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

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 DG221/DG222
- Microprocessor Bus Compatible

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

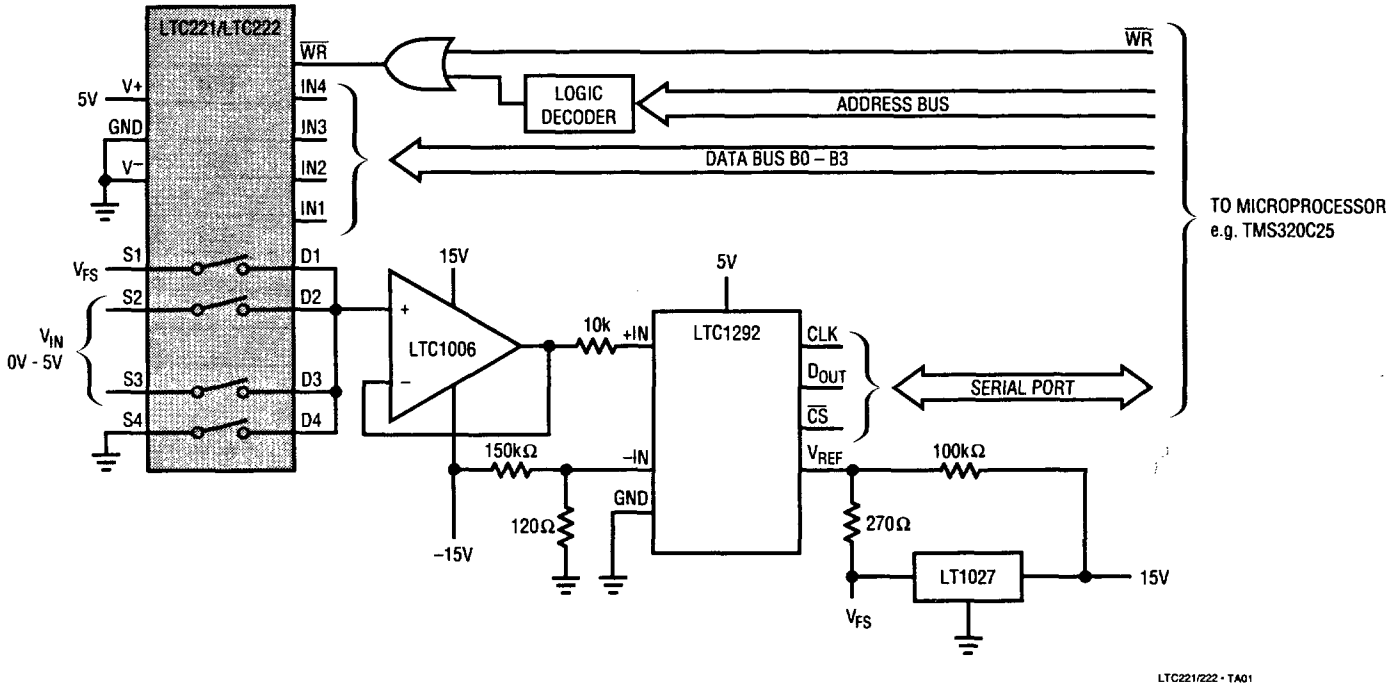
DESCRIPTION

The LTC221 and LTC222 are micropower, quad CMOS analog switches which typically dissipate only 250µW from ±15V supplies and 40µW from a single 5V supply. Onboard latches allow the LTC221 and LTC222 to interface directly to most microprocessor buses. The switches have 65Ω 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 ±15V with a supply voltage of ±15V and 0V-5V with a single 5V supply. The switches have special charge compensation circuitry which greatly reduces charge injection to a maximum of ±25pC (±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.

TYPICAL APPLICATION

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



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11

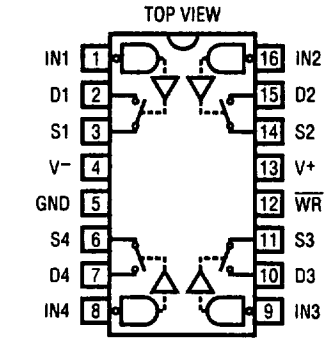
ABSOLUTE MAXIMUM RATINGS

(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
  LTC221C/LTC222C ..... 0°C to 70°C
  LTC221M/LTC222M ..... – 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
LTC221MJ
LTC221CJ
LTC221CN
LTC221CS
LTC222MJ
LTC222CJ
LTC222CN
LTC222CS

