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^+ = 40μA, I^- = 5μA Max
- Charge Injection
  - ±15V Supplies ..... ±25pC Max
  - Single 5V Supply ..... 2pC Typ
- R_{ON} ..... 65Ω Typ
- Signal Range ..... ±15V

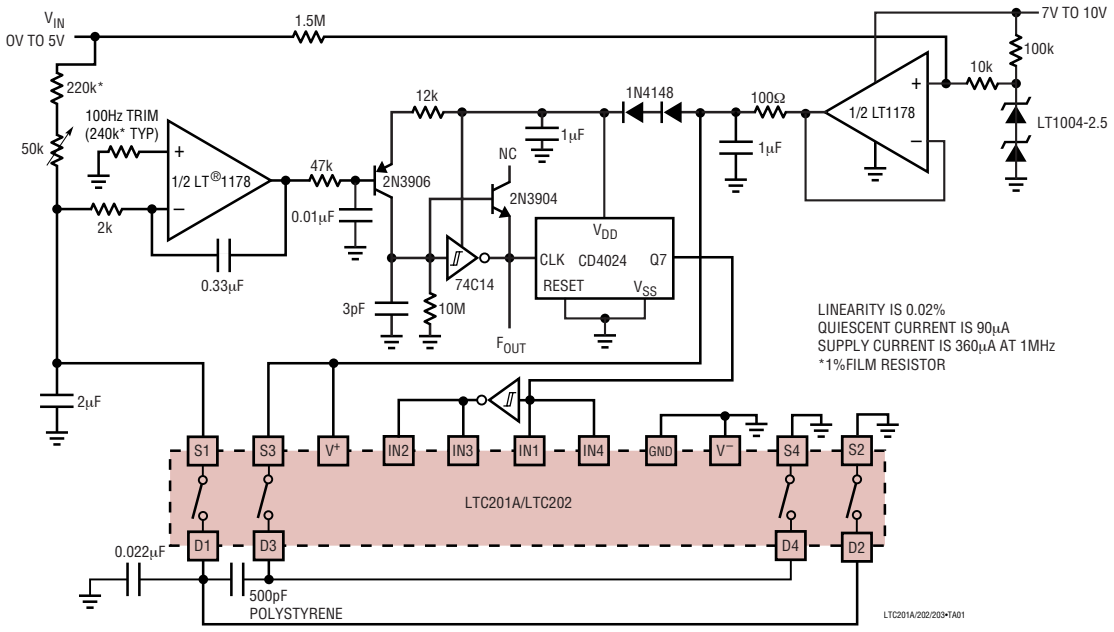
DESCRIPTION

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.

TYPICAL APPLICATION

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



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

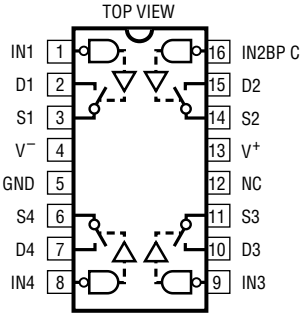
ESD Susceptibility (Note 3) 4kV
Power Dissipation (Plastic) 500mW
Power Dissipation (Ceramic) 900mW
Operating Temperature Range
- LTC201AC/LTC202C/LTC203C ..... 0°C to 70°C
- LTC201AM/LTC202M/LTC203M .....–55°C to 125°C

Storage Temperature Range .....–65°C to 150°C
Lead Temperature (Soldering, 10 sec).....300°C

LOGIC TABLE

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

PACKAGE/ORDER INFORMATION



N PACKAGE
16-LEAD PDIP
T_{JMAX} = 110°C, θ_{JA} - 120C/W

S PACKAGE
16-LEAD PLASTIC SO
T_{JMAX} = 110°C, θ_{JA} - 130C/W

ORDER PART NUMBER

LTC201ACN
LTC201ACS
LTC202CN
LTC202CS
LTC203CN
LTC203CS

J PACKAGE
16-LEAD CERDIP
T_{JMAX} = 150°C, θ_{JA} - 100C/W

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°C. V^+ = 15V, V^- = –15V, GND = 0V.

PARAMETER	CONDITIONS			LTC201AM/LTC202M/LTC203M MIN	LTC201AM/LTC202M/LTC203M TYP	LTC201AM/LTC202M/LTC203M MAX	LTC201AC/LTC202C/LTC203C MIN	LTC201AC/LTC202C/LTC203C TYP	LTC201AC/LTC202C/LTC203C MAX	UNITS
Analog Signal Range			●			±15			±15	V
R_{ON}	V_S = ±10V	T_{MIN}				110			125	Ω
	I_D = 1mA	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 = 0V, I_{DS} = 1mA				5			5		%
Off Input Leakage I_S (OFF)	V_D = ±14V, V_S = ±14V				0.01	±1		0.01	±5	nA
	Switch Off		●			±100			±100	nA

DIGITAL AND DC ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over full operating temperature range, otherwise specifications are at T_A = 25°C. V^+ = 15V, V^- = –15V, GND = 0V.

PARAMETER	CONDITIONS		LTC201AM/LTC202M/ LTC203M MIN	TYP	MAX	LTC201AC/LTC202C/ LTC203C MIN	TYP	MAX	UNITS
Off Output Leakage I_D (OFF)	V_D = ±14V, V_S = ±14V Switch Off	● ●		0.01	±1 ±100		0.01	±5 ±100	nA nA
On Channel Leakage I_D (ON)	V_D = V_S = ±14V			0.02	±1		0.02	±5	nA
	Switch On	●			±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} = 15V, 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} = 0V or 4.0V	●			60			60	µA
I^-				0.1	5		0.1	5	µA
		●			10			10	µA

AC ELECTRICAL CHARACTERISTICS

V^+ = 15V, V^- = –15V, GND = 0V unless otherwise noted.

