



LTC201A/LTC202/LTC203

Micropower, Low Charge Injection, Quad CMOS Analog Switches

FEATURES

- Micropower Operation
- Single 5V or ±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
 - ±15V Supplies ±25pC Max
 - Single 5V Supply 2pC Typ
- R_{ON} 65Ω Typ
- Signal Range ±15V

DESCRIPTION

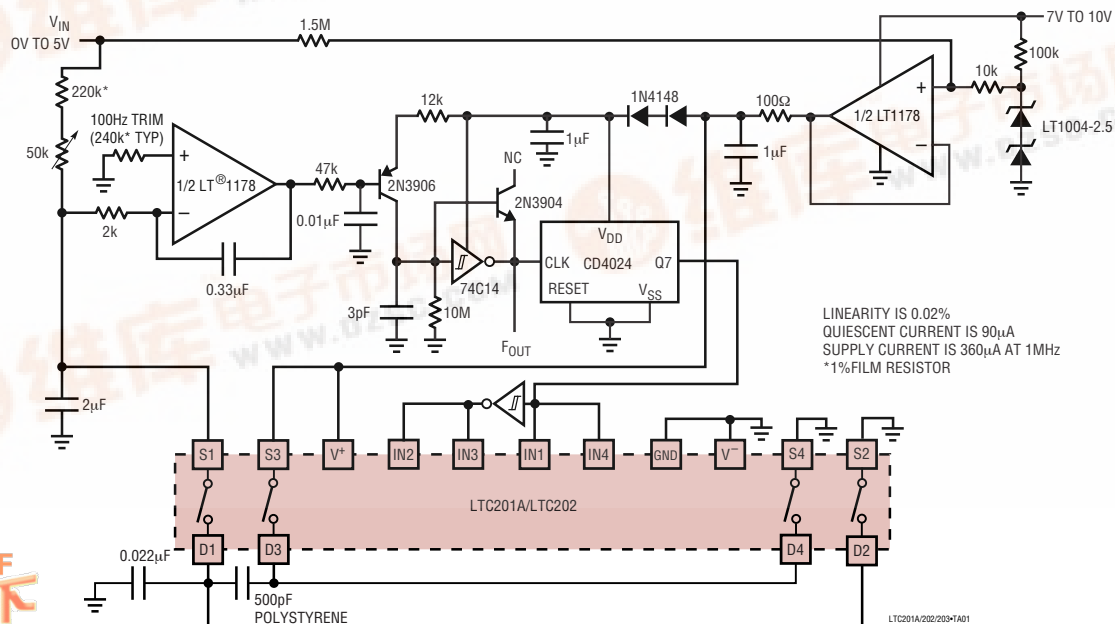
The LTC[®]201A, LTC202, and LTC203 are micropower, quad CMOS analog switches which typically dissipate only 250μW from ±15V supplies and 40μW from a single 5V supply. The switches have 65Ω typical on resistance and a very high off resistance. A break-before-make characteristic, inherent in these switches, 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 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

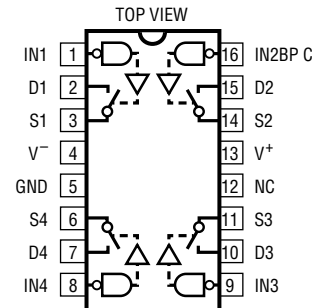
LTC201AC/LTC202C/LTC203C	0°C to 70°C
LTC201AM/LTC202M/LTC203M	-55°C to 125°C

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

IN1 1, IN2BP C 16, D1 2, D2 15, S1 3, S2 14, V- 4, V+ 13, GND 5, NC 12, S4 6, S3 11, D4 7, D3 10, IN4 8, IN3 9

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

ORDER PART NUMBER

LTC201AMJ
LTC201ACJ
LTC202MJ
LTC202CJ
LTC203MJ
LTC203CJ

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

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	Ω	
		25°C				65	110	65	125	Ω
		T_{MAX}						160	160	Ω
ΔR_{ON} vs V_S						20	20	%		
ΔR_{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	±5 ±100	nA nA	

LTC201A/LTC202/LTC203

DIGITAL AND DC ELECTRICAL CHARACTERISTICS

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

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	± 1 ± 100		0.01	± 5 ± 100	nA nA
On Channel Leakage I_D (ON)	$V_D = V_S = \pm 14\text{V}$ Switch On			0.02	± 1		0.02	± 5	nA
		●			± 200			± 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}	$V_{IN} = 15\text{V}$, 0V	●			± 1			± 1	μA
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	μA
	$V_{IN} = 0\text{V}$ or 4.0V	●			60			60	μA
I^-				0.1	5		0.1	5	μA
		●			10			10	μA

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_{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	$V_S = 2\text{V}_{P-P}$, $R_L = 1\text{k}\Omega$, $f = 100\text{kHz}$			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	± 25		8	± 25	pC
Total Harmonic Distortion THD	$V_S = 2\text{V}_{P-P}$, $R_L = 10\text{k}\Omega$			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	Ω	
		25°C		280	450	280	525	Ω	
		T_{MAX}			650		650	Ω	
ΔR_{ON} vs V_S				20		20	%		
ΔR_{ON} vs Temperature				0.5		0.5	$\%/^\circ\text{C}$		
ΔR_{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	± 1	0.01	± 5	nA	
		●			± 100		± 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	± 1	0.01	+5	nA	
		●			± 100		± 100	nA	
On Channel Leakage I_D (ON)	$V_D = V_S = 1\text{V}, 4\text{V}$ (Note 4) Switch On			0.01	± 1	0.01	± 5	nA	
		●			± 200		± 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}	$V_{IN} = 5\text{V}, 0\text{V}$		●		± 1		± 1	μA	
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 4.0V			8	20	8	20	μA	
		●			30		30	μA	

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 O_{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.

