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

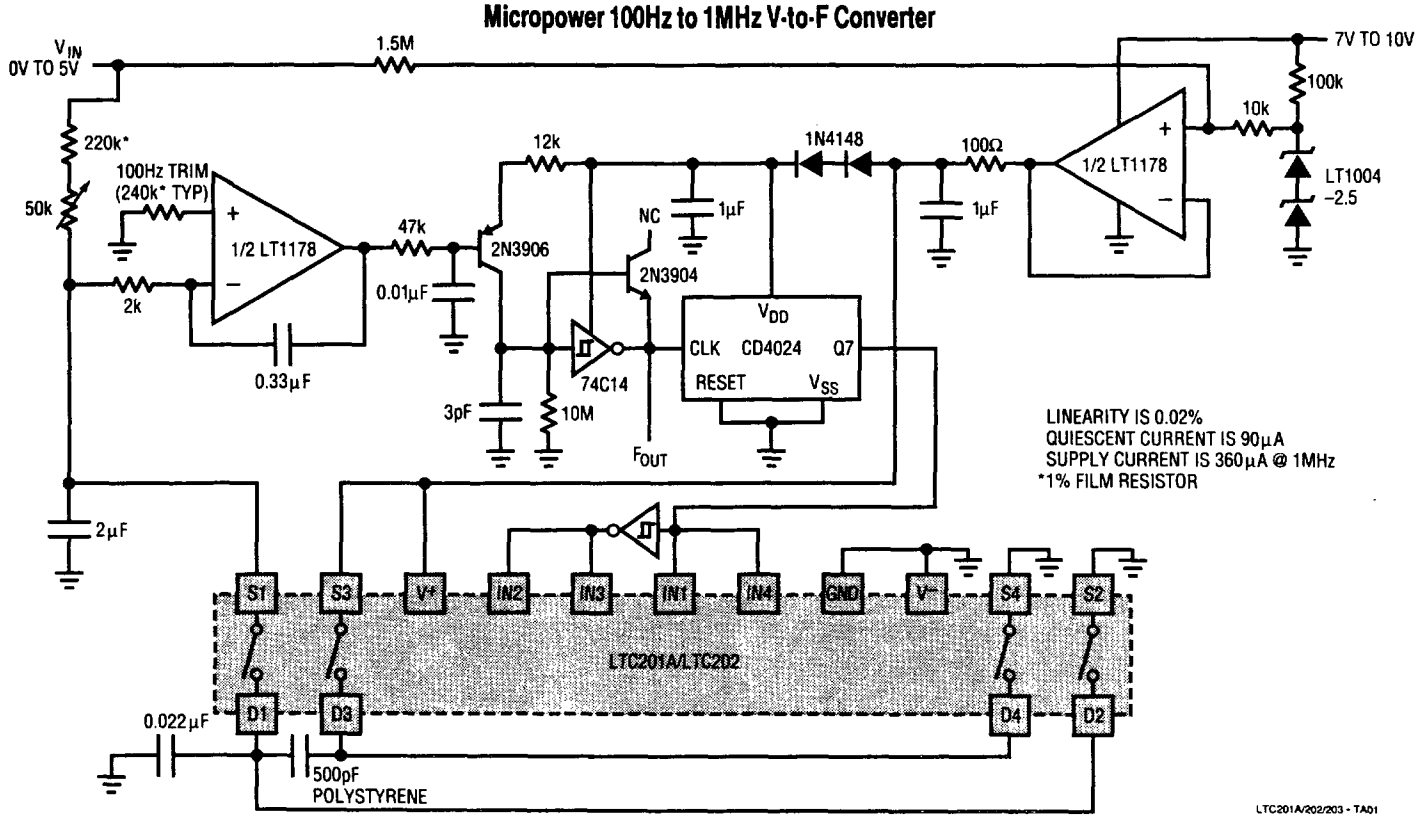
DESCRIPTION

The LTC201A, 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



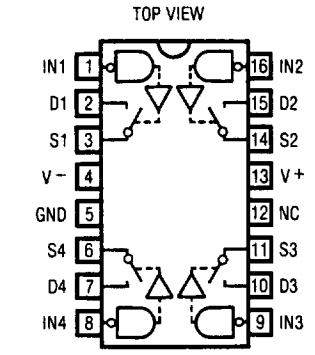
ABSOLUTE MAXIMUM RATINGS

(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
  Peaks 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

PACKAGE/ORDER INFORMATION



J PACKAGE
16-LEAD CERAMIC DIP

N PACKAGE
16-LEAD PLASTIC DIP

SO PACKAGE
16-LEAD PLASTIC SOIC

ORDER PART NUMBER
LTC201AMJ
LTC201ACJ
LTC201ACN
LTC201ACS
LTC202MJ
LTC202CJ
LTC202CN
LTC202CS
LTC203MJ
LTC203CJ
LTC203CN
LTC203CS

