

Micropower, Low Charge Injection, Quad CMOS Analog Switches with Data Latches

FEATURES

- Micropower Operation
- Single 5V or $\pm 15V$ Supply Operation
- Low Charge Injection
- Low R_{ON}
- Low Leakage
- Guaranteed Break Before Make
- Latch Resistant Design
- TLL/CMOS Compatible
- Improved Second Source for DG221/DG222
- Microprocessor Bus Compatible

KEY SPECIFICATIONS

- Supply Current $I^+ = 40\mu A$, $I^- = 5\mu A$ Max
- Charge Injection
 - $\pm 15V$ Supplies $\pm 25pC$ Max
 - Single 5V Supply 2pC Typ
- R_{ON} 65Ω Typ
- Signal Range $\pm 15V$

DESCRIPTION

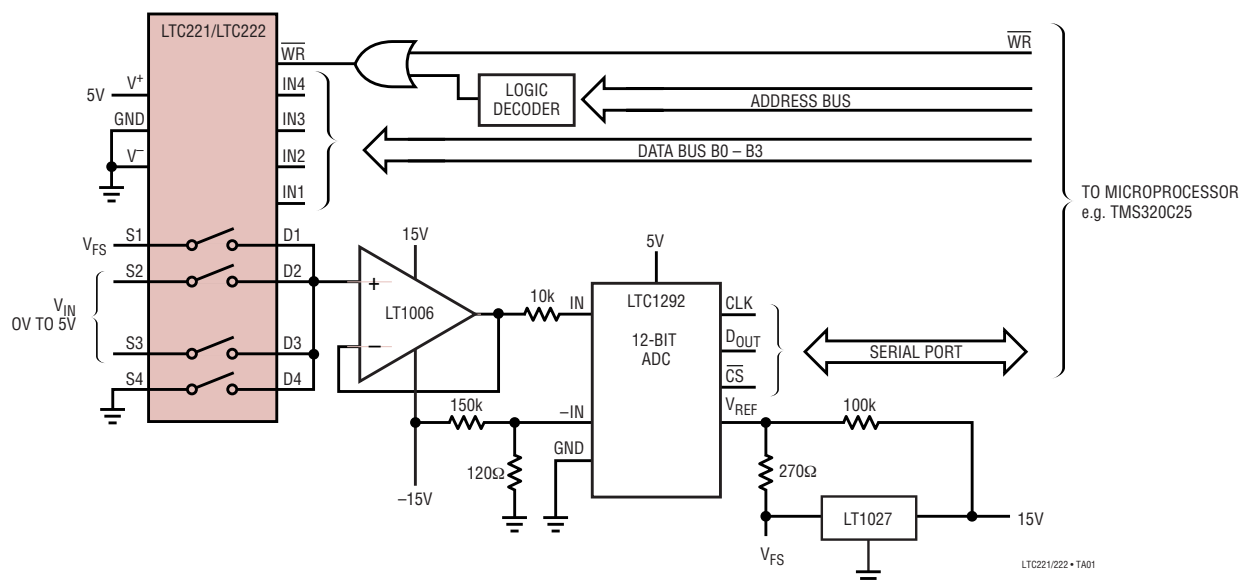
The LTC[®]221 and LTC222 are micropower, quad CMOS analog switches which typically dissipate only 250 μW from $\pm 15V$ supplies and 40 μW from a single 5V supply. Onboard latches allow the LTC221 and LTC222 to interface directly to most microprocessor buses. The switches have 65 Ω typical on resistance and a very high off resistance. A break before make characteristic is inherent in these switches to prevent the shorting of two channels. The signal range is $\pm 15V$ with a supply voltage of $\pm 15V$ and 0V to 5V with a single 5V supply. The switches have special charge compensation circuitry which greatly reduces charge injection to a maximum of $\pm 25pC$ ($\pm 15V$ supplies).

The LTC221 and LTC222 are designed for applications such as microprocessor controlled programmable gain amplifiers, automatic test equipment, communication systems, and data acquisition systems. The LTC221 is normally closed and the LTC222 is normally open as shown in the Logic Table.