PARAMETER	CONDITIONS	LTC201AM/LTC202M/ LTC203M MIN	TYP	MAX	LTC201AC/LTC202C/ LTC203C MIN	TYP	MAX	UNITS
t_{ON}	V_S = 2V, R_L = 1kΩ, C_L = 35pF		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 = 1kΩ, f 100kHz		75			75		dB
Crosstalk			90			90		dB
Charge Injection O_{INJ}	R_S = 0Ω, C_L = 1000pF, V_S = 0V		5	±25		8	±25	pC
Total Harmonic Distortion THD	V_S = $2V_{P-P}$, R_L = 10kΩ		0.01			0.01		%

DIGITAL AND DC ELECTRICAL CHARACTERISTICS

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

PARAMETER	CONDITIONS			LTC201AM/LTC202M/LTC203M MIN	TYP	MAX	LTC201AC/LTC202C/LTC203C MIN	TYP	MAX	UNITS
Analog Signal Range			●	0		5	0		5	V
R_{ON}	V_S = ±1.5V, +3V	T_{MIN}				450			520	Ω
	I_D = 0.25mA	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		%/°C
ΔR_{ON} Match	V_S = 2.5V, I_{DS} = 0.25mA				5			5		%
Off Input Leakage I_S (OFF)	V_D = 4V, 1V; V_S = 1V, 4V (Note 4)				0.01	±1		0.01	±5	nA
	Switch Off		●			±100			±100	nA
Off Output Leakage I_D (0FF)	V_D = 4V, 1V; V_S = 1V, 4V (Note 4)				0.01	±1		0.01	+5	nA
	Switch Off		●			±100			±100	nA
On Channel Leakage I_D (ON)	V_D = V_S = 1V, 4V (Note 4)				0.01	±1		0.01	±5	nA
	Switch On		●			±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} = 5V, 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				8	20		8	20	µA
	V_{IN} = 0V OR 4.0V		●			30			30	µA

AC ELECTRICAL CHARACTERISTICS

V^+ = 5V, V^- = GND = 0V unless otherwise noted.

PARAMETER	CONDITIONS	LTC201AM/LTC202M/LTC203M MIN	TYP	MAX	LTC201AC/LTC202C/LTC203C MIN	TYP	MAX	UNITS
t_{ON}	V_S = 2V, R_L = 1kΩ, C_L = 35pF		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 = 1kΩ, f = 100Hz		75			75		dB
Crosstalk			90			90		dB
Charge Injection O_{INJ}	R_S = 0Ω, C_L = 1000pF, V_S = 2.5V		2			2		pC
Total Harmonic Distortion THD	V_S = $2V_{P-P}$, R_L = 10kΩ		0.01			0.01		%

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

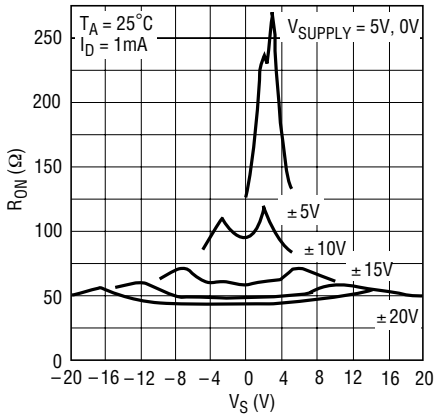
Note 2: Signals on S, D, or IN exceeding V^+ or V^- will be clamped by internal diodes. Limit forward diode current to maximum current rating.

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 ±15V leakage current.

