

## FEATURES

- Micropower Operation
- Single 5V or  $\pm 15\text{V}$  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     |                                      |
| ±15V Supplies .....    | ±25pC Max                            |
| Single 5V Supply ..... | 2pC Typ                              |
| ■ $R_{ON}$ .....       | 65Ω Typ                              |
| ■ Signal Range .....   | ±15V                                 |

## DESCRIPTION

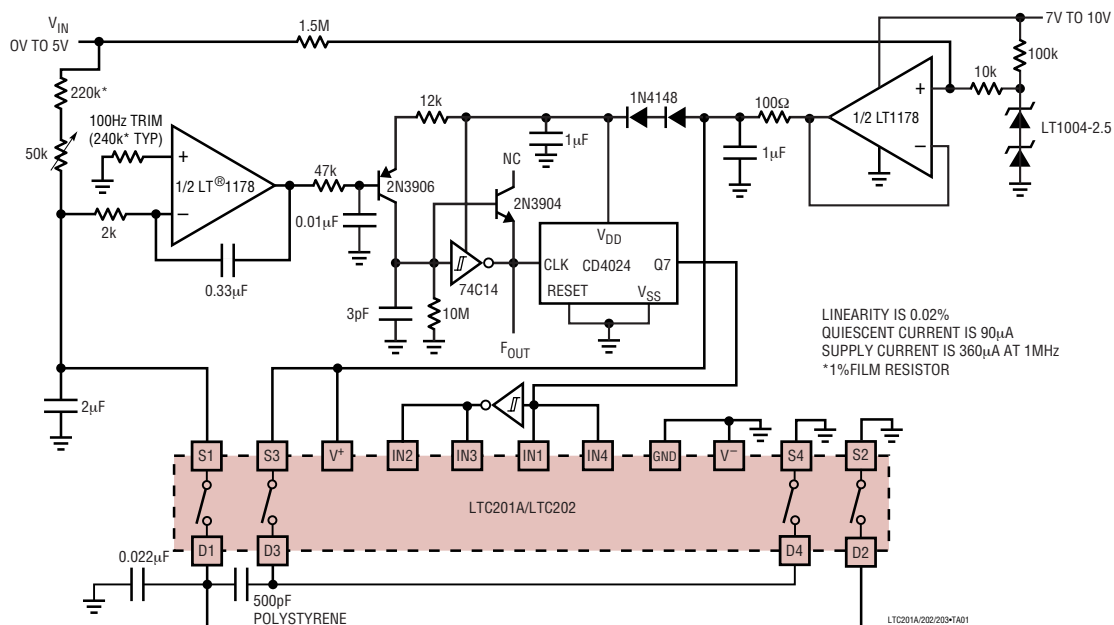
The LTC®201A, LTC202, and LTC203 are micropower, quad CMOS analog switches which typically dissipate only 250µW from ±15V supplies and 40µW from a single 5V supply. The switches have 65Ω typical on resistance and a very high off resistance. A break-before-make characteristic, inherent in these switches, prevents the shorting of two channels. With a supply voltage of ±15V, the signal range is ±15V. These switches have special charge compensation circuitry which greatly reduces charge injection to a maximum of ±25pC (±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<br>20mA, Whichever Occurs First |

Current

|                                                          |      |
|----------------------------------------------------------|------|
| Any Input Except S or D .....                            | 30mA |
| Continuous S or D .....                                  | 20mA |
| Peak S or D (Pulsed at 1ms,<br>10% Duty Cycle Max) ..... | 70mA |

ESD Susceptibility (Note 3) .....

Power Dissipation (Plastic) .....

Power Dissipation (Ceramic) .....

Operating Temperature Range

LTC201AC/LTC202C/LTC203C .....

LTC201AM/LTC202M/LTC203M .....

Storage Temperature Range .....

Lead Temperature (Soldering, 10 sec) .....

## LOGIC TABLE

| $IN_X$ | LTC201A<br>IN1 TO IN4 | LTC202<br>IN1 TO IN4 | LTC203   |          |
|--------|-----------------------|----------------------|----------|----------|
|        | IN1 TO IN4            | IN1 TO IN4           | IN1, IN4 | IN2, IN3 |
| 0      | ON                    | OFF                  | OFF      | ON       |
| 1      | OFF                   | ON                   | ON       | OFF      |

## PACKAGE/ORDER INFORMATION

|                                                                                                                                                                                                                                                                                                                            |                                                                                    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| <p>TOP VIEW</p> <p>N PACKAGE<br/>16-LEAD PDIP<br/><math>T_{JMAX} = 110^{\circ}C, \theta_{JA} = 120C/W</math></p> <p>S PACKAGE<br/>16-LEAD PLASTIC SO<br/><math>T_{JMAX} = 110^{\circ}C, \theta_{JA} = 130C/W</math></p> <p>J PACKAGE<br/>16-LEAD CERDIP<br/><math>T_{JMAX} = 150^{\circ}C, \theta_{JA} = 100C/W</math></p> | ORDER PART<br>NUMBER                                                               |
|                                                                                                                                                                                                                                                                                                                            | <p>LTC201ACN<br/>LTC201ACS<br/>LTC202CN<br/>LTC202CS<br/>LTC203CN<br/>LTC203CS</p> |
|                                                                                                                                                                                                                                                                                                                            | ORDER PART<br>NUMBER                                                               |
|                                                                                                                                                                                                                                                                                                                            | <p>LTC201AMJ<br/>LTC201ACJ<br/>LTC202MJ<br/>LTC202CJ<br/>LTC203MJ<br/>LTC203CJ</p> |

### OBsolete 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  $T_A = 25^{\circ}C$ .  $V^+ = 15V$ ,  $V^- = -15V$ , GND = 0V.

