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.

**TYPICAL APPLICATION**

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

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*LTC and LT are registered trademarks of Linear Technology Corporation.*
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

<table>
<thead>
<tr>
<th>INX</th>
<th>LTC201A IN1 TO IN4</th>
<th>LTC202 IN1 TO IN4</th>
<th>LTC203 IN1, IN4 IN2, IN3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>1</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
</tr>
</tbody>
</table>

DIGITAL AND DC ELECTRICAL CHARACTERISTICS

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

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CONDITIONS</th>
<th>LTC201A/LTC202/LTC203M</th>
<th>LTC201AC/LTC202C/LTC203C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog Signal Range</td>
<td>●</td>
<td>±15</td>
<td>±15</td>
</tr>
<tr>
<td>RON</td>
<td>V+ = ±10V</td>
<td>T_MIN</td>
<td>110</td>
</tr>
<tr>
<td></td>
<td>I_D = 1mA</td>
<td>25°C</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T_MAX</td>
<td>160</td>
</tr>
<tr>
<td>ΔRON vs V_S</td>
<td></td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>ΔRON vs Temperature</td>
<td></td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>RON Match</td>
<td>V_S = 0V, I_D = 1mA</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Off Input Leakage I_S (OFF)</td>
<td>V_S = ±14V, V_D = ±14V</td>
<td>Switch Off</td>
<td>0.01</td>
</tr>
</tbody>
</table>

OBSOLET 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.

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

## AC ELECTRICAL CHARACTERISTICS

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

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CONDITIONS</th>
<th>LTC201AM/LTC202M/ LTC203M</th>
<th>LTC201AC/LTC202C/ LTC203C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>MIN</td>
<td>TYP</td>
</tr>
<tr>
<td>$I_{ON}$</td>
<td>$V_S = 2V, R_L = 1k\Omega, C_L = 35pF$</td>
<td>290</td>
<td>400</td>
</tr>
<tr>
<td>$I_{OFF}$</td>
<td></td>
<td>210</td>
<td>300</td>
</tr>
<tr>
<td>$I_{OPEN}$</td>
<td></td>
<td>20</td>
<td>85</td>
</tr>
<tr>
<td>Off Isolation</td>
<td>$V_S = 2V_{P,P}, R_L = 1k\Omega, f = 100kHz$</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Crosstalk</td>
<td></td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>Charge Injection $O_{INJ}$</td>
<td>$R_S = 0\Omega, C_L = 1000pF; V_S = 0V$</td>
<td>5</td>
<td>±25</td>
</tr>
<tr>
<td>Total Harmonic Distortion THD</td>
<td>$V_S = 2V_{P,P}, R_L = 10k\Omega$</td>
<td>0.01</td>
<td></td>
</tr>
</tbody>
</table>
### AC Electrical Characteristics

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

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CONDITIONS</th>
<th>LTC201AM/LTC202M/ LTC203M</th>
<th>LTC201AC/LTC202C/ LTC203C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>V$_{IN}$ = 0V OR 4.0V</td>
<td>MIN  TYP MAX</td>
<td>MIN  TYP MAX</td>
</tr>
<tr>
<td></td>
<td>I$^+$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>µA</td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td>I$^+$</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>µA</td>
<td>µA</td>
</tr>
</tbody>
</table>

### 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**

1. **$R_{ON}$ vs $V_S$ Over Supply Voltage**
   - $T_A = 25^\circ C$
   - $I_D = 1mA$
   - $V_{SUPPLY} = 5V, 0V$

2. **$R_{ON}$ vs $V_S$ Over Temperature**
   - $V^+ = 15V$
   - $V^- = 0V$
   - $T_A = 25^\circ C$
   - $V^+ = 15V$
   - $V^- = -15V$

3. **$Q_{INJ}$ vs $V_S$ Over Supply Voltage**
   - $T_A = 25^\circ C$
   - $C_L = 1000pF$
   - $V^+ = 5V$
   - $V^- = -5V$
   - $V^+ = 6V$
   - $V^- = 0V$

4. **Positive Supply Current vs Logic Input Voltage**
   - $V^+ = 15V$
   - $V^- = -15V$
   - $T_A = 25^\circ C$
   - All logic inputs tied together

5. **Supply Current vs Logic Input Voltage**
   - $V^+ = 5V$
   - $V^- = 0V$
   - $T_A = 25^\circ C$
   - All logic inputs tied together
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.

