A. To reduce voltage drop for low voltage and high current rails, the device implements an ultra-low resistance P-channel MOSFET which reduces the dropout voltage through the device.

The device has a programmable slew rate which helps reduce or eliminate power supply droop due to large inrush currents. During shutdown, the device has very low leakage currents.

7.2 Functional Block Diagram



7.3 Feature Description

The TPS27081A device uses a low-voltage power PMOS transistor used as the pass element or switch between the supply and load. The device also uses an NMOS transistor to turn the PMOS on and off by interfacing with a wide range of GPIO voltages. Asserting an input voltage higher than V_{IH} (1 V) enables the PMOS switch by turning the NMOS and the NMOS driving the PMOS gate towards ground. When using R2 to control output rise time and a pullup resistor R1 to tie the gate of the PMOS to the source to ensure turnoff, be sure to use an R1 value big enough to source a small enough of current into R2 to not grossly effect the PMOS ON-state gate voltage.

TPS27081A offers additional ports to control the output rise time by connecting passive elements between these pins, VIN, and VOUT.

7.4 Device Functional Modes

7.4.1 ON/OFF

When V_{IN} > approximately 1 V and $V_{(ON/OFF)}$ > 1 V, the switch turns on and $V_{OUT} \approx V_{IN}$.

When V_{IN} > approximately 1 V and $V_{(ON/OFF)}$ <1 V, the switch turns off and $V_{OUT} \neq V_{IN}$.

7.4.2 Fastest Output Rise Time

Whenever it is desired to achieve the fastest output rise time, tie pin 1 (R2) to ground and do not put a capacitor between VOUT (pins 2 and 3) and R1 and C1 (pin 6).

7.4.3 Controlled Output Rise Time

Whenever it is desired to control the output rise time, tie pin 1 (R2) to a resistance (R2) and put a capacitor (C1) between VOUT (pins 2 and 3) and R1 and C1 (pin 6). The values needed to determine a certain output rise time can be determined by Equation 3.

8 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.

8.1 Application Information

This section highlights some of the design considerations when implementing this device in various applications.

8.2 Typical Application

8.2.1 Standard Load Switching Application

The TPS27081A device is a high-side load switch that integrates a power PFET and a control NMOS in a tiny package. The device internal components are rated for up to 8-V supply and support up to 3 A of load current. The device can be used in a variety applications. Figure 13 shows a general application of the TPS27081A device to control the load inrush current.

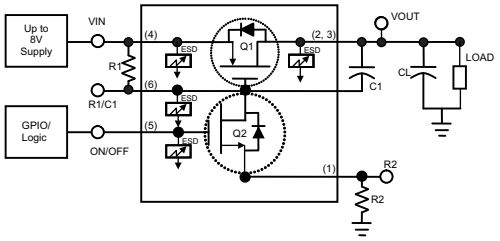


Figure 13. Standard Application Diagram

8.2.1.1 Design Requirements

Table 1. Component Table

COMPONENT	DESCRIPTION
R1	Level shift and pullup resistor
R2	Optional(1)
C1	Optional(1)

(1) Required for load inrush current (slew rate) control.

8.2.1.2 Detailed Design Procedure

8.2.1.2.1 Configuring Q1 ON Resistance

The $V_{GS(Q1)}$ gate-to-source voltage across the PMOS transistor Q1 sets its ON-resistance $R_{Q1(on)}$. Directly connecting the pin R2 to ground maximizes the ON state $V_{GS(Q1)}$ and thus minimizes the VIN to VOUT voltage dropout. Equation 1 describes the $V_{GS(Q1)}$ when a resistor R2 is installed to control the turnon slew rate.

$$V_{GS(Q1)} = -V_{VIN} \times \frac{R_{R1}}{(R_{R1}+R_{R2})} (V) \quad (1)$$

For example,when $R_{R1} = 10 \times R_{R2}$ and $V_{VIN} = 5$ V, $V_{GS(Q1)} = -4.5$ V

NOTE

TI recommends maintaining R_{R1} > 10 × R_{R2}. The higher value of resistor R1 minimizes quiescent current when PMOS is on, however, the higher value may adversely impact OFF-state leakage current. Refer to the load current (I_{LOAD}) specifications in the *Electrical Characteristics* table.