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

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## 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/<br>LTC203M |      |                      | LTC201AC/LTC202C/<br>LTC203C |      |                      | UNITS         |
|------------------------------------------------------|---------------------------------------------------------------|---|------------------------------|------|----------------------|------------------------------|------|----------------------|---------------|
|                                                      |                                                               |   | MIN                          | TYP  | MAX                  | MIN                          | TYP  | MAX                  |               |
| Off Output Leakage $I_D$ (OFF)                       | $V_D = \pm 14\text{V}$ , $V_S = \pm 14\text{V}$<br>Switch Off | ● |                              | 0.01 | $\pm 1$<br>$\pm 100$ |                              | 0.01 | $\pm 5$<br>$\pm 100$ | nA<br>nA      |
| On Channel Leakage $I_D$ (ON)                        | $V_D = V_S = \pm 14\text{V}$                                  |   |                              | 0.02 | $\pm 1$              |                              | 0.02 | $\pm 5$              | nA            |
|                                                      | Switch On                                                     | ● |                              |      | $\pm 200$            |                              |      | $\pm 200$            | 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<br>$I_{INH}$ and $I_{INL}$ | $V_{IN} = 15\text{V}$ , $0\text{V}$                           | ● |                              |      | $\pm 1$              |                              |      | $\pm 1$              | $\mu\text{A}$ |
| $C_S$ (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                   | $\mu\text{A}$ |
|                                                      | $V_{IN} = 0\text{V}$ 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/<br>LTC203M |      |          | LTC201AC/LTC202C/<br>LTC203C |      |          | UNITS |
|-------------------------------|-------------------------------------------------------------------|--|------------------------------|------|----------|------------------------------|------|----------|-------|
|                               |                                                                   |  | MIN                          | TYP  | MAX      | MIN                          | TYP  | MAX      |       |
| $t_{ON}$                      | $V_S = 2\text{V}$ , $R_L = 1\text{k}\Omega$ , $C_L = 35\text{pF}$ |  |                              | 290  | 400      |                              | 290  | 400      | ns    |
| $t_{OFF}$                     |                                                                   |  |                              | 210  | 300      |                              | 210  | 300      | ns    |
| $t_{OPEN}$                    |                                                                   |  | 20                           | 85   |          | 20                           | 85   |          | ns    |
| Off Isolation                 | $V_S = 2V_{P-P}$ , $R_L = 1\text{k}\Omega$ , $f = 100\text{kHz}$  |  |                              | 75   |          |                              | 75   |          | dB    |
| Crosstalk                     |                                                                   |  |                              | 90   |          |                              | 90   |          | dB    |
| Charge Injection $O_{INJ}$    | $R_S = 0\Omega$ , $C_L = 1000\text{pF}$ , $V_S = 0\text{V}$       |  |                              | 5    | $\pm 25$ |                              | 8    | $\pm 25$ | pC    |
| Total Harmonic Distortion THD | $V_S = 2V_{P-P}$ , $R_L = 10\text{k}\Omega$                       |  |                              | 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/<br>LTC203M |      |           | LTC201AC/LTC202C/<br>LTC203C |      |           | UNITS               |
|------------------------------------------------------|------------------------------------------------------------------------------------|--------------------|------------------------------|------|-----------|------------------------------|------|-----------|---------------------|
|                                                      |                                                                                    |                    | MIN                          | TYP  | MAX       | MIN                          | TYP  | MAX       |                     |
| Analog Signal Range                                  |                                                                                    | ●                  | 0                            |      | 5         | 0                            |      | 5         | V                   |
| $R_{ON}$                                             | $V_S = \pm 1.5\text{V}, +3\text{V}$<br>$I_D = 0.25\text{mA}$                       | $T_{MIN}$          |                              |      | 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)<br>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)<br>Switch Off |                    |                              | 0.01 | $\pm 1$   |                              | 0.01 | $\pm 5$   | nA                  |
|                                                      |                                                                                    | ●                  |                              |      | $\pm 100$ |                              |      | $\pm 100$ | nA                  |
| On Channel Leakage $I_D$ (ON)                        | $V_D = V_S = 1\text{V}, 4\text{V}$ (Note 4)<br>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<br>$I_{INH}$ 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<br>$V_{IN} = 0\text{V}$ 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/<br>LTC203M |      |     | LTC201AC/LTC202C/<br>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 |     | %     |

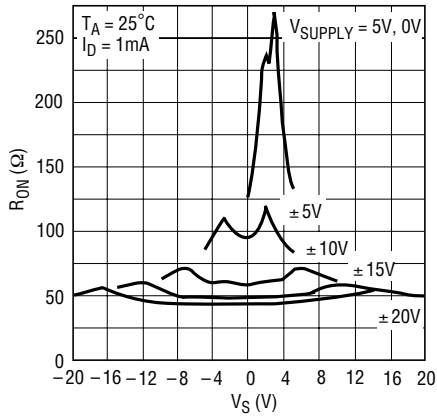
**Note 1:** Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

**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.

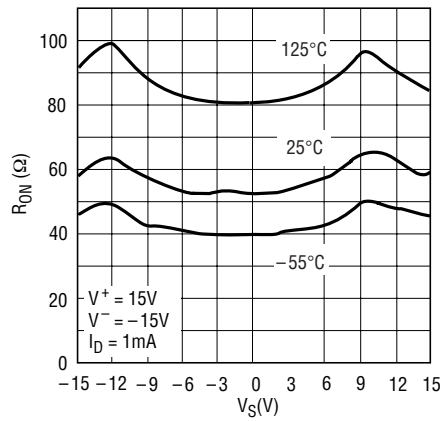
**Note 3:** In-circuit ESD on the switch pins (S or D) exceeds 4kV (see test circuit).