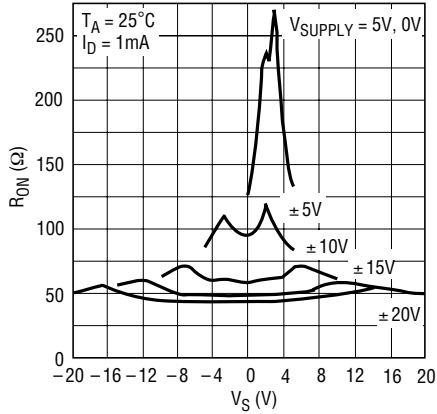
Note 2: Signals on S, D, or IN exceeding V^+ or V^- will be clamped by internal diodes. Limit forward diode current to maximum current rating.

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.

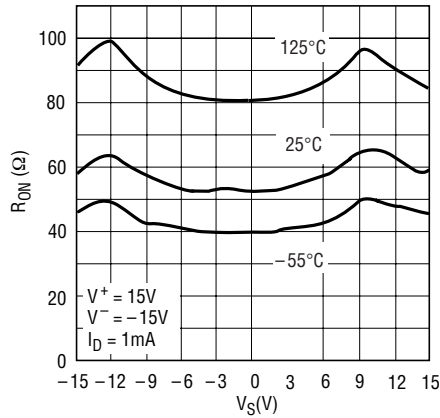
TYPICAL PERFORMANCE CHARACTERISTICS

R_{ON} vs V_S Over Supply Voltage



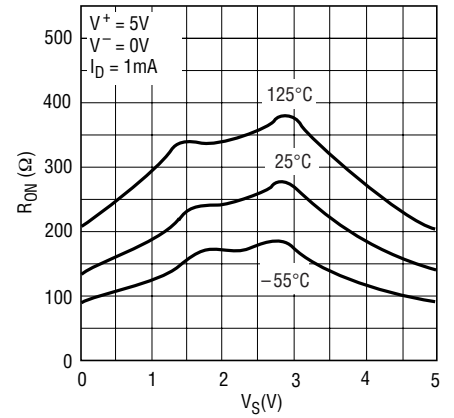
LT201_202_203 • TPC01

R_{ON} vs V_S Over Temperature



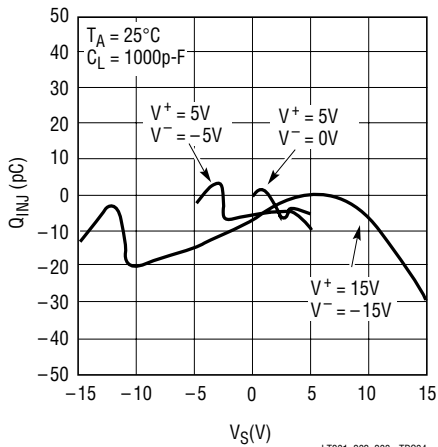
LT201_202_203 • TPC02

R_{ON} vs V_S Over Temperature



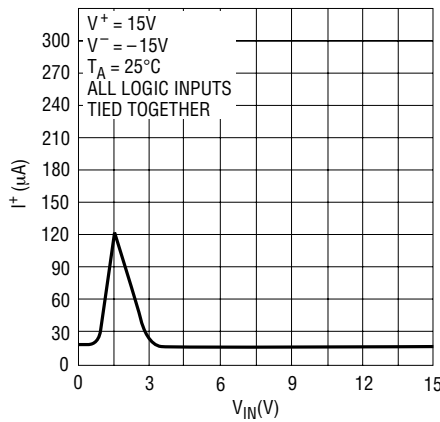
LT201_202_203 • TPC03

Q_{INJ} vs V_S Over Supply Voltage



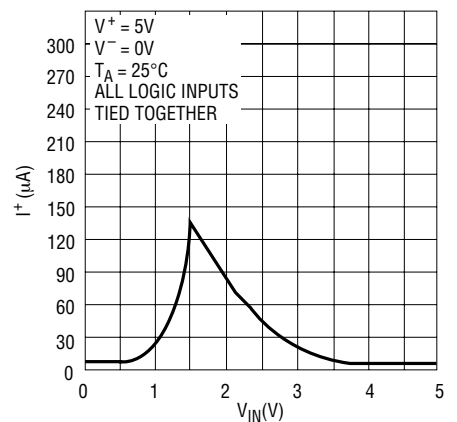
LT201_202_203 • TPC04

Positive Supply Current vs Logic Input Voltage



LT201_202_203 • TPC05

Supply Current vs Logic Input Voltage



LT201_202_203 • TPC06

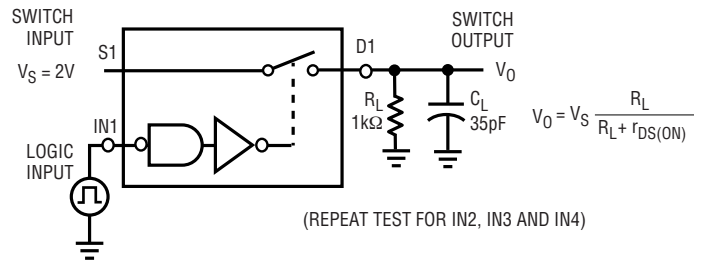
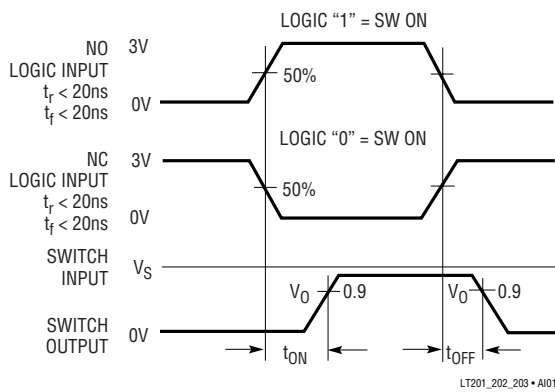
APPLICATIONS INFORMATION

