

## FEATURES

- Micropower Operation
- Single 5V or  $\pm 15V$  Supply Operation
- Low Charge Injection
- Low  $R_{ON}$
- Low Leakage
- Guaranteed Break Before Make
- Latch Resistant Design
- TTL/CMOS Compatible
- Improved Second Source for DG201A/DG202

## KEY SPECIFICATIONS

- Supply Current .....  $I^+ = 40\mu A, I^- = 5\mu A$  Max
- Charge Injection
  - $\pm 15V$  Supplies .....  $\pm 25pC$  Max
  - Single 5V Supply ..... 2pC Typ
- $R_{ON}$  ..... 65 $\Omega$  Typ
- Signal Range .....  $\pm 15V$

## DESCRIPTION

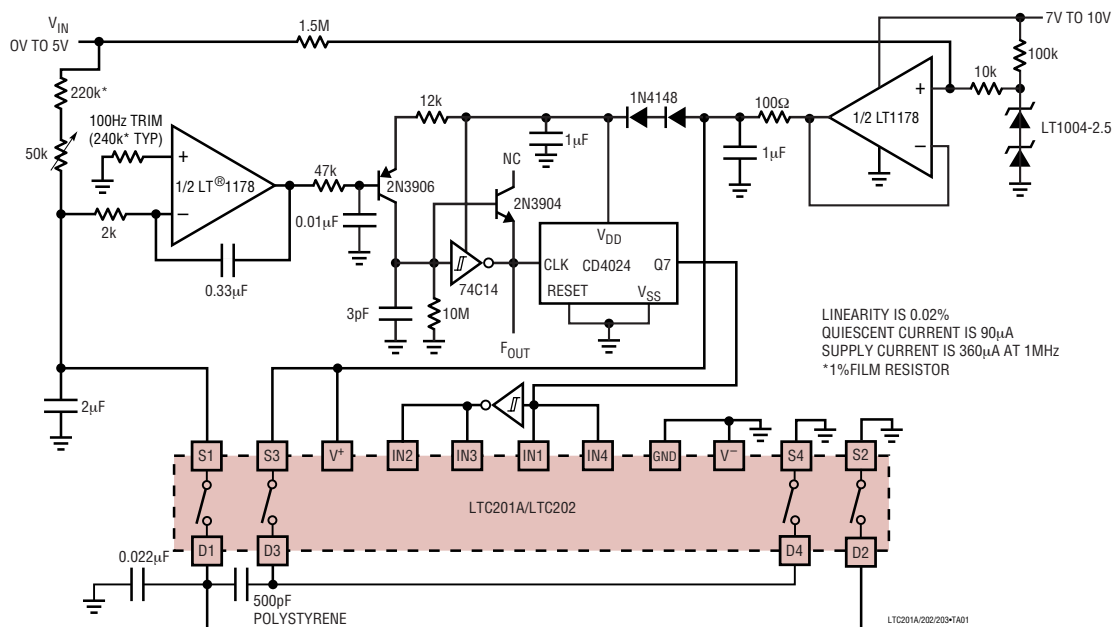
The LTC<sup>®</sup>201A, LTC202, and LTC203 are micropower, quad CMOS analog switches which typically dissipate only 250 $\mu W$  from  $\pm 15V$  supplies and 40 $\mu W$  from a single 5V supply. The switches have 65 $\Omega$  typical on resistance and a very high off resistance. A break-before-make characteristic, inherent in these switches, prevents the shorting of two channels. With a supply voltage of  $\pm 15V$ , the signal range is  $\pm 15V$ . These switches have special charge compensation circuitry which greatly reduces charge injection to a maximum of  $\pm 25pC$  ( $\pm 15V$  supplies).

The LTC201A, LTC202, and LTC203 are designed for applications such as programmable gain amplifiers, analog multiplexers, sample-and-hold circuits, precision charge switching and remote switching. These three devices are differentiated by the type of switch action, as shown in the logic table.

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## TYPICAL APPLICATION

Micropower 100Hz to 1MHz V-to-F Converter



# LTC201A/LTC202/LTC203

## ABSOLUTE MAXIMUM RATINGS

(Note 1)

Voltages Referenced to  $V^-$

$V^+$ .....	44V
GND .....	25V
Digital Inputs, S, D (Note 2) .....	-2V to ( $V^+ + 2V$ ) or 20mA, Whichever Occurs First

Current

Any Input Except S or D .....	30mA
Continuous S or D .....	20mA
Peak S or D (Pulsed at 1ms, 10% Duty Cycle Max) .....	70mA
ESD Susceptibility (Note 3) .....	4kV
Power Dissipation (Plastic) .....	500mW
Power Dissipation (Ceramic) .....	900mW

Operating Temperature Range

LTC201AC/LTC202C/LTC203C .....	0°C to 70°C
LTC201AM/LTC202M/LTC203M .....	-55°C to 125°C
Storage Temperature Range .....	-65°C to 150°C
Lead Temperature (Soldering, 10 sec) .....	300°C

## LOGIC TABLE

$IN_x$	LTC201A	LTC202	LTC203	
	IN1 TO IN4	IN1 TO IN4	IN1, IN4	IN2, IN3
0	ON	OFF	OFF	ON
1	OFF	ON	ON	OFF

## PACKAGE/ORDER INFORMATION

TOP VIEW

N PACKAGE  
16-LEAD PDIP  
 $T_{JMAX} = 110^\circ\text{C}$ ,  $\theta_{JA} = 120\text{C/W}$

S PACKAGE  
16-LEAD PLASTIC SO  
 $T_{JMAX} = 110^\circ\text{C}$ ,  $\theta_{JA} = 130\text{C/W}$

J PACKAGE  
16-LEAD CERDIP  
 $T_{JMAX} = 150^\circ\text{C}$ ,  $\theta_{JA} = 100\text{C/W}$

ORDER PART NUMBER

LTC201ACN  
LTC201ACS  
LTC202CN  
LTC202CS  
LTC203CN  
LTC203CS

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ORDER PART NUMBER

LTC201AMJ  
LTC201ACJ  
LTC202MJ  
LTC202CJ  
LTC203MJ  
LTC203CJ

**OBSELETE PACKAGE**

Consider the N16 or SO-16 Package for Alternate Source

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

## DIGITAL AND DC ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over full operating temperature range, otherwise specifications are at  $T_A = 25^\circ\text{C}$ .  $V^+ = 15\text{V}$ ,  $V^- = -15\text{V}$ ,  $\text{GND} = 0\text{V}$ .

PARAMETER	CONDITIONS	LTC201AM/LTC202M/ LTC203M			LTC201AC/LTC202C/ LTC203C			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Analog Signal Range				±15			±15	V
$R_{ON}$	$V_S = \pm 10\text{V}$ $I_D = 1\text{mA}$	$T_{MIN}$		110			125	$\Omega$
		25°C		65	110	65	125	$\Omega$
		$T_{MAX}$			160			160
$\Delta R_{ON}$ vs $V_S$			20		20			%
$\Delta R_{ON}$ vs Temperature			0.5		0.5			%/°C
$R_{ON}$ Match	$V_S = 0\text{V}$ , $I_{DS} = 1\text{mA}$		5		5			%
Off Input Leakage $I_S$ (OFF)	$V_D = \pm 14\text{V}$ , $V_S = \pm 14\text{V}$ Switch Off		0.01	±1 ±100		0.01	±5 ±100	nA nA

201a23fb

## DIGITAL AND DC ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over full operating temperature range, otherwise specifications are at  $T_A = 25^\circ\text{C}$ .  $V^+ = 15\text{V}$ ,  $V^- = -15\text{V}$ ,  $\text{GND} = 0\text{V}$ .