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

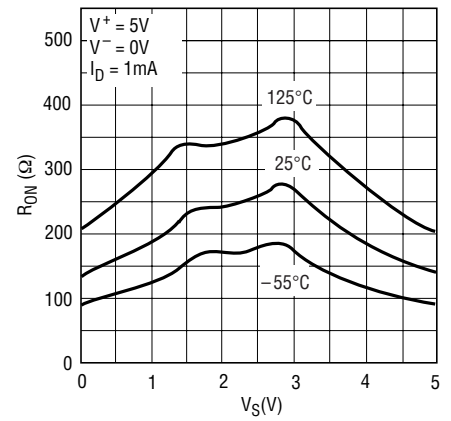
## TYPICAL PERFORMANCE CHARACTERISTICS

 **$R_{ON}$  vs  $V_S$  Over Supply Voltage**

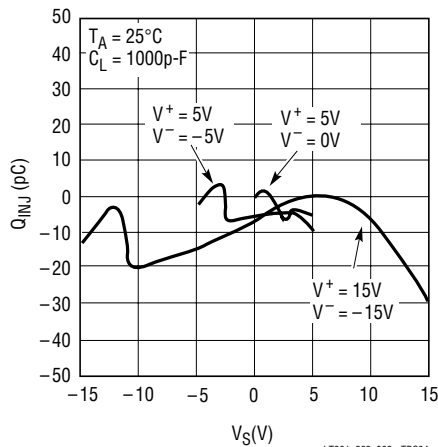
LT201\_202\_203 • TPC01

 **$R_{ON}$  vs  $V_S$  Over Temperature**

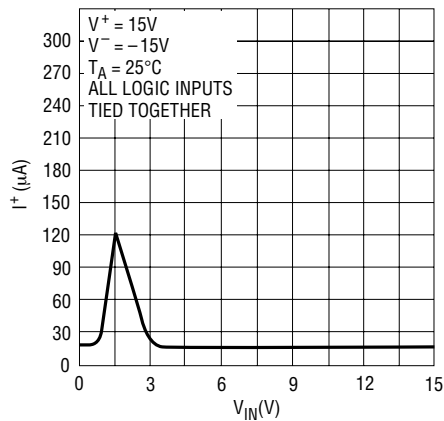
LT201\_202\_203 • TPC02

 **$R_{ON}$  vs  $V_S$  Over Temperature**

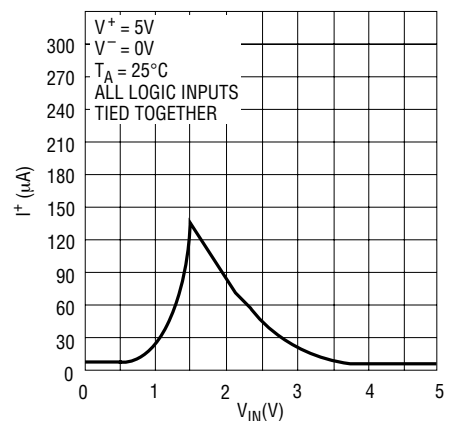
LT201\_202\_203 • TPC03

 **$Q_{INJ}$  vs  $V_S$  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

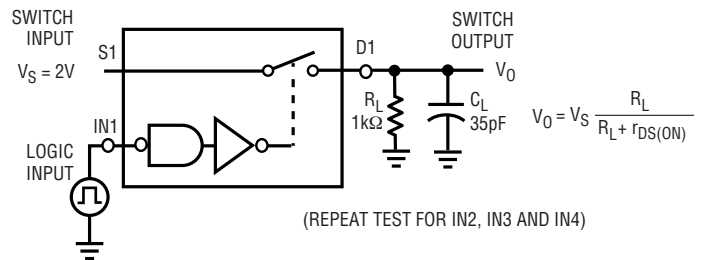
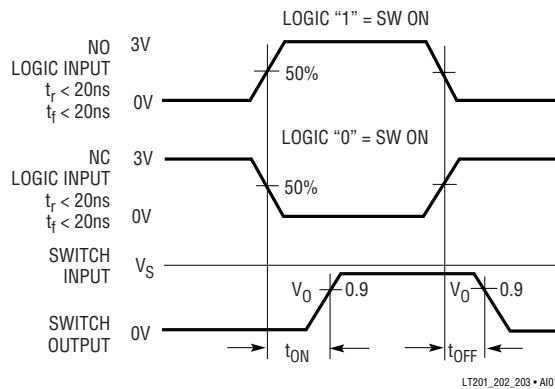
## APPLICATIONS INFORMATION

### 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

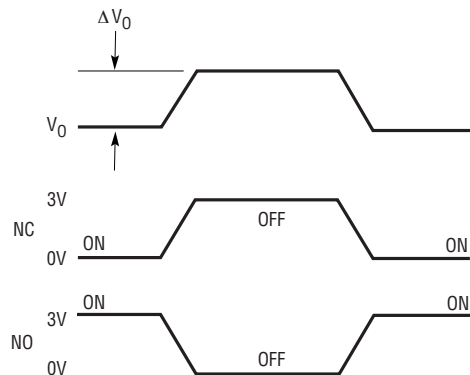
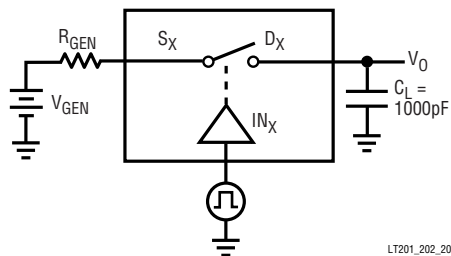
output switch on. Feedthrough via gate capacitance may result in spikes at leading and trailing edge of output waveform.

### Switching Time Test Circuit



LT201\_202\_203 • A102

### 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

|                       |    |
|-----------------------|----|
| <b>V<sub>IN</sub></b> |    |
| 3V                    | NC |
| 0V                    | NO |