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TYPICAL APPLICATION

Two-Channel, 12-Bit, Self Calibrating Data Acquisition System



LTC221/222 • TA01

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LTC221/LTC222

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 1 ms, 10% Duty Cycle Max) 70mA

ESD Susceptibility (Note 3) 4kV

Power Dissipation (Plastic) 500mW

Power Dissipation (Ceramic) 900mW

Operating Temperature Range

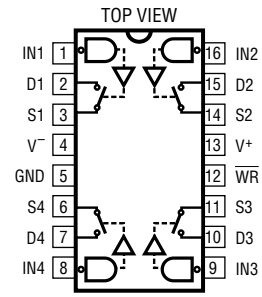
LTC221C/LTC222C 0°C to 70°C

LTC221M/LTC222M (OBSOLETE) –55°C to 125°C

Storage Temperature Range –65°C to 150°C

Lead Temperature (Soldering, 10 sec) 300°C

PACKAGE/ORDER INFORMATION

 N PACKAGE 16-LEAD PDIP $J_{MAX} = 110^\circ\text{C}$, $\theta_{JA} = 120^\circ\text{C/W}$ S PACKAGE 16-LEAD PLASTIC SO $J_{MAX} = 110^\circ\text{C}$, $\theta_{JA} = 130^\circ\text{C/W}$ J PACKAGE 16-LEAD CERDIP OBSOLETE PACKAGE Consider the N or S Package for Alternate Source	ORDER PART NUMBER
	LTC221CN LTC221CS LTC222CN LTC222CS LTC221MJ LTC221CJ LTC222MJ LTC222CJ

Consult LTC Marketing for parts specified with wider operating temperature ranges.

LOGIC TABLE

INX	$\overline{WR}$	LTC221	LTC222
0	0	On	Off
1	0	Off	On
X	1	Maintain Previous State	Maintain Previous State

DIGITAL AND DC ELECTRICAL CHARACTERISTICS

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

PARAMETER	CONDITIONS		LTC221M/LTC222M			LTC221C/LTC222C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Analog Signal Range		●			± 15			± 15	V
R_{ON}	$V_S = \pm 10V$ $I_D = 1mA$	T_{MIN}			90			90	Ω
		25°C		65	90		65	90	Ω
		T_{MAX}			135			135	Ω
Off Input Leakage I_S (OFF)	$V_D = 14V$, $V_S = \pm 14V$	●		0.01	± 1		0.01	± 5	nA
		●			± 100			± 100	nA
Off Output Leakage I_D (OFF)	$V_{IN} = 2.4V$, LTC221	●		0.01	± 1		0.01	± 5	nA
	$V_{IN} = 0.8V$, LTC222	●			± 100			± 100	nA
On Channel Leakage I_D (ON)	$V_D = V_S = \pm 14V$, $V_{IN} = 2.4V$, LTC222	●		0.02	± 1		0.02	± 5	nA
	$V_{IN} = 0.8V$, LTC221	●			± 200			± 200	nA
Input High Voltage V_{INH} , V_{WRH}		●	2.4			2.4			V
Input Low Voltage V_{INL} , V_{WRL}		●			0.8			0.8	V
Input High or Low Current I_{INH} , I_{INL} , I_{WRH} , I_{WRL}	$V_{IN} = 15V$, 0V $V_{WR} = 15V$, 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 Channels On or Off $V_{IN} = V_{WR} = 0V$ or 4.0V			16	40		16	40	μA
		●			60			60	μA

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DIGITAL AND DC ELECTRICAL CHARACTERISTICS

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

PARAMETER	CONDITIONS	LTC221M/LTC222M			LTC221C/LTC222C			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
I^-			0.1	5		0.1	5	μA
		●		10			10	

AC ELECTRICAL CHARACTERISTICS

$V^+ = 15\text{V}$, $V^- = -15\text{V}$, $\text{GND} = 0\text{V}$, unless otherwise noted.

PARAMETER	CONDITIONS	LTC221M/LTC222M			LTC221C/LTC222C			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	
t_{OPEN}		20	85		20	85		ns
Off Isolation	$V_S = 2\text{Vp-p}$, $R_L = 1\text{k}\Omega$ $f = 100\text{kHz}$		75			75		dB
Crosstalk			90			90		
Charge Injection O_{INJ}	$R_{\text{GEN}} = 0\Omega$, $C_L = 1000\text{pF}$, $V_{\text{GEN}} = 0$		5	± 25		8	± 25	pC
Total Harmonic Distortion THD	$V_S = 2\text{Vp-p}$, $R_L = 10\text{k}\Omega$		0.01			0.01		%
$t_{\text{ON}}, \overline{\text{WR}}$	$V_S = 2\text{V}$, $R_L = 1\text{k}\Omega$, $C_L = 35\text{pF}$		270	400		270	400	ns
$t_{\text{OFF}}, \overline{\text{WR}}$			160	300		160	300	

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 noted.