LOGIC TABLE

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

DIGITAL AND DC 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
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	
		T_{MAX}				160			160	
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	
Off Output Leakage I_D(OFF)	V_D = ±14V, V_S = ∓14V				0.01	±1		0.01	±5	nA
	Switch Off		•			±100			±100	
On Channel Leakage I_D(ON)	V_D = V_S = ±14V				0.02	±1		0.02	±5	nA
	Switch On		•			±200			±200	
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

11

DIGITAL AND DC 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
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	
I^-				0.1	5		0.1	5	
		●			10			10	

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	
T_{OPEN}		20	85		20	85		ns
Off Isolation	V_S = 2Vp-p, R_L = 1kΩ, f = 100kHz		75			75		dB
Crosstalk			90			90		
Charge Injection Q_{INJ}	R_S = 0Ω, C_L = 1000pF, V_S = 0V		5	±25		8	±25	pC
Total Harmonic Distortion THD	V_S = 2Vp-p, R_L = 10kΩ		0.01			0.01		%

DIGITAL AND DC 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
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	
		T_{MAX}			650			650	
ΔR_{ON} vs V_S				20			20		%
ΔR_{ON} vs Temperature				0.5			0.5		%/°C
R_{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	
Off Output Leakage I_D(OFF)	V_D = 4V, 1V; V_S = 1V, 4V (Note 4)			0.01	±1		0.01	±5	nA
	Switch Off	●			±100			±100	
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	
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

DIGITAL AND DC 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
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	

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	
T_{OPEN}		100	250		100	250		ns
Off Isolation	V_S = 2Vp-p, R_L = 1kΩ, f = 100kHz		75			75		dB
Crosstalk			90			90		
Charge Injection Q_{INJ}	R_S = 0Ω, C_L = 1000pF, V_S = 2.5V		2			2		pC
Total Harmonic Distortion THD	V_S = 2Vp-p, R_L = 10kΩ		0.01			0.01		%

The • denotes the specifications which apply over full operating temperature range. All other limits and typicals T_A = 25°C.

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

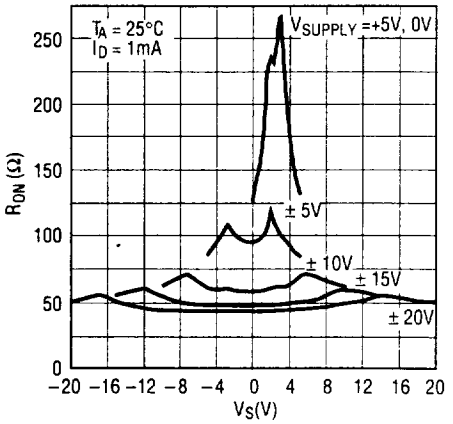
Note 2: Signals on S, D, or IN exceeding V^+ or V^- will be clamped by internal diodes. Limit forward diode current to maximum current rating.

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

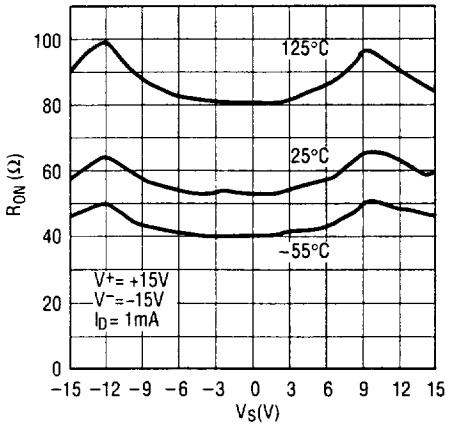
Note 4: Leakage current with a single 5V supply is guaranteed by correlation with the ±15V leakage current.