8.2.1.2.2 Configuring Turnon Slew Rate

Switching a large capacitive load C_{LOAD} instantaneously results in a load inrush current given by Equation 2.

$$I_{INRUSH} = C_{LOAD} \times \frac{dv}{dt} = C_{LOAD} \times \frac{V_{OUT(final)} - V_{OUT(initial)}}{V_{OUT(SR)}} \quad (2)$$

where

- $V_{OUT(SR)}$ is the output voltage slew rate

An uncontrolled fast rising ON/OFF logic input may result in a high slew rate at the output resulting in a very high dv/dt, thus, leading to a higher inrush current. To control the inrush current, connect a resistor R2 and a capacitor C1 as shown in Figure 13. Use the following equation to configure the TPS27081A slew rate to a specific value. Refer to Table 2 for component values to configure TPS27081A to achieve standard slew rates.

$$t_{RISE} = \frac{3.9 \times R_{R2} \times C_{C1}}{(V_{VIN})^{2/3}} \text{ (s)} \quad (3)$$

where

- t_{RISE} is the time delta starting from the rising edge of the ON/OFF signal to charge up the load capacitor C_{LOAD} from 10% to 90% of VIN voltage.

NOTE

Equation 3 is accurate to within ±20% across full VIN range supported by TPS27081A. Ensure that R1 > 10 × R2.

Table 2. Component Values for VOUT Rise Time

C_{C1}	RISE TIME (µs)(1)(2)							
	R_{R1} = 10 kΩ, R_{R2} = 1 kΩ				R_{R1} = 5.1 kΩ, R_{R2} = 510 Ω			
	V_{VIN} (V)				V_{VIN} (V)			
	7	5	3.3	1.2	7	5	3.3	1.2
220 pF	0.253	0.316	0.416	0.810	0.129	0.161	0.212	0.413
1000 pF	1.15	1.44	1.89	3.68	.586	.732	.963	1.88
4700 pF	5.4	6.75	8.88	17.3	2.76	3.44	4.53	8.83
0.18 µF	207	258	340	663	106	132	173	338
0.27 µF	310	388	510	994	158	198	260	507
0.33 µF	379	474	623	1220	194	242	318	620
1 µF	1150	1440	1890	3680	586	732	963	1880

(1) C_{LOAD} = 10 µF. Output rise time is independent of C_{LOAD} when C_{LOAD} >> C_{C1}.
(2) Rise time is 250 ns for R_{R2} = 0 Ω and C_{C1} = C_{LOAD} = 0 F.

8.2.1.2.3 Configuring Turnoff Delay

TPS27081A PMOS turnoff delay from the falling edge of ON/OFF logic signal depends upon the component values of resistor R1 and capacitor C1. Lower values of resistor R1 ensures quicker turnoff.

t_{off} > 2 × R1 × C1 sec (4)

8.2.1.2.4 Low Voltage ON/OFF Interface

The $V_{GS(Q2)}$ is set by the ON/OFF logic level. To turn ON, the transistor Q2 requires a V_{GS} > 1.0 V (typical). For reliable operation, apply ON/OFF logic following the high-level input voltage (V_{IH}) and low-level input voltage (V_{IL}) limits expressed in Equation 5 and Equation 6.

$$V_{IH(on)} > 1.0\ V + I_{Q2} \times R2\ V \quad (5)$$

$$V_{IL(off)} < 0.2\ V \quad (6)$$

Minimizing I_{Q2} × R2 drop helps achieve a direct interface with a low voltage ON/OFF logic. To minimize I_{Q2} × R2 voltage drop, select a high R1 and R2 ratio. For example, when V_{VIN} = 1.8 V, selecting R1 and R2 = 40 requires V_{IH} > 1 + 45 mV and thus allowing a 1.2-V GPIO interface.

In applications where ON/OFF signal is not available, connect ON/OFF pin to VIN. The TPS27081A turns ON/OFF in sync with the input supply connected to the VIN pin.

NOTE

Connect a pulldown resistor between ON/OFF pin to GND when ON/OFF is driven by a high-impedance (tri-state) driver.

8.2.1.2.5 ON-Chip Power Dissipation

Use Equation 7 to calculate TPS27081A ON-chip power dissipation P_D:

$$PD = ID_{Q1}^2 \times R_{Q1(on)} + ID_{Q2}^2 \times R_{Q2(on)} \quad (7)$$

where

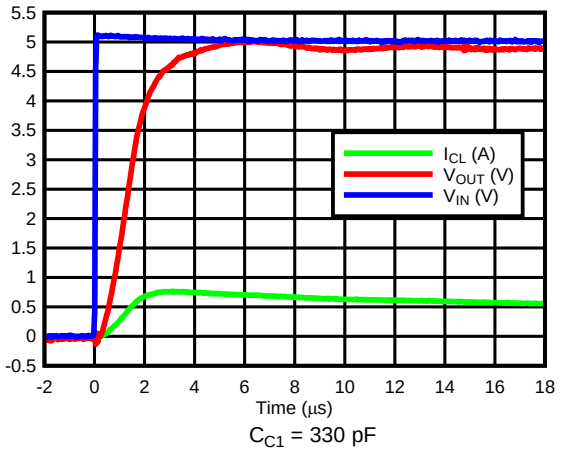
- ID_{Q1} and ID_{Q2} are the DC current flowing through the transistors Q1 and Q2, respectively.

