

## FEATURES

- SIM Power Supply: 1.8V/3V at 50mA
- Input Voltage Range: 3V to 6V
- Controller Voltage Range: 1.2V to 4.4V
- 14kV ESD on all SIM Contact Pins
- Meets all ETSI, IMT-2000 and ISO7816 SIM/Smart Card Interface Requirements
- Level Translators to 1.8V or 3V
- 20 $\mu$ A Operating Current
- Logic Controlled Shutdown ( $I_{SD} < 1\mu$ A)
- Available in 0.75mm Profile, 3mm  $\times$  3mm QFN Package

## APPLICATIONS

- SIM Interface in 3G Cellular Telephones
- Smart Card Readers

## DESCRIPTION

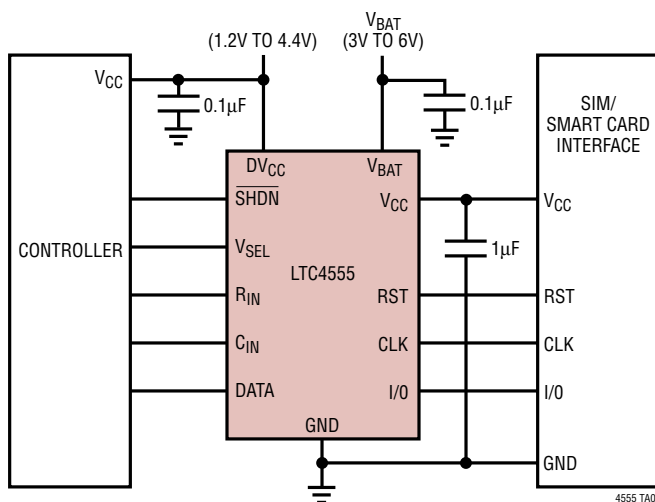
The LTC<sup>®</sup>4555 provides power conversion and signal level shifting needed for low voltage 2.5G and 3G cellular telephones to interface with 1.8V or 3V subscriber identity modules (SIMs). The part meets all type approval requirements for 1.8V and 3V SIMs and smart cards. The part contains an LDO linear regulator to supply SIM power at either 1.8V or 3V from a 3V to 6V input. The output voltage is selected with a single pin and up to 50mA of load current can be supplied.

Internal level translators allow controllers operating with supplies as low as 1.2V to interface with 1.8V or 3V smart cards. Battery life is maximized by 20 $\mu$ A operating current and <1 $\mu$ A shutdown current. Board area is minimized by the 3mm  $\times$  3mm leadless QFN package.

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## TYPICAL APPLICATION

Typical SIM Interface



## ABSOLUTE MAXIMUM RATINGS

(Note 1)

$V_{BAT}$ , $DV_{CC}$ , $V_{CC}$ to GND .....	-0.3V to 6.5V
Digital Inputs to GND .....	-0.3V to 6.5V
CLK, RST, I/O to GND .....	-0.3V to $V_{CC} + 0.3V$
$V_{CC}$ Short-Circuit Duration .....	Infinite
Operating Temperature Range (Note 2) ..	-40°C to 85°C
Storage Temperature Range .....	-65°C to 125°C
Lead Temperature (Soldering, 10 sec) .....	300°C

## PACKAGE/ORDER INFORMATION

TOP VIEW

UD PACKAGE  
16-LEAD (3mm × 3mm) PLASTIC QFN  
 $T_{JMAX} = 125^{\circ}C$ ,  $\theta_{JA} = 68^{\circ}C/W$ ,  $\theta_{JC} = 4.2^{\circ}C/W$   
EXPOSED PAD (PIN 17) IS GND  
(MUST BE SOLDERED TO PCB)

ORDER PART NUMBER	PART MARKING
LTC4555EUD	LAAA

**Order Options** Tape and Reel: Add #TR  
Lead Free: Add #PBF Lead Free Tape and Reel: Add #TRPBF  
Lead Free Part Marking: <http://www.linear.com/leadfree/>

Consult LTC Marketing for parts specified with wider operating temperature ranges.

## ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at  $T_A = 25^{\circ}C$ .

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS	
$V_{BAT}$ Operating Voltage		●	3	6	V	
$V_{BAT}$ Operating Current	$I_{CC} = 0mA$	●		20	30	$\mu A$
$V_{BAT}$ Shutdown Current	$\overline{SHDN} = 0V$ , $V_{BAT} = 4.5V$	●		1	$\mu A$	
$DV_{CC}$ Operating Voltage		●	1.2	4.4	V	
$DV_{CC}$ Operating Current	$f_{CLK} = 1MHz$	●		5	10	$\mu A$
$DV_{CC}$ Shutdown Current	$\overline{SHDN} = 0V$	●		1	$\mu A$	
$DV_{CC}$ Undervoltage Lockout		●	0.5	1.1	V	
$V_{CC}$ Output Voltage	$V_{SEL} = DV_{CC}$ , $V_{BAT} = 3V$ , $I_{VCC} = 50mA$			2.8	V	
	● $V_{SEL} = DV_{CC}$ , $V_{BAT} = 3.3V$ to $6V$ , $I_{VCC} = 0mA$ to $50mA$	●	2.8	3.0	3.2	V
	● $V_{SEL} = 0$ , $V_{BAT} = 2.6V$ to $6V$ , $I_{VCC} = 0mA$ to $50mA$	●	1.7	1.8	1.9	V
$V_{CC}$ Short-Circuit Current	$V_{CC}$ Shorted to GND	●	60	110	175	mA
<b>Controller Inputs/Outputs</b>						
Input Voltage Range	$\overline{SHDN}$ , $V_{SEL}$ , $R_{IN}$ , $C_{IN}$ , DATA		0	$DV_{CC}$	V	
Input Current ( $I_{IH}/I_{IL}$ )	$\overline{SHDN}$ , $V_{SEL}$ , $R_{IN}$ , $C_{IN}$	●	-100	100	nA	
High Input Threshold Voltage ( $V_{IH}$ )	$R_{IN}$ , $C_{IN}$	●		$0.7 \times DV_{CC}$	V	
Low Input Threshold Voltage ( $V_{IL}$ )	$R_{IN}$ , $C_{IN}$	●	$0.2 \times DV_{CC}$		V	
High Input Threshold Voltage ( $V_{IH}$ )	$\overline{SHDN}$ , $V_{SEL}$	●		1	V	
Low Input Threshold Voltage ( $V_{IL}$ )	$\overline{SHDN}$ , $V_{SEL}$	●	0.4		V	

## ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at  $T_A = 25^\circ\text{C}$ .

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
High Level Input Current ( $I_{IH}$ )	DATA	●	-20		20	$\mu\text{A}$
Low Level Input Current ( $I_{IL}$ )	DATA	●			1	$\text{mA}$
High Level Output Voltage ( $V_{OH}$ )	DATA $I_{OH} = 20\mu\text{A}$ , $I/O = V_{CC}$	●	$0.7 \times DV_{CC}$			V
Low Level Output Voltage ( $V_{OL}$ )	DATA $I_{OL} = -200\mu\text{A}$ , $I/O = 0\text{V}$	●			0.4	V
DATA Pull-Up Resistance	Between DATA and $DV_{CC}$		13	20	30	$\text{k}\Omega$
<b>SIM Inputs/Outputs (<math>V_{CC} = 3\text{V}</math>)</b>						
High Level Output Voltage ( $V_{OH}$ )	$I/O$ , $I_{OH} = 20\mu\text{A}$ , DATA = $DV_{CC}$	●	$0.8 \times V_{CC}$			V
Low Level Output Voltage ( $V_{OL}$ )	$I/O$ , $I_{OL} = -1\text{mA}$ , DATA = $0\text{V}$	●			0.4	V
High Level Output Voltage ( $V_{OH}$ )	RST, CLK, $I_{OH} = 20\mu\text{A}$	●	$0.9 \times V_{CC}$			V
Low Level Output Voltage ( $V_{OL}$ )	RST, CLK, $I_{OL} = -200\mu\text{A}$	●			0.4	V
$I/O$ Pull-Up Resistance	Between $I/O$ and $V_{CC}$		6.5	10	14	$\text{k}\Omega$
<b>SIM Inputs/Outputs (<math>V_{CC} = 1.8\text{V}</math>)</b>						
High Level Output Voltage ( $V_{OH}$ )	$I/O$ , $I_{OH} = 20\mu\text{A}$ , DATA = $DV_{CC}$	●	$0.8 \times V_{CC}$			V
Low Level Output Voltage ( $V_{OL}$ )	$I/O$ , $I_{OL} = -1\text{mA}$ , DATA = $0\text{V}$	●			0.3	V
High Level Output Voltage ( $V_{OH}$ )	RST, CLK, $I_{OH} = 20\mu\text{A}$	●	$0.9 \times V_{CC}$			V
Low Level Output Voltage ( $V_{OL}$ )	RST, CLK, $I_{OL} = -200\mu\text{A}$	●			$0.2 \times V_{CC}$	V
$I/O$ Pull-Up Resistance	Between $I/O$ and $V_{CC}$		6.5	10	14	$\text{k}\Omega$
<b>SIM Timing Parameters</b>						
CLK Rise/Fall Time	$C_{CLK} = 30\text{pF}$ , $V_{CC} = 1.8\text{V}/3\text{V}$	●			18	ns
RST, $I/O$ Rise/Fall Time	RST, $I/O$ Loaded with $30\text{pF}$ , $V_{CC} = 1.8\text{V}/3\text{V}$	●			1	$\mu\text{s}$
Max CLK Frequency			5			MHz
$V_{CC}$ Turn-On Time	$\overline{\text{SHDN}} = 1$ , (Note 3)			0.5		ms
$V_{CC}$ Discharge Time to $1\text{V}$	$\overline{\text{SHDN}} = 0$ , (Note 3)			0.5		ms