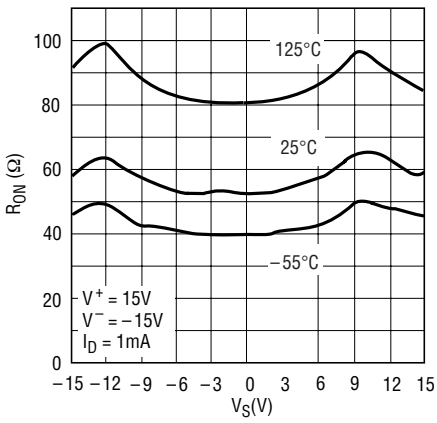
TYPICAL PERFORMANCE CHARACTERISTICS

R_{ON} vs V_S Over Supply Voltage



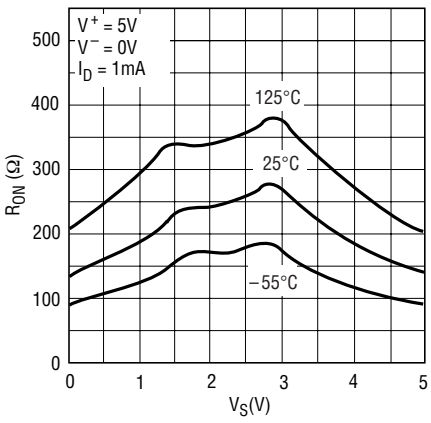
LT201_202_203 • TPC01

R_{ON} vs V_S Over Temperature



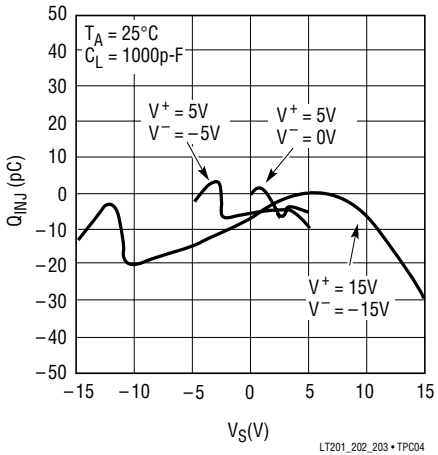
LT201_202_203 • TPC02

R_{ON} vs V_S Over Temperature



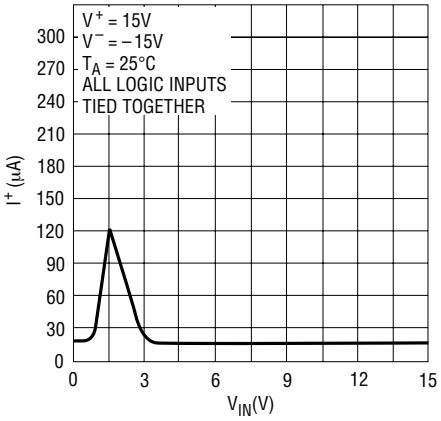
LT201_202_203 • TPC03

Q_{INJ} vs V_S Over Supply Voltage



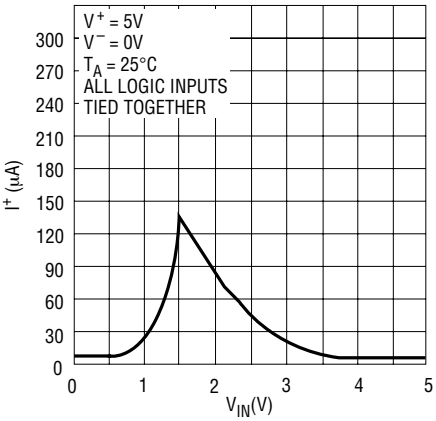
LT201_202_203 • TPC04

Positive Supply Current vs Logic Input Voltage



LT201_202_203 • TPC05

Supply Current vs Logic Input Voltage



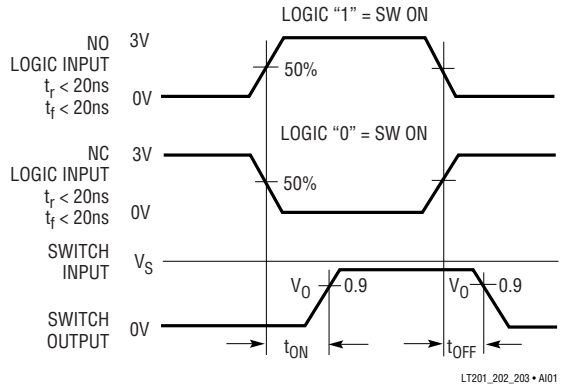
LT201_202_203 • TPC06

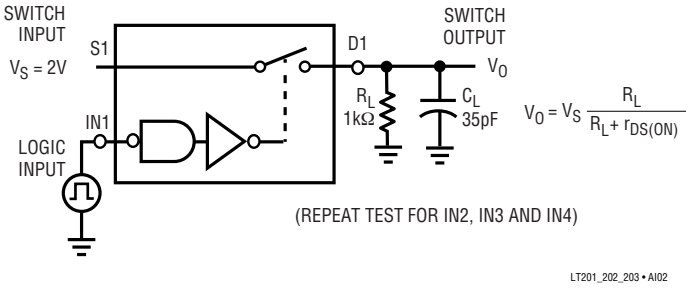
APPLICATIONS INFORMATION

Switching Time Test Circuit

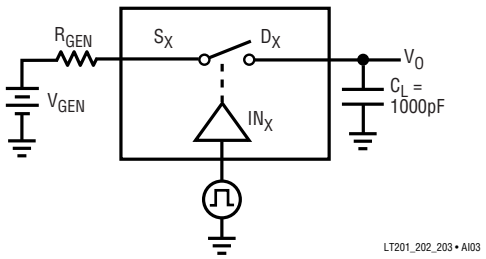
Switch output waveform shown for V_S = constant with logic input waveform as shown. Note that V_S may be + or – as per switching time test circuit. V_O is the steady state output switch on. Feedthrough via gate capacitance may result in spikes at leading and trailing edge of output waveform.

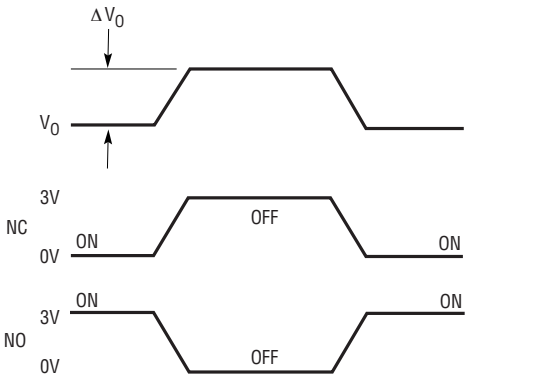
Switching Time Test Circuit





Charge Injection Test Circuit



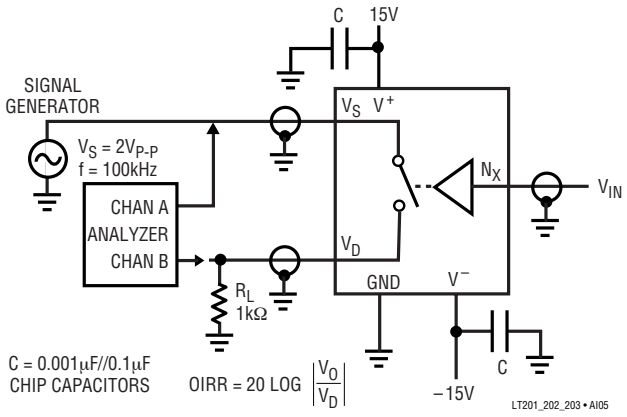


ΔV_O IS THE MEASURED VOLTAGE ERROR DUE TO CHARGE INJECTION.
THE ERROR VOLTAGE IN COULOMBS IS $\Delta Q = C_L \bullet \Delta V_O$