Switching Time Test Circuit

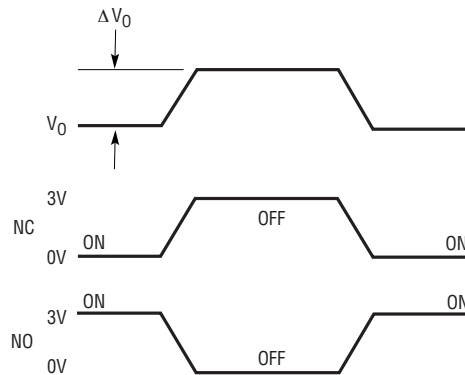
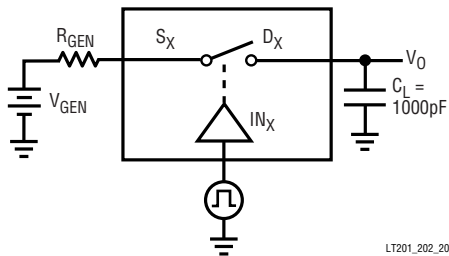
Switch output waveform shown for $V_S =$ constant with logic input waveform as shown. Note that V_S may be + or – as per switching time test circuit. V_O is the steady state

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

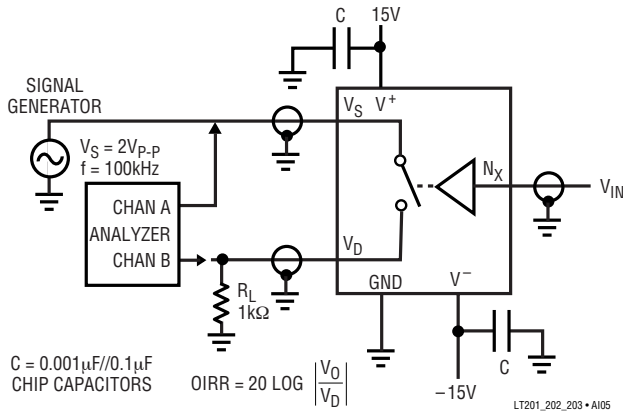


ΔV_O IS THE MEASURED VOLTAGE ERROR DUE TO CHARGE INJECTION.
THE ERROR VOLTAGE IN COULOMBS IS $\Delta Q = C_L \cdot \Delta V_O$