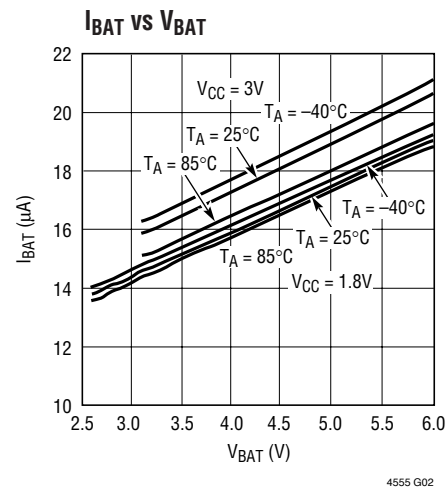
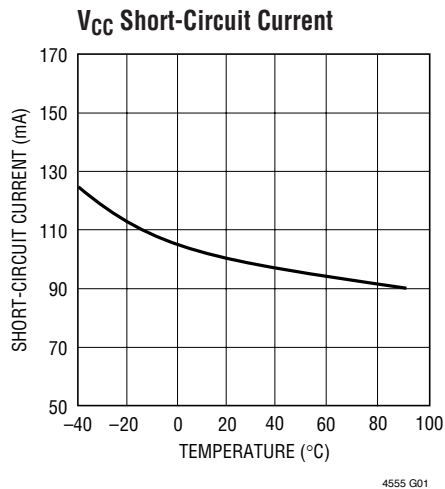
**Note 1:** Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

**Note 2:** The LTC4555E is guaranteed to meet performance specifications from  $0^\circ\text{C}$  to  $85^\circ\text{C}$ . Specifications over the  $-40^\circ\text{C}$  to  $85^\circ\text{C}$  operating

temperature range are assured by design, characterization and correlation with statistical process controls.

**Note 3:** Specification is guaranteed by design and not 100% tested in production.

## TYPICAL PERFORMANCE CHARACTERISTICS



## PIN FUNCTIONS

**SHDN (Pin 1):** Controller Driven Shutdown Pin. This pin should be high (DV<sub>CC</sub>) for normal operation and low to activate a low current shutdown mode.

**V<sub>SEL</sub> (Pin 2):** V<sub>CC</sub> Voltage Select Pin. A low level selects V<sub>CC</sub> = 1.8V while driving this pin to DV<sub>CC</sub> selects V<sub>CC</sub> = 3V.

**DV<sub>CC</sub> (Pin 3):** Supply Voltage for the Controller Side I/O Pins (C<sub>IN</sub>, R<sub>IN</sub>, DATA). When below 1.1V, the V<sub>CC</sub> supply is disabled, placing the LTC4555 in shutdown mode. This pin should be bypassed with a 0.1µF ceramic capacitor close to the pin.