PARAMETER	CONDITIONS		LTC201AM/LTC202M/ LTC203M			LTC201AC/LTC202C/ LTC203C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Off Output Leakage $I_D$ (OFF)	$V_D = \pm 14\text{V}$ , $V_S = \pm 14\text{V}$ Switch Off	●		0.01	$\pm 1$ $\pm 100$		0.01	$\pm 5$ $\pm 100$	nA nA
On Channel Leakage $I_D$ (ON)	$V_D = V_S = \pm 14\text{V}$ Switch On			0.02	$\pm 1$		0.02	$\pm 5$	nA
		●			$\pm 200$			$\pm 200$	nA
Input High Voltage $V_{\text{INH}}$		●	2.4			2.4			V
Input Low Voltage $V_{\text{INL}}$		●			0.8			0.8	V
Input High or Low Current $I_{\text{INH}}$ and $I_{\text{INL}}$	$V_{\text{IN}} = 15\text{V}$ , $0\text{V}$	●			$\pm 1$			$\pm 1$	$\mu\text{A}$
$C_S$ (OFF)				5			5		pF
$C_D$ (OFF)				12			12		pF
$C_D$ , $C_S$ (ON)				30			30		pF
$I^+$	All Logic Inputs Tied Together		16		40		16	40	$\mu\text{A}$
	$V_{\text{IN}} = 0\text{V}$ or $4.0\text{V}$	●			60			60	$\mu\text{A}$
$I^-$				0.1	5		0.1	5	$\mu\text{A}$
		●			10			10	$\mu\text{A}$

## AC ELECTRICAL CHARACTERISTICS

$V^+ = 15\text{V}$ ,  $V^- = -15\text{V}$ ,  $\text{GND} = 0\text{V}$  unless otherwise noted.

PARAMETER	CONDITIONS		LTC201AM/LTC202M/ LTC203M			LTC201AC/LTC202C/ LTC203C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
$t_{\text{ON}}$	$V_S = 2\text{V}$ , $R_L = 1\text{k}\Omega$ , $C_L = 35\text{pF}$			290	400		290	400	ns
$t_{\text{OFF}}$				210	300		210	300	ns
$t_{\text{OPEN}}$			20	85		20	85		ns
Off Isolation	$V_S = 2V_{\text{p-p}}$ , $R_L = 1\text{k}\Omega$ , $f = 100\text{kHz}$			75			75		dB
Crosstalk				90			90		dB
Charge Injection $O_{\text{INJ}}$	$R_S = 0\Omega$ , $C_L = 1000\text{pF}$ , $V_S = 0\text{V}$			5	$\pm 25$		8	$\pm 25$	pC
Total Harmonic Distortion THD	$V_S = 2V_{\text{p-p}}$ , $R_L = 10\text{k}\Omega$			0.01			0.01		%

# LTC201A/LTC202/LTC203

## DIGITAL AND DC ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over full operating temperature range, otherwise specifications are at  $T_A = 25^\circ\text{C}$ .  $V^+ = 5\text{V}$ ,  $V^- = \text{GND} = 0\text{V}$  unless otherwise noted.

PARAMETER	CONDITIONS		LTC201AM/LTC202M/ LTC203M			LTC201AC/LTC202C/ LTC203C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Analog Signal Range			●	0	5	0	5	V	
$R_{ON}$	$V_S = \pm 1.5\text{V}, +3\text{V}$ $I_D = 0.25\text{mA}$	$T_{MIN}$			450		520	$\Omega$	
		$25^\circ\text{C}$		280	450	280	525	$\Omega$	
		$T_{MAX}$			650		650	$\Omega$	
$\Delta R_{ON}$ vs $V_S$				20		20	%		
$\Delta R_{ON}$ vs Temperature				0.5		0.5	$\%/^\circ\text{C}$		
$\Delta R_{ON}$ Match	$V_S = 2.5\text{V}, I_{DS} = 0.25\text{mA}$			5		5	%		
Off Input Leakage $I_S$ (OFF)	$V_D = 4\text{V}, 1\text{V}; V_S = 1\text{V}, 4\text{V}$ (Note 4) Switch Off			0.01	$\pm 1$	0.01	$\pm 5$	nA	
		●			$\pm 100$		$\pm 100$	nA	
Off Output Leakage $I_D$ (OFF)	$V_D = 4\text{V}, 1\text{V}; V_S = 1\text{V}, 4\text{V}$ (Note 4) Switch Off			0.01	$\pm 1$	0.01	+5	nA	
		●			$\pm 100$		$\pm 100$	nA	
On Channel Leakage $I_D$ (ON)	$V_D = V_S = 1\text{V}, 4\text{V}$ (Note 4) Switch On			0.01	$\pm 1$	0.01	$\pm 5$	nA	
		●			$\pm 200$		$\pm 200$	nA	
Input High Voltage $V_{INH}$			●	2.4		2.4	V		
Input Low Voltage $V_{INL}$			●		0.8		0.8	V	
Input High or Low Current $I_{INH}$ and $I_{INL}$	$V_{IN} = 5\text{V}, 0\text{V}$		●		$\pm 1$		$\pm 1$	$\mu\text{A}$	
$C_S$ (OFF)				5		5	pF		
$C_D$ (OFF)				12		12	pF		
$C_D, C_S$ (ON)				30		30	pF		
$I^+$	All Logic Inputs Tied Together $V_{IN} = 0\text{V}$ OR $4.0\text{V}$			8	20	8	20	$\mu\text{A}$	
		●			30		30	$\mu\text{A}$	

## AC ELECTRICAL CHARACTERISTICS

$V^+ = 5\text{V}$ ,  $V^- = \text{GND} = 0\text{V}$  unless otherwise noted.

PARAMETER	CONDITIONS	LTC201AM/LTC202M/ LTC203M			LTC201AC/LTC202C/ LTC203C			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
$t_{ON}$	$V_S = 2\text{V}, R_L = 1\text{k}\Omega, C_L = 35\text{pF}$		450	600		450	600	ns
$t_{OFF}$			190	300		190	300	ns
$t_{OPEN}$		100	250		100	250	ns	
Off Isolation	$V_S = 2V_{P-P}, R_L = 1\text{k}\Omega, f = 100\text{Hz}$		75			75		dB
Crosstalk			90			90		dB
Charge Injection $Q_{INJ}$	$R_S = 0\Omega, C_L = 1000\text{pF}, V_S = 2.5\text{V}$		2			2		pC
Total Harmonic Distortion THD	$V_S = 2V_{P-P}, R_L = 10\text{k}\Omega$		0.01			0.01		%

**Note 1:** Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

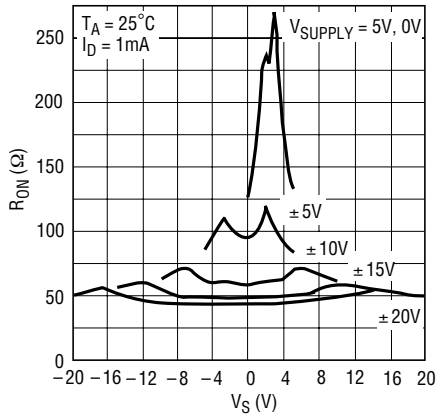
**Note 2:** Signals on S, D, or IN exceeding  $V^+$  or  $V^-$  will be clamped by internal diodes. Limit forward diode current to maximum current rating.