Refer to *Electrical Characteristics* and/or Figure 1 through Figure 7 to estimate $R_{Q1(on)}$ and $R_{Q2(on)}$ for various values of $V_{GS(Q1)}$ and $V_{GS(Q2)}$, respectively.

NOTE

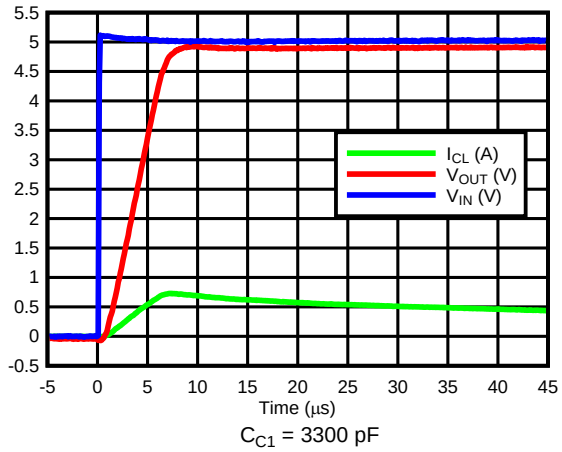
MOS switches can get extremely hot when operated in saturation region. As a general guideline, to avoid transistors Q1 and Q2 going into saturation region, set V_{GS} > VT + VDS. For example, V_{GS} > 1.5 V and VDS < 200 mV ensures operation as a switch.

8.2.1.3 Application Curves



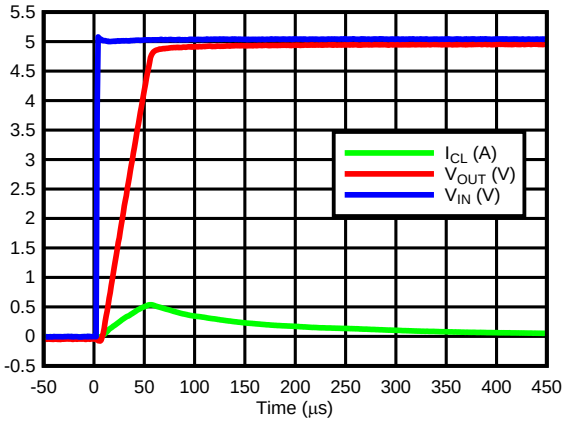
C_{C1} = 330 pF

Figure 14. Output Rise Time and Inrush Current



C_{C1} = 3300 pF

Figure 15. Output Rise Time and Inrush Current



C_{C1} = 33 nF

Figure 16. Output Rise Time and Inrush Current

8.3 System Examples

8.3.1 Standby Power Isolation

Many applications have some always ON modules to support various core functions. However, some modules are selectively powered ON or OFF to save power and multiplexing of various on board resources. Such modules that are selectively turned ON or OFF require standby power generation. In such applications TPS27081A requires only a single pull-up resistor. In the configuration shown in Figure 17, the VOUT voltage rise time is approximately 250 ns when V_{VIN} = 5 V.

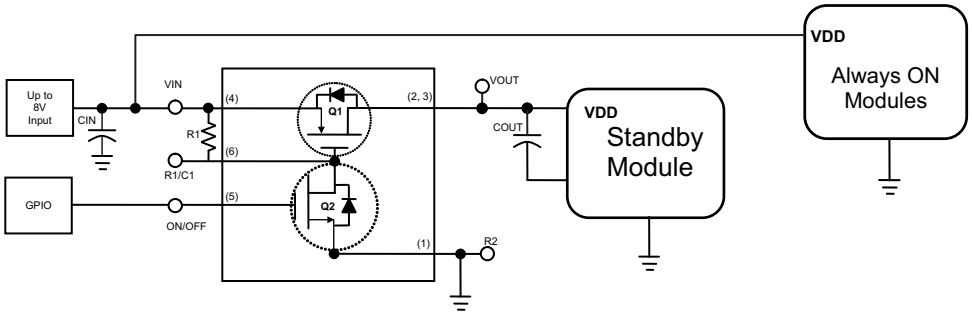


Figure 17. Standby Power Generation Using TPS27081A

8.3.2 Boost Regulator With True Shutdown

The most common boost regulator topology provides a current leakage path through inductor and diode into the feedback resistor even when the regulator shuts down. Adding a TPS27081A device in the input-side power path prevents this leakage current and thus providing a true shutdown, as shown in Figure 18.