**NC (Pins 4, 6, 12, 16):** No Connect.

**V<sub>BAT</sub> (Pin 5):** V<sub>CC</sub> Supply Input. This pin can be between 3V and 6V for normal operation. V<sub>BAT</sub> quiescent current reduces to <1µA in shutdown. This pin should be bypassed with a 0.1µF ceramic capacitor close to the pin.

**V<sub>CC</sub> (Pin 7):** SIM Card V<sub>CC</sub> Supply. A 1µF low ESR capacitor needs to be connected close to the V<sub>CC</sub> pin for stable operation. This pin is discharged to GND during shutdown.

**I/O (Pin 8):** SIM-Side Data I/O. The SIM card output must be on an open drain driver capable of sourcing >1mA.

**RST (Pin 9):** Reset Output Pin for the SIM Card.

**GND (Pin 10):** Ground for the SIM and Controller. Proper grounding and bypassing is required to meet 14kV ESD specifications. Exposed pad must also be connected to GND.

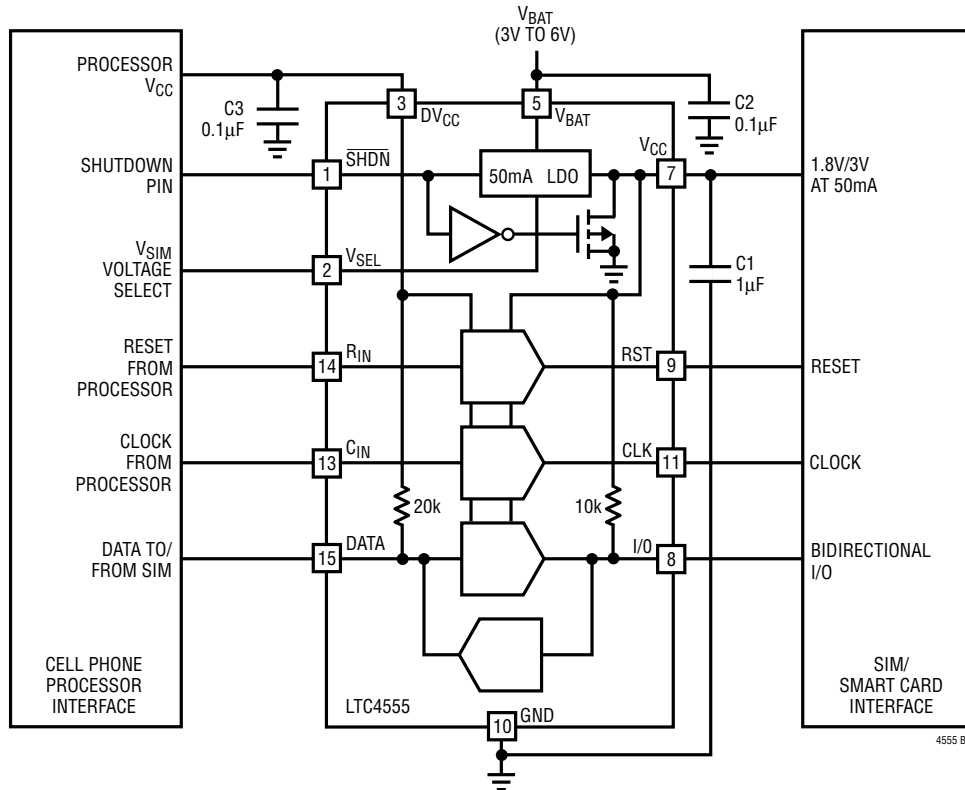
**CLK (Pin 11):** Clock Output Pin for the SIM Card. This pin is pulled to ground during shutdown. Fast rising and falling edges necessitate careful board layout for the CLK node.

**C<sub>IN</sub> (Pin 13):** Clock Input from the Controller.

**R<sub>IN</sub> (Pin 14):** Reset Input from the Controller.

**DATA (Pin 15):** Controller Side Data I/O. This pin is used for bidirectional data transfer. The controller output must be an open-drain configuration. The open-drain output must be capable of sinking greater than 1mA.

