

# OP-07

*OP-07 Low Offset, Low Drift Operational Amplifier*



Literature Number: SNOS556A

## OP-07 Low Offset, Low Drift Operational Amplifier

### General Description

The OP-07 has very low input offset voltage which is obtained by trimming at the wafer stage. These low offset voltages generally eliminate any need for external nulling. The OP-07 also features low input bias current and high open-loop gain. The low offsets and high open-loop gain make the OP-07 particularly useful for high-gain applications.

The wide input voltage range of  $\pm 13V$  minimum combined with high CMRR of 110 dB and high input impedance provide high accuracy in the non-inverting circuit configuration. Excellent linearity and gain accuracy can be maintained even at high closed-loop gains.

Stability of offsets and gain with time or variation in temperature is excellent.

The OP-07 is available in TO-99 metal can, ceramic or molded DIP.

For improved specifications, see the LM607.

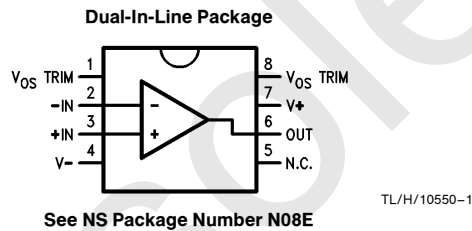
### Features

- Low  $V_{OS}$  75  $\mu V$  Max
- Low  $V_{OS}$  Drift 0.6  $\mu V/^{\circ}C$  Max
- Ultra-Stable vs Time 1.0  $\mu V$ /Month Max
- Low Noise 0.6  $\mu V$ p-p Max
- Wide Input Voltage Range  $\pm 14V$
- Wide Supply Voltage Range  $\pm 3V$  to  $\pm 18V$
- Fits 725/108A/308A, 741, AD510 Sockets
- Replaces the  $\mu A714$

### Applications

- Strain Gauge Amplifiers
- Thermocouple Amplifiers
- Precision Reference Buffer
- Analog Computing Functions

### Connection Diagram



### Ordering Information

$T_A = 25^{\circ}C$ $V_{OS}Max$ ( $\mu V$ )	N08E Plastic	Operating Temperature Range
75	OP07EP	COM
150	OP07CP	COM
150	OP07DP	COM

\*Also available per SMD #8203602

## Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

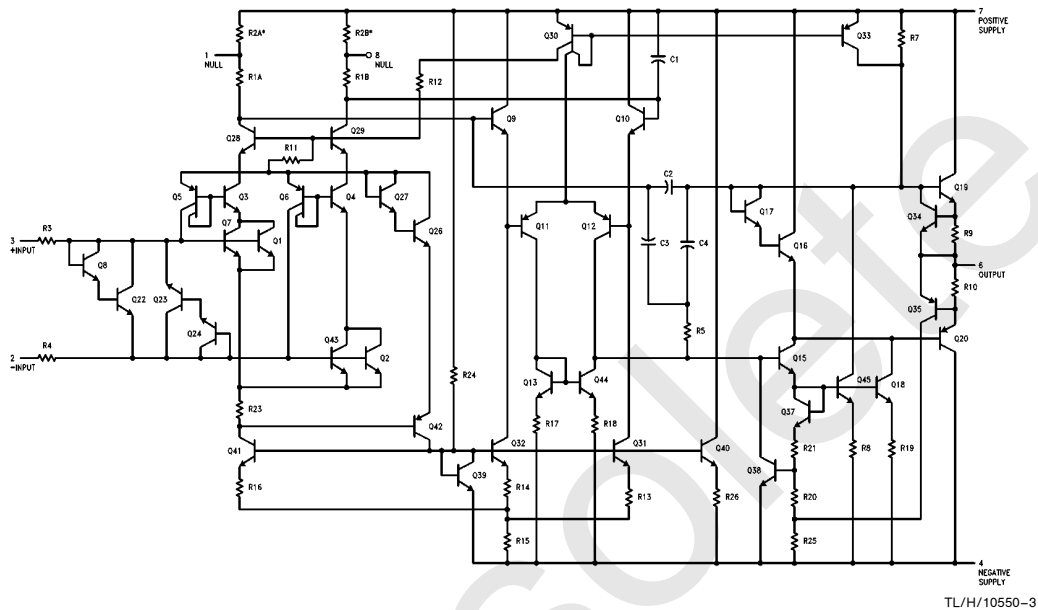
Supply Voltage	±22V
Internal Power Dissipation (Note 5)	500 mW
Differential Input Voltage	±30V
Input Voltage (Note 6)	±22V
Output Short-Circuit Duration	Continuous