LT201_202_203 • A104

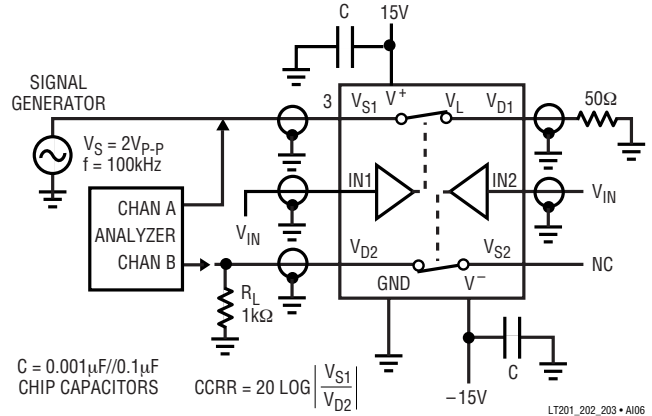
APPLICATIONS INFORMATION

OIRR-Off Isolation Test Circuit



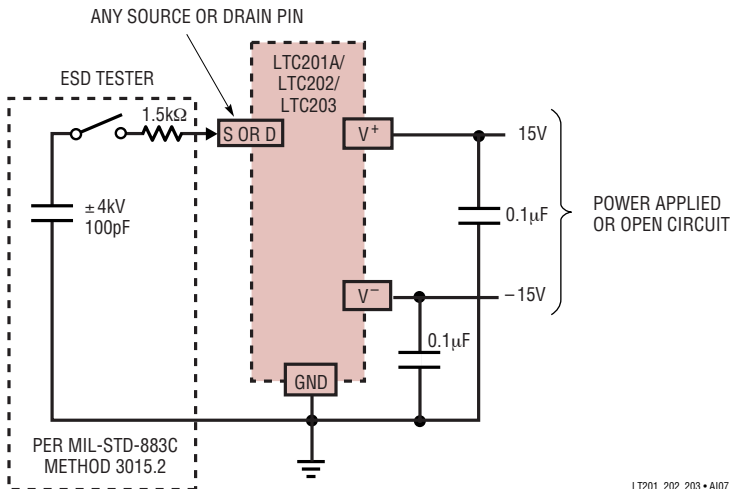
V_{IN}	
3V	NC
0V	NO

CCRR-Channel to Channel Crosstalk Test Circuit

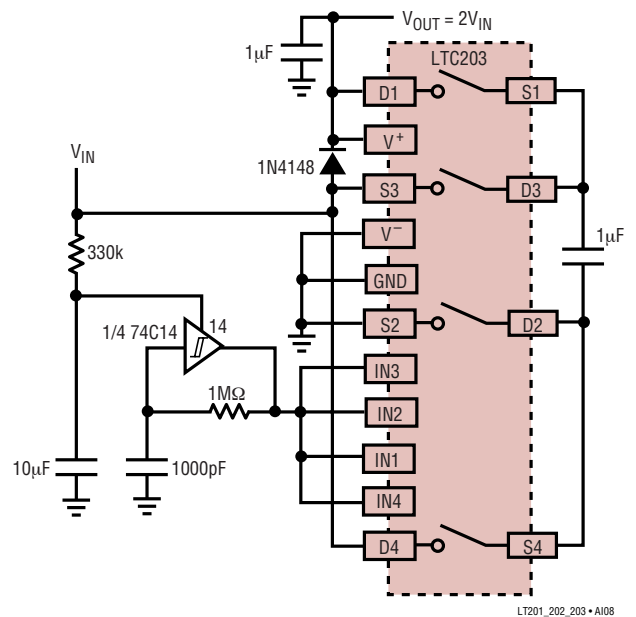


V_{IN}	
3V	NC
0V	NO

In-Circuit ESD Test Circuit



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

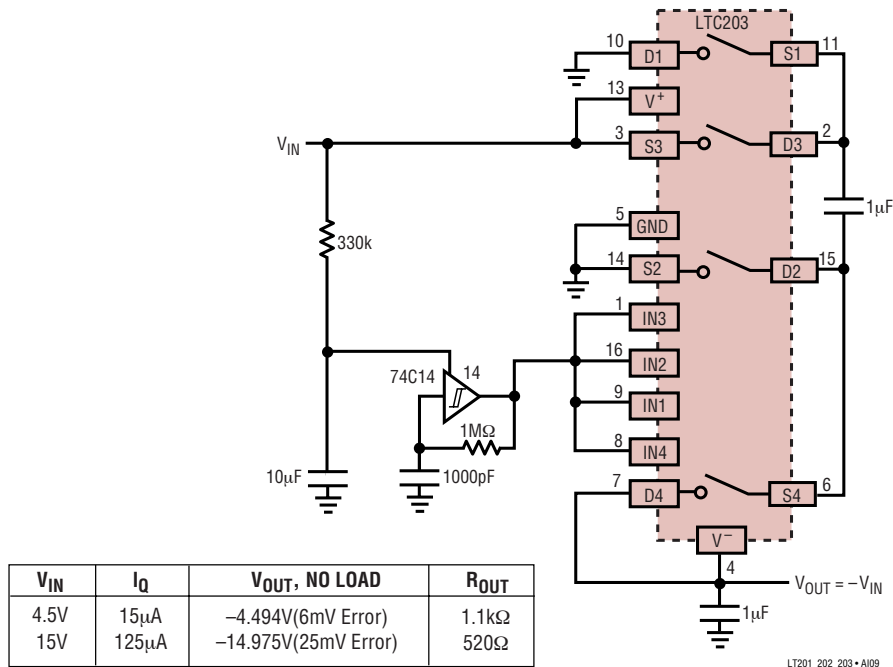


V_{IN}	I_Q	$V_{OUT, \text{ NO LOAD}}$	R_{OUT}
4.5V	20μA	8.988V(12mV Error)	1.2k
15V	130μA	29.96V(40mV Error)	600Ω