LCD panels require inrush current control to prevent permanent system damages during turnon and turnoff events.

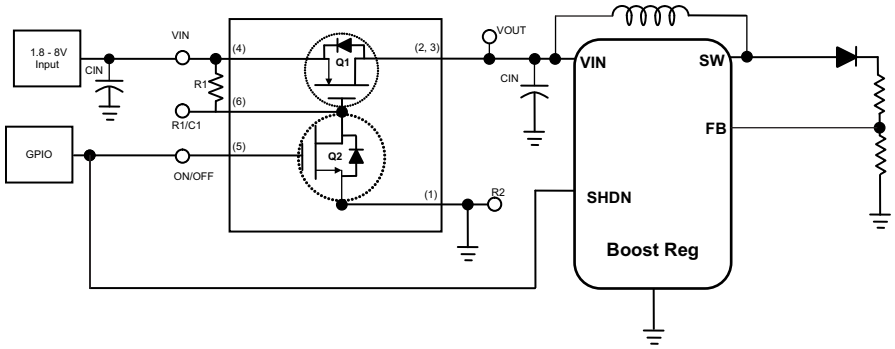


Figure 18. True Shutdown Using TPS27081A

System Examples (continued)

8.3.3 Single Module Multiple Power Supply Sequencing

Most modern SOCs and CPUs require multiple voltage inputs for its analog cores, digital cores, and I/O interfaces. These devices require that these supplies be applied simultaneously or in a certain sequence. The TPS27081A device, when configured as shown in Figure 19 with the VOUT1 rise time adjusted appropriately through resistor R2 and capacitor C1, delays the early arriving LDO output to match up with late-arriving DC-DC output and thus, achieving power sequencing.

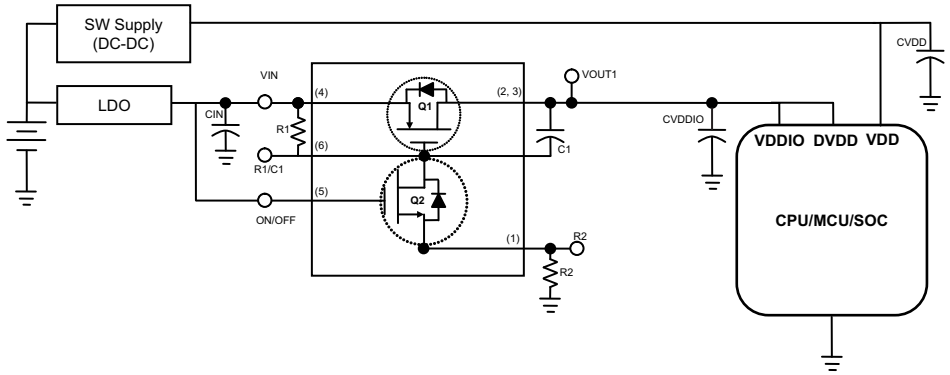


Figure 19. Power Sequencing Using TPS27081A

8.3.4 Multiple Modules Interdependent Power Supply Sequencing

For system integrity reasons, a certain power sequencing may be required among various modules. As shown in Figure 20, Module 2 powers up only after Module 1 is powered up and the Module 1 GPIO output is enabled to turn ON Module 2. The TPS27081A device, when used as shown in this example does not only sequence the Module 2 power, but it also helps prevent inrush current into the power path of Module 1 and 2.

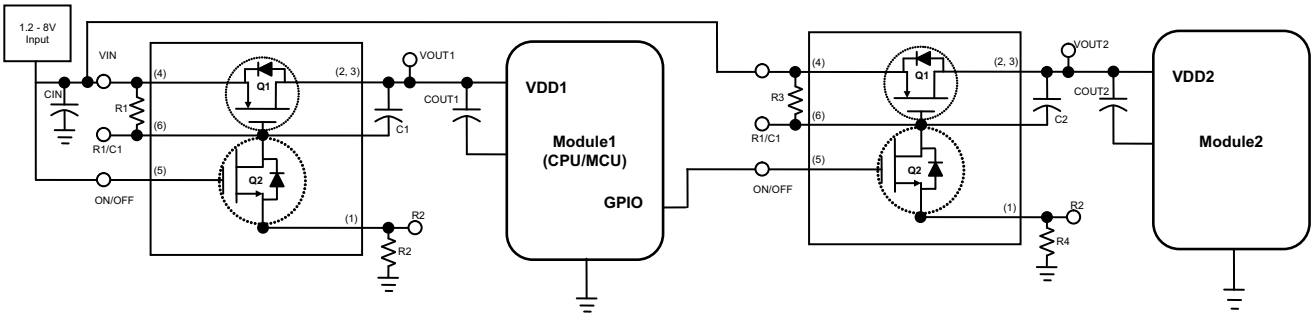


Figure 20. Power Sequencing Using TPS27081A

System Examples (continued)