TYPICAL PERFORMANCE CHARACTERISTICS

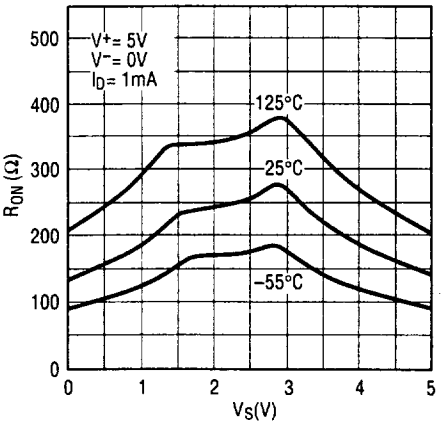
R_{ON} vs V_S Over Supply Voltage



R_{ON} vs V_S Over Temperature



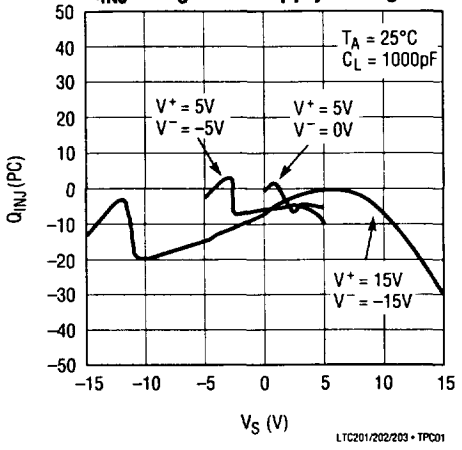
R_{ON} vs V_S Over Temperature



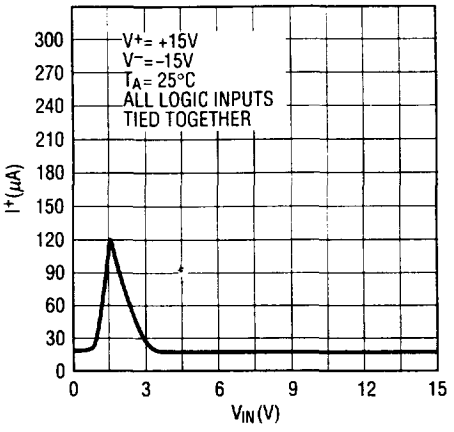
11

TYPICAL PERFORMANCE CHARACTERISTICS

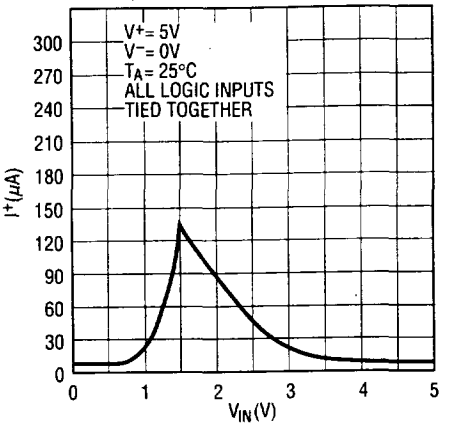
Q_{INJ} vs V_S Over Supply Voltage



Positive Supply Current vs Logic Input Voltage



Supply Current vs Logic Input Voltage

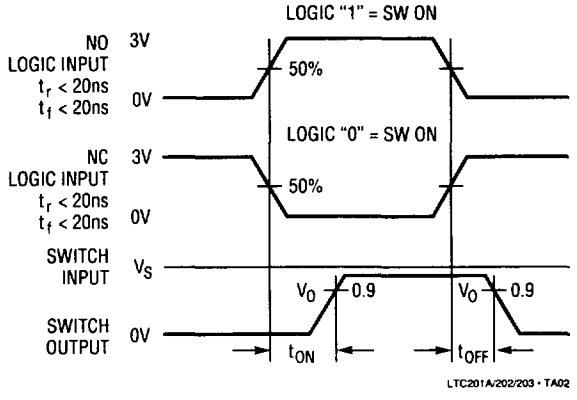


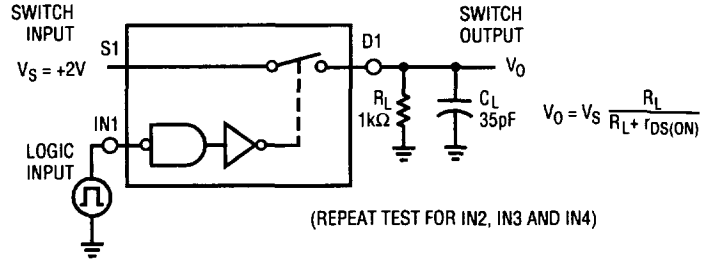
APPLICATIONS INFORMATION

Switching Time Test Circuit

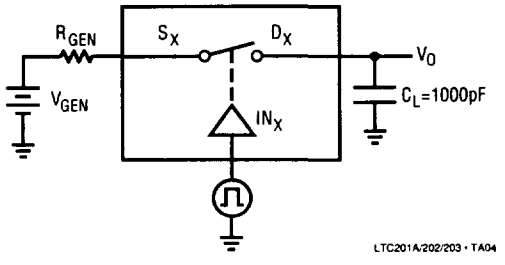
Switch output waveform shown for V_S = constant with logic input waveform as shown. Note that V_S may be + or − as per switching time test circuit. V_O is the steady state output switch on. Feedthrough via gate capacitance may result in spikes at leading and trailing edge of output waveform.