LT201_202_203 • AI04

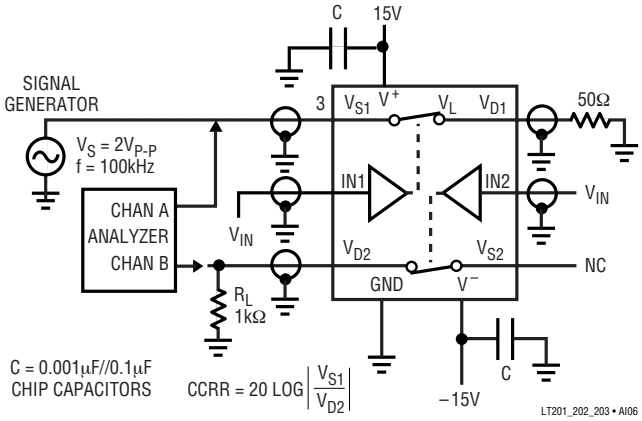
APPLICATIONS INFORMATION

OIRR-Off Isolation Test Circuit



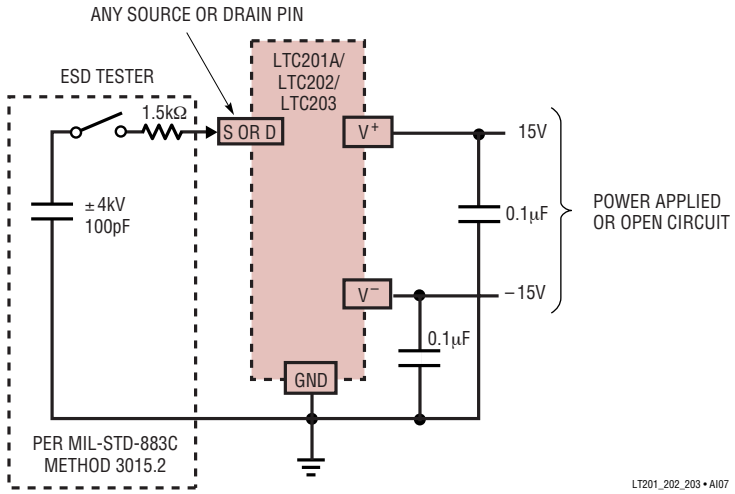
V_{IN}	
3V	NC
0V	NO

CCRR-Channel to Channel Crosstalk Test Circuit

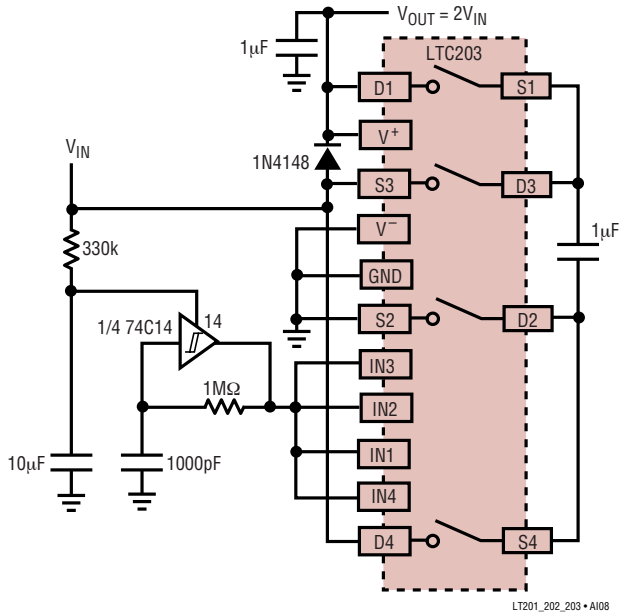


V_{IN}	
3V	NC
0V	NO

In-Circuit ESD Test Circuit



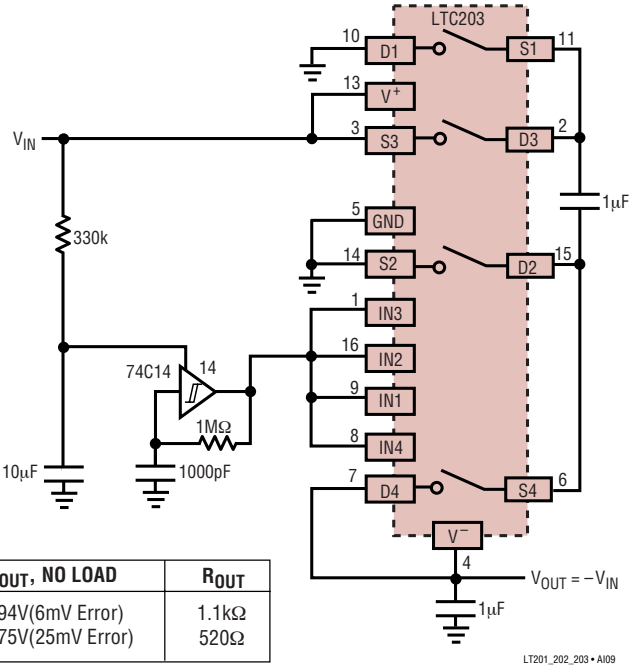
Micropower, 4.5V to 15V Input, Voltage Doubler Using the LTC203



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

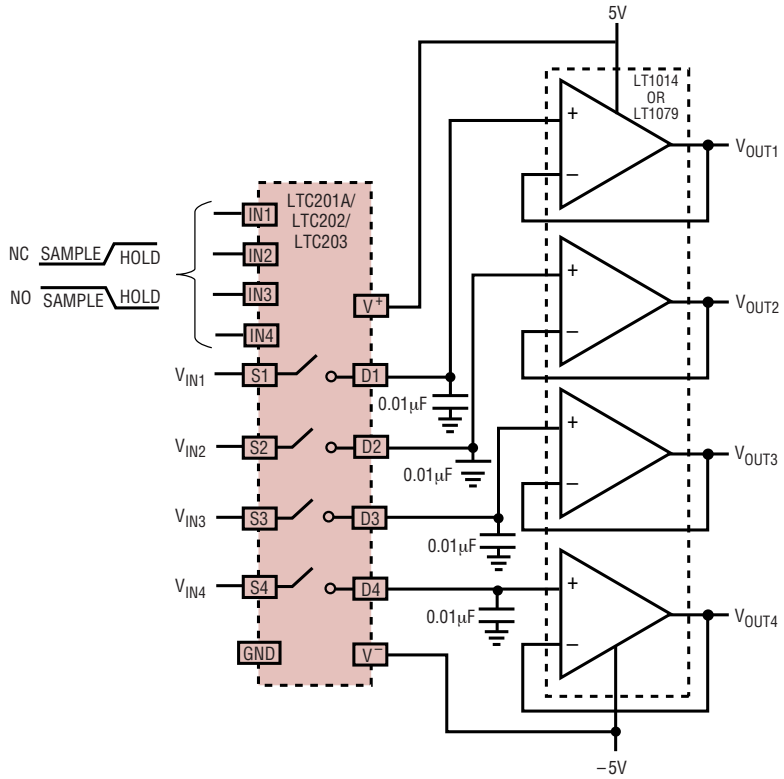
APPLICATIONS INFORMATION

Micropower, ±4.5V to ±15V, Voltage Inverter Using the LTC203



V_{IN}	I_Q	V_{OUT}, NO LOAD	R_{OUT}
4.5V	15µA	–4.494V(6mV Error)	1.1kΩ
15V	125µA	–14.975V(25mV Error)	520Ω