**Note 3:** In-circuit ESD on the switch pins (S or D) exceeds 4kV (see test circuit).

**Note 4:** Leakage current with a single 5V supply is guaranteed by correlation with the  $\pm 15\text{V}$  leakage current.

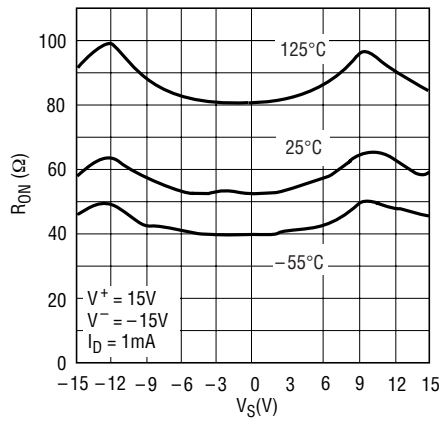
# TYPICAL PERFORMANCE CHARACTERISTICS

**R<sub>ON</sub> vs V<sub>S</sub> Over Supply Voltage**



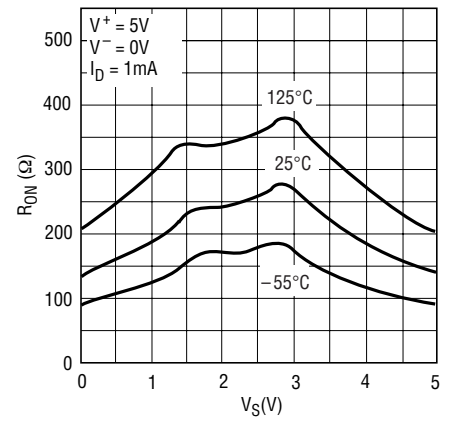
LT201\_202\_203 • TPC01

**R<sub>ON</sub> vs V<sub>S</sub> Over Temperature**



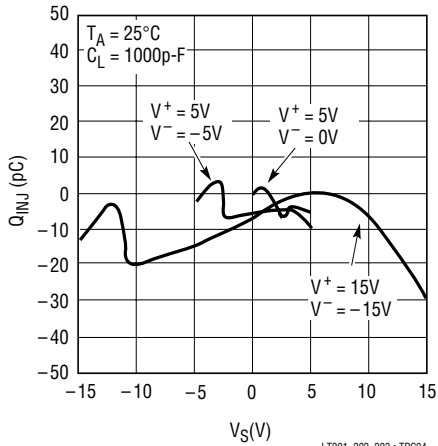
LT201\_202\_203 • TPC02

**R<sub>ON</sub> vs V<sub>S</sub> Over Temperature**



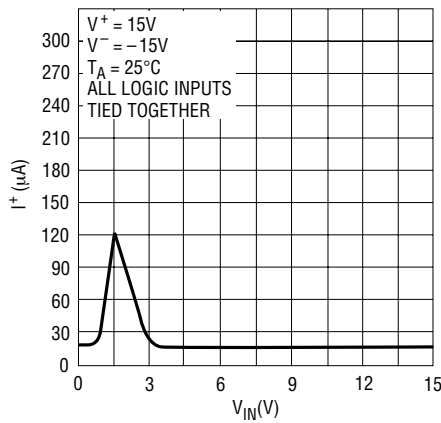
LT201\_202\_203 • TPC03

**Q<sub>INJ</sub> vs V<sub>S</sub> Over Supply Voltage**



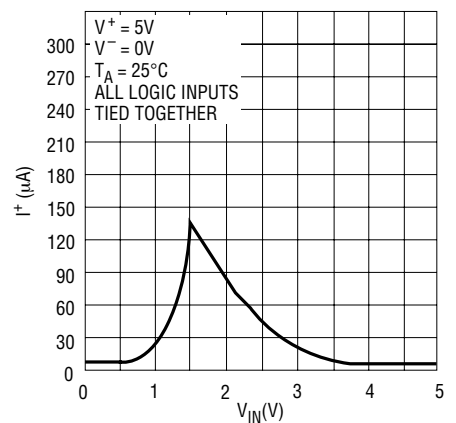
LT201\_202\_203 • TPC04

**Positive Supply Current vs Logic Input Voltage**



LT201\_202\_203 • TPC05

**Supply Current vs Logic Input Voltage**



LT201\_202\_203 • TPC06

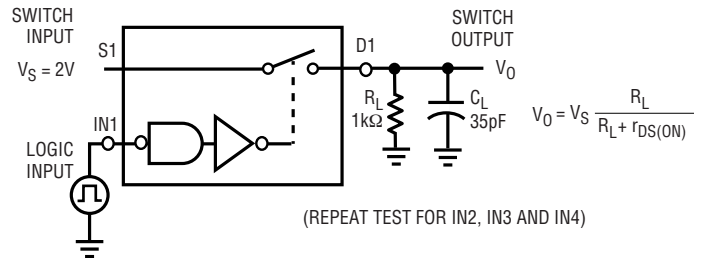
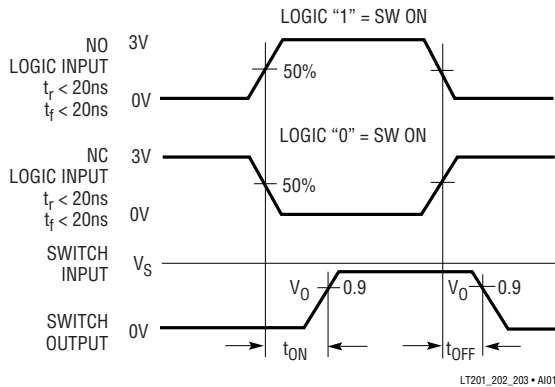
## APPLICATIONS INFORMATION

### Switching Time Test Circuit

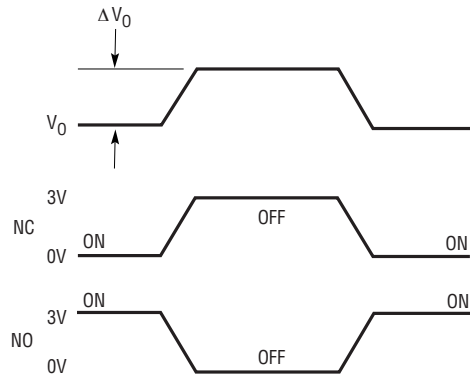
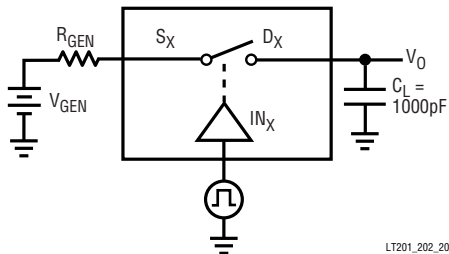
Switch output waveform shown for  $V_S = \text{constant}$  with logic input waveform as shown. Note that  $V_S$  may be + or – as per switching time test circuit.  $V_O$  is the steady state

output switch on. Feedthrough via gate capacitance may result in spikes at leading and trailing edge of output waveform.