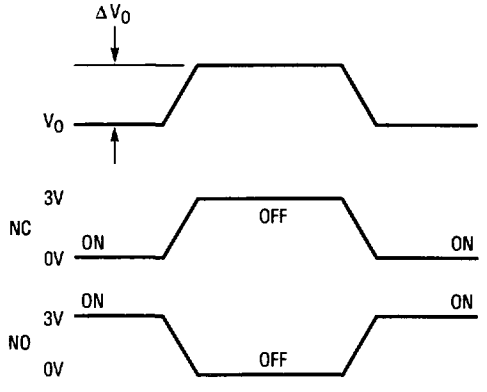
Switching Time Test Circuit





Charge Injection Test Circuit

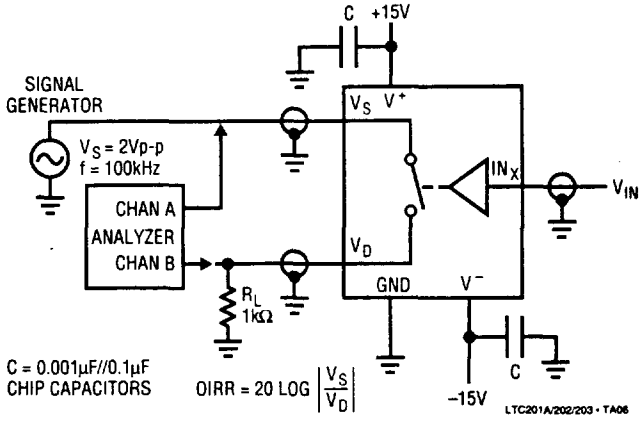




ΔV_O IS THE MEASURED VOLTAGE ERROR DUE TO CHARGE INJECTION. THE ERROR VOLTAGE IN COULOMBS IS $\Delta Q = C_L \times \Delta V_O$. LTC201A/202/203 • TA05

