



# LTC221/LTC222

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

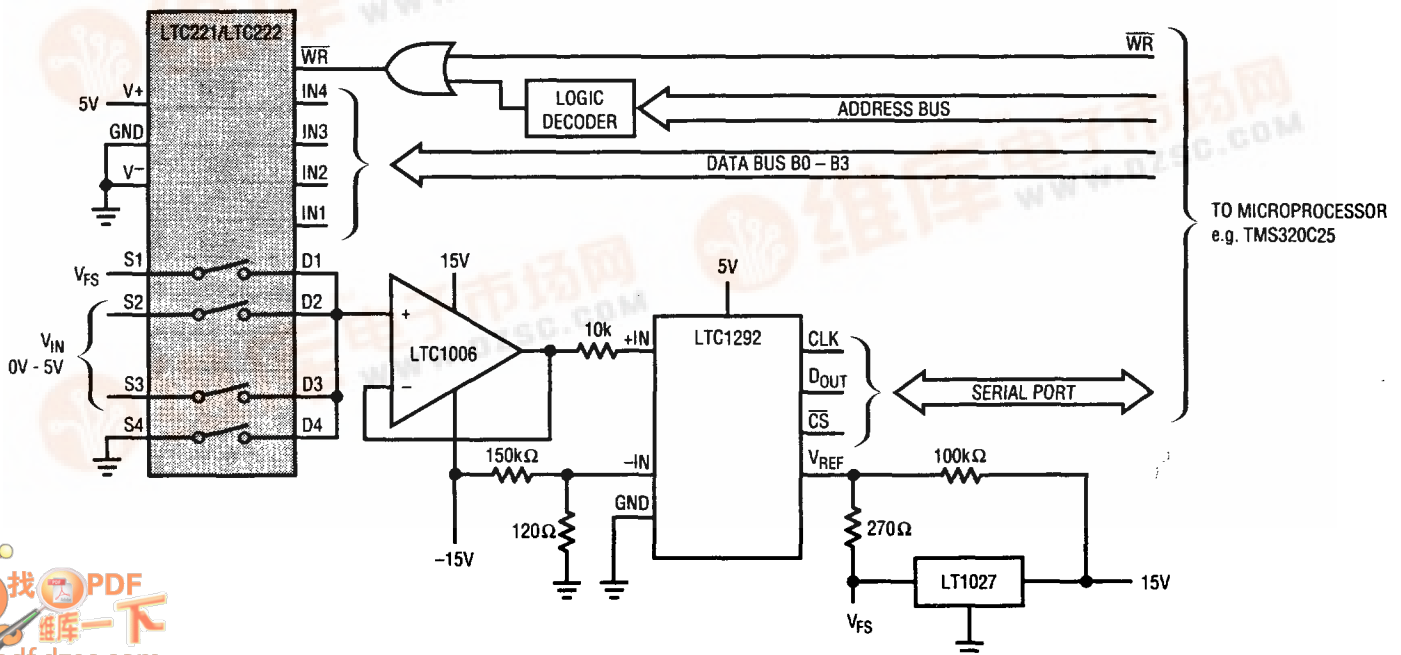
### DESCRIPTION

The LTC221 and LTC222 are micropower, quad CMOS analog switches which typically dissipate only  $250\mu W$  from  $\pm 15V$  supplies and  $40\mu W$  from a single 5V supply. Onboard latches allow the LTC221 and LTC222 to interface directly to most microprocessor buses. The switches have  $65\Omega$  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-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.

### TYPICAL APPLICATION

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



# LTC221/LTC222

## ABSOLUTE MAXIMUM RATINGS

(Note 1)

Voltages Referenced to V<sup>-</sup>

V <sup>+</sup> .....	44V
GND .....	25V
Digital Inputs, S, D (Note 2) .....	- 2V to (V <sup>+</sup> + 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) .....

Power Dissipation (Plastic) .....

Power Dissipation (Ceramic) .....

Operating Temperature Range

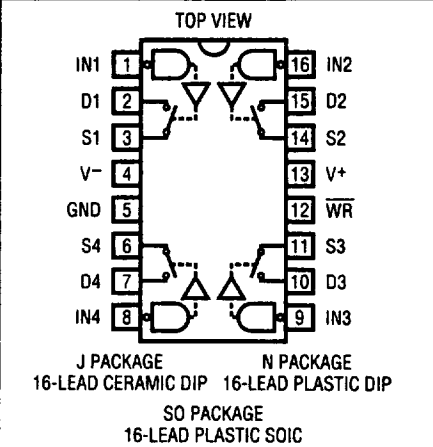
LTC221C/LTC222C .....