### Switching Time Test Circuit



### Charge Injection Test Circuit

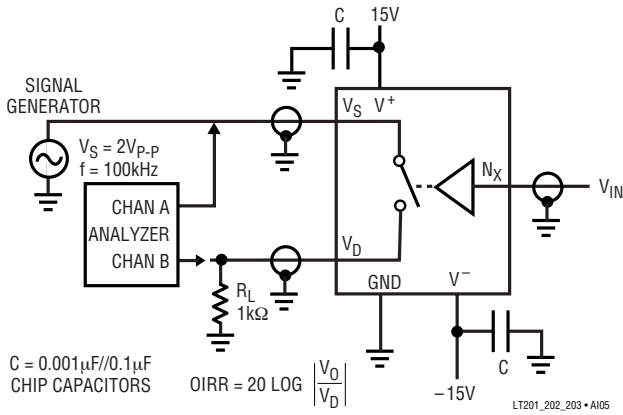


$\Delta V_O$  IS THE MEASURED VOLTAGE ERROR DUE TO CHARGE INJECTION.  
THE ERROR VOLTAGE IN COULOMBS IS  $\Delta Q = C_L \cdot \Delta V_O$

LT201\_202\_203 • A104

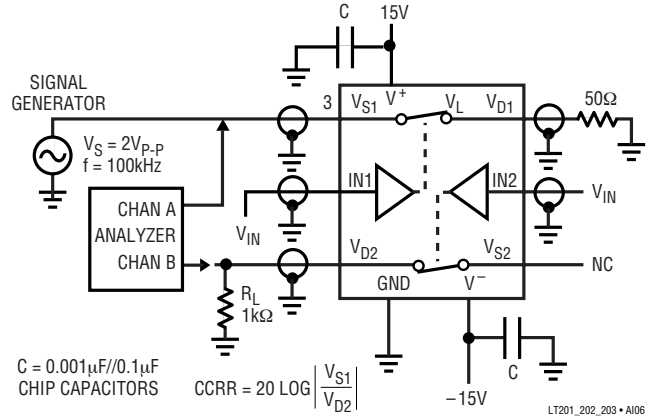
# APPLICATIONS INFORMATION

**OIRR-Off Isolation Test Circuit**



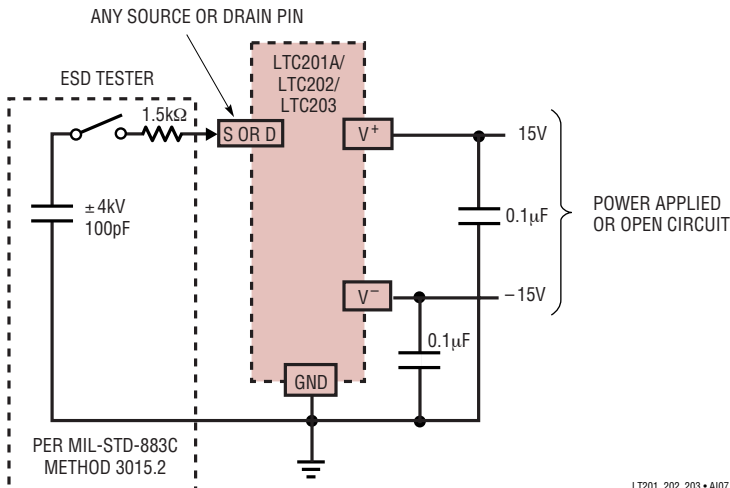
$V_{IN}$	
3V	NC
0V	NO

**CCRR-Channel to Channel Crosstalk Test Circuit**

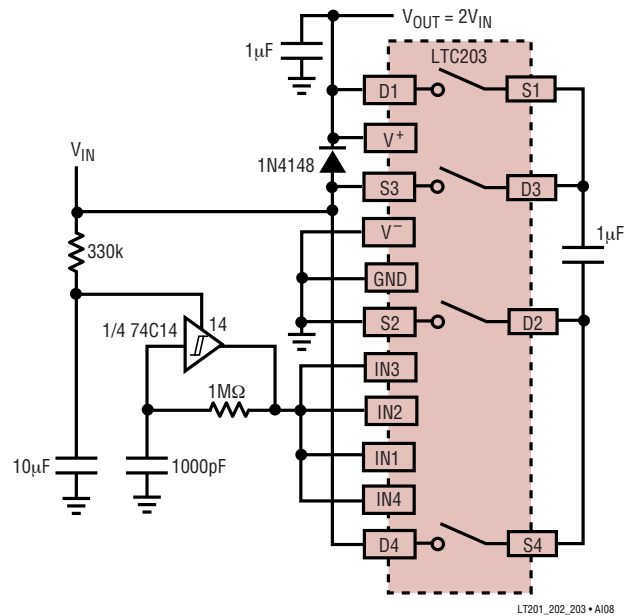


$V_{IN}$	
3V	NC
0V	NO

**In-Circuit ESD Test Circuit**



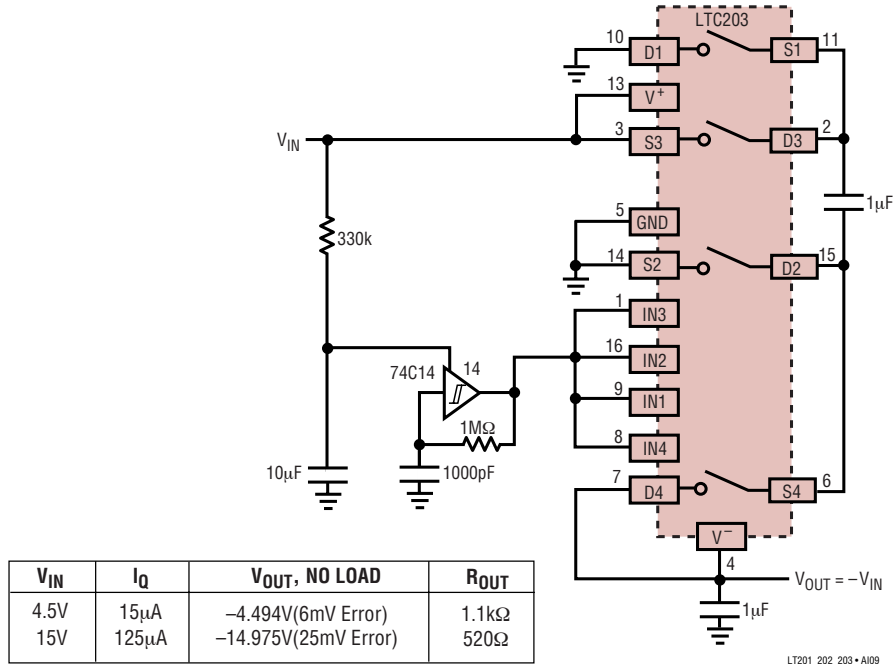
**Micropower, 4.5V to 15V Input, Voltage Doubler Using the LTC203**