8.3.5 TFT LCD Module Inrush Current Control

As shown in Figure 21, LCD panels require inrush current control to prevent permanent system damages during turnon and turnoff events.

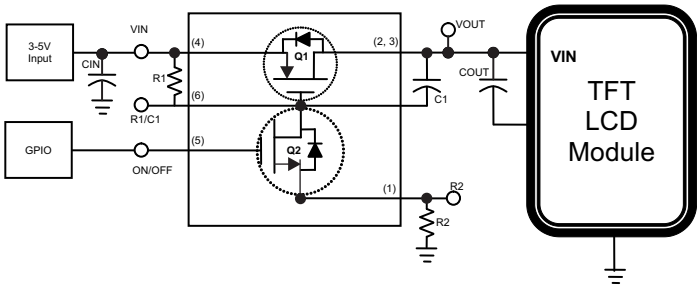


Figure 21. Inrush Current Control Using TPS27081A

8.3.6 Multiple Modules Interdependent Supply Sequencing Without a GPIO Input

When a GPIO signal is not available, connecting the ON/OFF pin of the TPS27081 device as connected to Module 2 powers up Module 2 after poweing up Module 1 when the values for resistor R4 and capacitor C1 are chosen appropriately. The two TPS27081A in this configuration as shown in Figure 22 can control load inrush current.

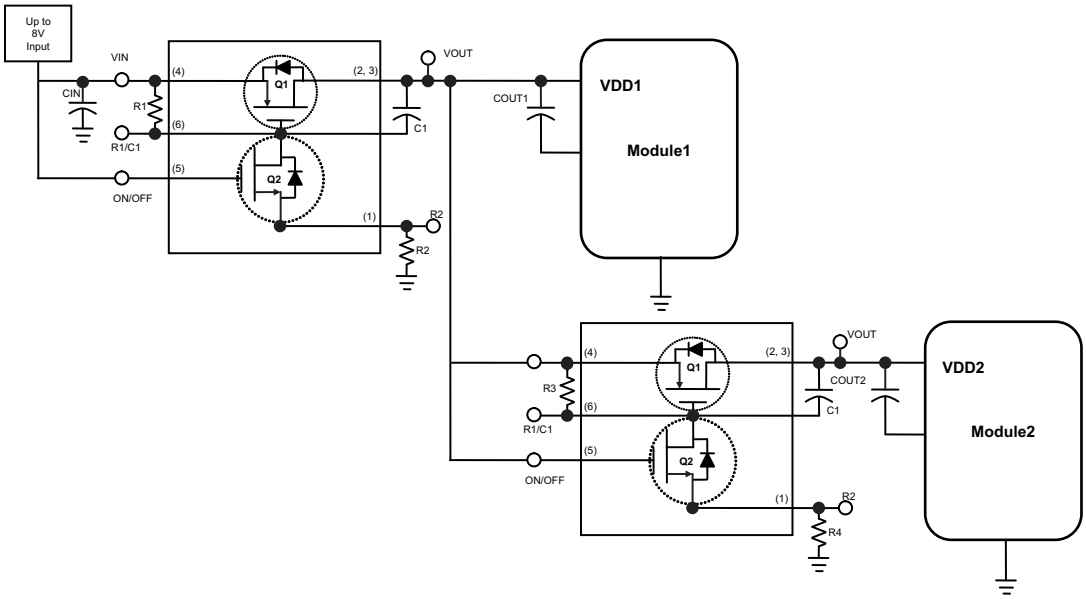


Figure 22. Power Sequencing Using TPS27081A

9 Power Supply Recommendations

The device is designed to operate from a VIN range of 1 V to 8 V. This supply must be well regulated and placed as close to the device terminal as possible with the recommended 1-µF bypass capacitor. If the supply is located more than a few inches from the device terminals, additional bulk capacitance may be required in addition to the ceramic bypass capacitors. If additional bulk capacitance is required, an electrolytic, tantalum, or ceramic capacitor of 1 µF may be sufficient.