LTC221M/LTC222M .....

Storage Temperature Range .....

Lead Temperature (Soldering, 10 sec.) .....

## PACKAGE/ORDER INFORMATION

	ORDER PART NUMBER
	LTC221MJ LTC221CJ LTC221CN LTC221CS LTC222MJ LTC222CJ LTC222CN LTC222CS

## LOGIC TABLE

IN <sub>x</sub>	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<sup>+</sup> = +15V, V<sup>-</sup> = -15V, GND = 0V unless otherwise noted.

PARAMETER	CONDITIONS	LTC221M/LTC222M			LTC221C/LTC222C			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Analog Signal Range				±15			±15	V
R <sub>ON</sub>	V <sub>S</sub> = ±10V I <sub>D</sub> = 1mA	T <sub>MIN</sub>		90			90	Ω
		25°C		65 90			65 90	
		T <sub>MAX</sub>		135			135	
Off Input Leakage I <sub>S</sub> (OFF)	V <sub>D</sub> = ±14V, V <sub>S</sub> = ∓14V		0.01 ±1			0.01 ±5		nA
Off Output Leakage I <sub>O</sub> (OFF)	V <sub>IN</sub> = 2.4V, LTC221		0.01 ±1			0.01 ±5		
	V <sub>IN</sub> = 0.8V, LTC222		±100			±100		
On Channel Leakage I <sub>D</sub> (ON)	V <sub>D</sub> = V <sub>S</sub> = ±14V, V <sub>IN</sub> = 2.4V, LTC222		0.02 ±1			0.02 ±5		nA
	V <sub>IN</sub> = 0.8V, LTC221		±200			±200		
Input High Voltage V <sub>INH</sub> , V <sub>WRH</sub>		2.4			2.4			V
Input Low Voltage V <sub>INL</sub> , V <sub>WRL</sub>			0.8			0.8		V
Input High or Low Current I <sub>INH</sub> , I <sub>INL</sub> , I <sub>WRH</sub> , I <sub>WRL</sub>	V <sub>IN</sub> = 15V, 0V V <sub>WR</sub> = 15V, 0V		±1			±1		μA
C <sub>S</sub> (OFF)			5			5		pF
C <sub>D</sub> (OFF)			12			12		pF
C <sub>D</sub> , C <sub>S</sub> (ON)			30			30		pF
I <sup>+</sup>	All Channels On or Off V <sub>IN</sub> = V <sub>WR</sub> = 0V or 4.0V		16 40			16 40		μA
			60			60		
			0.1 5			0.1 5		
I <sup>-</sup>			10			10		

**AC ELECTRICAL CHARACTERISTICS**V<sup>+</sup> = +15V, V<sup>-</sup> = -15V, GND = 0V unless otherwise noted.

PARAMETER	CONDITIONS	LTC221M/LTC222M			LTC221C/LTC222C			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
T <sub>ON</sub>	V <sub>S</sub> = 2V, R <sub>L</sub> = 1kΩ, C <sub>L</sub> = 35pF		290	400		290	400	ns
T <sub>OFF</sub>			210	300		210	300	
T <sub>OPEN</sub>		20	85		20	85	ns	
Off Isolation	V <sub>S</sub> = 2Vp-p, R <sub>L</sub> = 1kΩ		75			75	dB	
Crosstalk	f = 100kHz		90			90		
Charge Injection Q <sub>INJ</sub>	R <sub>GEN</sub> = 0Ω, C <sub>L</sub> = 1000pF, V <sub>GEN</sub> = 0		5	±25		8	±25	pC
Total Harmonic Distortion THD	V <sub>S</sub> = 2Vp-p, R <sub>L</sub> = 10kΩ		0.01			0.01		%
T <sub>ON, <math>\overline{WR}</math></sub>	V <sub>S</sub> = 2V, R <sub>L</sub> = 1kΩ, C <sub>L</sub> = 35pF		270	400		270	400	ns
T <sub>OFF, <math>\overline{WR}</math></sub>			160	300		160	300	