Storage Temperature Range	-65°C to +150°C
Lead Temperature (Soldering, 60 sec.)	260°C
Junction Temperature	-65°C to +150°C

## Operating Temperature Range

OP-07E, OP-07C, OP-07D	0°C to +70°C
------------------------	--------------

## Simplified Schematic



\*R2A and R2B are electronically trimmed on chip at the factory for minimum offset voltage.

## Electrical Characteristics

Unless otherwise specified,  $V_S = \pm 15V$ ,  $T_A = 25^\circ C$ . **Boldface** type refers to limits over  $0^\circ C \leq T_A \leq 70^\circ C$

Symbol	Parameter	Conditions	OP-07E			OP-07C			Units
			Min	Typ	Max	Min	Typ	Max	
$V_{OS}$	Input Offset Voltage	(Note 1)		30 <b>45</b>	75 <b>130</b>		60 <b>85</b>	150 <b>250</b>	$\mu V$
$V_{OS/t}$	Long-Term $V_{OS}$ Stability	(Note 2)		0.3	1.5		0.4	2.0	$\mu V/Mo$
$I_{OS}$	Input Offset Current			0.5 <b>0.9</b>	3.8 <b>5.3</b>		0.8 <b>1.6</b>	6.0 <b>8.0</b>	nA
$I_B$	Input Bias Current			$\pm 1.2$ $\pm$ <b>1.5</b>	$\pm 4.0$ $\pm$ <b>5.5</b>		$\pm 1.8$ $\pm$ <b>2.2</b>	$\pm 7.0$ $\pm$ <b>9.0</b>	nA
$e_{np-p}$	Input Noise Voltage	0.1 Hz to 10 Hz (Note 3)		0.35	0.6		0.38	0.65	$\mu V_{p-p}$
$e_n$	Input Noise Voltage Density	$f_O = 10$ Hz $f_O = 100$ Hz (Note 3) $f_O = 1000$ Hz		10.3 10.0 9.6	18.0 13.0 11.0		10.5 10.2 9.8	20.0 13.5 11.5	$nV/\sqrt{Hz}$
$i_{np-p}$	Input Noise Current	0.1 Hz to 10 Hz (Note 3)		14	30		15	35	$pA_{p-p}$
$i_n$	Input Noise Current Density	$f_O = 10$ Hz $f_O = 100$ Hz (Note 3) $f_O = 1000$ Hz		0.32 0.14 0.12	0.80 0.23 0.17		0.35 0.15 0.13	0.90 0.27 0.18	$pA/\sqrt{Hz}$
$R_{IN}$	Input Resistance Differential-Mode	(Note 4)	15	50		8	33		$M\Omega$
$R_{INCM}$	Input Resistance Common-Mode			160			120		$G\Omega$
IVR	Input Voltage Range		$\pm 13.0$	$\pm 14.0$		$\pm 13$	$\pm 14$		V
CMRR	Common-Mode Rejection Ratio	$V_{CM} = \pm 13V$	106 <b>103</b>	123 <b>123</b>		100 <b>97</b>	120 <b>120</b>		dB