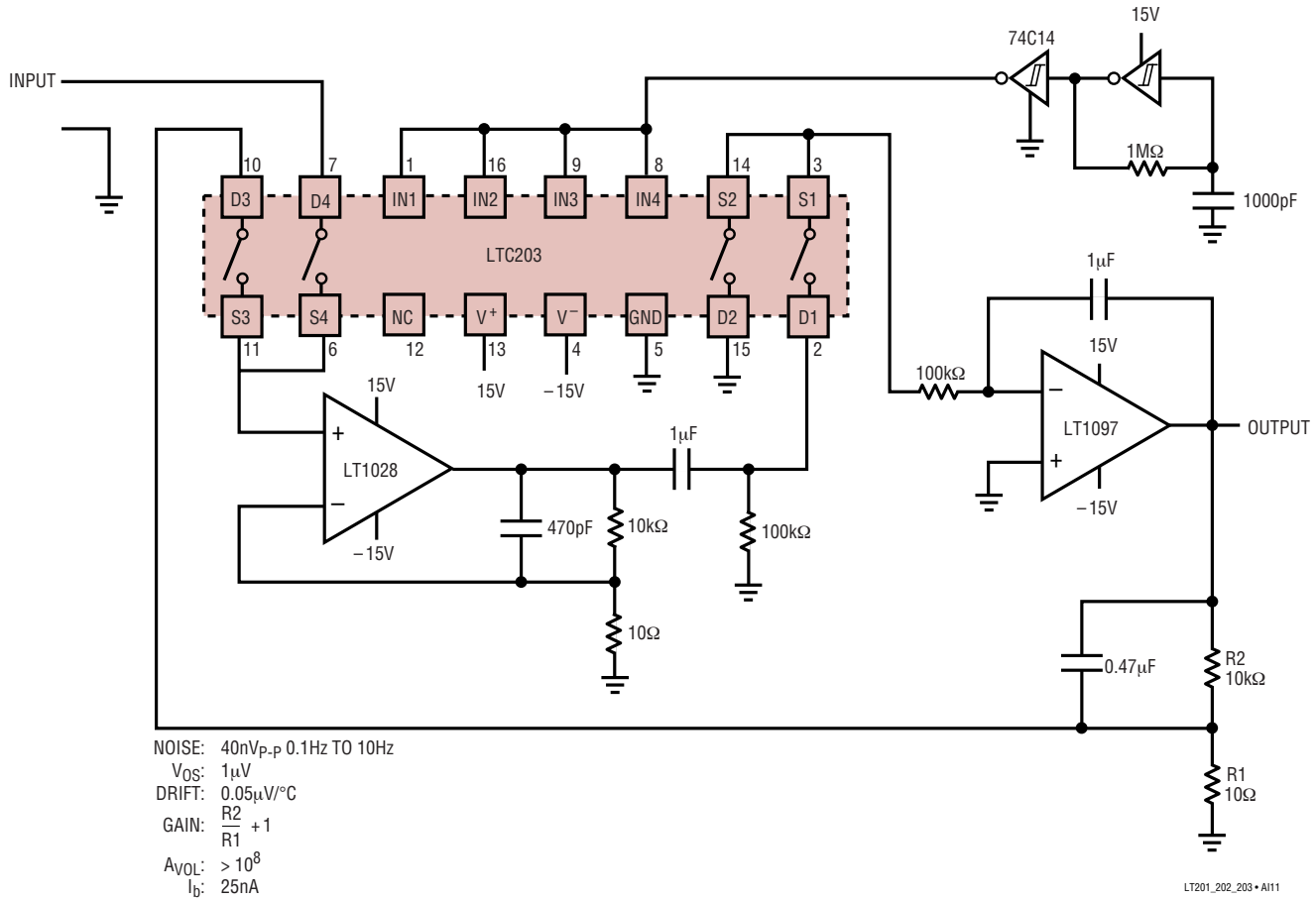
Quad 12-Bit Sample-and-Hold



	LT1014	LT1079
SAMPLE-TO-HOLD OFFSET	0.6mV	0.6mV
APERTURE TIME	300ns	300ns
AQUISITION TIME TO 0.01% (0 TO 2V STEP)	14µs	27µs
SLEW RATE (0 TO 5V STEP)	0.4V/µs	0.07V/µs
DROOP RATE	0.8mV/ms	0.6mV/ms
SUPPLY CURRENT	1.6mA	180µA