# BLOCK DIAGRAM



## APPLICATIONS INFORMATION

The LTC4555 provides both regulated power and internal level translators to allow low voltage controllers to interface with 1.8V or 3V SIMs or smart cards. The part meets all ETSI, IMT-2000 and ISO7816 requirements for SIM and smart card interfaces.

### V<sub>CC</sub> Voltage Regulator

The V<sub>CC</sub> voltage regulator is a 50mA low dropout (LDO) regulator with a digitally selected 1.8V or 3V output.

The output voltage is selected via the V<sub>SEL</sub> pin. The output is internally current limited and is capable of surviving an indefinite short to GND.

The V<sub>CC</sub> output should be bypassed with a 1 $\mu$ F capacitor. The LTC4555 can use either a low ESR ceramic capacitor or a tantalum electrolytic capacitor on the V<sub>CC</sub> pin, with no special ESR requirements.

V<sub>BAT</sub> should be bypassed with a 0.1 $\mu$ F ceramic capacitor.

### Level Translators

All SIMs and smart cards contain a clock input, a reset input and a bidirectional data input/output. The LTC4555 provides level translators to allow controllers to commu-

nicate with the SIM. The CLK and RST lines to the SIM are level shifted from the controller supply (GND to DV<sub>CC</sub>) to the SIM supply (GND to V<sub>CC</sub>). The data input to the SIM requires an open-drain output on the controller. On-chip pull-up resistors are provided for both the DATA and I/O lines.

### Shutdown Modes

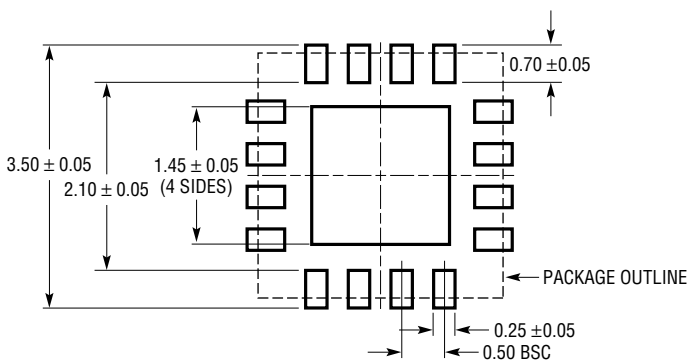
The LTC4555 can enter a low current shutdown mode by one of two methods. First, the SHDN pin is an active low input that the controller can use to directly shut down the part. The other way is to lower DV<sub>CC</sub> below 1.1V at which point and undervoltage lockout circuit puts the part into shutdown mode.

### ESD Protection

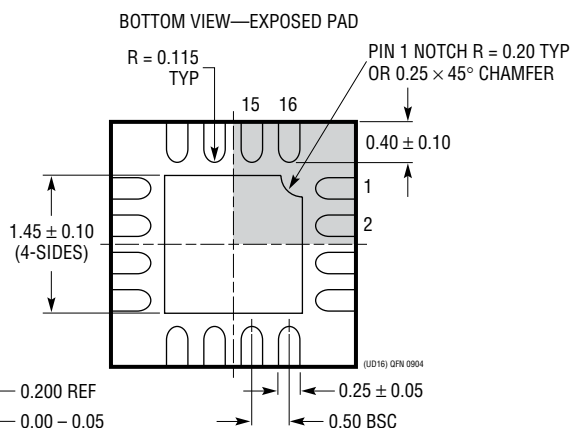
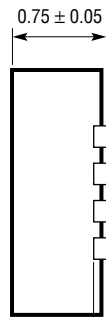
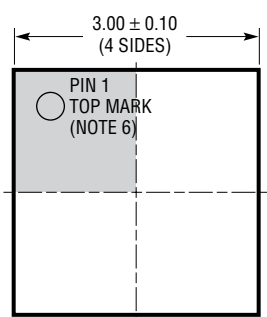
All pins that connect to the SIM/smart card will withstand 14kV of human body model ESD. In order to ensure proper ESD protection, careful board layout is required. The GND pin should be tied directly to a GND plane. The V<sub>CC</sub> capacitor should be located very close to the V<sub>CC</sub> pin and tied directly to the GND plane.