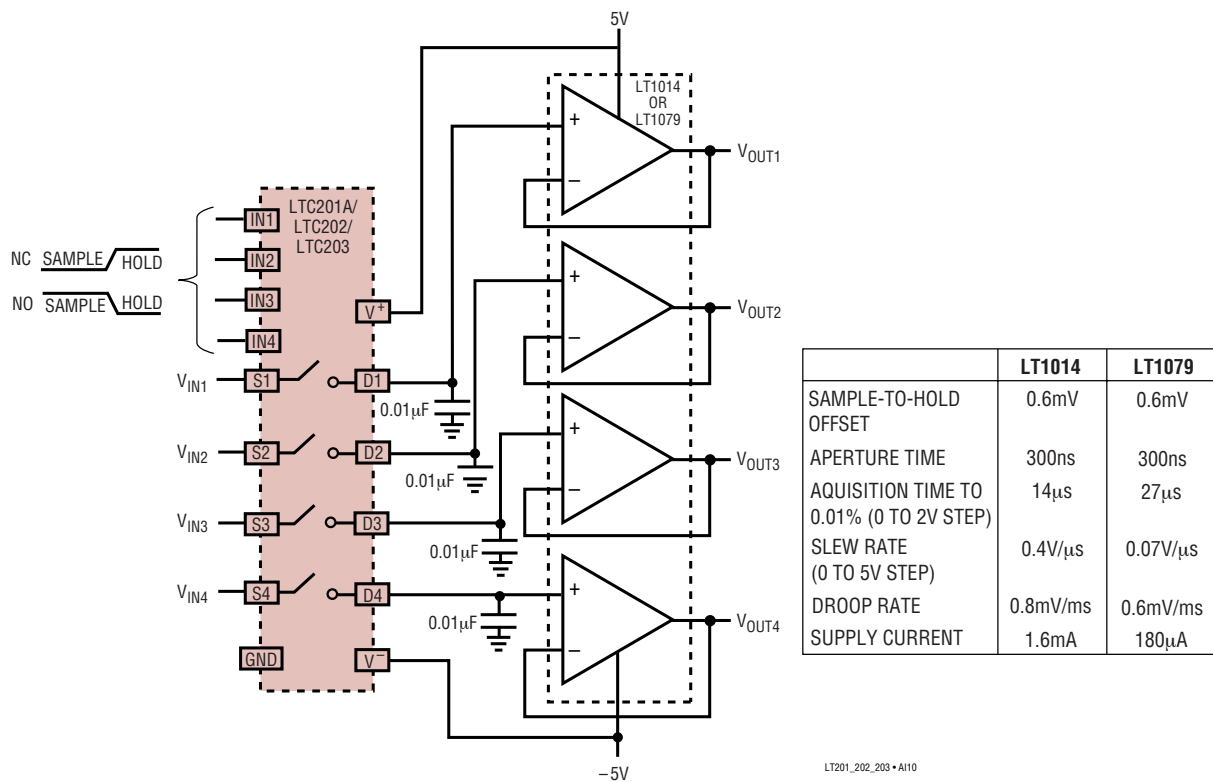
LTC201A/LTC202/LTC203

APPLICATIONS INFORMATION

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

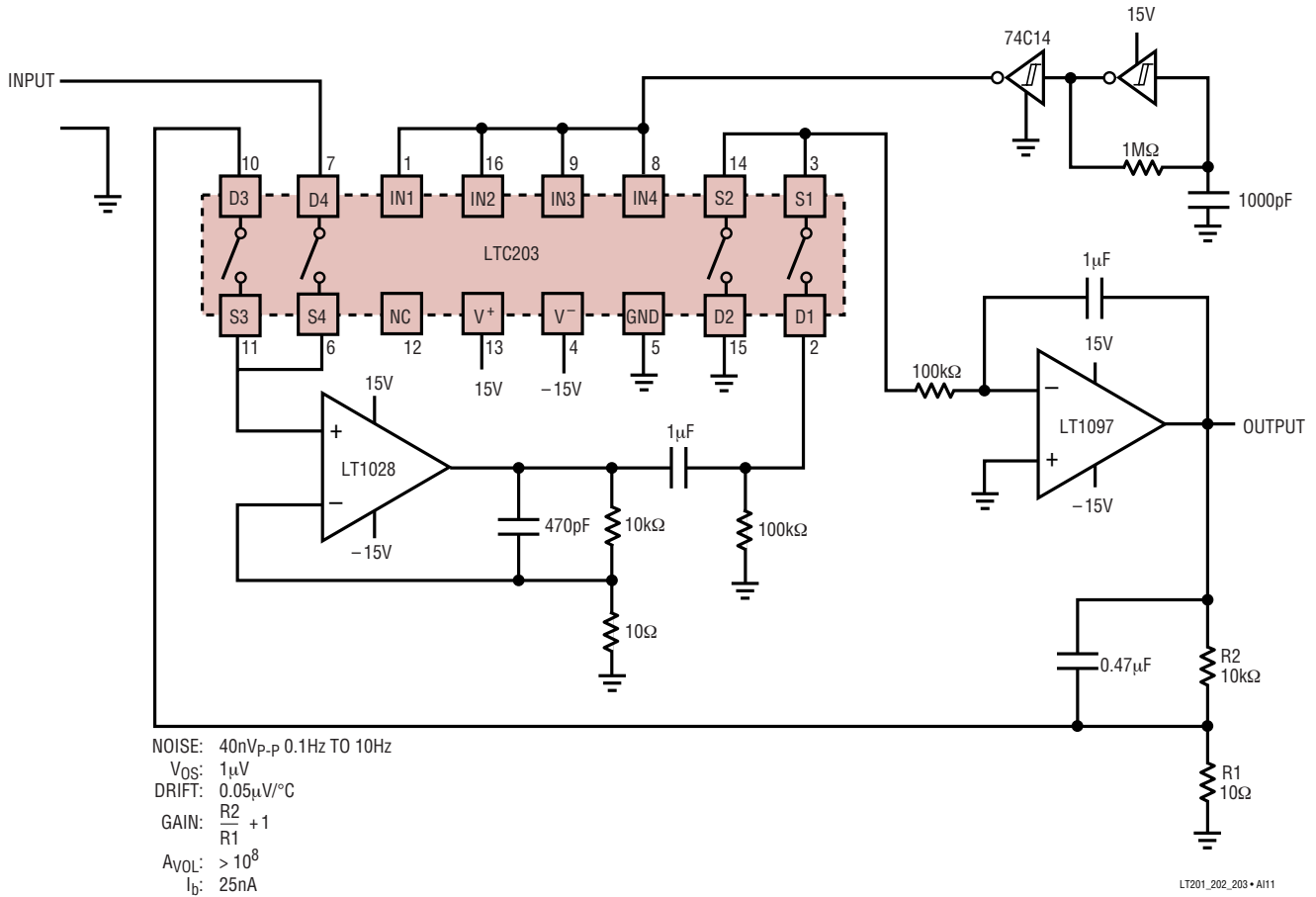


Quad 12-Bit Sample-and-Hold

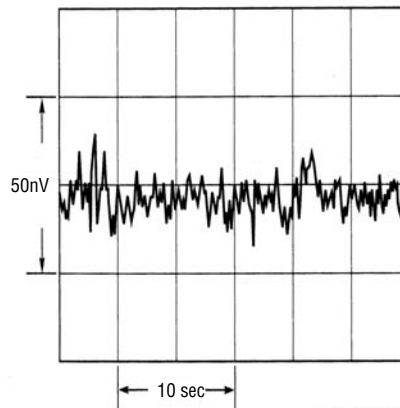


APPLICATIONS INFORMATION