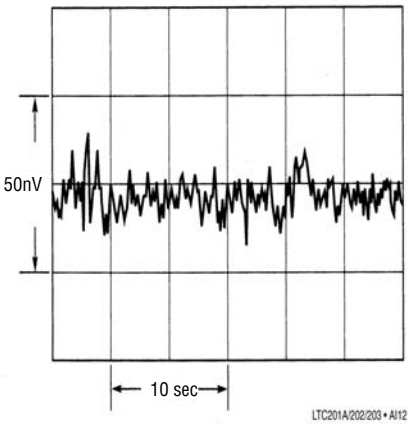
APPLICATIONS INFORMATION

Ultra Low Noise, Low Drift Chopper Amplifier



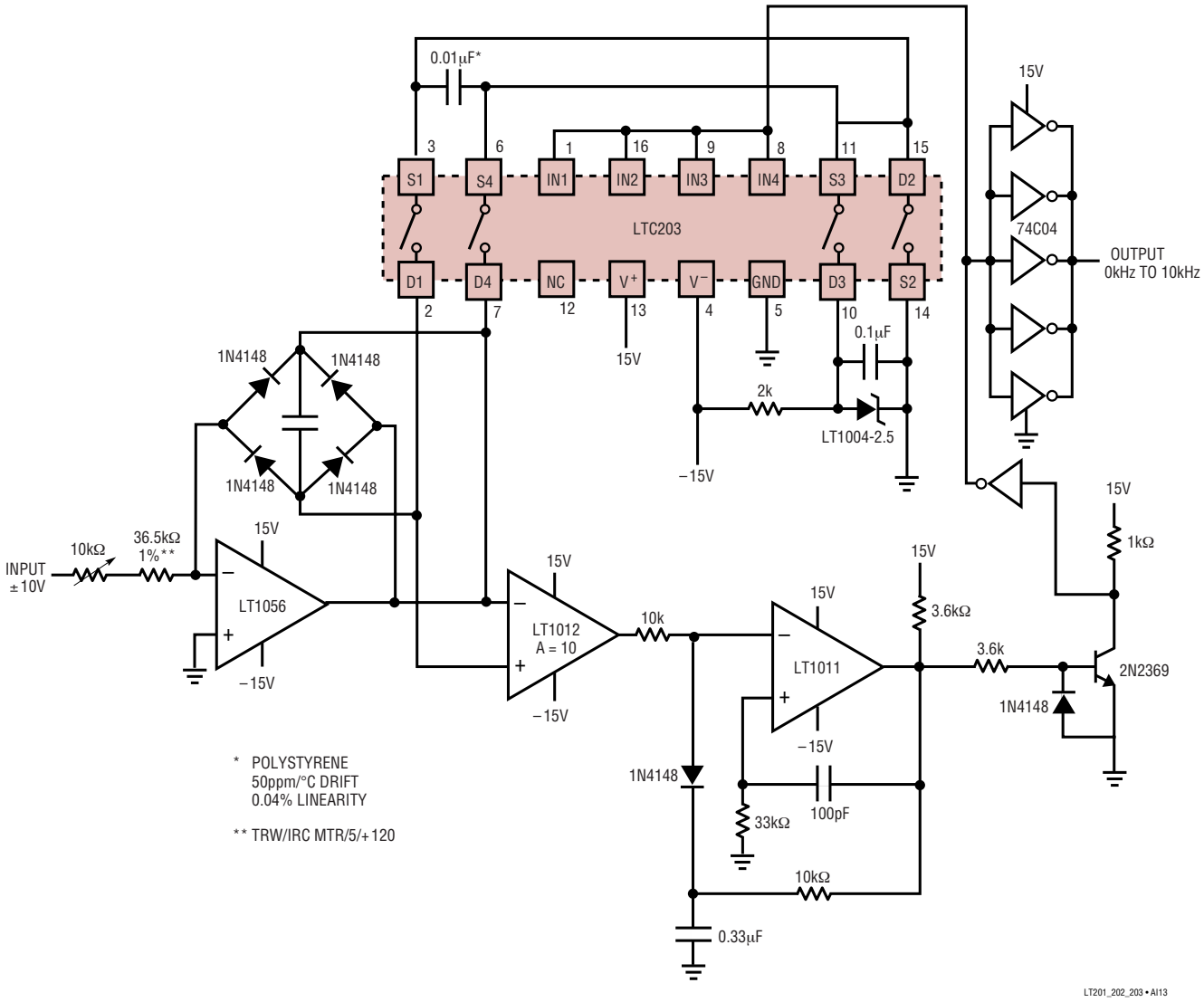
NOISE: $40nV_{P-P}$ 0.1Hz TO 10Hz
V_{OS}: 1μV
DRIFT: 0.05μV/°C
GAIN: $\frac{R2}{R1} + 1$
A_{VOL}: $> 10^8$
I_b: 25nA