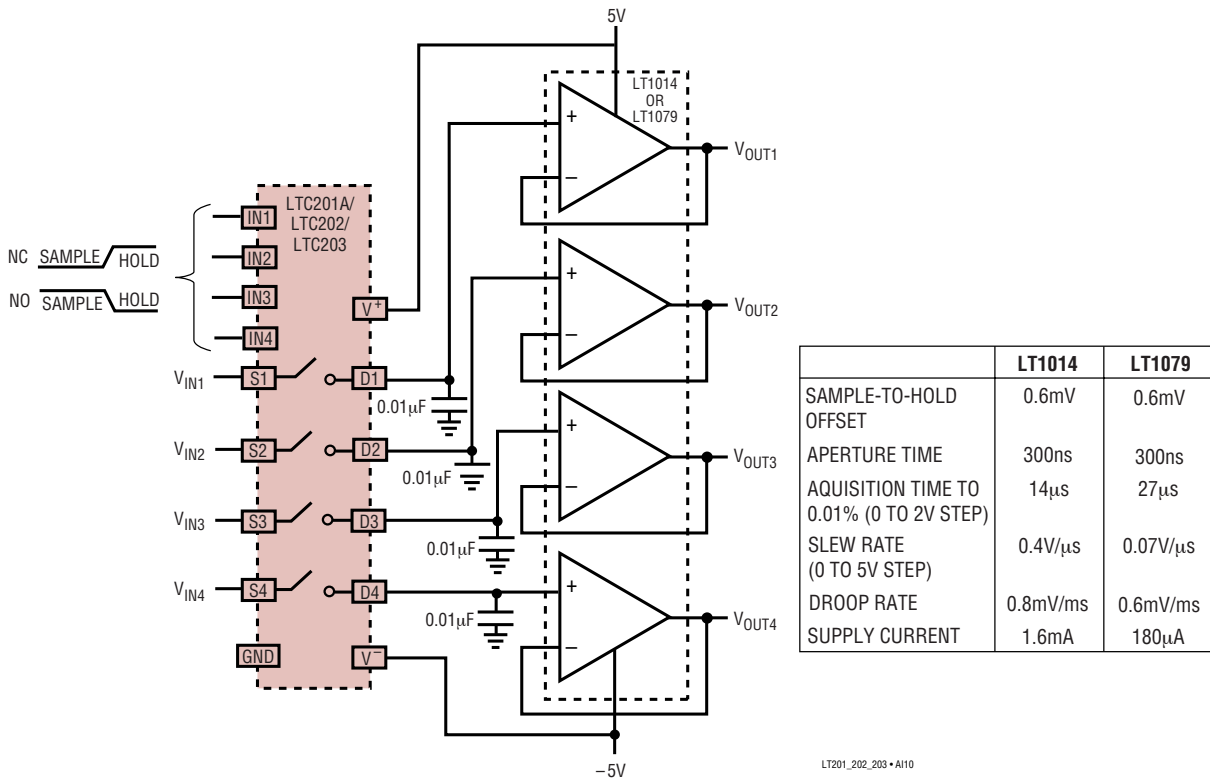
$V_{IN}$	$I_Q$	$V_{OUT}, \text{ NO LOAD}$	$R_{OUT}$
4.5V	20 $\mu\text{A}$	8.988V(12mV Error)	1.2k
15V	130 $\mu\text{A}$	29.96V(40mV Error)	600 $\Omega$

## APPLICATIONS INFORMATION

### Micropower, $\pm 4.5V$ to $\pm 15V$ , Voltage Inverter Using the LTC203



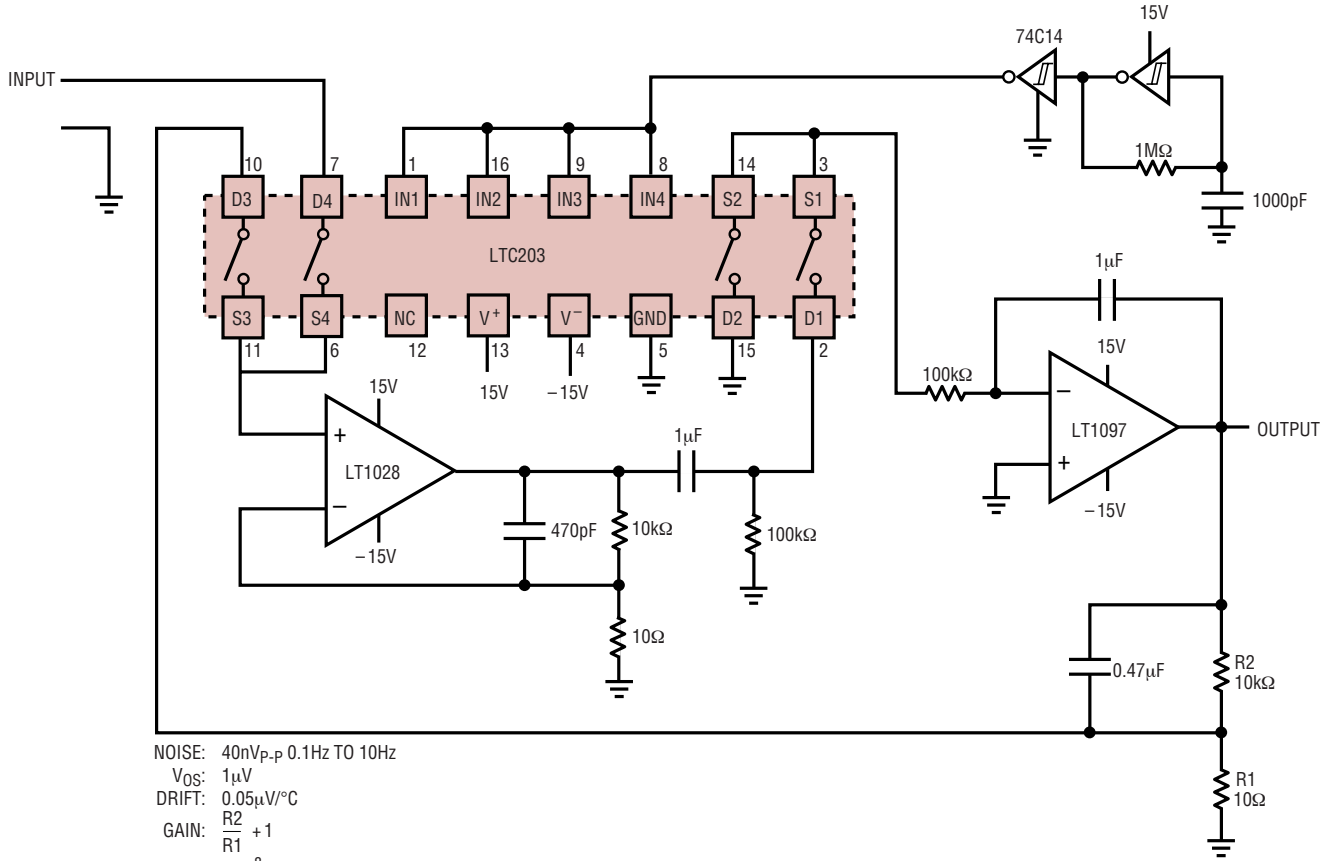
### Quad 12-Bit Sample-and-Hold





APPLICATIONS INFORMATION

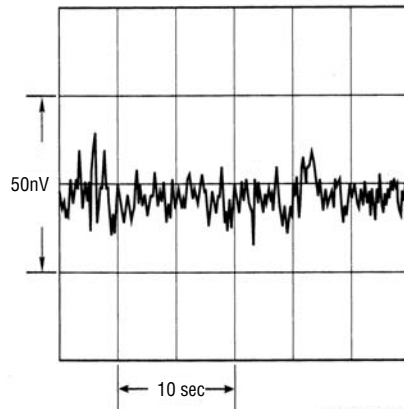
Ultra Low Noise, Low Drift Chopper Amplifier