10 Layout

10.1 Layout Guidelines

For best operational performance of the device, use good PCB layout practices, including:

- VIN and VOUT traces should be as short and wide as possible to accommodate for high current.
- The VIN pin should be bypassed to ground with low ESR ceramic bypass capacitors. The typical recommended bypass capacitance is 1-µF ceramic with X5R or X7R dielectric. This capacitor should be placed as close to the device pins as possible.
- The VOUT pin should be bypassed to ground with low ESR ceramic bypass capacitors. The typical recommended bypass capacitance is one-tenth of the VIN bypass capacitor of X5R or X7R dielectric rating. This capacitor should be placed as close to the device pins as possible.

10.2 Layout Example

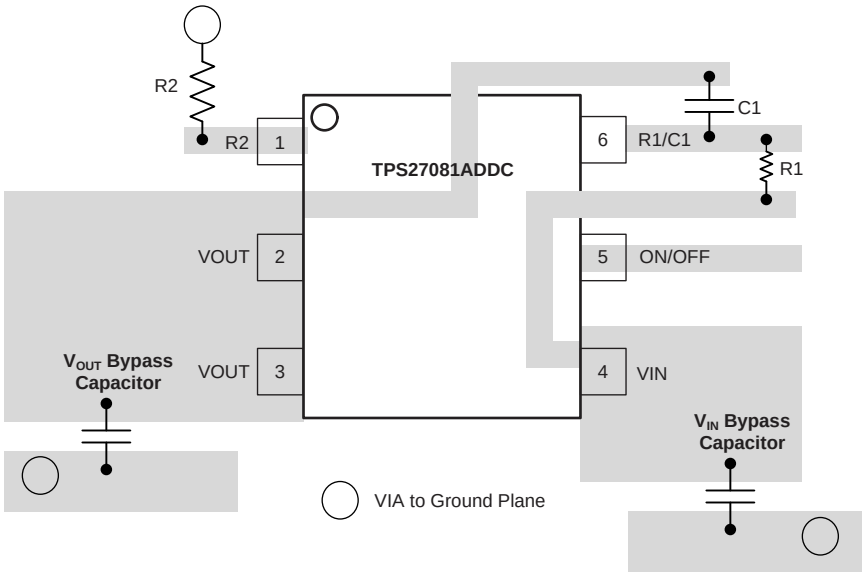


Figure 23. Layout Example

10.3 Thermal Reliability

For higher reliability, TI recommends limiting the TPS27081A die junction temperature to less than 105°C. The device junction temperature is directly proportional to the ON-chip power dissipation. Use the following equation to calculate maximum ON-chip power dissipation to achieve the maximum die junction temperature target:

$$PD_{MAX} = \frac{T_{J(max)} - T_A}{R_{\theta JA}} \quad (8)$$

where

- $T_{J(max)}$ is the target maximum junction temperature
- T_A is the operating ambient temperature
- $R_{\theta JA}$ is the package junction to ambient thermal resistance

10.4 Improving Package Thermal Performance

The package $R_{\theta JA}$ value under standard conditions on a High-K board is listed in . $R_{\theta JA}$ value depends on the PC board layout. An external heat sink and/or a cooling mechanism, like a cold air fan, can help reduce $R_{\theta JA}$ and thus improve device thermal capabilities. Refer to TI's design support web page at www.ti.com/thermal for a general guidance on improving device thermal performance.

11 Device and Documentation Support

11.1 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.

11.2 Trademarks

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

11.3 Electrostatic Discharge Caution

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

11.4 Glossary

SLYZ022 — *TI Glossary*.

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

12 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/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TPS27081ADDCR	ACTIVE	SOT-23-THIN	DDC	6	3000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	AUA	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) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

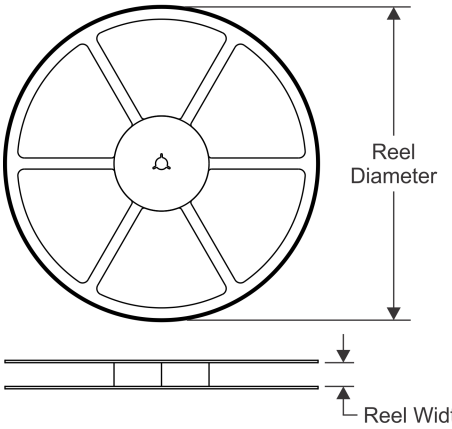
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(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.