Noise in a 0.1 to 10Hz Bandwidth



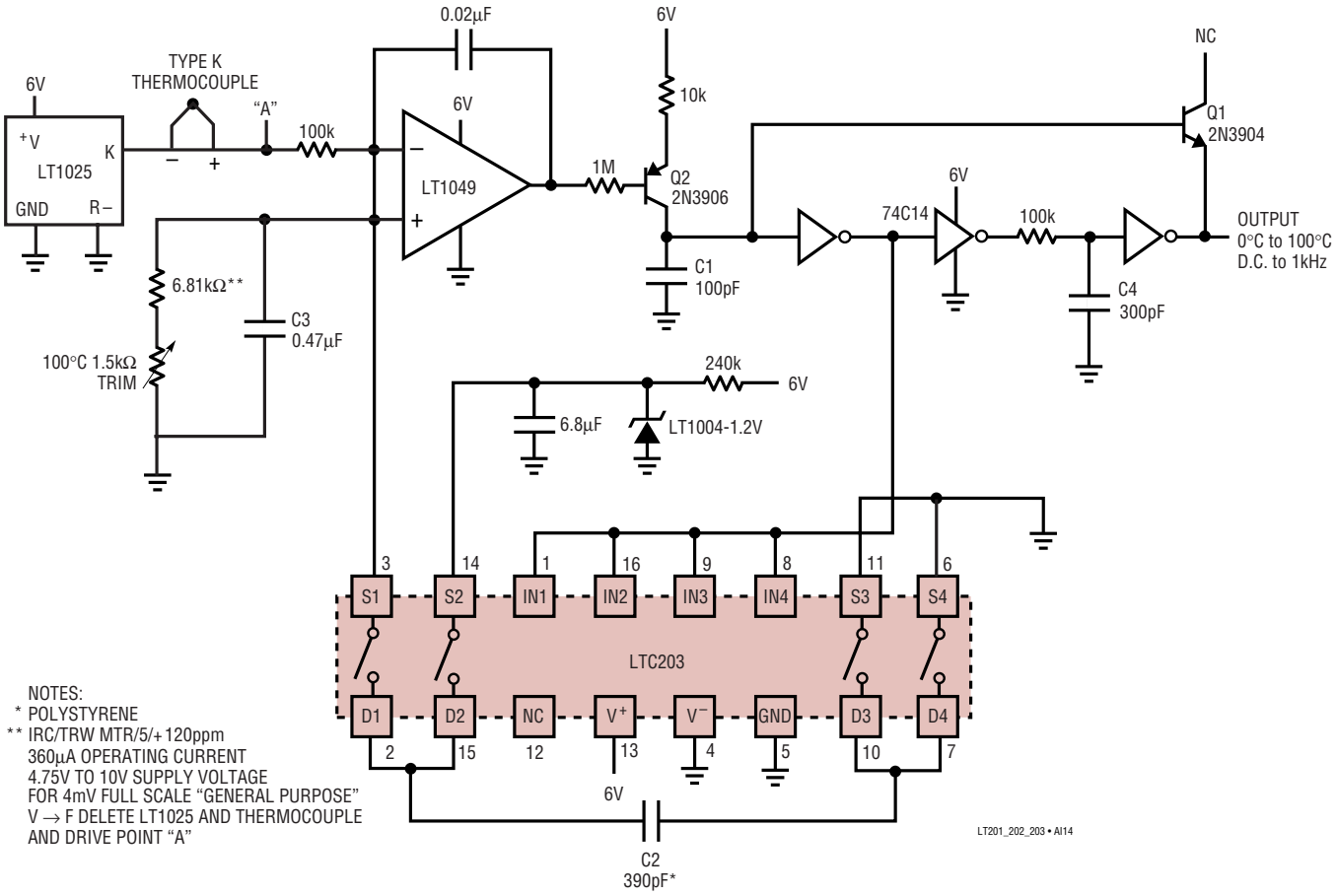
APPLICATIONS INFORMATION

Bipolar (AC) Input V/F Converter



APPLICATIONS INFORMATION

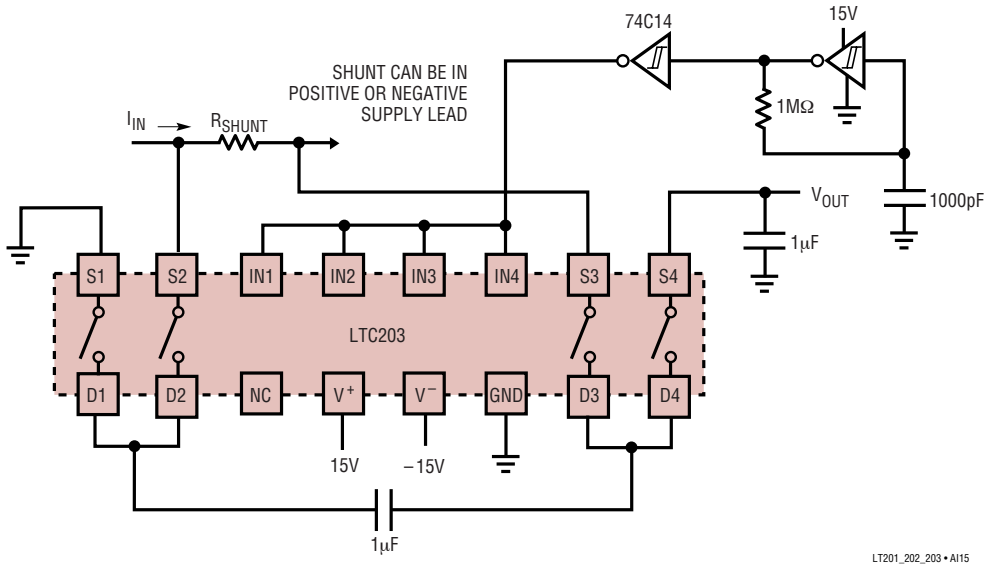
Micropower Thermocouple Temperature to Frequency Converter



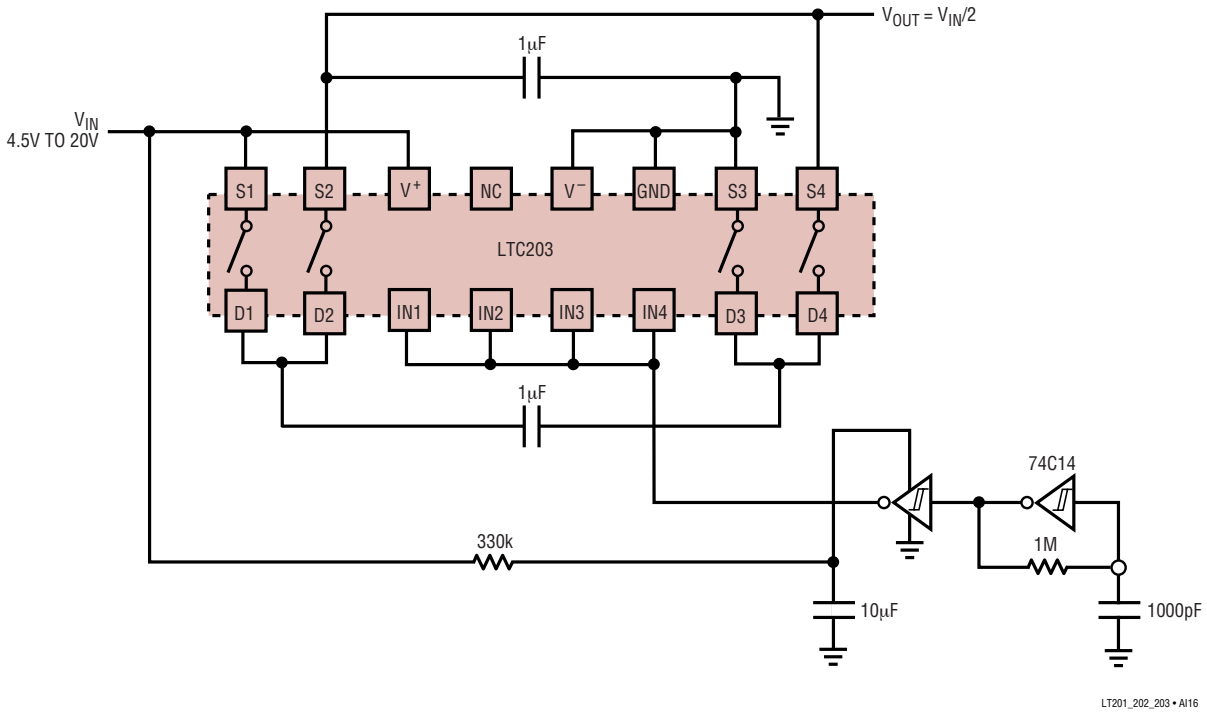
NOTES:
* POLYSTYRENE
** IRC/TRW MTR/5/+120ppm
360µA OPERATING CURRENT
4.75V TO 10V SUPPLY VOLTAGE
FOR 4mV FULL SCALE "GENERAL PURPOSE"
V → F DELETE LT1025 AND THERMOCOUPLE
AND DRIVE POINT "A"