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

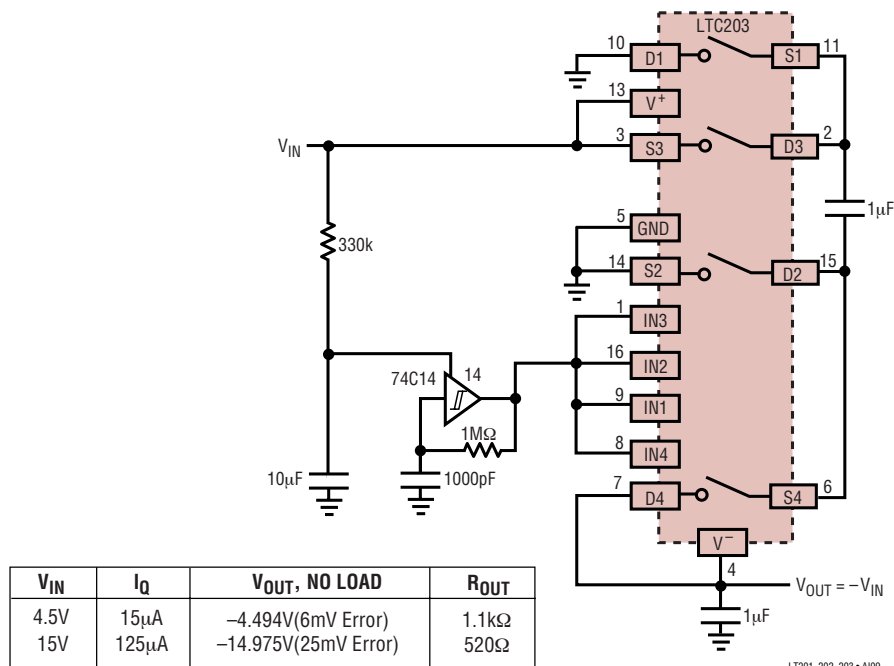
Diagram illustrating the ESD testing setup for the LTC201A/LTC202/LTC203 IC, following MIL-STD-883C Method 3015.2.

The setup includes:

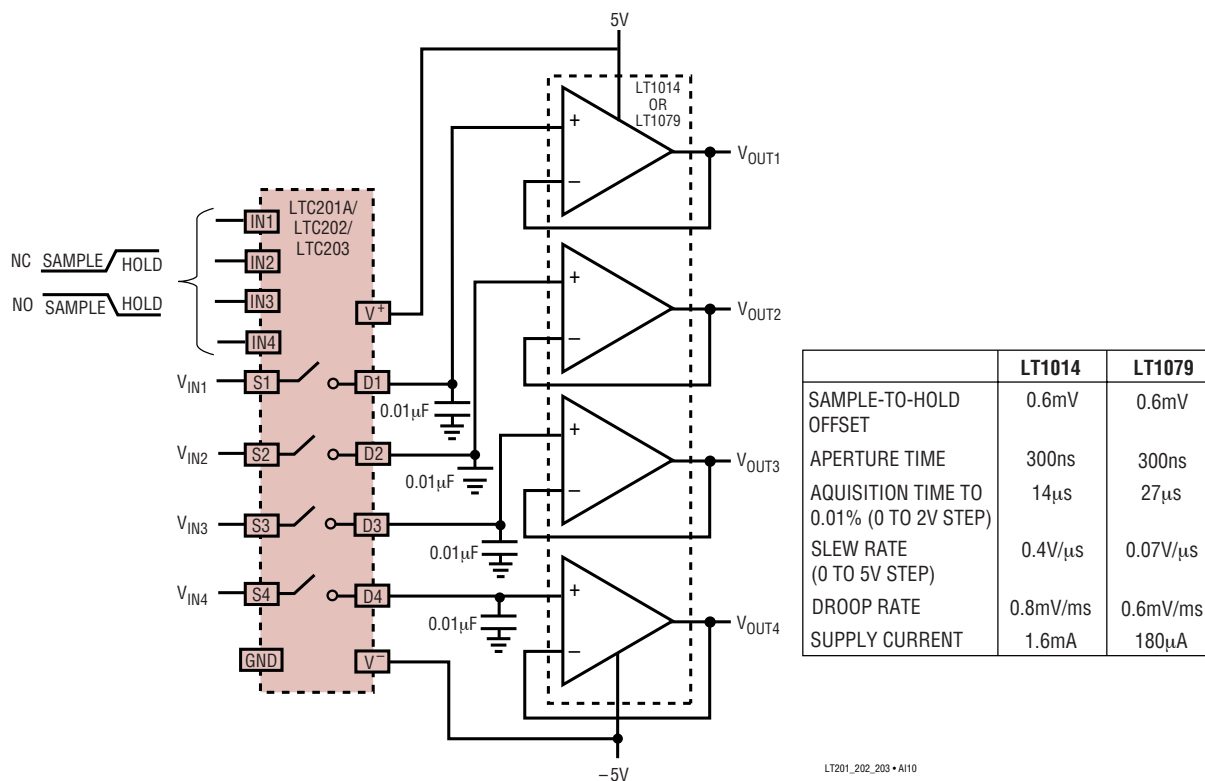
- ESD TESTER:** Connected to the **S OR D** pin via a  $1.5k\Omega$  resistor.
- IC Pin:** Labeled **S OR D**, corresponding to the **ANY SOURCE OR DRAIN PIN**.
- Power Supply:** The IC is powered by  $\pm 15V$  rails ( $V^+$  and  $V^-$ ), each with a  $0.1\mu F$  bypass capacitor.
- Grounding:** The IC is connected to **GND**.
- Standard:** PER MIL-STD-883C METHOD 3015.2

| V <sub>IN</sub> | I <sub>Q</sub> | V <sub>OUT</sub> , NO LOAD | R <sub>OUT</sub> |
|-----------------|----------------|----------------------------|------------------|
| 4.5V            | 20μA           | 9.988V(12mV Error)         | 1.2k             |
| 15V             | 130μA          | 29.96V(40mV Error)         | 600Ω             |