PARAMETER	CONDITIONS	LTC221M/LTC222M			LTC221C/LTC222C			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Analog Signal Range		●	0	5		0	5	V
R_{ON}	$V_S = 1.5\text{V}$, 3V $I_D = 0.25\text{mA}$	T_{MIN}		450			520	Ω
		25°C		280	450		280	Ω
		T_{MAX}		650			650	Ω
Off Input Leakage I_S (OFF)	$V_D = 4\text{V}$, 1V ; $V_S = 1\text{V}$, 4V (Note 4)		0.01	± 1		0.01	± 5	nA
		●		± 100			± 100	nA
Off Output Leakage I_D (OFF)			0.01	± 1		0.01	± 5	nA
		●		± 100			± 100	nA
On Channel Leakage I_D (ON)	$V_D = V_S = 1\text{V}$, 4V (Note 4)		0.01	± 1		0.01	± 5	nA
		●		± 200			± 200	nA
Input High Voltage V_{INH} , V_{WRH}		●	2.4			2.4		V
Input Low Voltage V_{INL} , V_{WRL}		●		0.8			0.8	V
Input High or Low Current I_{INH} , I_{INL} , I_{WRH} , I_{WRL}	$V_{\text{IN}} = 5\text{V}$, 0V $V_{\text{WR}} = 5\text{V}$, 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 Channels On or Off $V_{\text{IN}} = V_{\text{WR}} = 0\text{V}$ or 4.0V		8	20		8	20	μA
		●		30			30	μA

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AC ELECTRICAL CHARACTERISTICS V⁺ = 5V, V⁻ = GND = 0V, unless otherwise noted.

PARAMETER	CONDITIONS	LTC221M/LTC222M			LTC221C/LTC222C			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
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		75			75		dB
Crosstalk	f = 100kHz		90			90		dB
Charge Injection O _{INJ}	R _{GEN} = 0Ω, C _L = 1000pF, V _{GEN} = 2.5V		2			2		pC
Total Harmonic Distortion THD	V _S = 2V _{P-P} , R _L = 10kΩ		0.01			0.01		%
t _{ON} , $\overline{WR}$	V _S = 2V, R _L = 1kΩ, C _L = 35pF		430	600		430	600	ns
t _{OFF} , $\overline{WR}$			160	300		160	300	ns

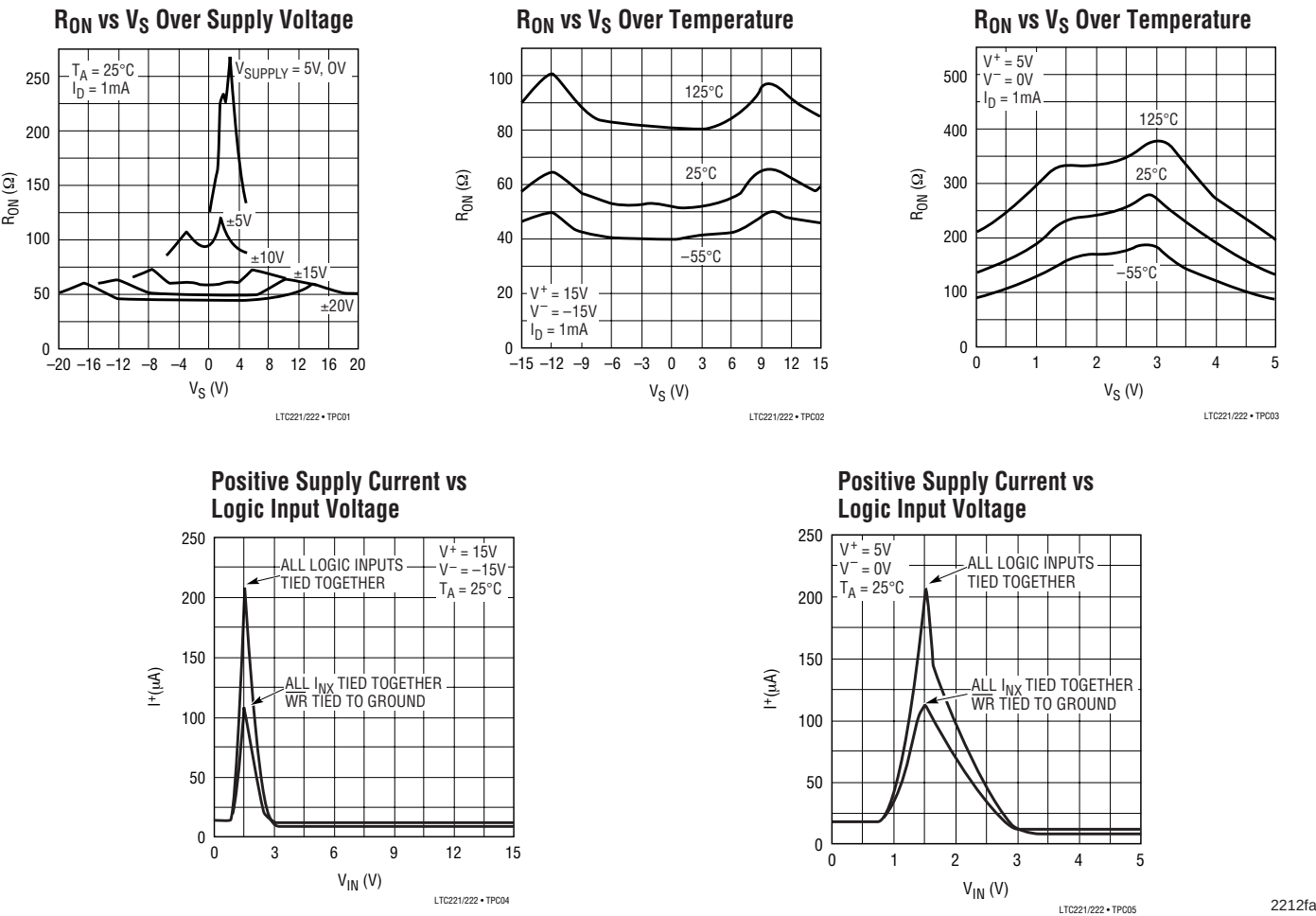
Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