NOISE: 40nV<sub>p-p</sub> 0.1Hz TO 10Hz  
 V<sub>OS</sub>: 1μV  
 DRIFT: 0.05μV/°C  
 GAIN:  $\frac{R2}{R1} + 1$   
 A<sub>VOL</sub>: > 10<sup>8</sup>  
 I<sub>b</sub>: 25nA

LT201\_202\_203 • AI11

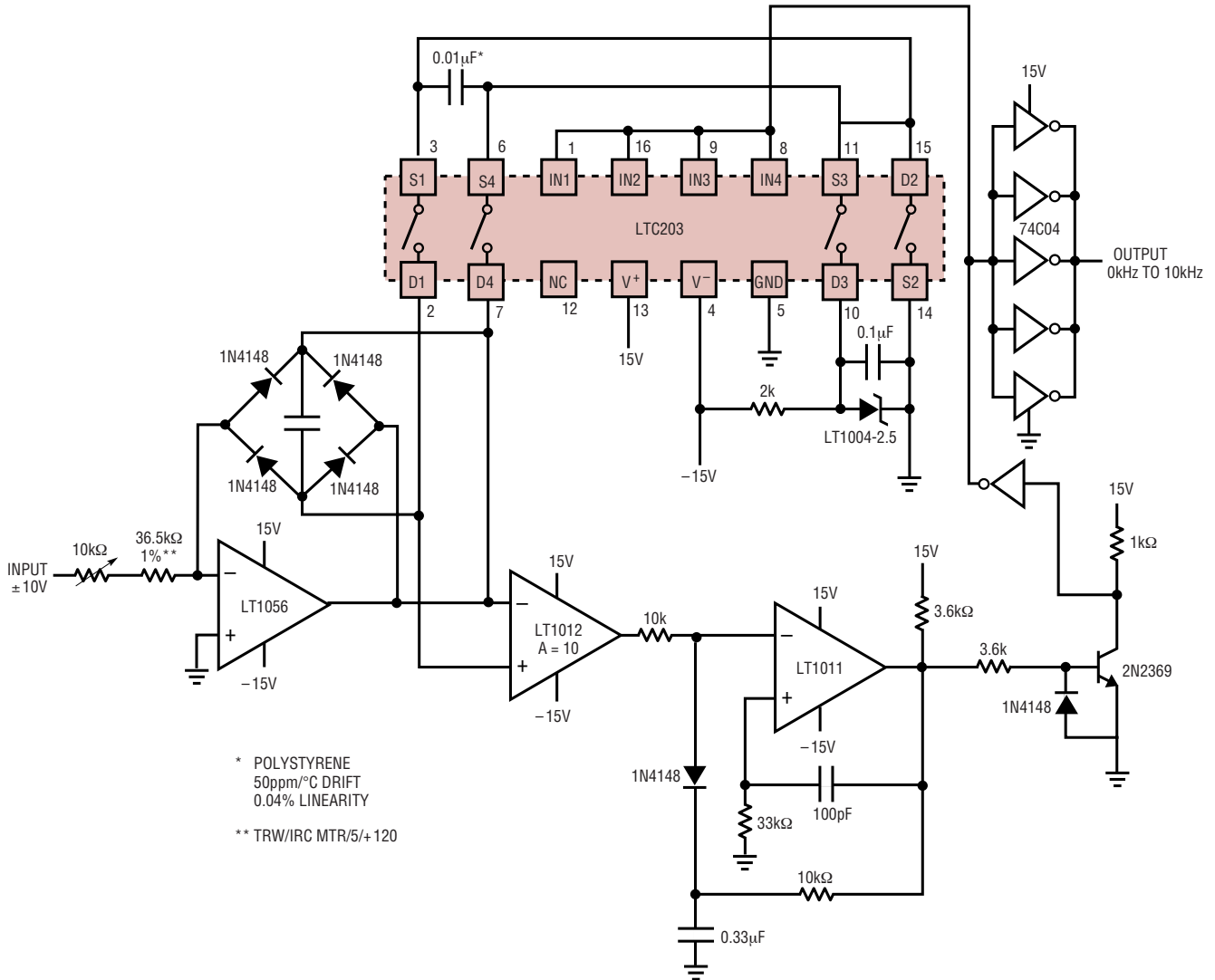
Noise in a 0.1 to 10Hz Bandwidth



LTC201A/202/203 • AI12

## APPLICATIONS INFORMATION

### Bipolar (AC) Input V/F Converter



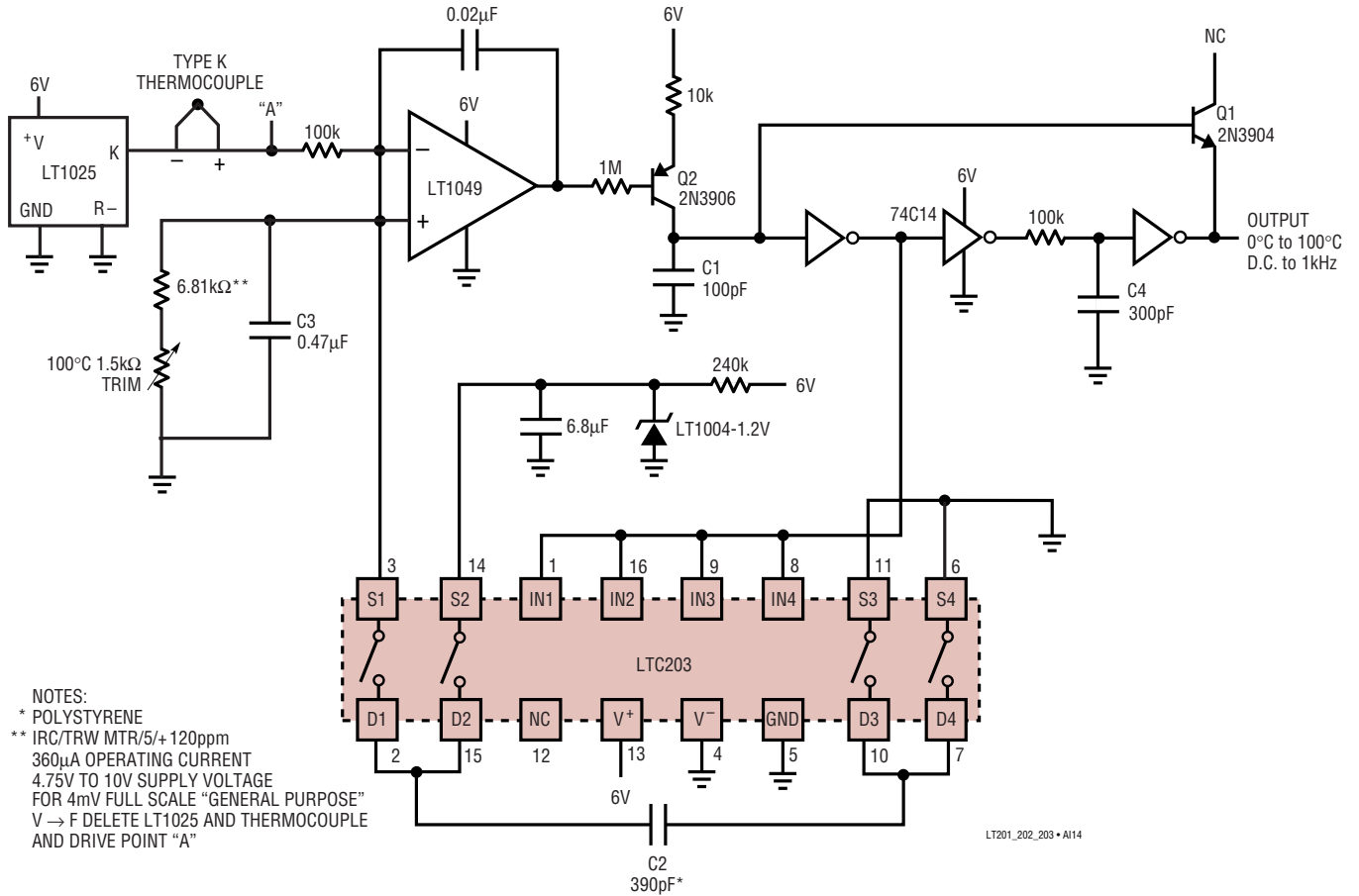
\* POLYSTYRENE  
50ppm/°C DRIFT  
0.04% LINEARITY