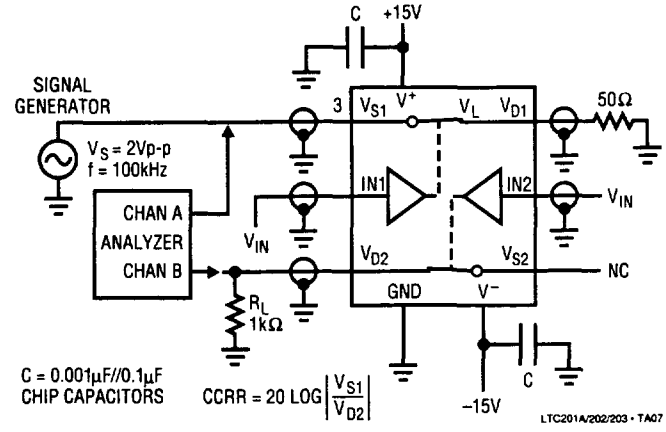
APPLICATIONS INFORMATION

OIRR-Off Isolation Test Circuit



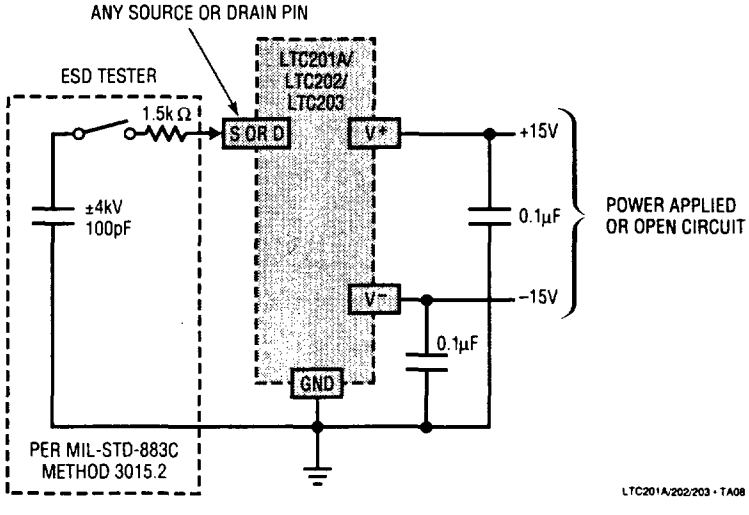
V_{IN}	
3V	NC
0V	NO

CCRR-Channel to Channel Crosstalk Test Circuit

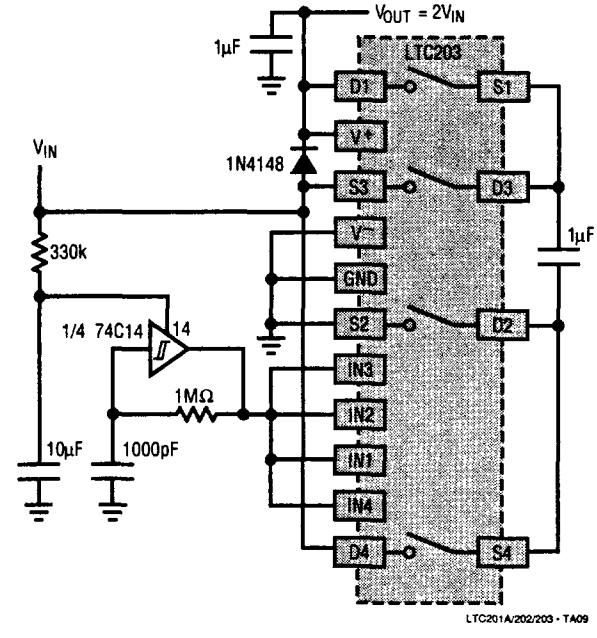


V_{IN}	
3V	NC
0V	NO

In-Circuit ESD Test Circuit



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

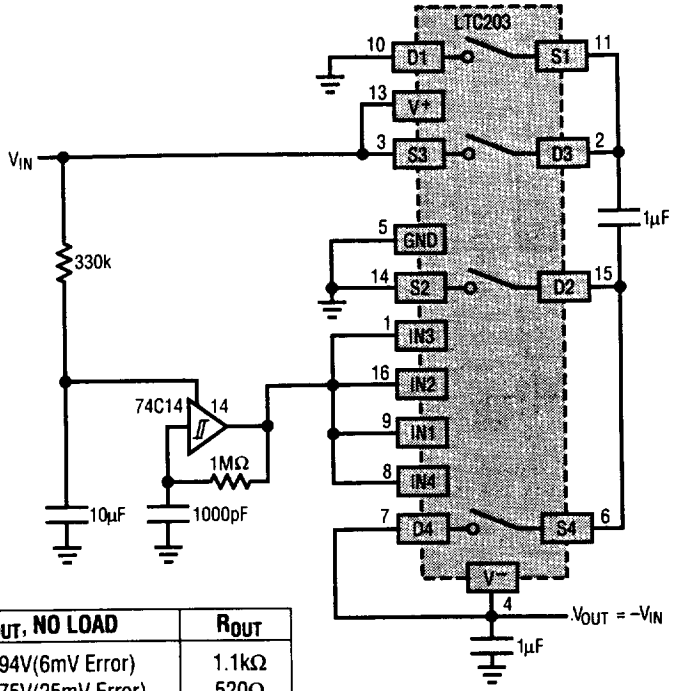


V_{IN}	I_Q	V_{OUT}, NO LOAD	R_{OUT}
4.5V	20µA	8.988V(12mV Error)	1.2k
15V	130µA	29.96V(40mV Error)	600Ω