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 5V supply is guaranteed by correlation with the ±15V leakage current.

TYPICAL PERFORMANCE CHARACTERISTICS

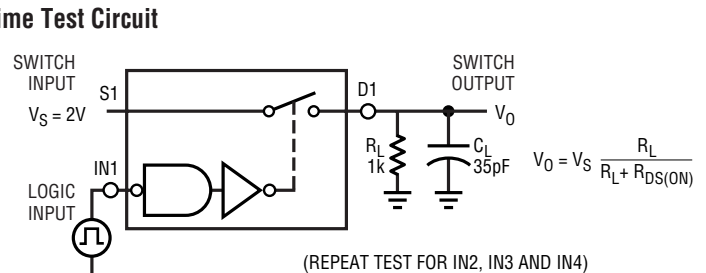
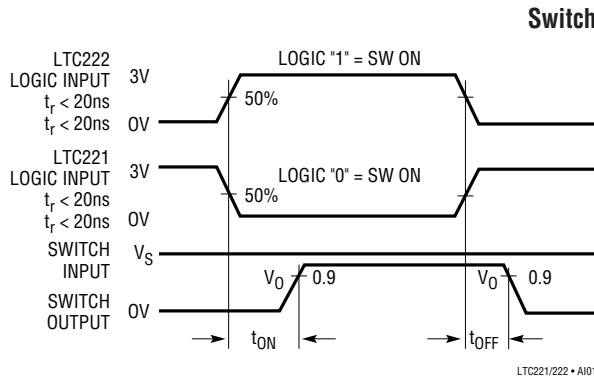


APPLICATIONS INFORMATION

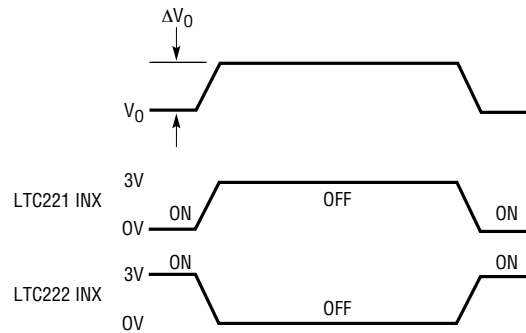
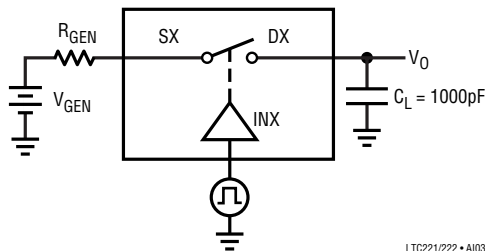
Switching Time Test Circuit

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.