LOGIC TABLE

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

DIGITAL AND DC ELECTRICAL CHARACTERISTICS

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

PARAMETER	CONDITIONS			LTC221M/LTC222M MIN	LTC221M/LTC222M TYP	LTC221M/LTC222M MAX	LTC221C/LTC222C MIN	LTC221C/LTC222C TYP	LTC221C/LTC222C MAX	UNITS
Analog Signal Range			•			±15			±15	V
R_{ON}	V_S = ±10V	T_{MIN}				90			90	Ω
	I_D = 1mA	25°C			65	90		65	90	
		T_{MAX}				135			135	
Off Input Leakage I_S (OFF)	V_D = ±14V, V_S = ∓14V				0.01	±1		0.01	±5	nA
			•			±100			±100	
Off Output Leakage I_D (OFF)	V_{IN} = 2.4V, LTC221				0.01	±1		0.01	±5	
	V_{IN} = 0.8V, LTC222		•			±100			±100	
On Channel Leakage I_D (ON)	V_D = V_S = ±14V, V_{IN} = 2.4V, LTC222				0.02	±1		0.02	±5	nA
	V_{IN} = 0.8V, LTC221		•			±200			±200	
Input High Voltage V_{INH}, $V_{\overline{WRH}}$			•	2.4			2.4			V
Input Low Voltage V_{INL}, $V_{\overline{WRL}}$			•			0.8			0.8	V
Input High or Low Current I_{INH}, I_{INL}, $I_{\overline{WRH}}$, $I_{\overline{WRL}}$	V_{IN} = 15V, 0V $V_{\overline{WR}}$ = 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				16	40		16	40	µA
	V_{IN} = $V_{\overline{WR}}$ = 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	LTC221M/LTC222M MIN	TYP	MAX	LTC221C/LTC222C MIN	TYP	MAX	UNITS
T_{ON}	$V_S = 2V$, $R_L = 1k\Omega$, $C_L = 35pF$		290	400		290	400	ns
T_{OFF}			210	300		210	300	
T_{OPEN}		20	85		20	85		ns
Off Isolation	$V_S = 2Vp\text{-}p$, $R_L = 1k\Omega$		75			75		dB
Crosstalk	f = 100kHz		90			90		
Charge Injection Q_{INJ}	$R_{GEN} = 0\Omega$, $C_L = 1000pF$, $V_{GEN} = 0$		5	±25		8	±25	pC
Total Harmonic Distortion THD	$V_S = 2Vp\text{-}p$, $R_L = 10k\Omega$		0.01			0.01		%
T_{ON}, $\overline{WR}$	$V_S = 2V$, $R_L = 1k\Omega$, $C_L = 35pF$		270	400		270	400	ns
T_{OFF}, $\overline{WR}$			160	300		160	300	

DIGITAL AND DC ELECTRICAL CHARACTERISTICS

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

PARAMETER	CONDITIONS			LTC221M/LTC222M MIN	TYP	MAX	LTC221C/LTC222C 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	520	
		T_{MAX}				650			650	
Off Input Leakage I_S (OFF)	$V_D = 4V, 1V$; $V_S = 1V, 4V$				0.01	±1		0.01	±5	nA
	(Note 4)		•			±100			±100	
Off Output Leakage I_D (OFF)					0.01	±1		0.01	±5	
			•			±100			±100	
On Channel Leakage I_D (ON)	$V_D = V_S = 1V, 4V$				0.01	±1		0.01	±5	nA
	(Note 4)		•			±200			±200	
Input High Voltage V_{INH}, $V_{\overline{WRH}}$			•	2.4			2.4			V
Input Low Voltage V_{INL}, $V_{\overline{WRL}}$			•			0.8			0.8	V
Input High or Low Current I_{INH}, I_{INL}, $I_{\overline{WRH}}$, $I_{\overline{WRL}}$	$V_{IN} = 5V, 0V$ $V_{\overline{WR}} = 5V, 0V$		•			±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 Channels On or Off				8	20		8	20	µA
	$V_{IN} = V_{\overline{WR}} = 0V$ or 4.0V		•			30			30	