Ultra Low Noise, Low Drift Chopper Amplifier



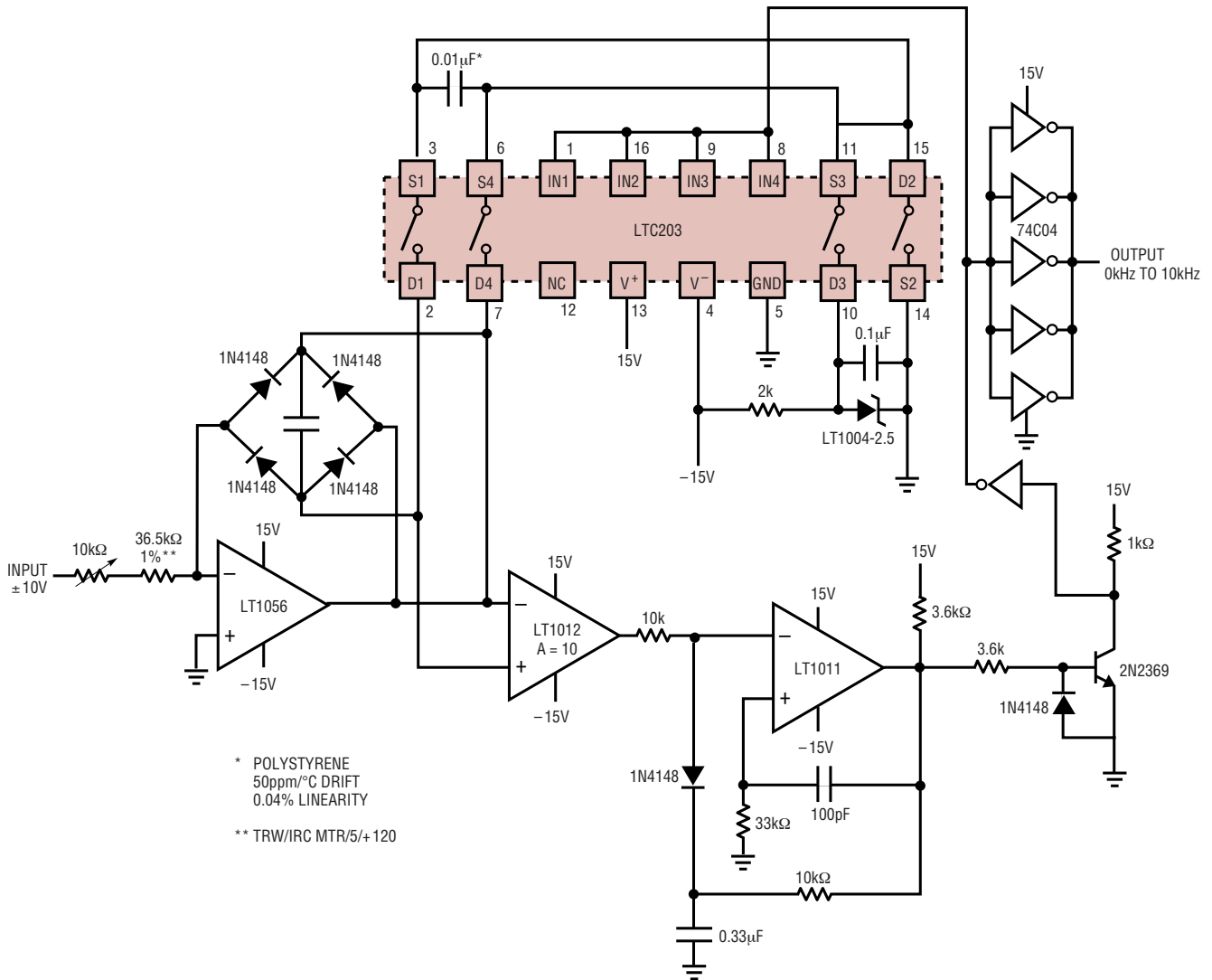
Noise in a 0.1 to 10Hz Bandwidth



LTC201A/LTC202/LTC203

APPLICATIONS INFORMATION

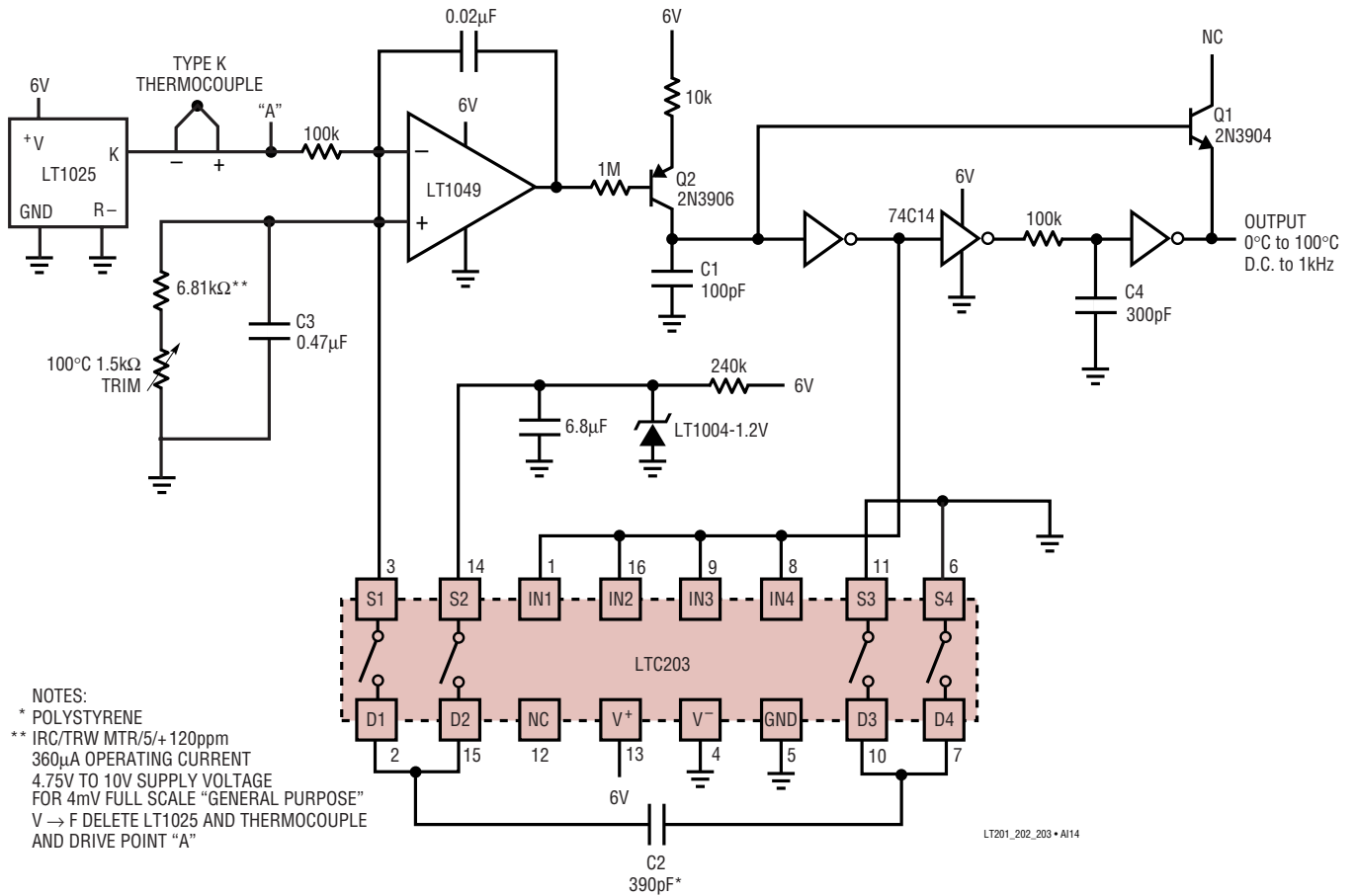
Bipolar (AC) Input V/F Converter



LT201_202_203 • A113

APPLICATIONS INFORMATION