APPLICATIONS INFORMATION

Precision Current Sensing in Supply Rails

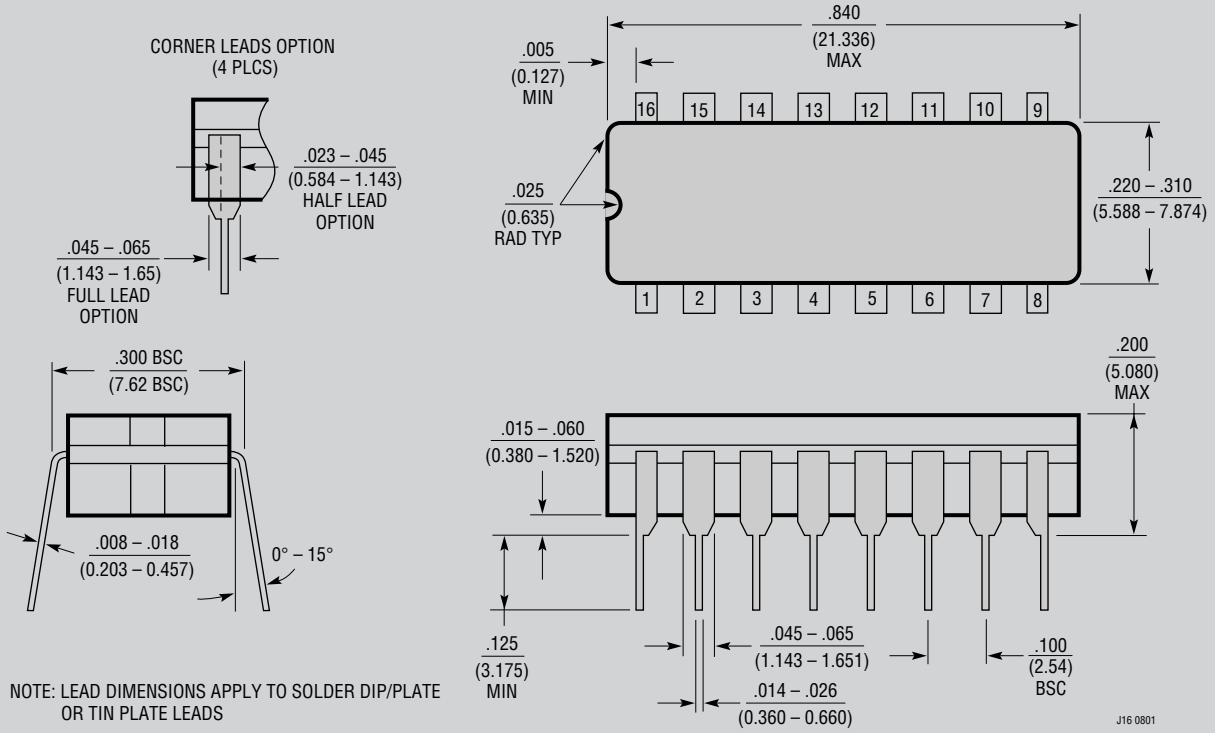


Precision Voltage Divide by 2 Circuit



PACKAGE DESCRIPTION

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

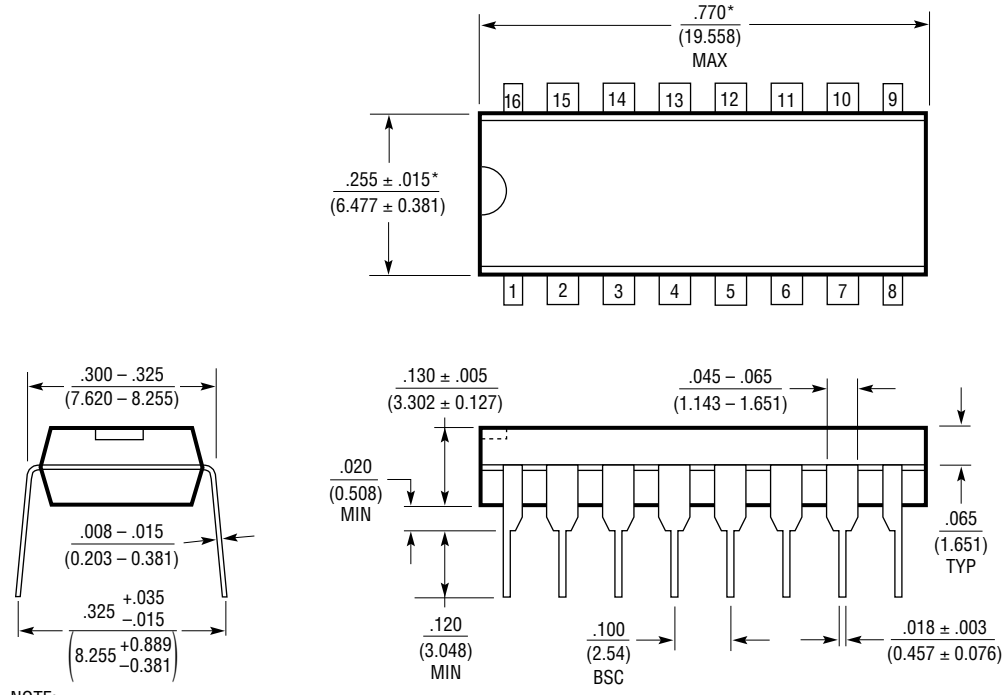


NOTE: LEAD DIMENSIONS APPLY TO SOLDER DIP/PLATE OR TIN PLATE LEADS

OBSOLETE PACKAGE

PACKAGE DESCRIPTION

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



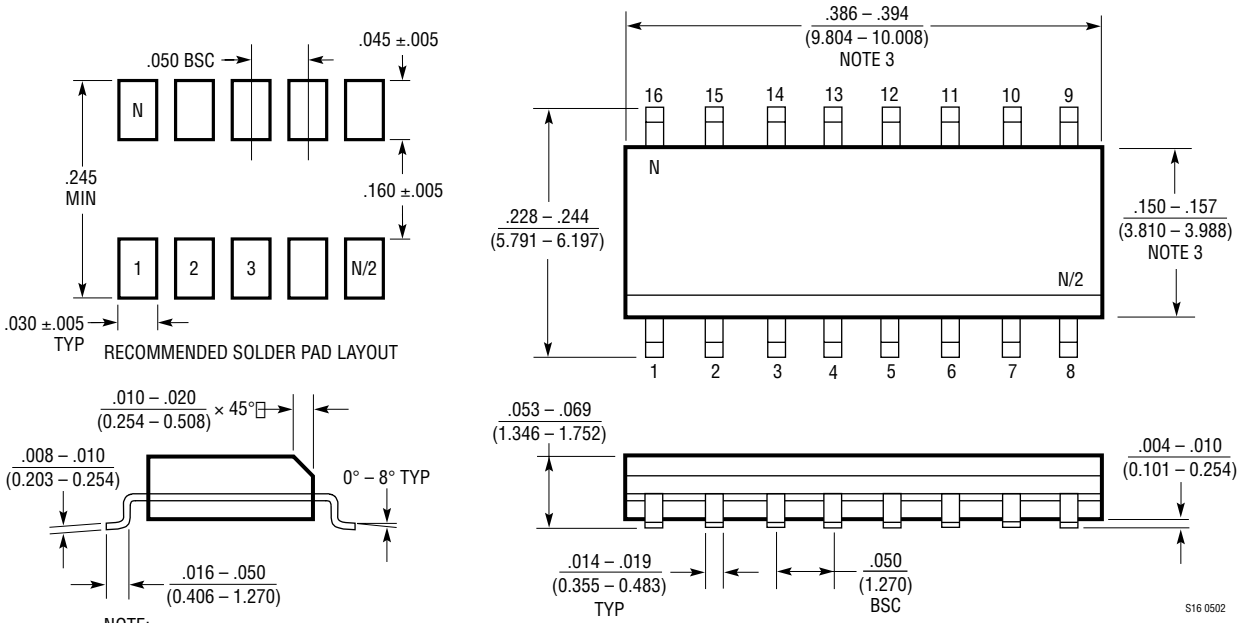
NOTE:
1. DIMENSIONS ARE $\frac{\text{INCHES}}{\text{MILLIMETERS}}$

*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)

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 ±15V, R_{ON} = 35Ω Single-Ended/70Ω Differential
LTC1390/LTC1391	8-Channel, Analog Multiplexer with Serial Interface	3V to ±15V, R_{ON} = 45Ω, Low Charge Injection
LT1675/LT1675-1	250MHz, Triple and Single RGB Multiplexer	100MHz Pixel Switching, 1100V/μs Slew Rate

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