**DIGITAL AND DC ELECTRICAL CHARACTERISTICS**V<sup>+</sup> = +5V, V<sup>-</sup> = GND = 0V unless otherwise noted.

PARAMETER	CONDITIONS		LTC221M/LTC222M			LTC221C/LTC222C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Analog Signal Range		●	0		5	0		5	V
R <sub>ON</sub>	V <sub>S</sub> = +1.5V, +3V I <sub>D</sub> = 0.25mA	T <sub>MIN</sub>			450			520	Ω
		25°C			280	450	280	520	
		T <sub>MAX</sub>			650		650		
Off Input Leakage I <sub>S</sub> (OFF)	V <sub>D</sub> = 4V, 1V; V <sub>S</sub> = 1V, 4V (Note 4)			0.01	±1		0.01	±5	nA
		●			±100		±100		
Off Output Leakage I <sub>D</sub> (OFF)				0.01	±1		0.01	±5	
		●			±100		±100		
On Channel Leakage I <sub>D</sub> (ON)	V <sub>D</sub> = V <sub>S</sub> = 1V, 4V (Note 4)			0.01	±1		0.01	±5	nA
		●			±200		±200		
Input High Voltage V <sub>INH</sub> , V <sub>WRH</sub>		●	2.4			2.4		V	
Input Low Voltage V <sub>INL</sub> , V <sub>WRL</sub>		●		0.8			0.8	V	
Input High or Low Current I <sub>INH</sub> , I <sub>INL</sub> , I <sub>WRH</sub> , I <sub>WRL</sub>	V <sub>IN</sub> = 5V, 0V V <sub>WR</sub> = 5V, 0V	●		±1			±1	μA	
C <sub>S</sub> (OFF)				5			5	pF	
C <sub>D</sub> (OFF)				12			12	pF	
C <sub>D</sub> , C <sub>S</sub> (ON)				30			30	pF	
I <sup>+</sup>	All Channels On or Off V <sub>IN</sub> = V <sub>WR</sub> = 0V or 4.0V			8	20		8	20	μA
		●			30		30		

# LTC221/LTC222

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

PARAMETER	CONDITIONS	LTC221M/LTC222M			LTC221C/LTC222C			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
$T_{ON}$	$V_S = 2V$ , $R_L = 1k\Omega$ , $C_L = 35pF$	450	600		450	600	ns	
$T_{OFF}$		190	300		190	300		
$T_{OPEN}$		100	250		100	250	ns	
Off Isolation	$V_S = 2Vp-p$ , $R_L = 1k\Omega$	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	$V_S = 2Vp-p$ , $R_L = 10k\Omega$	0.01			0.01		%	
$T_{ON, WR}$	$V_S = 2V$ , $R_L = 1k\Omega$ , $C_L = 35pF$	430	600		430	600	ns	
$T_{OFF, WR}$		160	300		160	300		

The ● denotes the specifications which apply over full operating temperature range. All other limits and typicals  $T_A = 25^\circ C$ .

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

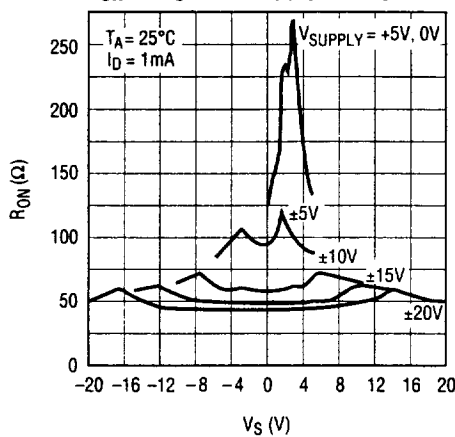
**Note 2:** Signals on S, D, or IN exceeding  $V^+$  or  $V^-$  will be clamped by internal diodes. Limit forward diode current to maximum current rating.

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

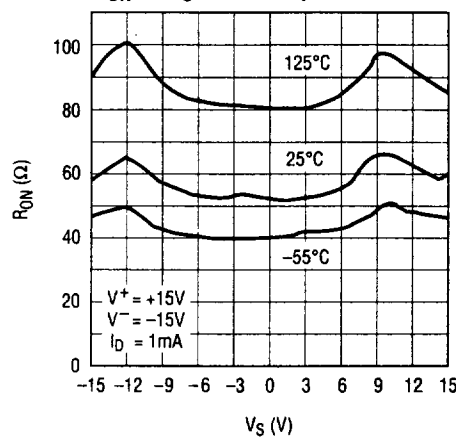
**Note 4:** Leakage current with a 5V supply is guaranteed by correlation with the  $\pm 15V$  leakage current.