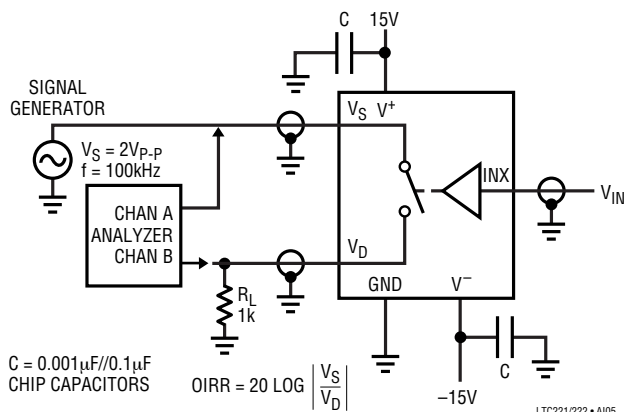
Charge Injection Test Circuit



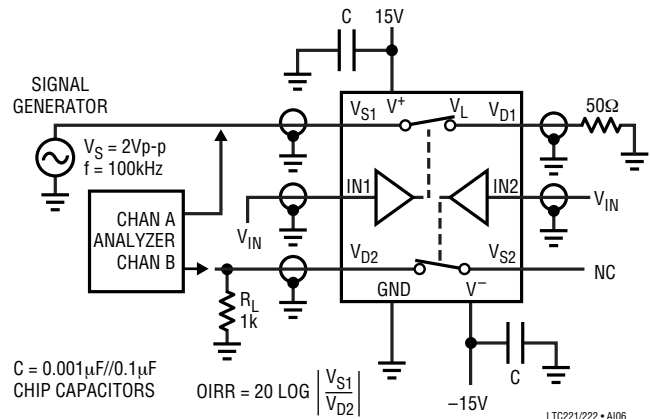
ΔV_O IS THE MEASURED VOLTAGE ERROR DUE TO CHARGE INJECTION.
 THE ERROR VOLTAGE IN COULOMBS IS $\Delta Q = V_L \cdot \Delta V_O$

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OIRR-Off Isolation Test Circuit



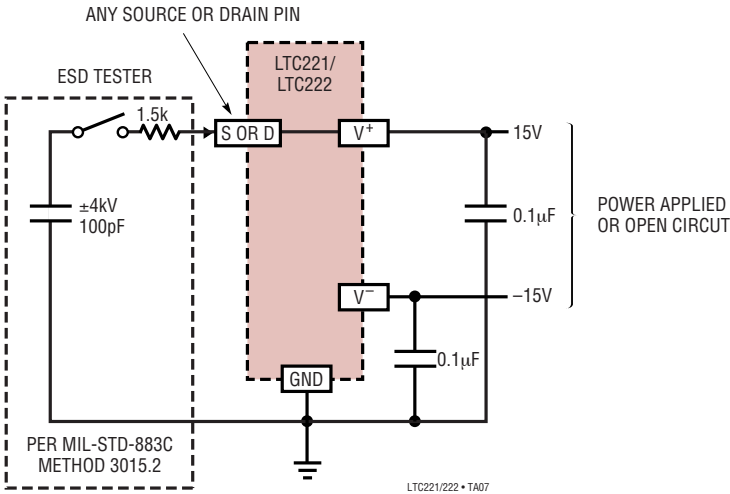
CCRR-Channel to Channel Crosstalk Test Circuit



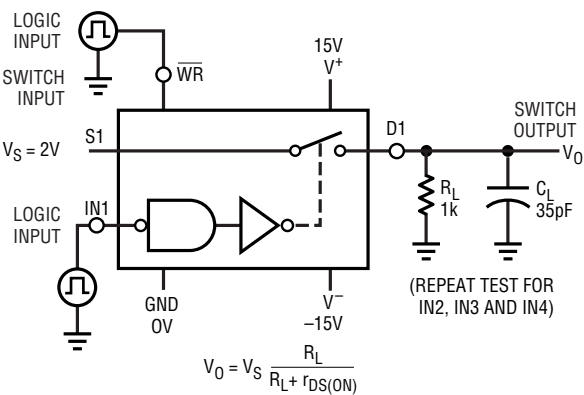
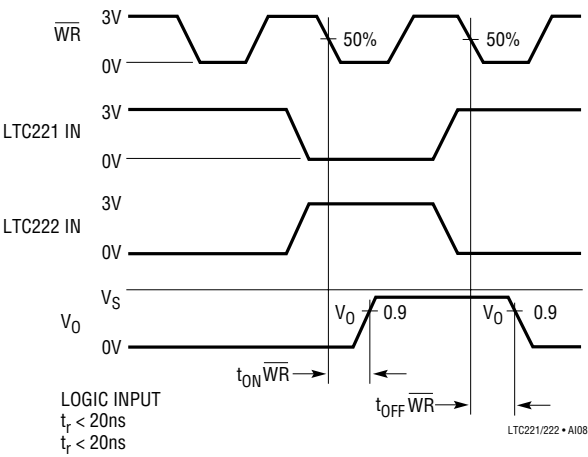
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APPLICATIONS INFORMATION