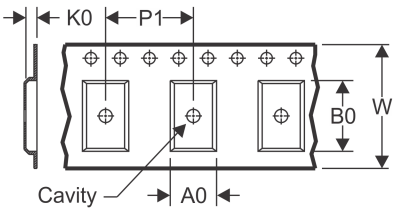
(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

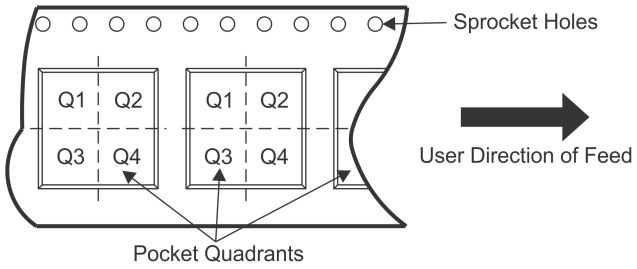


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

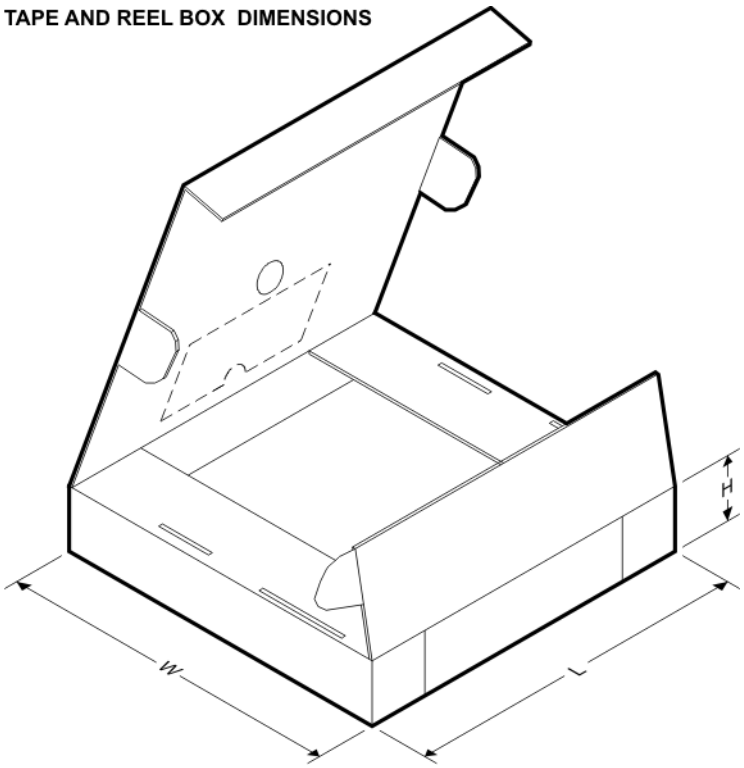
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TPS27081ADDCR	SOT-23-THIN	DDC	6	3000	180.0	9.5	3.17	3.1	1.1	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

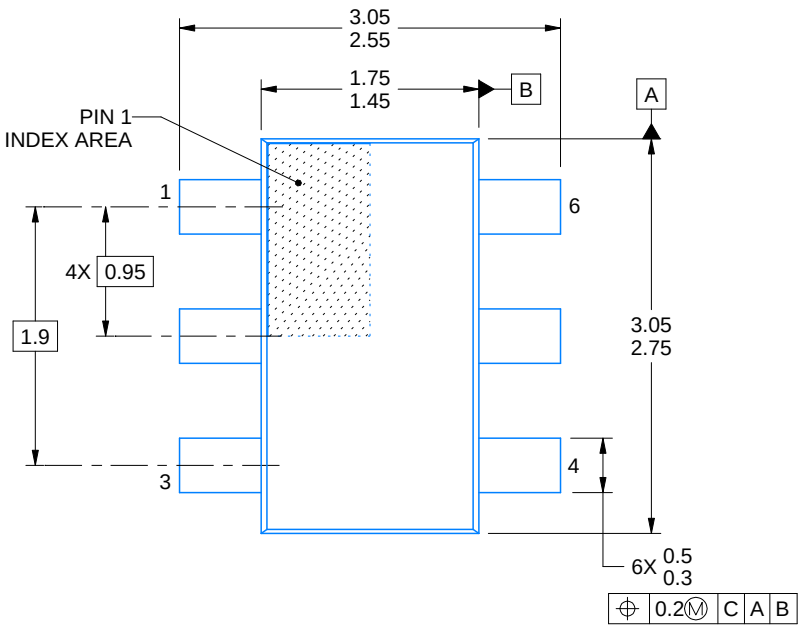
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS27081ADDCR	SOT-23-THIN	DDC	6	3000	184.0	184.0	19.0