PSRR	Power Supply Rejection Ratio	$V_S = \pm 3V$ to $\pm 18V$ $V_S = \pm 3V$ to $\pm 18V$		5 <b>7</b>	20 <b>32</b>		7 <b>10</b>	32 <b>51</b>	$\mu V/V$
$A_{VO}$	Large Signal Voltage Gain	$R_L \geq 2$ k $\Omega$ , $V_O = \pm 10V$ $R_L \geq 2$ k $\Omega$ $R_L \geq 500\Omega$ , $V_O = \pm 0.5V$ , $V_S = \pm 3V$ (Note 4)	200 <b>180</b> 150	500 <b>450</b> 400		120 <b>100</b> 100	400 <b>400</b> 400		V/mV
$V_O$	Output Voltage Swing	$R_L \geq 10$ k $\Omega$ $R_L \geq 2$ k $\Omega$ $R_L \geq 2$ k $\Omega$ $R_L \geq 1$ k $\Omega$	$\pm 12.5$ $\pm 12.0$ $\pm$ <b>12.0</b> $\pm 10.5$	$\pm 13.0$ $\pm 12.8$ $\pm$ <b>12.6</b> $\pm 12.0$		$\pm 12.0$ $\pm 11.5$ $\pm$ <b>11.0</b>	$\pm 13.0$ $\pm 12.8$ $\pm$ <b>12.6</b> $\pm 12.0$		V
SR	Slew Rate	$R_L \geq 2$ k $\Omega$ (Note 3)	0.1	0.3		0.1	0.3		$V/\mu s$
BW	Closed-Loop Bandwidth	$A_{VCL} = +1$ (Note 3)	0.4	0.6		0.4	0.6		MHz
$R_O$	Output Resistance	$V_O = 0$ , $I_O = 0$		60			60		$\Omega$
$P_d$	Power Consumption	$V_S = \pm 15V$ , No Load $V_S = \pm 3V$ , No Load		75 4	120 6		80 4	150 8	mW
	Offset Adj. Range	$R_P = 20$ k $\Omega$		$\pm 4$			$\pm 4$		mV
TCV <sub>OS</sub>	Average Input Offset Voltage Drift Without External Trim	(Note 4)		<b>0.3</b>	<b>1.3</b>		<b>0.5</b>	<b>1.8</b>	$\mu V/^\circ C$
TCV <sub>OSn</sub>	With External Trim	$R_P = 20$ k $\Omega$ (Note 4)		<b>0.3</b>	<b>1.3</b>		<b>0.4</b>	<b>1.6</b>	
TCI <sub>OS</sub>	Average Input Offset Current Drift	(Note 3)		<b>8</b>	<b>35</b>		<b>12</b>	<b>50</b>	$pA/^\circ C$
TCI <sub>B</sub>	Average Input Bias Current Drift	(Note 3)		<b>13</b>	<b>35</b>		<b>18</b>	<b>50</b>	$pA/^\circ C$

## Electrical Characteristics

Unless otherwise specified,  $V_S = \pm 15V$ ,  $T_A = 25^\circ C$ . **Boldface** type refers to limits over  $0^\circ C \leq T_A \leq + 70^\circ C$