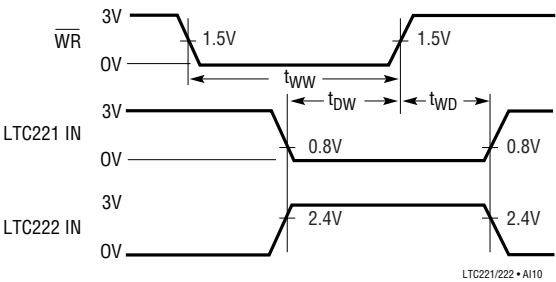
In-Circuit ESD Test Circuit



WR Switching Time Test Circuit



WR Setup Conditions

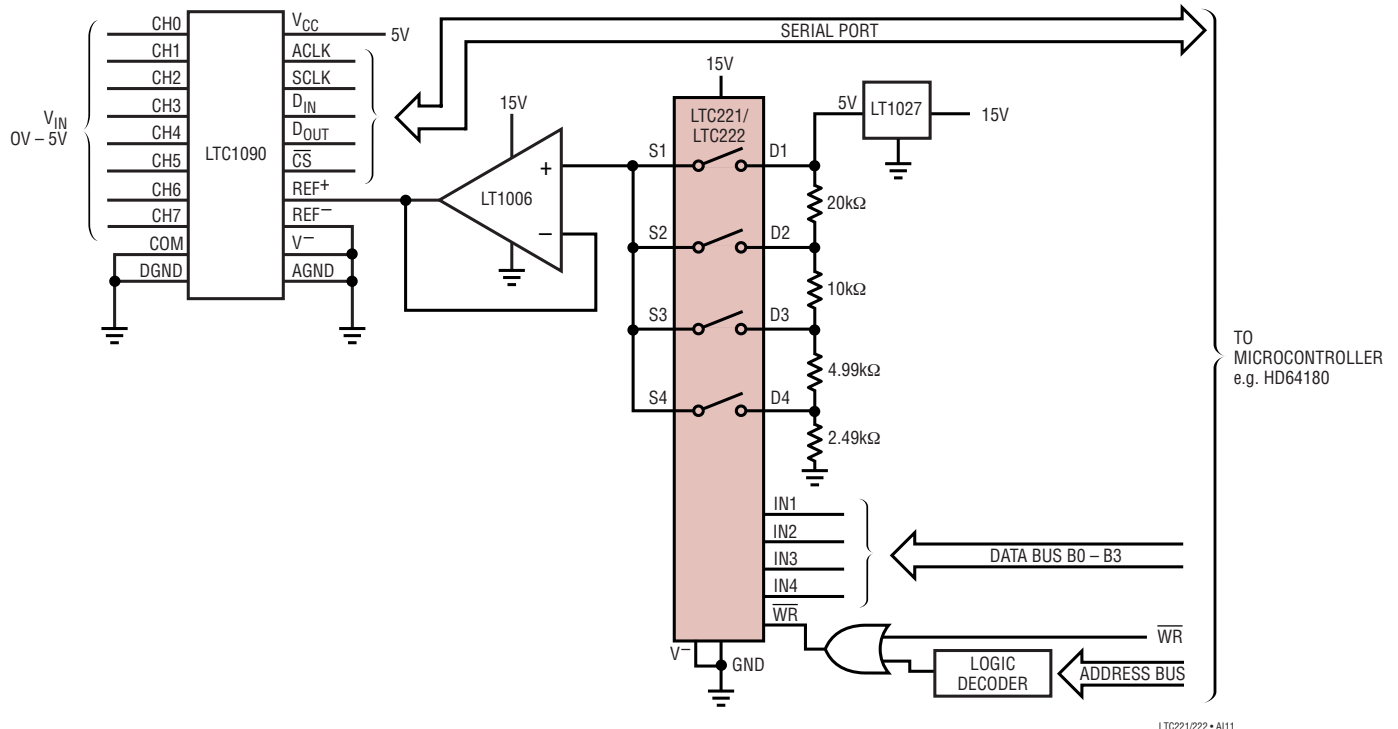


WR/Input Minimum Timing Requirements

PARAMETER	MIN LIMIT	UNITS
t _{WW}	230	ns
t _{DW}	180	ns
t _{WD}	30	ns

APPLICATIONS INFORMATION