\*\* TRW/IRC MTR/5/+120

LT201\_202\_203 • A113

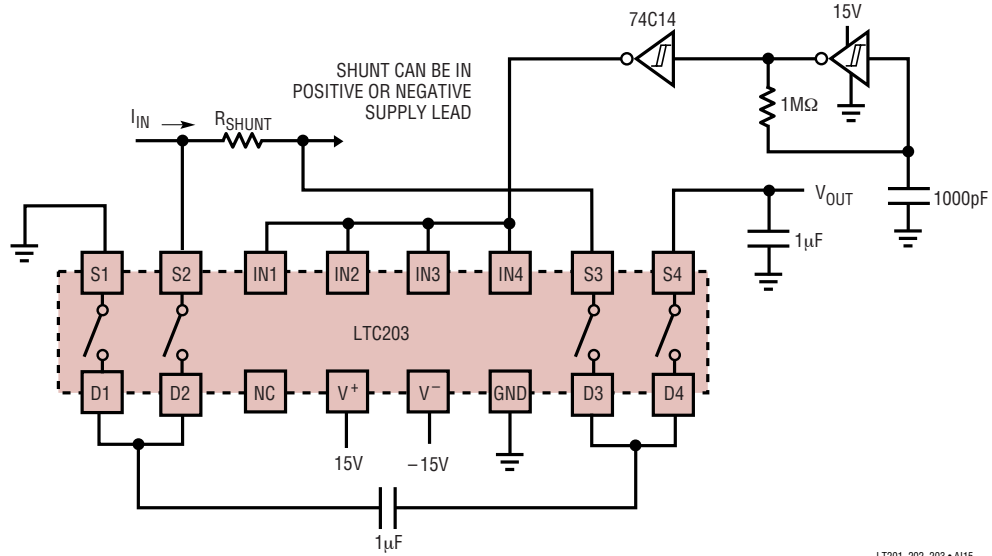
APPLICATIONS INFORMATION

Micropower Thermocouple Temperature to Frequency Converter

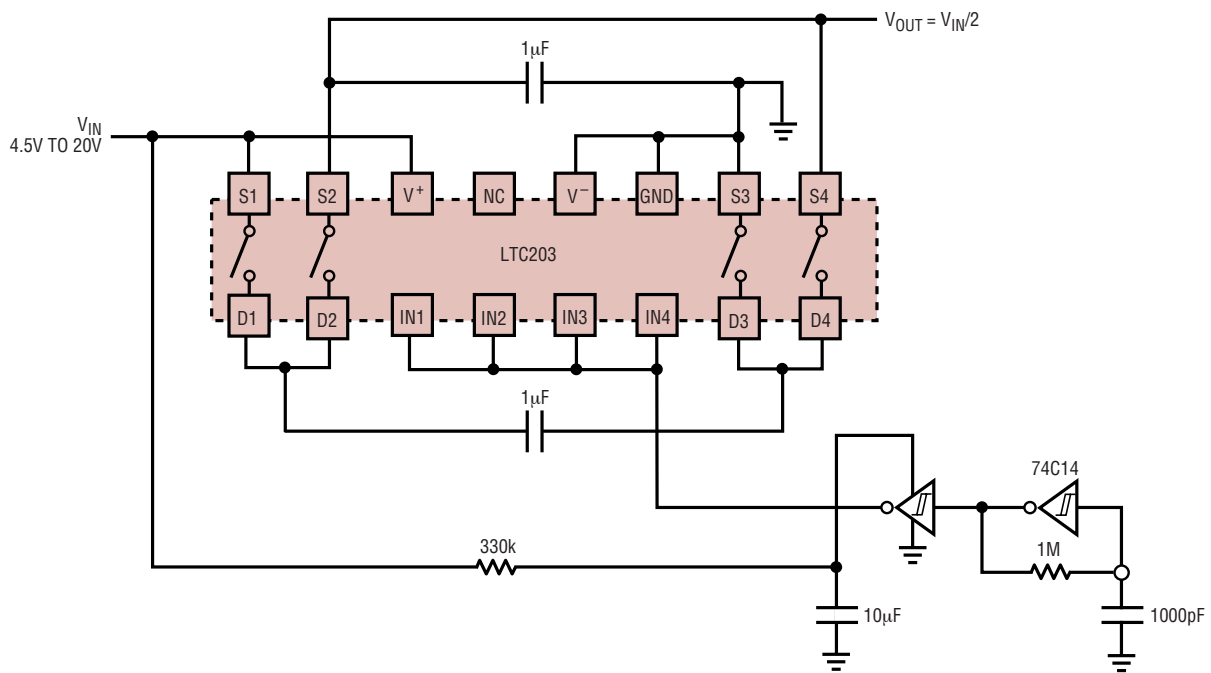


## APPLICATIONS INFORMATION

### Precision Current Sensing in Supply Rails

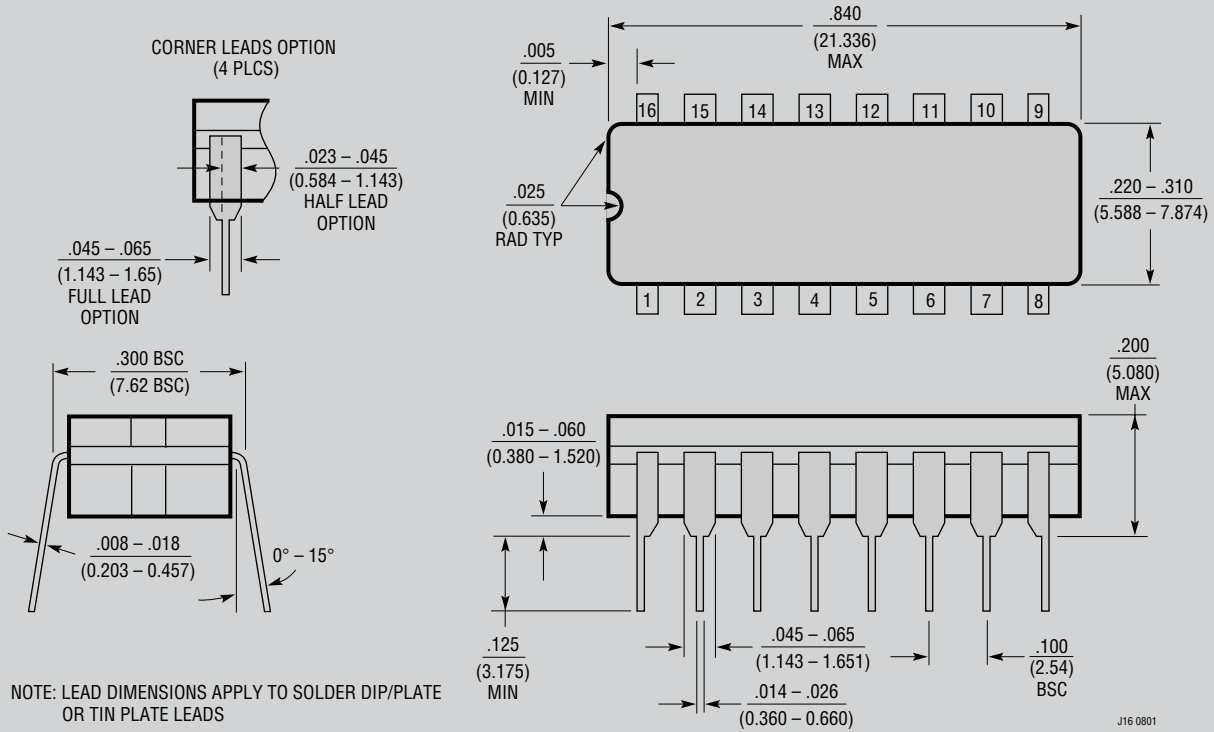


### Precision Voltage Divide by 2 Circuit



**PACKAGE DESCRIPTION**

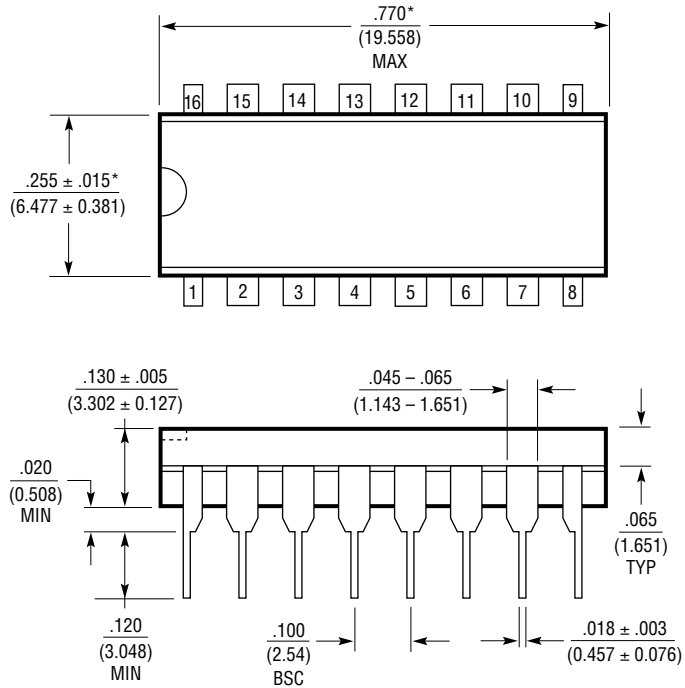
**J Package**  
**16-Lead CERDIP (Narrow .300 Inch, Hermetic)**  
 (Reference LTC DWG # 05-08-1110)



**OBSOLETE PACKAGE**

**PACKAGE DESCRIPTION**

**N Package**  
**16-Lead PDIP (Narrow .300 Inch)**  
 (Reference LTC DWG # 05-08-1510)



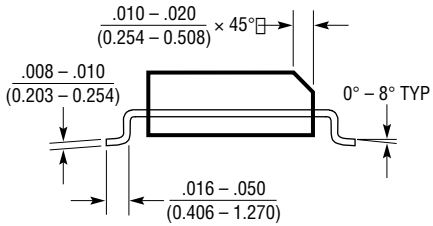
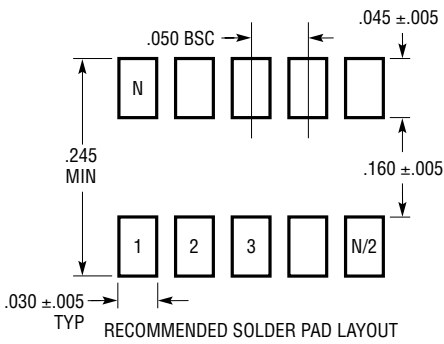
NOTE:  
 1. DIMENSIONS ARE  $\frac{\text{INCHES}}{\text{MILLIMETERS}}$

\*THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.  
 MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .010 INCH (0.254mm)

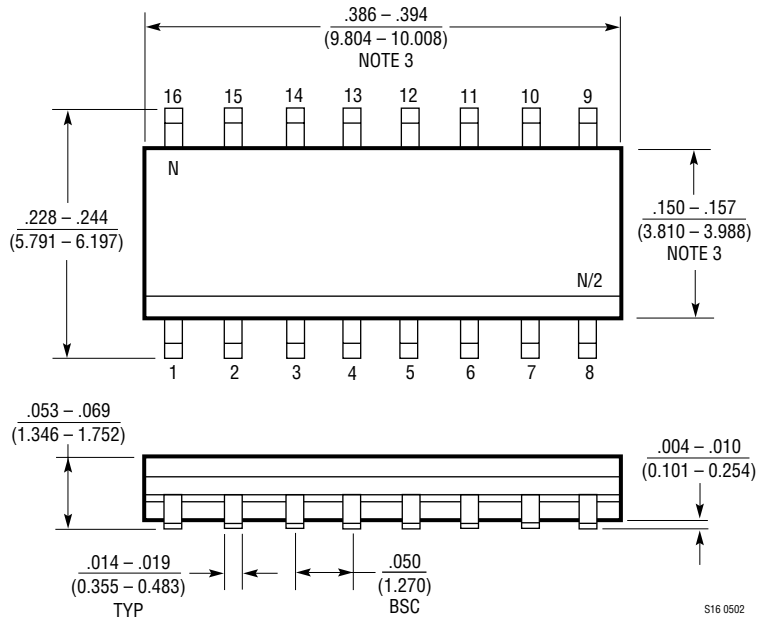
N16 1002

**PACKAGE DESCRIPTION**

**S Package**  
**16-Lead Plastic Small Outline (Narrow .150 Inch)**  
 (Reference LTC DWG # 05-08-1610)



- NOTE:  
 1. DIMENSIONS IN  $\frac{\text{INCHES}}{\text{(MILLIMETERS)}}$   
 2. DRAWING NOT TO SCALE  
 3. THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.  
 MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .006" (0.15mm)



S16 0502

# LTC201A/LTC202/LTC203

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## RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LTC221/LTC222	Micropower, Low Charge Injection, Quad CMOS Analog Switches	Parallel Controlled with Data Latches
LTC1380/LTC1393	8-Channel/4-Channel Differential Analog Multiplexer with SMBus Interface	3V to $\pm 15V$ , $R_{ON} = 35\Omega$ Single-Ended/70 $\Omega$ Differential
LTC1390/LTC1391	8-Channel, Analog Multiplexer with Serial Interface	3V to $\pm 15V$ , $R_{ON} = 45\Omega$ , Low Charge Injection
LT1675/LT1675-1	250MHz, Triple and Single RGB Multiplexer	100MHz Pixel Switching, 1100V/ $\mu s$ Slew Rate