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



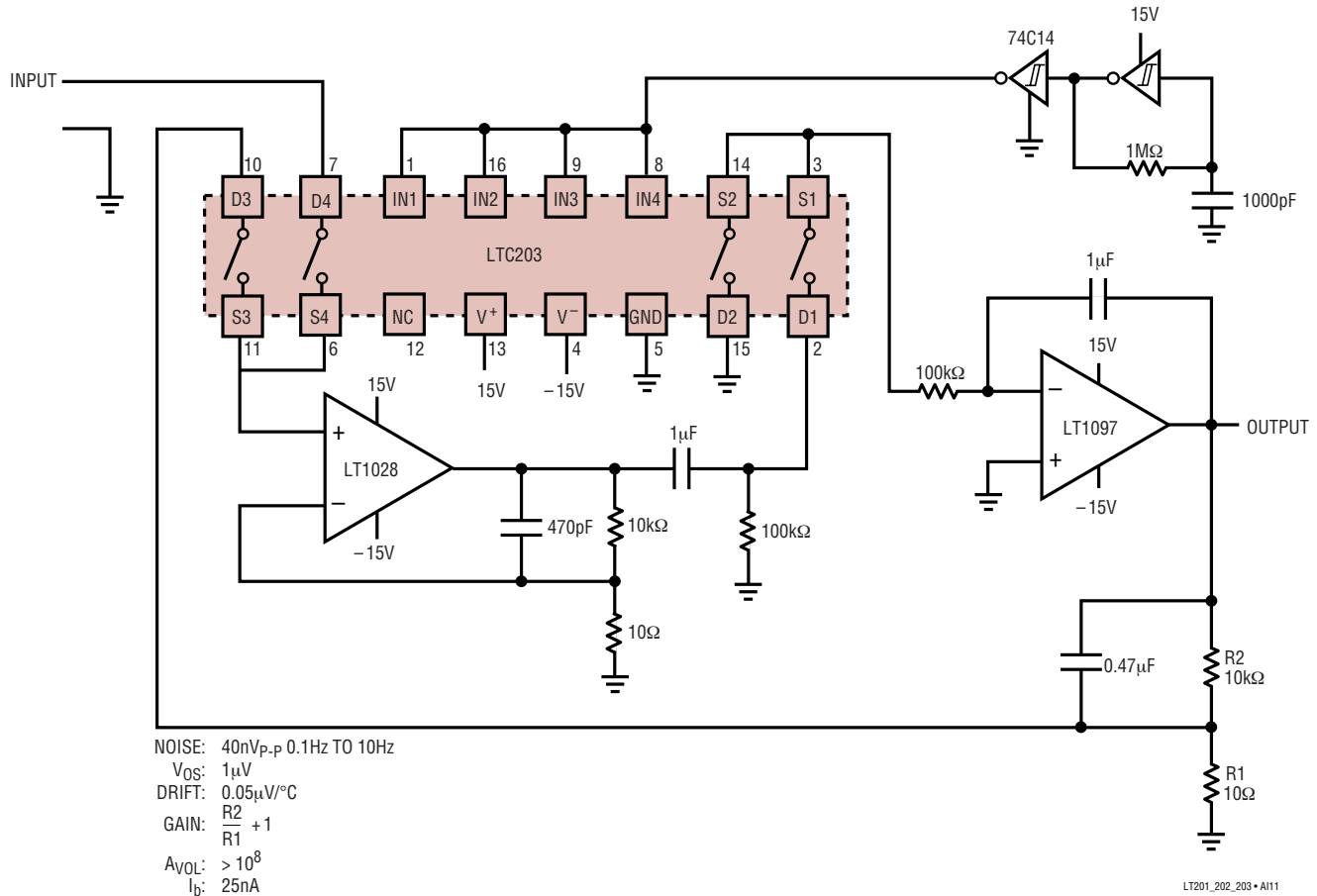
### Quad 12-Bit Sample-and-Hold



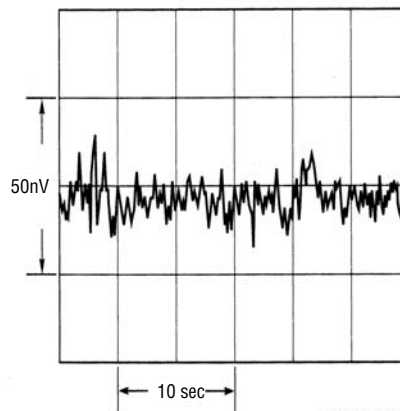


## APPLICATIONS INFORMATION

## Ultra Low Noise, Low Drift Chopper Amplifier

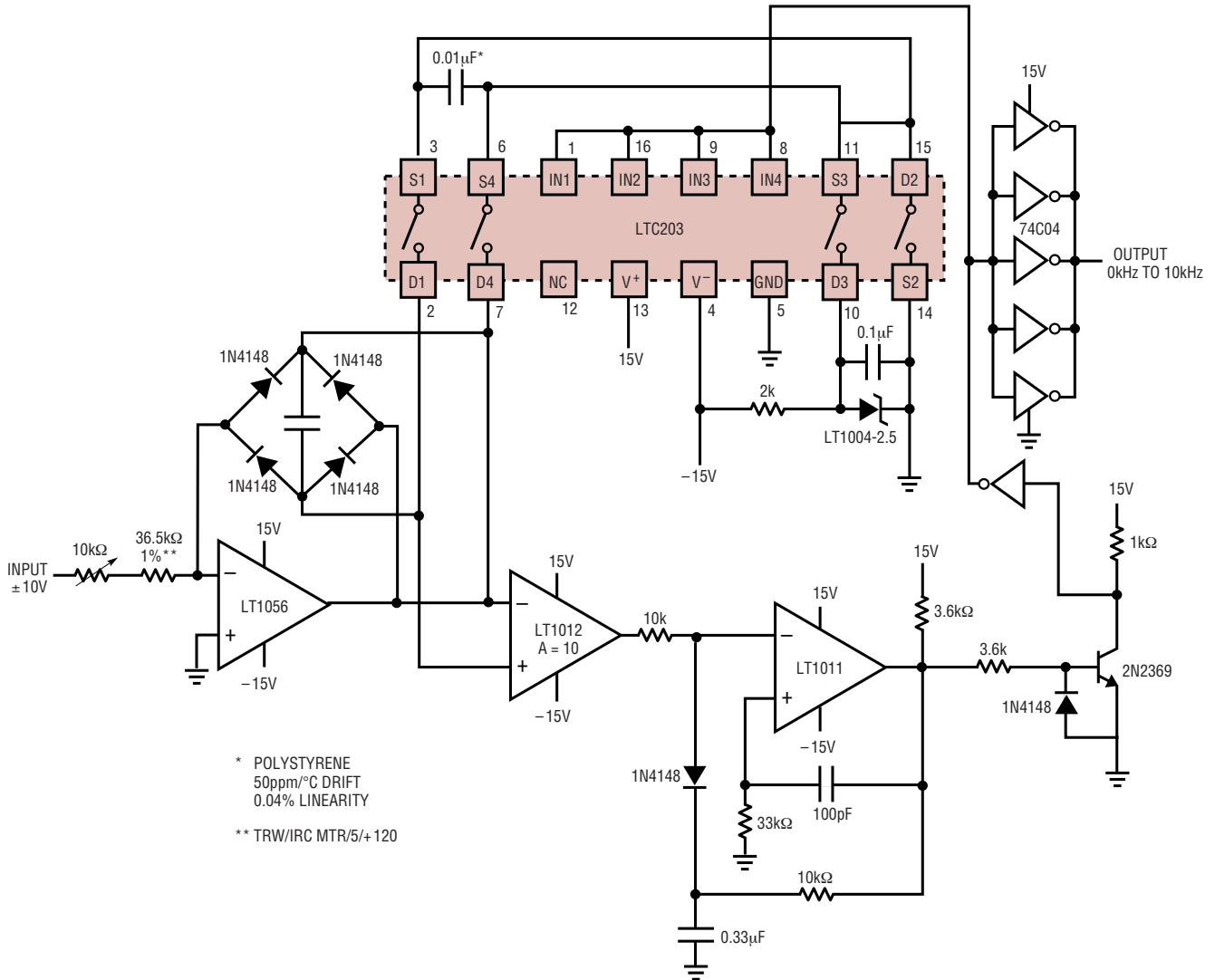


Noise in a 0.1 to 10Hz Bandwidth



## APPLICATIONS INFORMATION

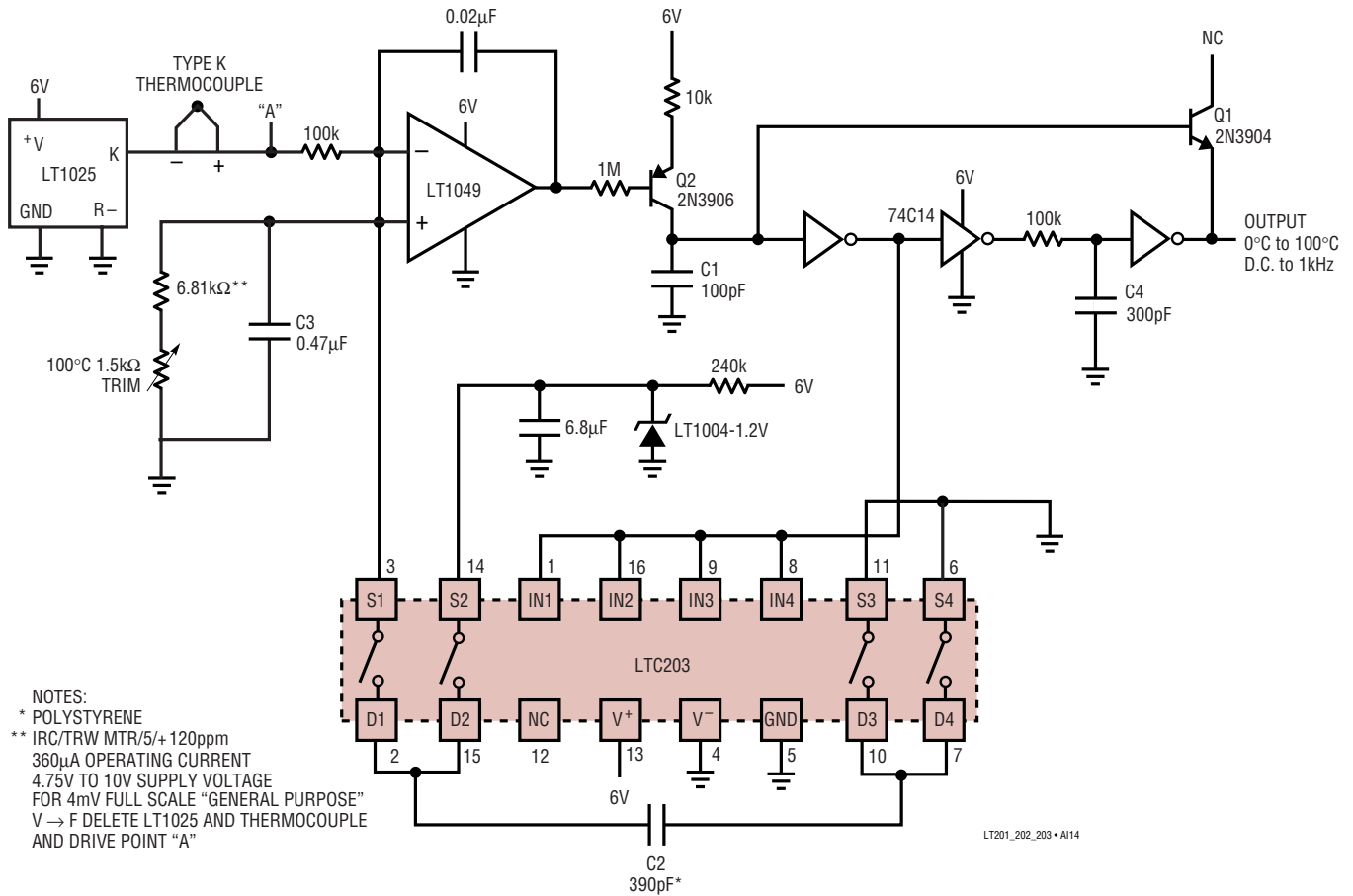