11

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

PARAMETER	CONDITIONS	LTC221M/LTC222M MIN	TYP	MAX	LTC221C/LTC222C MIN	TYP	MAX	UNITS
T_{ON}	$V_S = 2V$, $R_L = 1k\Omega$, $C_L = 35pF$		450	600		450	600	ns
T_{OFF}			190	300		190	300	
T_{OPEN}		100	250		100	250		ns
Off Isolation	$V_S = 2Vp\text{-}p$, $R_L = 1k\Omega$		75			75		dB
Crosstalk	f = 100kHz		90			90		
Charge Injection Q_{INJ}	$R_{GEN} = 0\Omega$, $C_L = 1000pF$, $V_{GEN} = 2.5V$		2			2		pC
Total Harmonic Distortion THD	$V_S = 2Vp\text{-}p$, $R_L = 10k\Omega$		0.01			0.01		%
T_{ON}, $\overline{WR}$	$V_S = 2V$, $R_L = 1k\Omega$, $C_L = 35pF$		430	600		430	600	ns
T_{OFF}, $\overline{WR}$			160	300		160	300	

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.

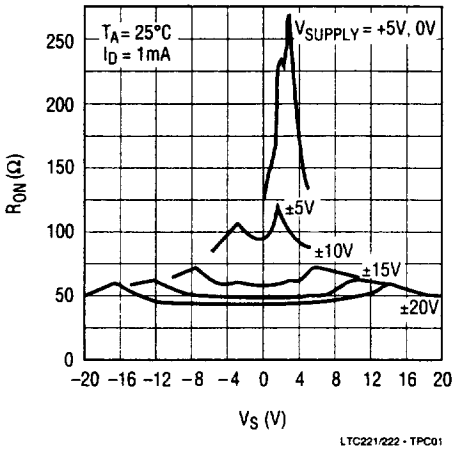
Note 2: Signals on S, D, or IN exceeding V^+ or V^- will be clamped by internal diodes. Limit forward diode current to maximum current rating.

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

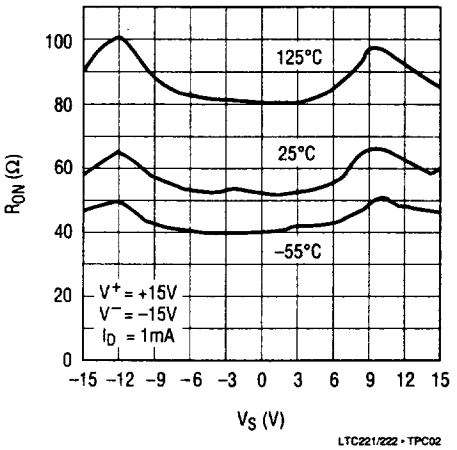
Note 4: Leakage current with a 5V supply is guaranteed by correlation with the ±15V leakage current.