# PACKAGE DESCRIPTION

**UD Package**  
**16-Lead Plastic QFN (3mm × 3mm)**  
 (Reference LTC DWG # 05-08-1691)



RECOMMENDED SOLDER PAD PITCH AND DIMENSIONS



- NOTE:
1. DRAWING CONFORMS TO JEDEC PACKAGE OUTLINE MO-220 VARIATION (WEED-2)
  2. DRAWING NOT TO SCALE
  3. ALL DIMENSIONS ARE IN MILLIMETERS
  4. DIMENSIONS OF EXPOSED PAD ON BOTTOM OF PACKAGE DO NOT INCLUDE MOLD FLASH. MOLD FLASH, IF PRESENT, SHALL NOT EXCEED 0.15mm ON ANY SIDE
  5. EXPOSED PAD SHALL BE SOLDER PLATED
  6. SHADED AREA IS ONLY A REFERENCE FOR PIN 1 LOCATION ON THE TOP AND BOTTOM OF PACKAGE

## RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LTC1514	50mA, 650kHz, Step-Up/Down Charge Pump with Low Battery Comparator	$V_{IN} = 2.7V$ to 10V, $V_{OUT} = 3V/5V$ , $I_Q = 60\mu A$ , $I_{SD} = 10\mu A$ , S8 Package
LTC1515	50mA, 650kHz, Step-Up/Down Charge Pump with Power On Reset	$V_{IN} = 2.7V$ to 10V, $V_{OUT} = 3.3V$ or 5V, $I_Q = 60\mu A$ , $I_{SD} = <1\mu A$ , S8 Package
LTC1555/LTC1556	650kHz, SIM Power Supply and Level Translator for 3V/5V SIM Cards	$V_{IN} = 2.7V$ to 10V, $V_{OUT} = 3V/5V$ , $I_Q = 60\mu A$ , $I_{SD} = <1\mu A$ , SSOP-16, SSOP-20 Packages
LTC1555L	1MHz, SIM Power Supply and Level Translator for 3V/5V SIM Cards	$V_{IN} = 2.6V$ to 6.6V, $V_{OUT} = 3V/5V$ , $I_Q = 40\mu A$ , $I_{SD} = <1\mu A$ , SSOP-16 Package
LTC1555L-1.8	1MHz, SIM Power Supply and Level Translator for 1.8V/3V/5V SIM Cards	$V_{IN} = 2.6V$ to 6.6V, $V_{OUT} = 1.8V/3V/5V$ , $I_Q = 32\mu A$ , $I_{SD} = <1\mu A$ , SSOP-16 Package
LTC1755/LTC1756	Smart Card Interface with Serial Control for 3V/5V Smart Card Applications	$V_{IN} = 2.7V$ to 7V, $V_{OUT} = 3V/5V$ , $I_Q = 60\mu A$ , $I_{SD} = <1\mu A$ , SSOP-16, SSOP-24 Packages
LTC1955	Dual Smart Card Interface with Serial Control for 1.8V/3V/5V Smart Card Applications	$V_{IN} = 3V$ to 6V, $V_{OUT} = 1.8V/3V$ , $I_Q = 200\mu A$ , $I_{SD} = <1\mu A$ , QFN-32 Package
LTC1986	900kHz, SIM Power Supply for 3V/5V SIM Cards	$V_{IN} = 2.6V$ to 4.4V, $V_{OUT} = 3V/5V$ , $I_Q = 14\mu A$ , $I_{SD} = <1\mu A$ , ThinSOT™ Package
LTC3250-1.5	250mA, 1.5MHz, High Efficiency Step-Down Charge Pump	85% Efficiency, $V_{IN} = 3.1V$ to 5.5V, $V_{OUT} = 1.5V$ , $I_Q = 35\mu A$ , $I_{SD} = <1\mu A$ , ThinSOT Package
LTC3251	500mA, 1MHz-16MHz, Spread Spectrum, Step-Down Charge Pump	85% Efficiency, $V_{IN} = 3.1V$ to 5.5V, $V_{OUT} = 0.9V$ to 1.6V, $I_Q = 9\mu A$ , $I_{SD} = <1\mu A$ , MS Package

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