Charge Injection Test Circuit

$\Delta V_O$ is the measured voltage error due to charge injection. The error voltage in coulombs is $\Delta Q = C_L \cdot \Delta V_O$.
APPLICATIONS INFORMATION

**OIRR-Off Isolation Test Circuit**

- **Signal Generator**
- **CH1 A**
- **Analyzer CH1 B**
- **C**
- **15V**
- **V**
- **IN**
- **V**
- **D**
- **GND**
- **V**
- **OUT = 2VIN**

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

- **Signal Generator**
- **IN1**
- **IN2**
- **IN3**
- **IN4**
- **V**
- **GND**
- **V**
- **OUT = 2VIN**

**In-Circuit ESD Test Circuit**

- **ESD Tester**
- **1.5kΩ**
- **±4kV/100pF**
- **POWER APPLIED OR OPEN CIRCUIT**
- **C = 0.001µF/0.1µF CHIP CAPACITORS**
- **ANY SOURCE OR DRAIN PIN**

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

<table>
<thead>
<tr>
<th>VIN</th>
<th>IQ</th>
<th>VOUT, NO LOAD</th>
<th>ROUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5V</td>
<td>20µA</td>
<td>8.988V(12mV Error)</td>
<td>1.2k</td>
</tr>
<tr>
<td>15V</td>
<td>130µA</td>
<td>29.96V(40mV Error)</td>
<td>600Ω</td>
</tr>
</tbody>
</table>
Micropower, ±4.5V to ±15V, Voltage Inverter Using the LTC203

<table>
<thead>
<tr>
<th>$V_{IN}$</th>
<th>$I_0$</th>
<th>$V_{OUT}$, NO LOAD</th>
<th>$R_{OUT}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5V</td>
<td>15μA</td>
<td>−4.494V (6mV Error)</td>
<td>1.1kΩ</td>
</tr>
<tr>
<td>15V</td>
<td>125μA</td>
<td>−14.975V (25mV Error)</td>
<td>520Ω</td>
</tr>
</tbody>
</table>

Quad 12-Bit Sample-and-Hold

<table>
<thead>
<tr>
<th></th>
<th>LT1014</th>
<th>LT1079</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAMPLE-TO-HOLD OFFSET</td>
<td>0.6mV</td>
<td>0.6mV</td>
</tr>
<tr>
<td>APERTURE TIME</td>
<td>300ns</td>
<td>300ns</td>
</tr>
<tr>
<td>ACQUISITION TIME TO 0.01% (0 TO 2V STEP)</td>
<td>14μs</td>
<td>27μs</td>
</tr>
<tr>
<td>SLEW RATE (0 TO 5V STEP)</td>
<td>0.4V/μs</td>
<td>0.07V/μs</td>
</tr>
<tr>
<td>DROOP RATE</td>
<td>0.8mV/ms</td>
<td>0.6mV/ms</td>
</tr>
<tr>
<td>SUPPLY CURRENT</td>
<td>1.6mA</td>
<td>180μA</td>
</tr>
</tbody>
</table>
Ultra Low Noise, Low Drift Chopper Amplifier

Noise in a 0.1 to 10Hz Bandwidth

- NOISE: 40nVp-p 0.1Hz TO 10Hz
- $V_{os}$: 1µV
- DRIFT: 0.05µV/°C
- GAIN: $\frac{R_2}{R_1} + 1$
- $A_{vOL}$: > $10^8$
- $I_B$: 25nA

NOISE: 40nVp-p 0.1Hz TO 10Hz

VOS: 1µV

DRIFT: 0.05µV/°C

GAIN: $\frac{R_2}{R_1} + 1$

$A_{vOL}$: > $10^8$

$I_B$: 25nA
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"
Precision Current Sensing in Supply Rails

SHUNT CAN BE IN POSITIVE OR NEGATIVE SUPPLY LEAD

Precision Voltage Divide by 2 Circuit

VOUT = VIN/2
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
N Package
16-Lead PDIP (Narrow .300 Inch)
(Reference LTC DWG # 05-08-1510)

NOTE:
1. DIMENSIONS ARE INCHES
MILLIMETERS
*THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .010 INCH (0.254mm)
PACKAGE DESCRIPTION

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

NOTE:
1. DIMENSIONS IN INCHES
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)
<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTC221/LTC222</td>
<td>Micropower, Low Charge Injection, Quad CMOS Analog Switches</td>
<td>Parallel Controlled with Data Latches</td>
</tr>
<tr>
<td>LTC1380/LTC1393</td>
<td>8-Channel/4-Channel Differential Analog Multiplexer with SMBus Interface</td>
<td>3V to ±15V, $R_{ON} = 35\Omega$ Single-Ended/70Ω Differential</td>
</tr>
<tr>
<td>LTC1390/LTC1391</td>
<td>8-Channel, Analog Multiplexer with Serial Interface</td>
<td>3V to ±15V, $R_{ON} = 45\Omega$, Low Charge Injection</td>
</tr>
<tr>
<td>LT1675/LT1675-1</td>
<td>250MHz, Triple and Single RGB Multiplexer</td>
<td>100MHz Pixel Switching, 1100V/µs Slew Rate</td>
</tr>
</tbody>
</table>