TYPICAL PERFORMANCE CHARACTERISTICS

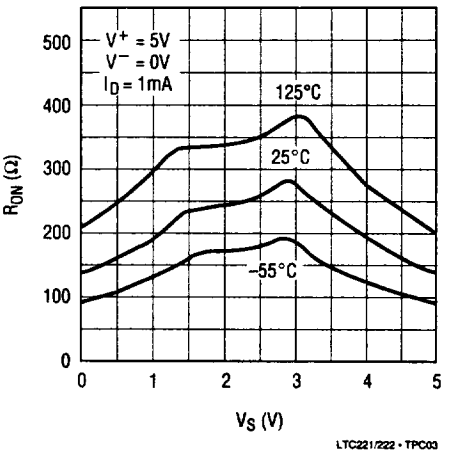
R_{ON} vs V_S Over Supply Voltage



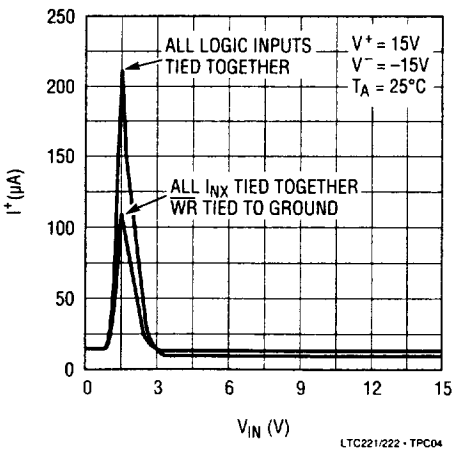
R_{ON} vs V_S Over Temperature



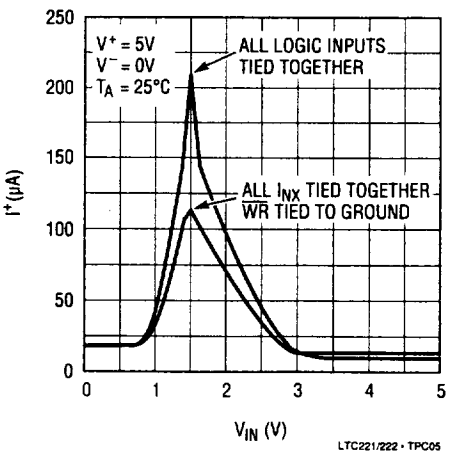
R_{ON} vs V_S Over Temperature



Positive Supply Current vs Logic Input Voltage



Positive Supply Current vs Logic Input Voltage

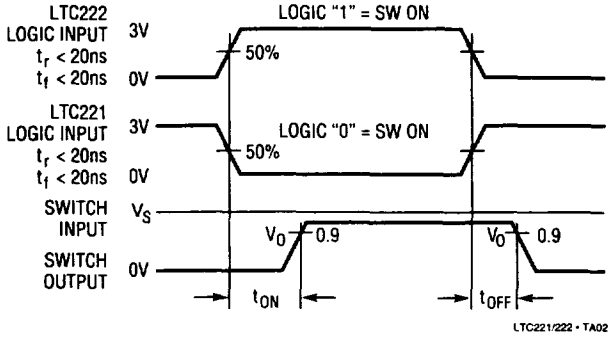


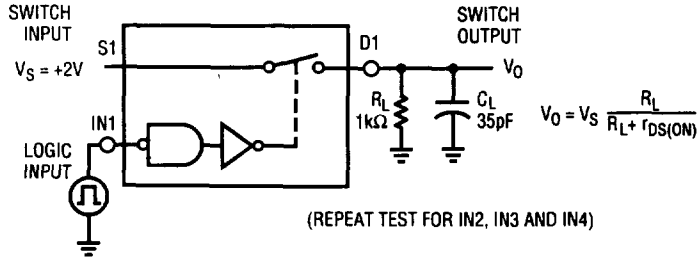
APPLICATIONS INFORMATION

Switching Time Test Circuit

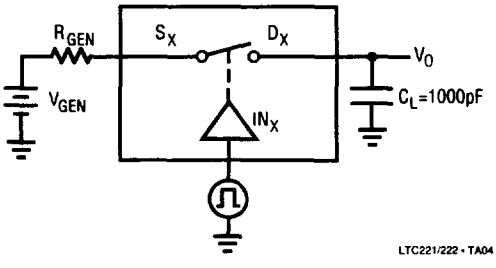
Switch output waveform shown for V_S = constant with logic input waveform as shown. Note that V_S may be (+) or (–) as per switching time test circuit. V_O is the steady state output switch on. Feedthrough via gate capacitance may result in spikes at leading and trailing edge of output waveform.