Bipolar (AC) Input V/F Converter



LT201\_202\_203 • A113

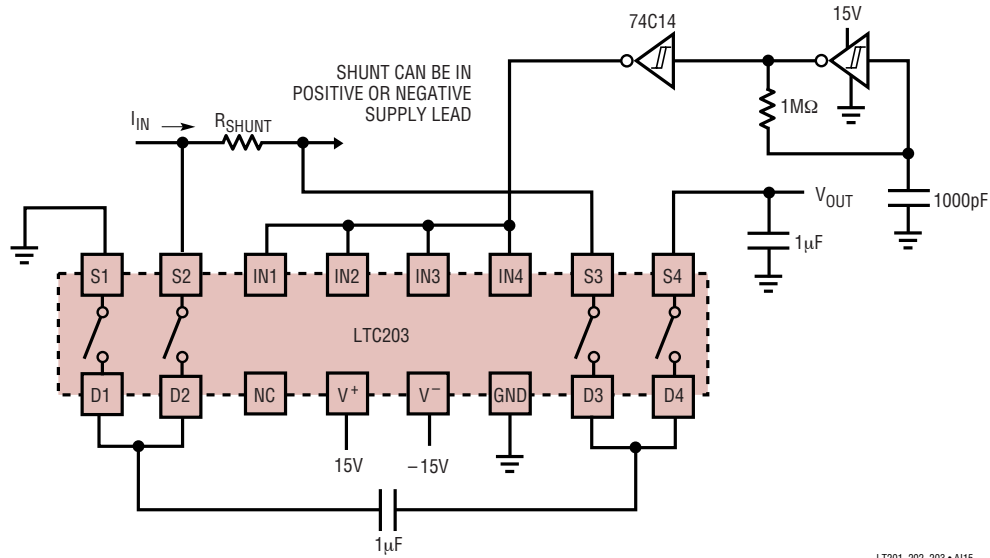
## APPLICATIONS INFORMATION

## Micropower Thermocouple Temperature to Frequency Converter

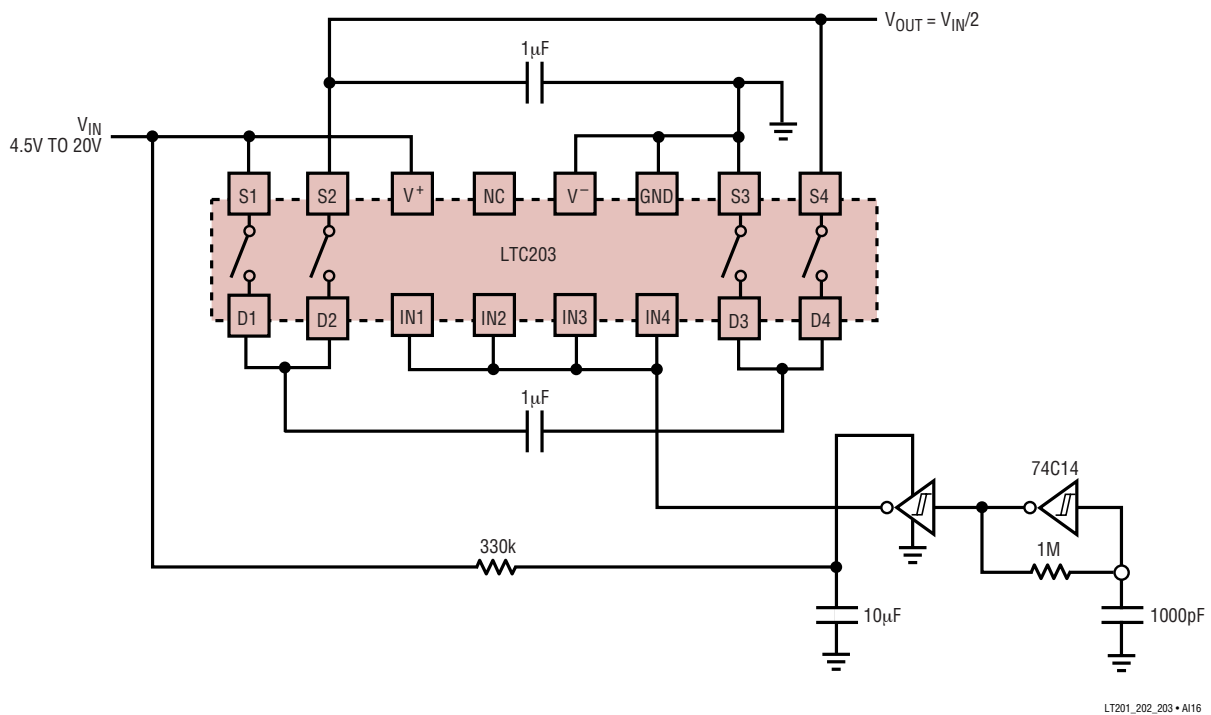


## APPLICATIONS INFORMATION

### Precision Current Sensing in Supply Rails

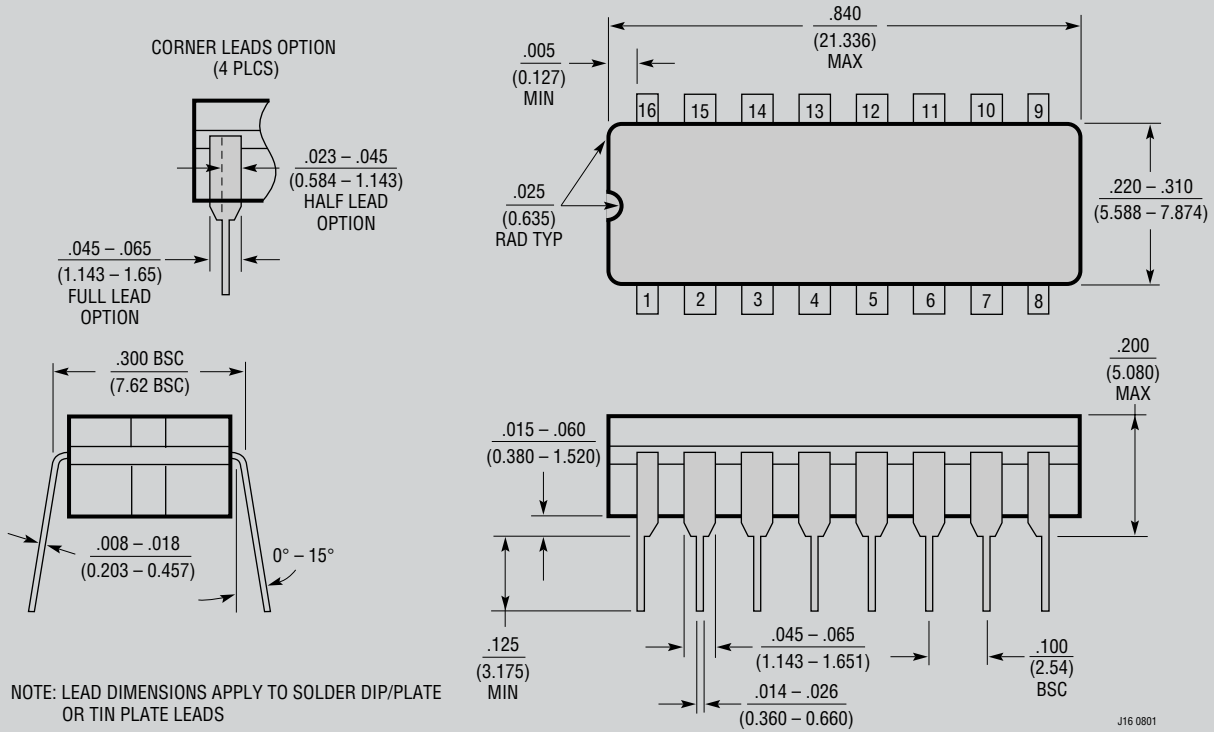