11

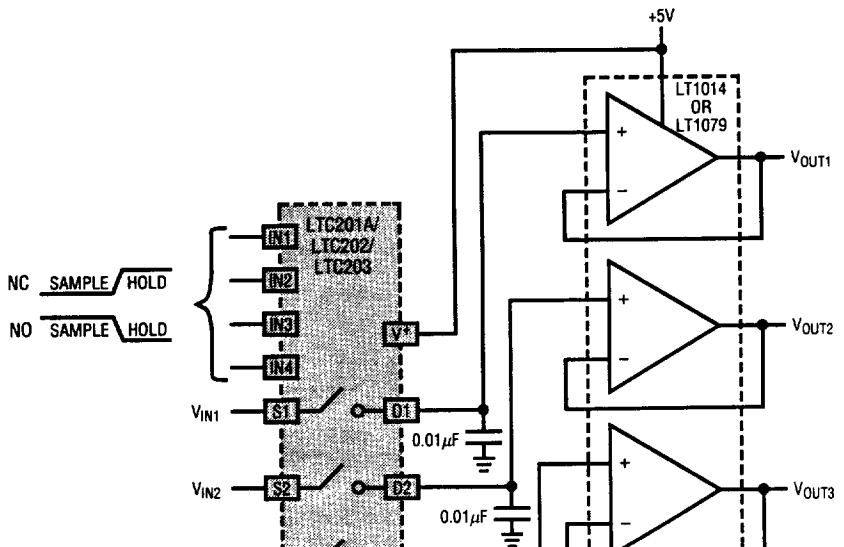
APPLICATIONS INFORMATION

Micropower, ±4.5V – ±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

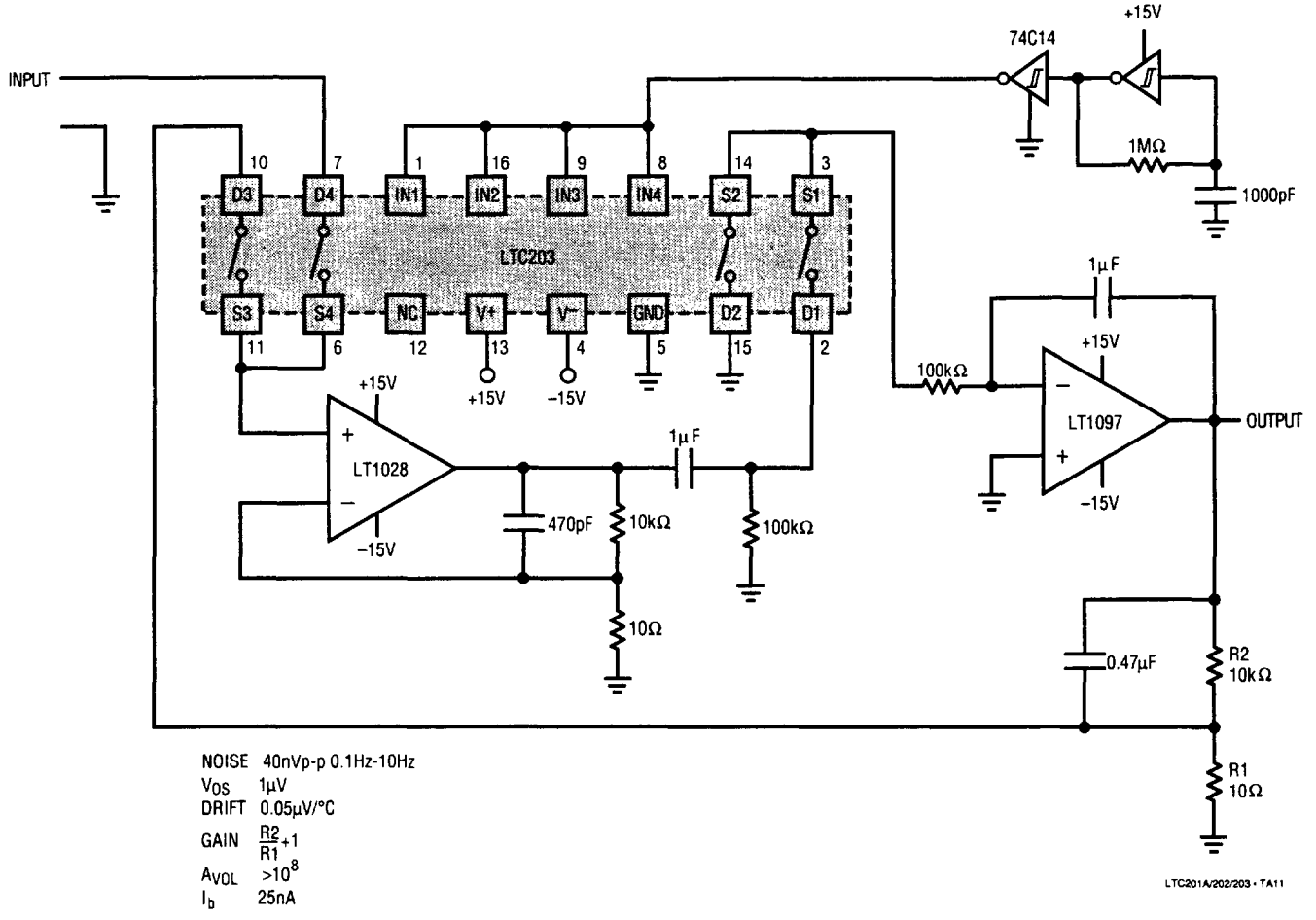
Quad 12-Bit Sample and Hold



	LT1014	LT1079
Sample-to-Hold Offset	0.6mV	0.6mV
Aperture Time	300ns	300ns
Acquisition Time to 0.01% (0 to 2V step)	14µs	27µs

APPLICATIONS INFORMATION

Ultra Low Noise, Low Drift Chopper Amplifier



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

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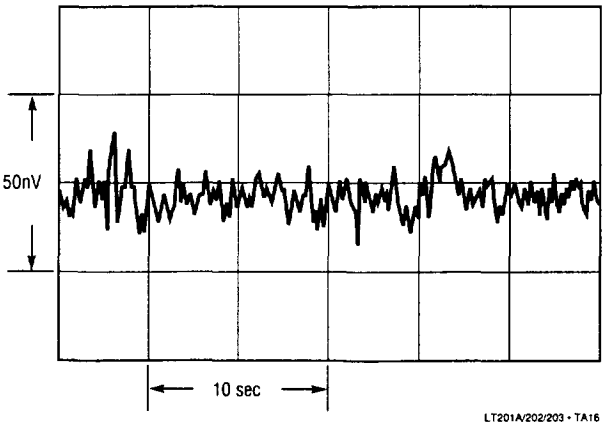
Noise in a 0.1-10Hz Bandwidth