Symbol	Parameter	Conditions	OP-07D			Units
			Min	Typ	Max	
$V_{OS}$	Input Offset Voltage	(Note 1)		60 <b>85</b>	150 <b>250</b>	$\mu V$
$V_{OS/t}$	Long-Term $V_{OS}$ Stability	(Note 2)		0.5	3.0	$\mu V/Mo$
$I_{OS}$	Input Offset Current			0.8 <b>1.6</b>	6.0 <b>8.0</b>	nA
$I_B$	Input Bias Current			$\pm 2.0$ $\pm$ <b>3.0</b>	$\pm 12.0$ $\pm$ <b>14.0</b>	nA
$e_{np-p}$	Input Noise Voltage	0.1 Hz to 10 Hz (Note 3)		0.38	0.65	$\mu Vp-p$
$e_n$	Input Noise Voltage Density	$f_O = 10$ Hz $f_O = 100$ Hz (Note 3) $f_O = 1000$ Hz		10.5 10.3 9.8	20.0 13.5 11.5	$nV/\sqrt{Hz}$
$i_{np-p}$	Input Noise Current	0.1 Hz to 10 Hz (Note 3)		15	35	$pAp-p$
$i_n$	Input Noise Current Density	$f_O = 10$ Hz $f_O = 100$ Hz (Note 3) $f_O = 1000$ Hz		0.35 0.15 0.13	0.90 0.27 0.18	$pA/\sqrt{Hz}$
$R_{IN}$	Input Resistance Differential-Mode	(Note 4)	7	31		$M\Omega$
$R_{INCM}$	Input Resistance Common-Mode			120		$G\Omega$
IVR	Input Voltage Range		$\pm 13$	$\pm 14$		V
CMRR	Common-Mode Rejection Ratio	$V_{CM} = \pm 13V$	94 <b>94</b>	110 <b>106</b>		dB
PSRR	Power Supply Rejection Ratio	$V_S = \pm 3V$ to $\pm 18V$		7 <b>10</b>	32 <b>51</b>	$\mu V/V$
$A_{VO}$	Large Signal Voltage Gain	$R_L \leq 2$ k $\Omega$ , $V_O = \pm 10V$ $R_L = 2$ k $\Omega$ , $V_O = \pm 10V$ $R_L \geq 500\Omega$ , $V_O = \pm 0.5V$ , $V_S \pm 3V$ (Note 4)	120 <b>100</b>	400 <b>400</b> 400		V/mV
$V_O$	Output Voltage Swing	$R_L \geq 10$ k $\Omega$ $R_L \geq 2$ k $\Omega$ $R_L \geq 2$ k $\Omega$ $R_L \geq 1$ k $\Omega$	$\pm 12.0$ $\pm 11.5$ $\pm$ <b>11.0</b>	$\pm 13.0$ $\pm 12.8$ $\pm$ <b>12.6</b> $\pm 12.0$		V
SR	Slew Rate	$R_L \geq 2$ k $\Omega$ (Note 3)	0.1	0.3		$V/\mu s$
BW	Closed-Loop Bandwidth	$A_{VCL} = +1$ (Note 3)	0.4	0.6		MHz
RO	Output Resistance	$V_O = 0$ , $I_O = 0$		60		$\Omega$
$P_d$	Power Consumption	$V_S = \pm 15V$ , No Load $V_S = \pm 3V$ , No Load		80 4	150 8	mW
	Offset Adj. Range	$R_P = 20$ k $\Omega$		$\pm 4$		mV
$TCV_{OS}$	Average Input Offset Voltage Drift Without External Trim	(Note 4)		<b>0.7</b>	<b>2.5</b>	$\mu V/^\circ C$
$TCV_{OSn}$	With External Trim	$R_P = 20$ k $\Omega$ (Note 4)		<b>0.7</b>	<b>2.5</b>	$\mu V/^\circ C$
$TCI_{OS}$	Average Input Offset Current Drift	(Note 3)		<b>12</b>	<b>50</b>	$pA/^\circ C$
$TCI_B$	Average Input Bias Current Drift	(Note 3)		<b>18</b>	<b>50</b>	$pA/^\circ C$

**Note 1:**  $V_{OS}$  is measured approximately 0.5 second after application of power.

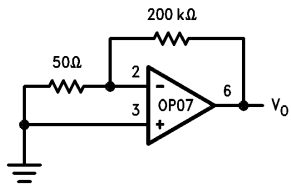
**Note 2:** Long-Term Offset Voltage Stability refers to the averaged trend line of  $V_{OS}$  vs Time over extended periods after the first 30 days of operation. Excluding the initial hour of operation, changes in  $V_{OS}$  during the first 30 operating days are typically  $2.5 \mu V$ . Parameter is sample tested.