### Precision Voltage Divide by 2 Circuit



## PACKAGE DESCRIPTION

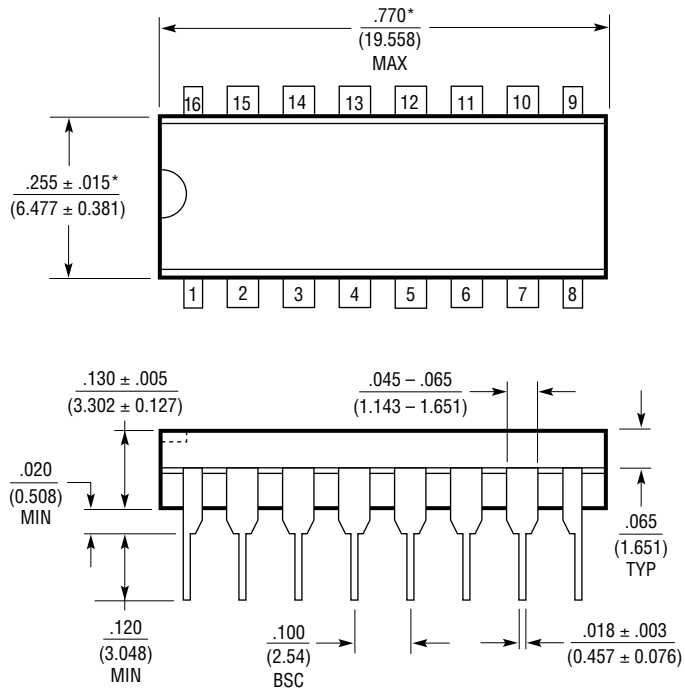
**J Package**  
**16-Lead CERDIP (Narrow .300 Inch, Hermetic)**  
 (Reference LTC DWG # 05-08-1110)



**OBSOLETE PACKAGE**

## PACKAGE DESCRIPTION

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



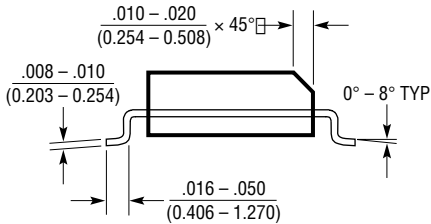