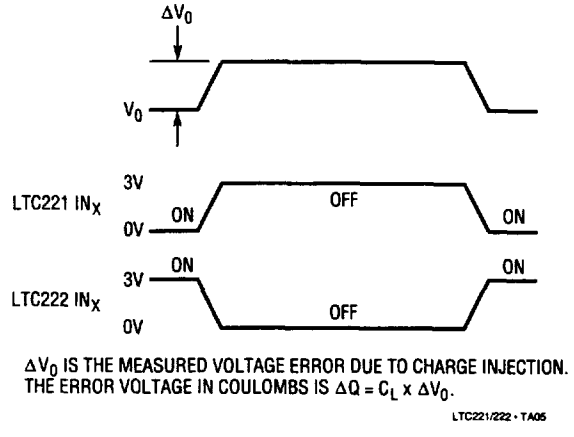
Switching Time Test Circuit





Charge Injection Test Circuit





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

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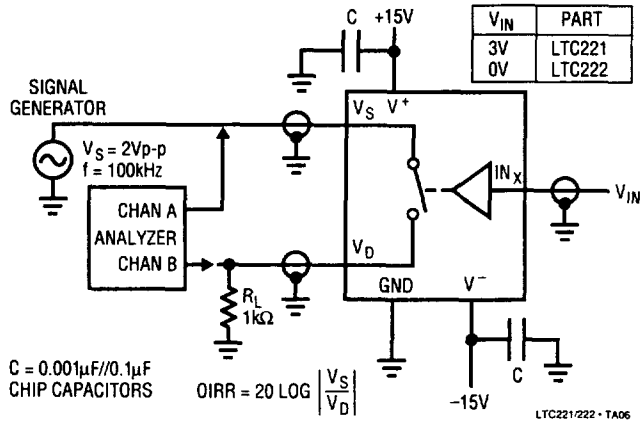
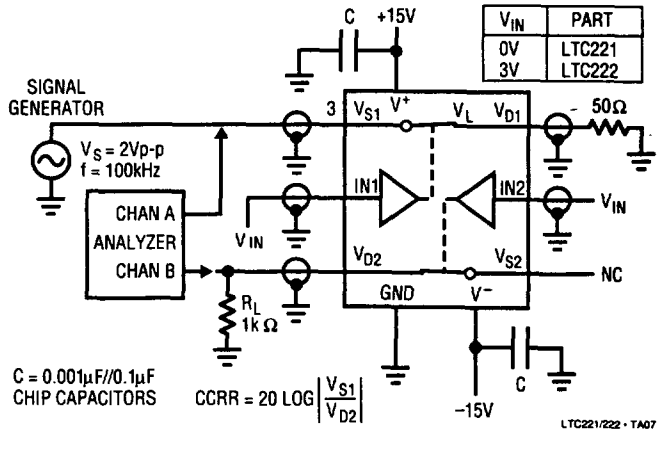
OIRR-Off Isolation Test Circuit