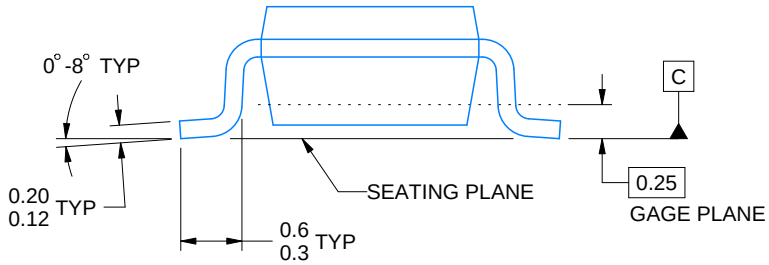
PACKAGE OUTLINE

DDC0006A

SOT - 1.1 max height

SOT





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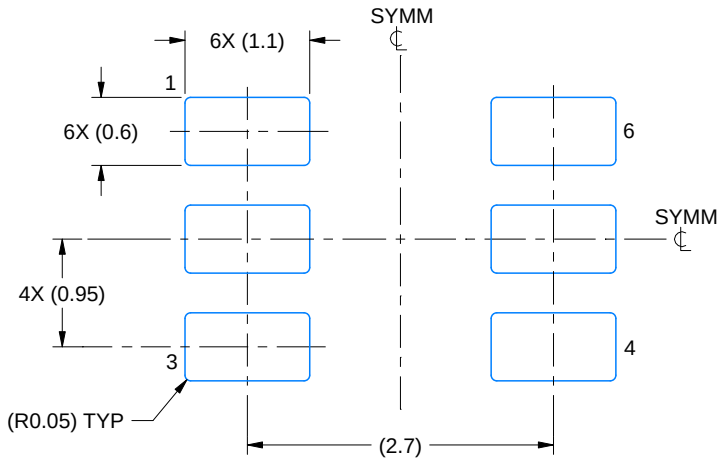
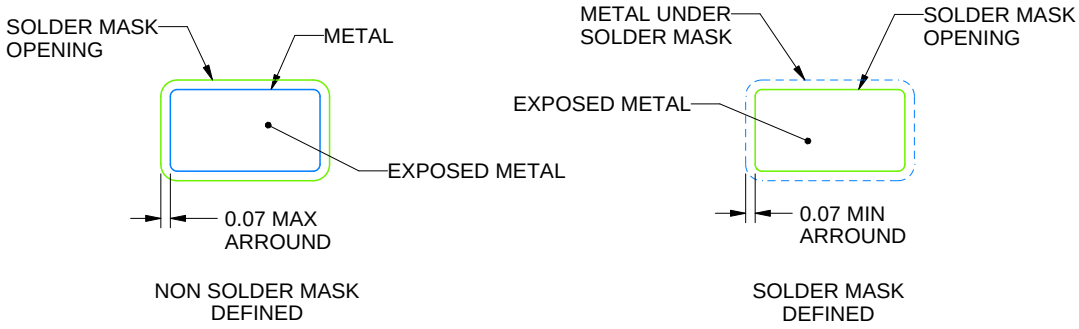
NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Reference JEDEC MO-193.



LAND PATTERN EXAMPLE
EXPLOSED METAL SHOWN
SCALE:15X



SOLDERMASK DETAILS

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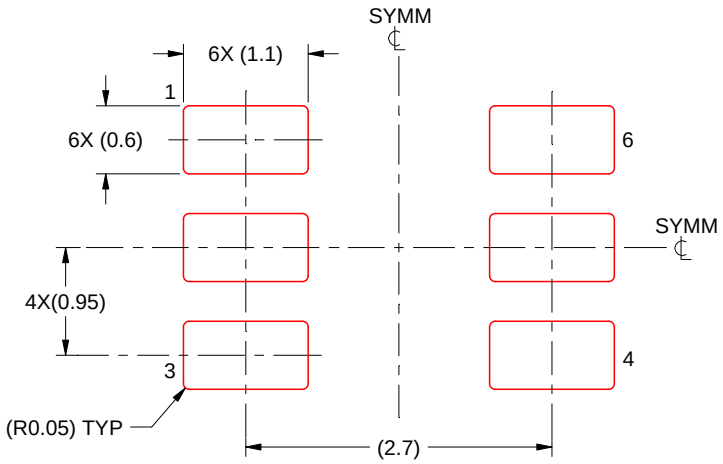
NOTES: (continued)

4. Publication IPC-7351 may have alternate designs.
5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 THICK STENCIL
SCALE:15X

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NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
7. Board assembly site may have different recommendations for stencil design.

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