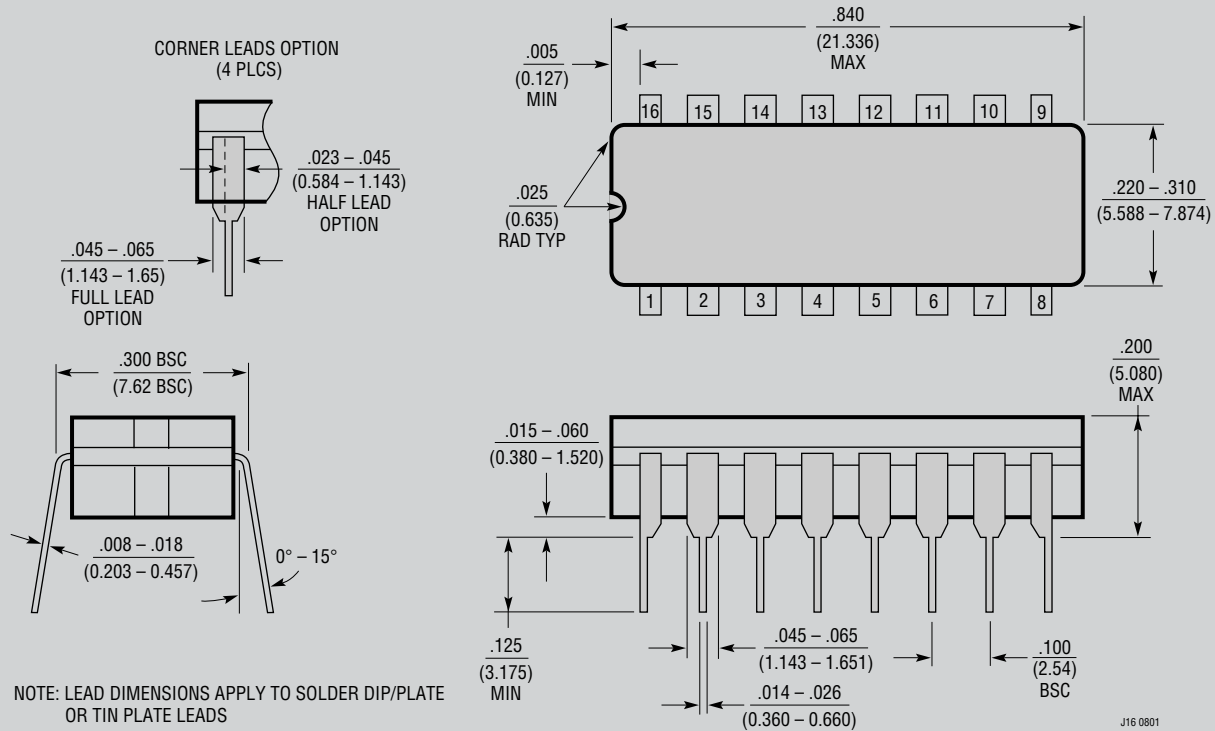
Auto Ranging an 8-Channel, 10-Bit A/D Converter



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PACKAGE DESCRIPTION

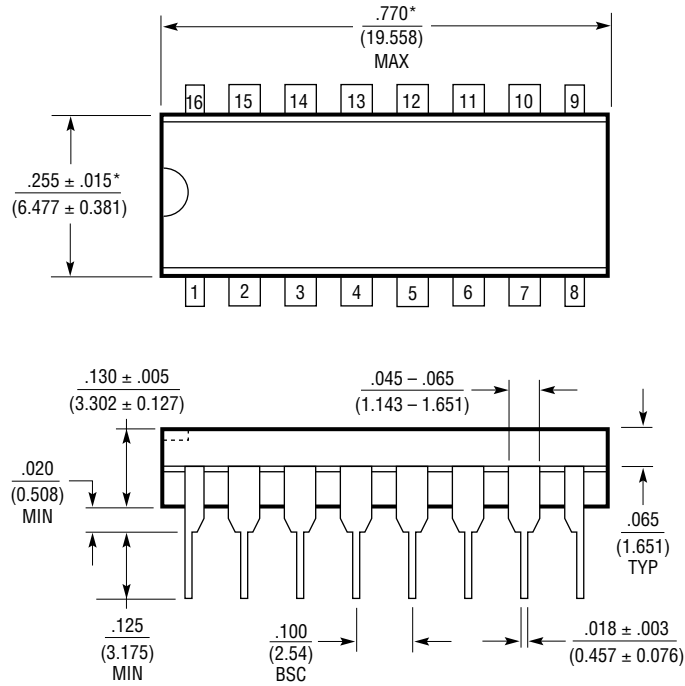
J Package
16-Lead CERDIP (Narrow .300 Inch, Hermetic)
 (Reference LTC DWG # 05-08-1110)