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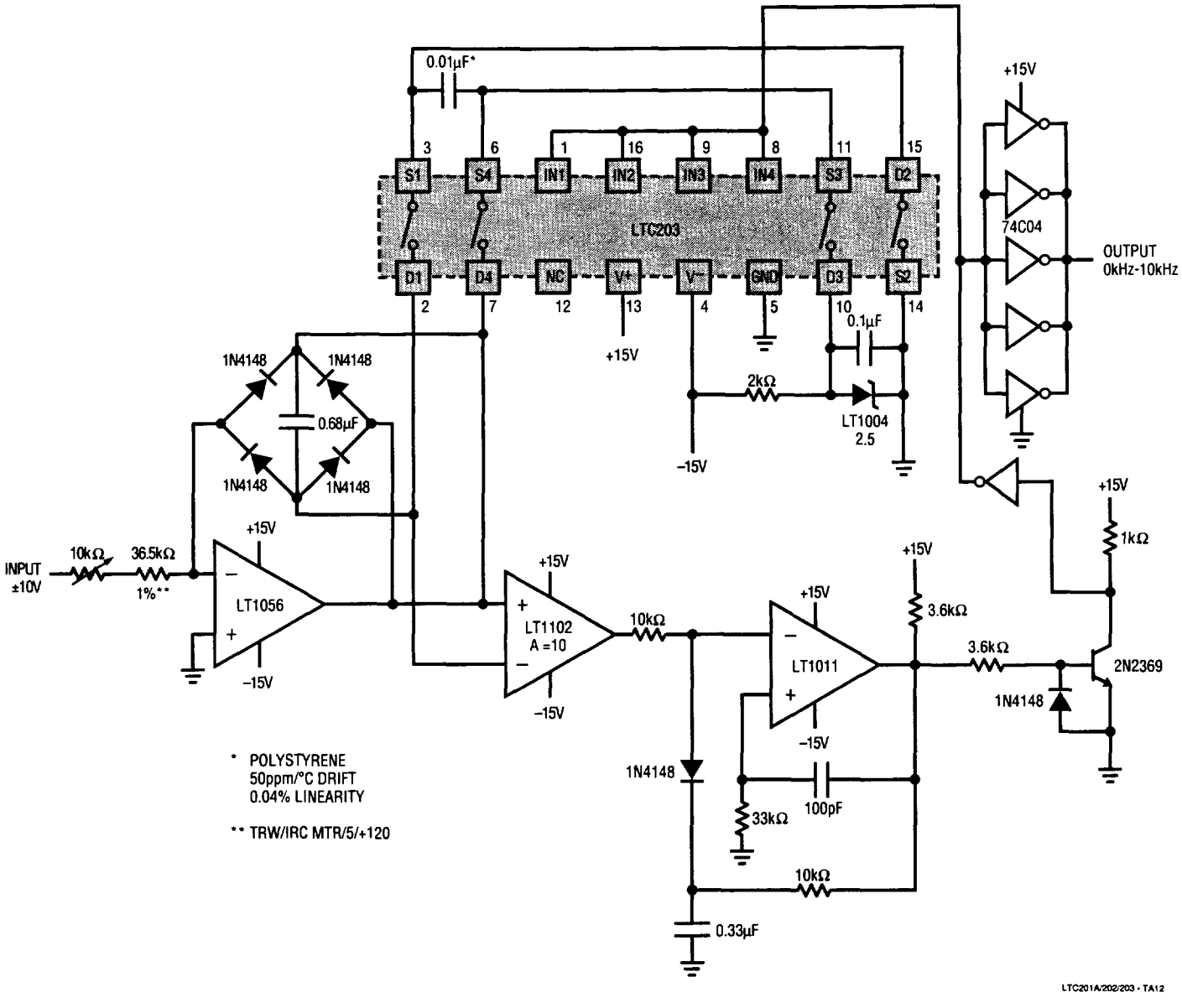
11