V_{IN}	PART
3V	LTC221
0V	LTC222

CCRR-Channel to Channel Crosstalk Test Circuit

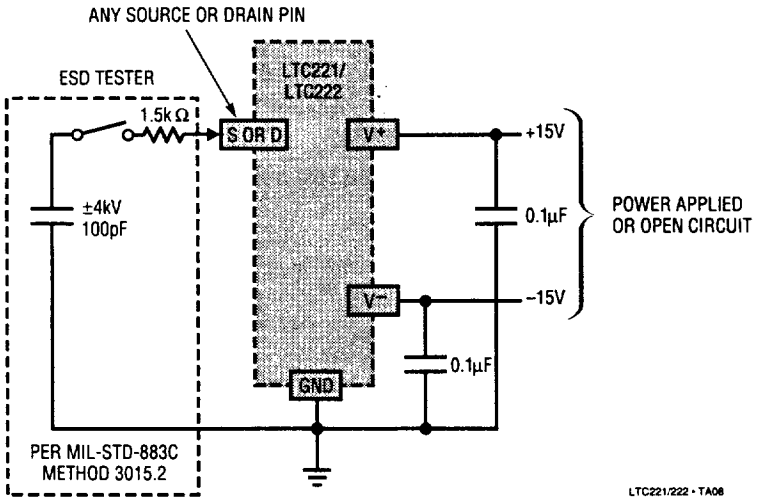


V_{IN}	PART
0V	LTC221
3V	LTC222

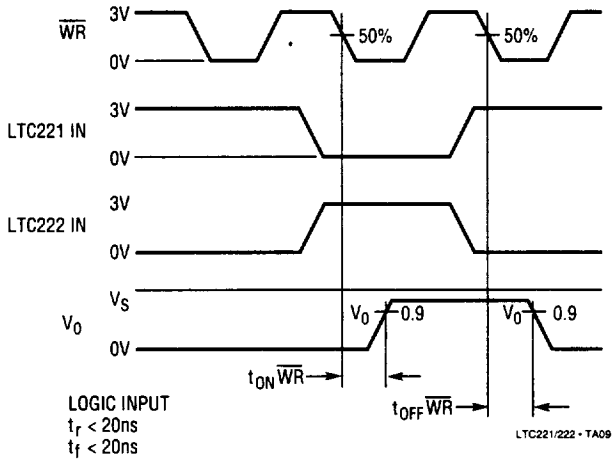
11

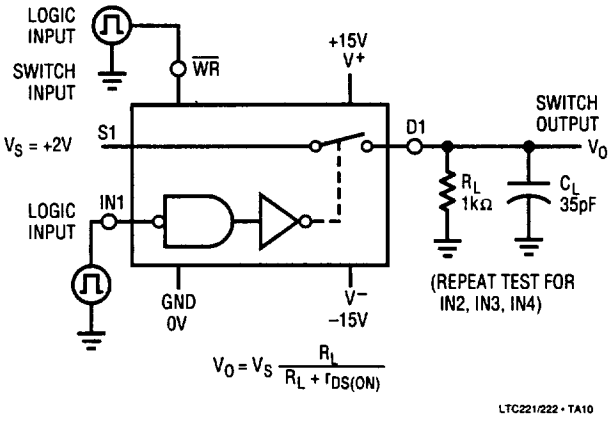
APPLICATIONS INFORMATION

In-Circuit ESD Test Circuit

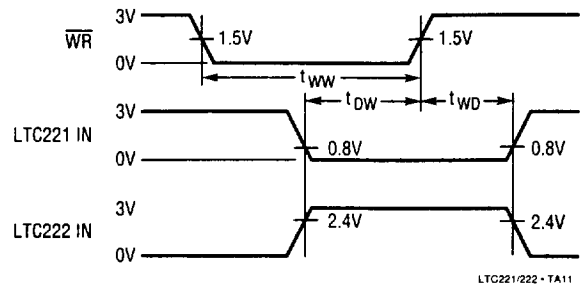


$\overline{WR}$ Switching Time Test Circuit





$\overline{WR}$ Setup Conditions

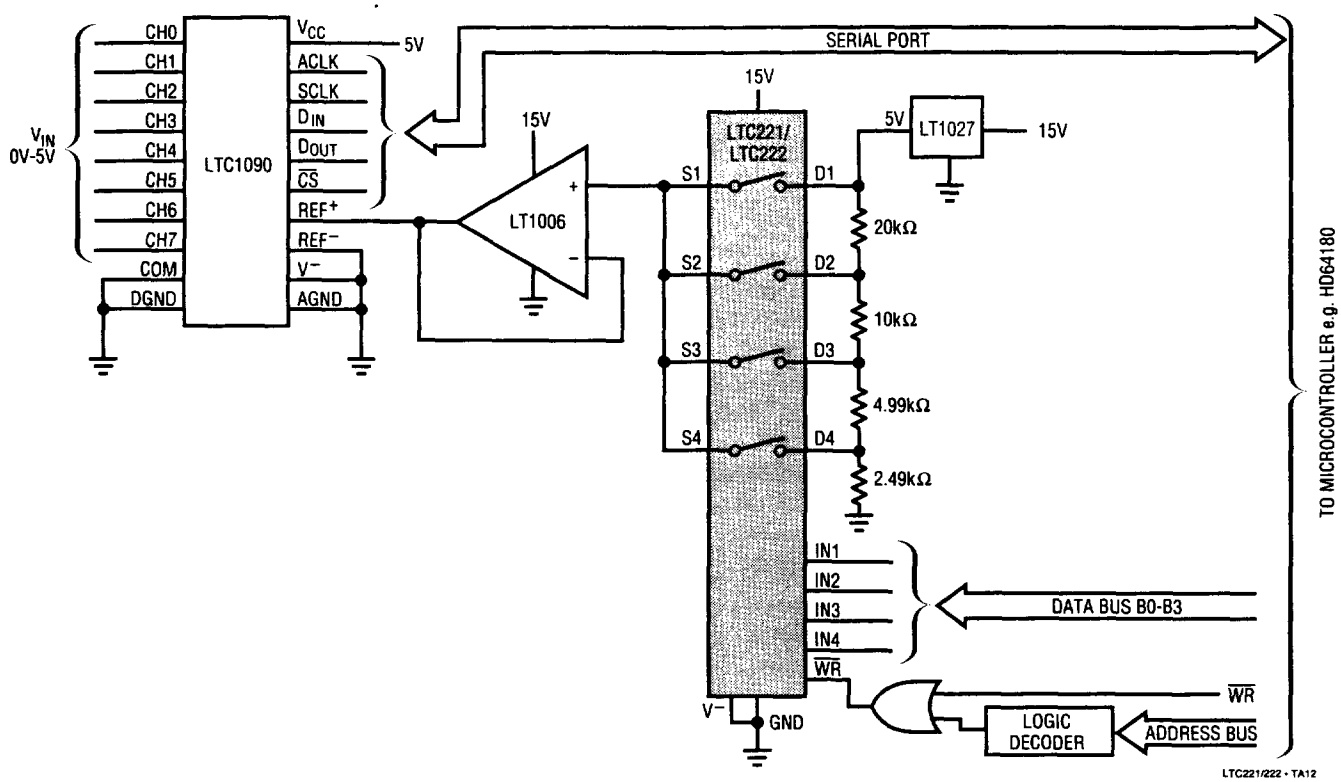


$\overline{WR}$/Input Minimum Timing Requirements

	PARAMETER	MIN LIMIT	UNITS
t_{WW}	Write Pulse Width	230	ns
t_{DW}	Data Valid to Write	180	
t_{WD}	Data Valid After Write	30	

APPLICATIONS INFORMATION

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



8-Channel, 14-Bit A/D Converter