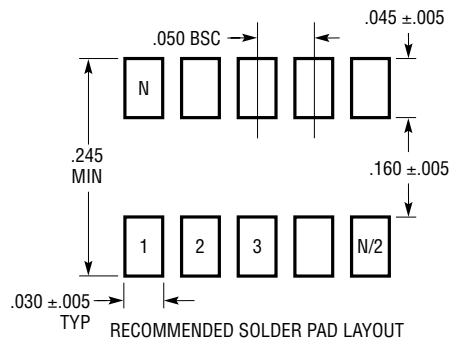
NOTE:  
1. DIMENSIONS ARE  $\frac{\text{INCHES}}{\text{MILLIMETERS}}$

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

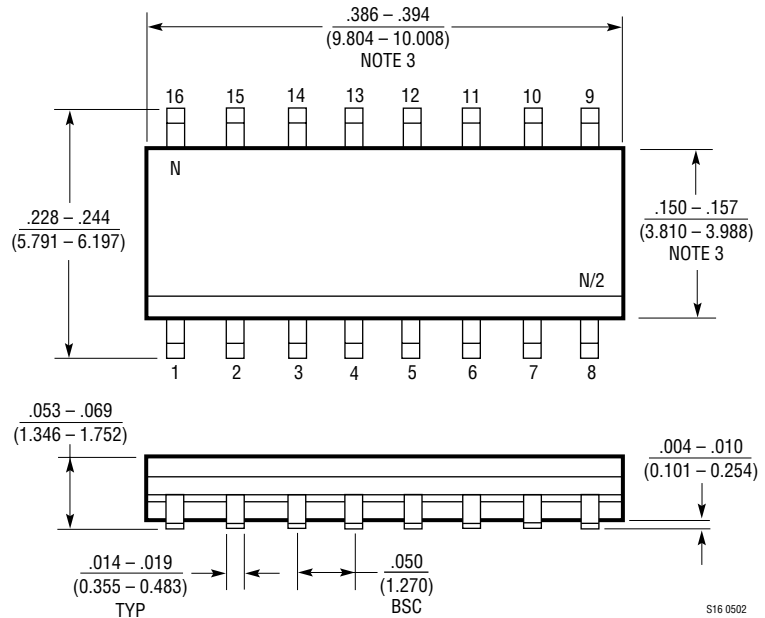
N16 1002

# 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

## 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                            |