Micropower Thermocouple Temperature to Frequency Converter

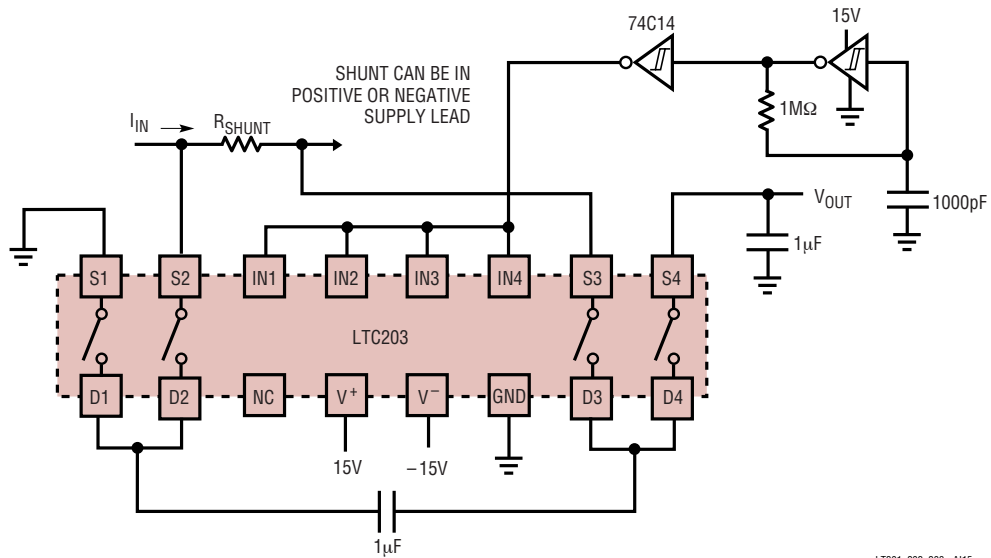


NOTES:
 * POLYSTYRENE
 IRC/TRW MTR/5/+ 120ppm
 360μA OPERATING CURRENT
 4.75V TO 10V SUPPLY VOLTAGE
 FOR 4mV FULL SCALE "GENERAL PURPOSE"
 V → F DELETE LT1025 AND THERMOCOUPLE
 AND DRIVE POINT "A"