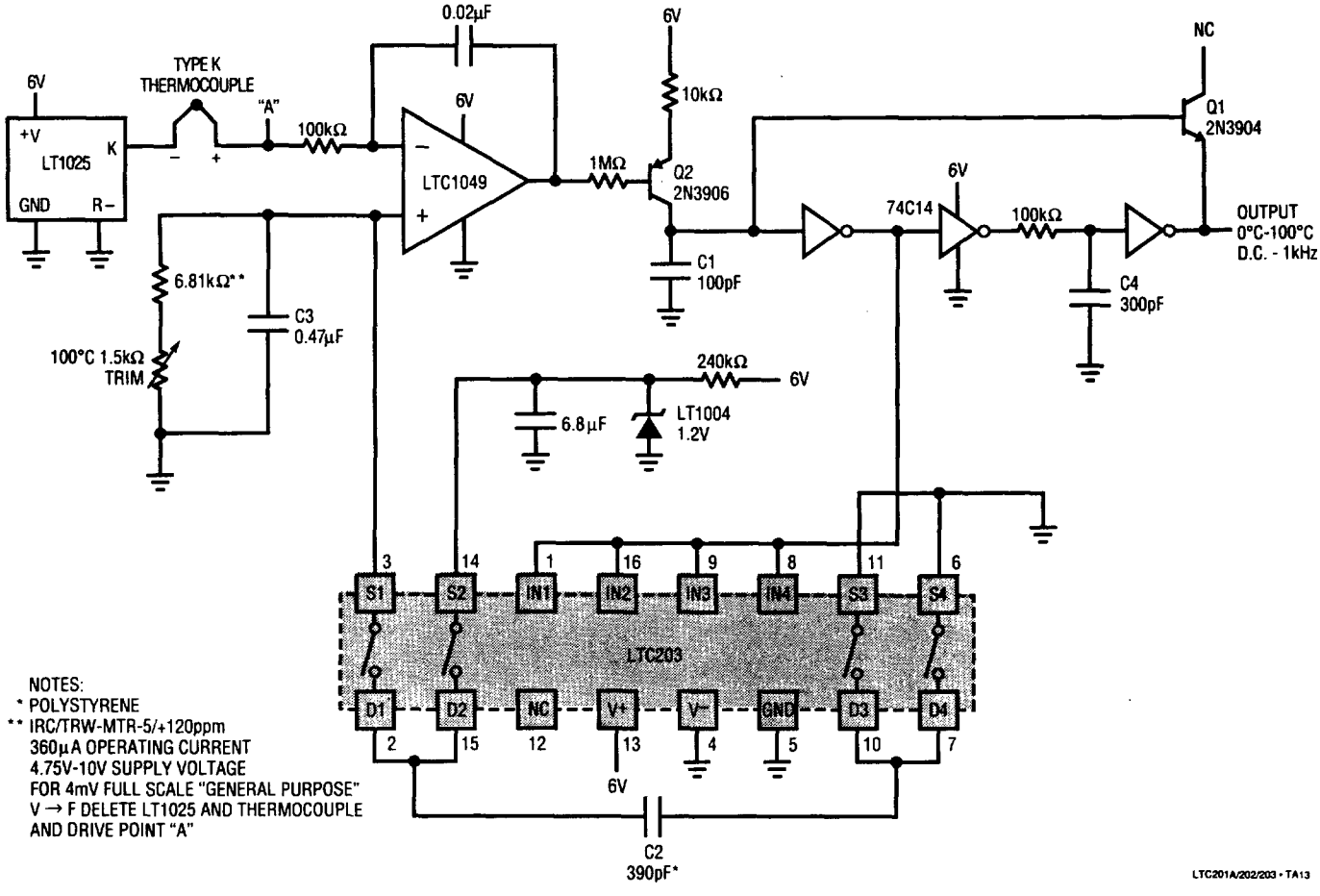
APPLICATIONS INFORMATION

Bipolar (AC) Input V → F Converter



APPLICATIONS INFORMATION

Micropower Thermocouple Temperature to Frequency Converter



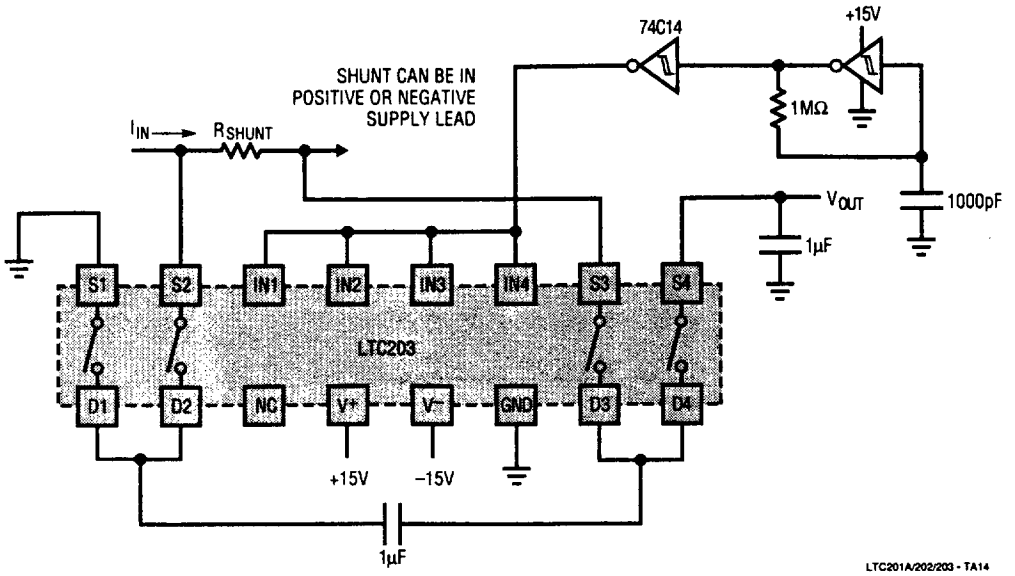
NOTES:
* POLYSTYRENE
** IRC/TRW-MTR-5/+120ppm
360µA OPERATING CURRENT
4.75V-10V SUPPLY VOLTAGE
FOR 4mV FULL SCALE "GENERAL PURPOSE"
V → F DELETE LT1025 AND THERMOCOUPLE
AND DRIVE POINT "A"

LTC201A/202/203 • TA13

11

APPLICATIONS INFORMATION

Precision Current Sensing in Supply Rails



Precision Voltage Divide by 2 Circuit