**Note 3:** Sample Tested.

**Note 4:** Guaranteed by design.

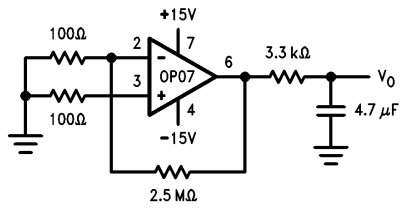
## Test Circuits

### Offset Voltage Test Circuit



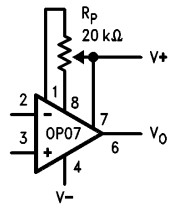
TL/H/10550-4

### Low Frequency Noise Test Circuit



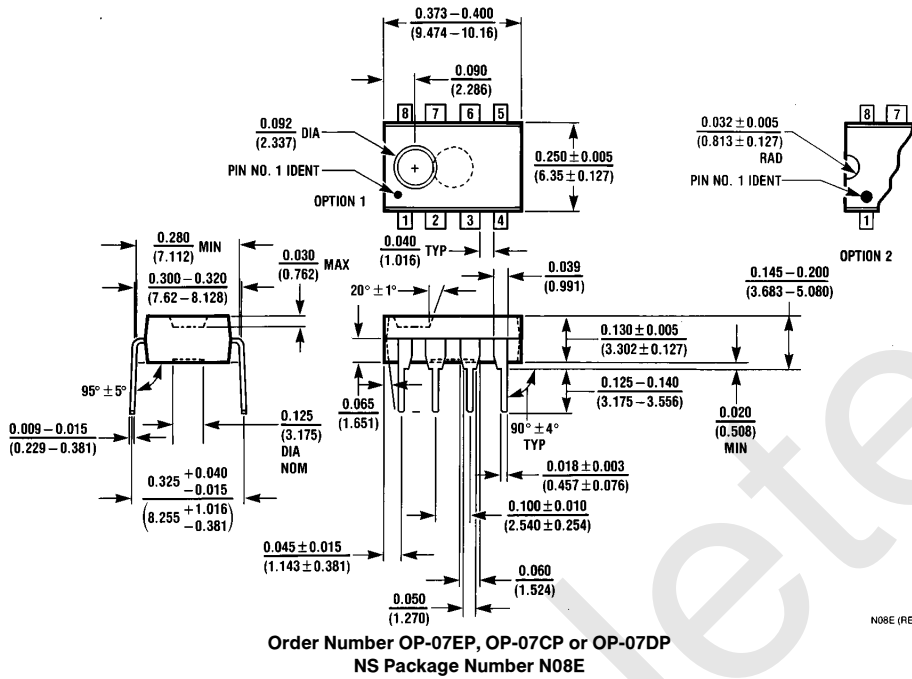
TL/H/10550-5

### Optional Offset Nulling Circuit



TL/H/10550-6

**Physical Dimensions** inches (millimeters) (Continued)



**LIFE SUPPORT POLICY**

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.



**National Semiconductor Corporation**  
1111 West Bardin Road  
Arlington, TX 76017  
Tel: 1(800) 272-9959  
Fax: 1(800) 737-7018

**National Semiconductor Europe**  
Fax: (+49) 0-180-530 85 86  
Email: cnjwge@tevm2.nsc.com  
Deutsch Tel: (+49) 0-180-530 85 85  
English Tel: (+49) 0-180-532 78 32  
Français Tel: (+49) 0-180-532 93 58  
Italiano Tel: (+49) 0-180-534 16 80

**National Semiconductor Hong Kong Ltd.**  
13th Floor, Straight Block,  
Ocean Centre, 5 Canton Rd.  
Tsimshatsui, Kowloon  
Hong Kong  
Tel: (852) 2737-1600  
Fax: (852) 2736-9960

**National Semiconductor Japan Ltd.**  
Tel: 81-043-299-2309  
Fax: 81-043-299-2408

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Mobile Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Transportation and Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

TI E2E Community Home Page

[e2e.ti.com](http://e2e.ti.com)

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2011, Texas Instruments Incorporated