OBSOLETE PACKAGE

PACKAGE DESCRIPTION

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



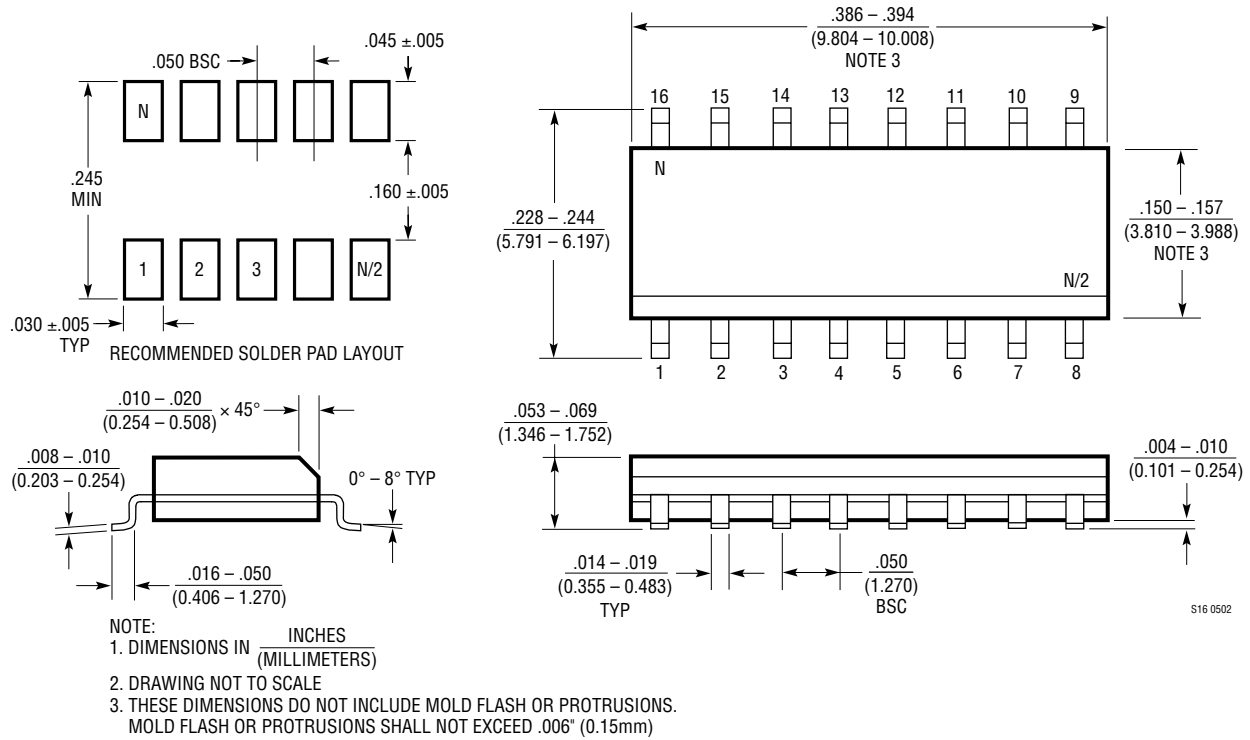
NOTE:

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 0502

PACKAGE DESCRIPTION

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



S16 0502

LTC221/LTC222

RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LTC201/LTC202/LTC203	Micropower, Low Charge Injection, Quad CMOS Analog Switches	DG201/DG202 Compatible
LTC1380/LTC1393	8-Channel/4-Channel Analog Multiplexer with SMBus Interface	3V to $\pm 15V$, 8 Single Ended/4 Differential Inputs
LTC1390/LTC1391	8-Channel, Analog Multiplexer with Serial Interface	3V to $\pm 15V$ Operation

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