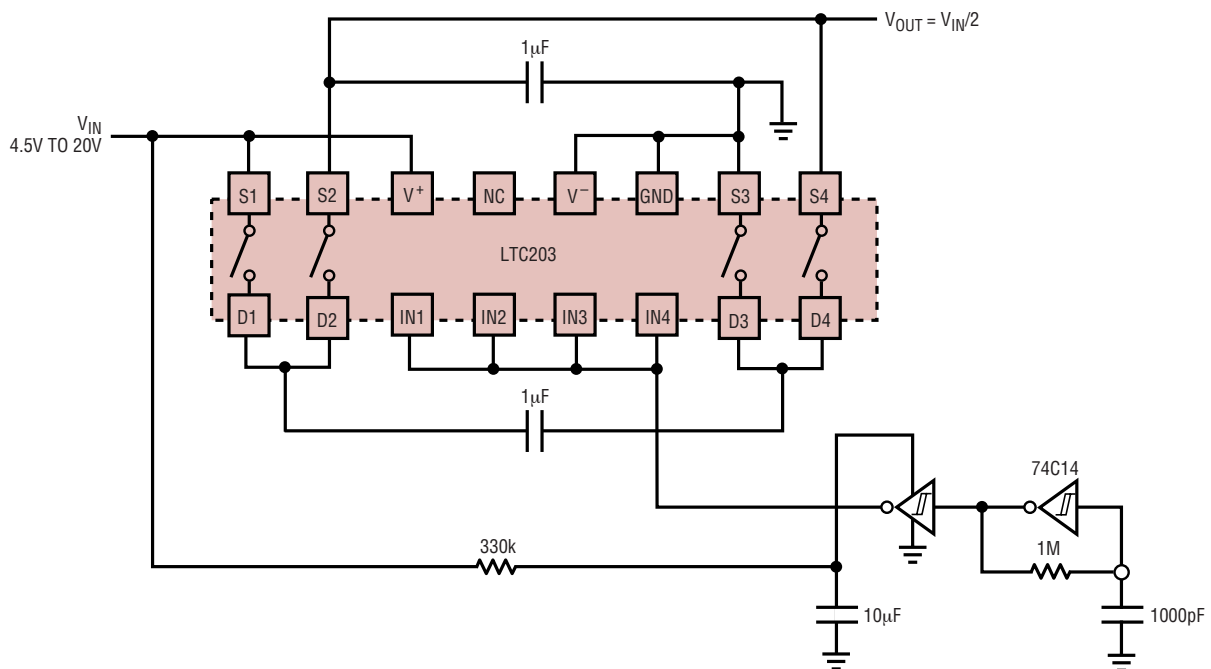
LT201_202_203 • A114

APPLICATIONS INFORMATION

Precision Current Sensing in Supply Rails

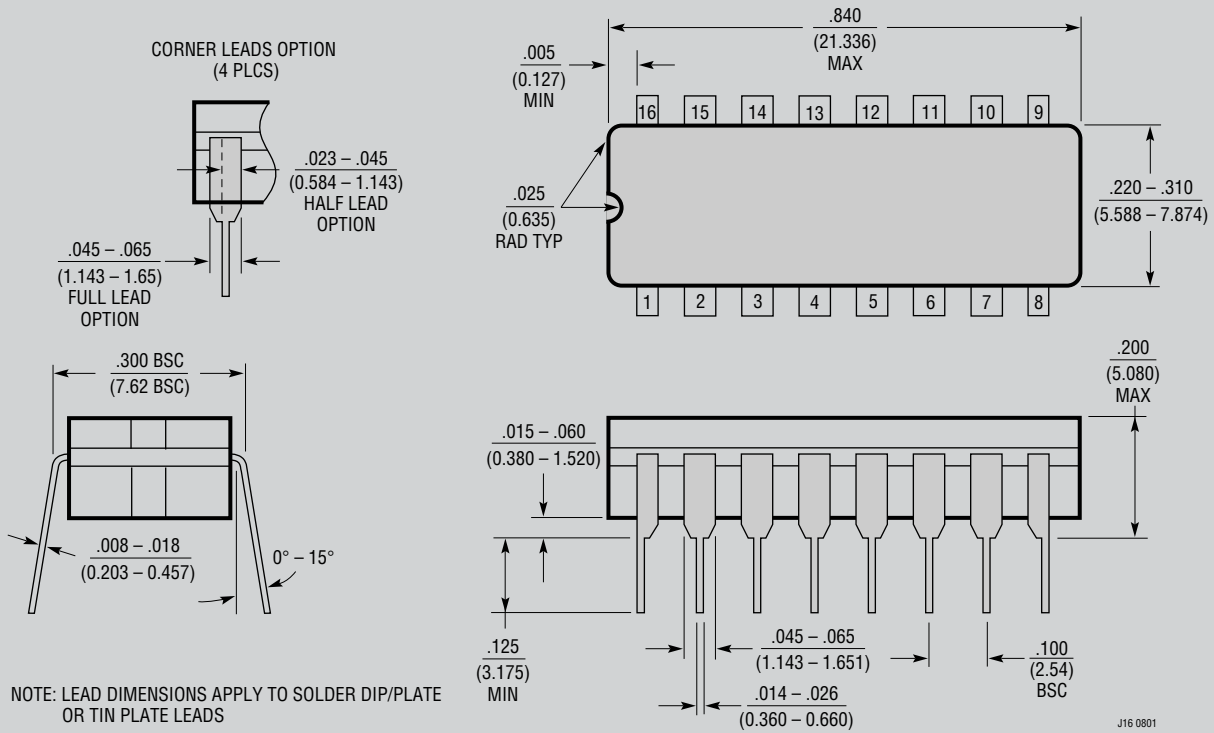


Precision Voltage Divide by 2 Circuit



PACKAGE DESCRIPTION

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



NOTE: LEAD DIMENSIONS APPLY TO SOLDER DIP/PLATE OR TIN PLATE LEADS

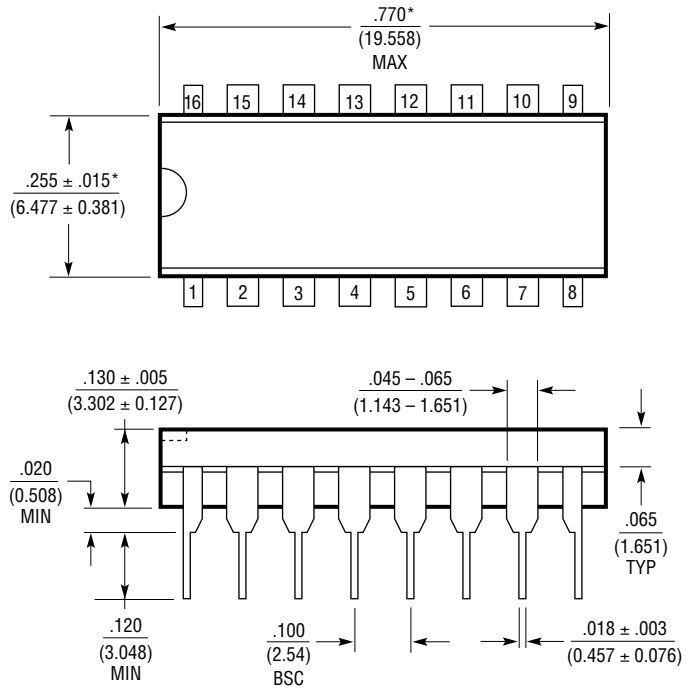
J16 0801

OBSOLETE PACKAGE

LTC201A/LTC202/LTC203

PACKAGE DESCRIPTION

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



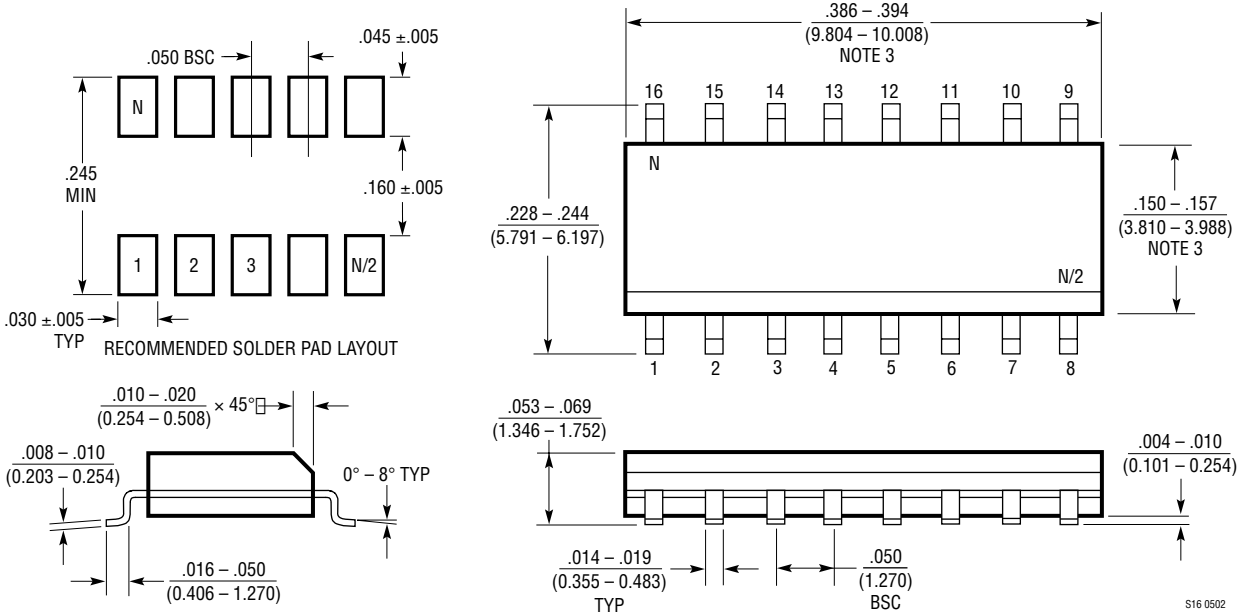
NOTE:
1. DIMENSIONS ARE $\frac{\text{INCHES}}{\text{MILLIMETERS}}$

*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/ 70Ω 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/ μs Slew Rate