## TYPICAL PERFORMANCE CHARACTERISTICS

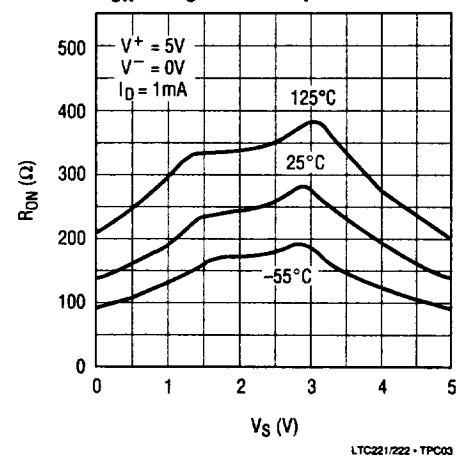
$R_{ON}$  vs  $V_S$  Over Supply Voltage



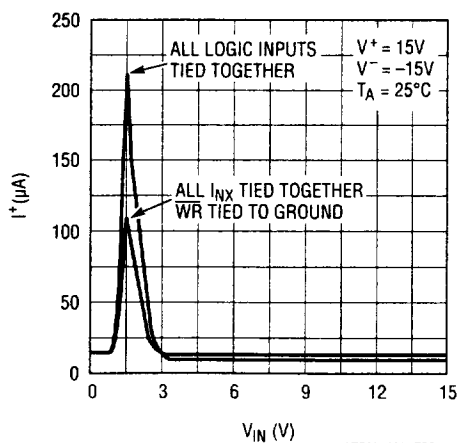
$R_{ON}$  vs  $V_S$  Over Temperature



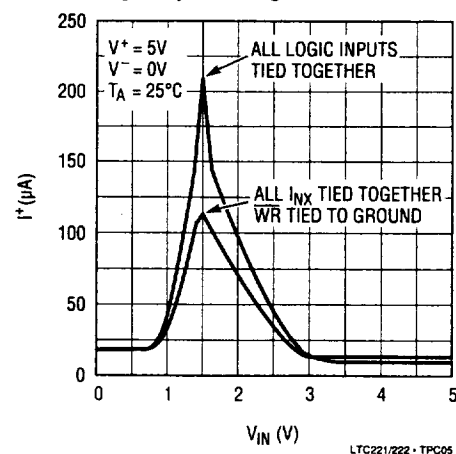
$R_{ON}$  vs  $V_S$  Over Temperature



Positive Supply Current vs Logic Input Voltage



Positive Supply Current vs Logic Input Voltage

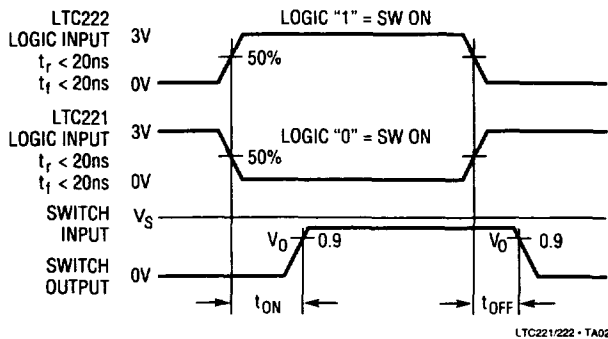


# APPLICATIONS INFORMATION

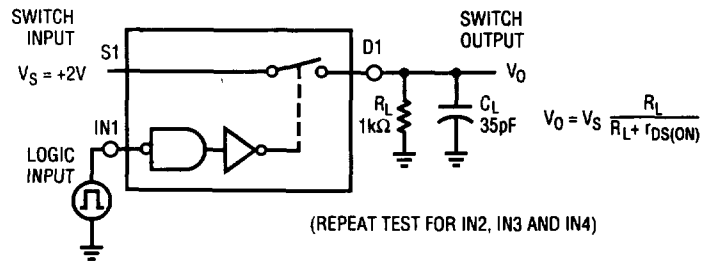
## Switching Time Test Circuit

Switch output waveform shown for  $V_S = \text{constant}$  with logic input waveform as shown. Note that  $V_S$  may be (+) or (-) as per switching time test circuit.  $V_O$  is the steady

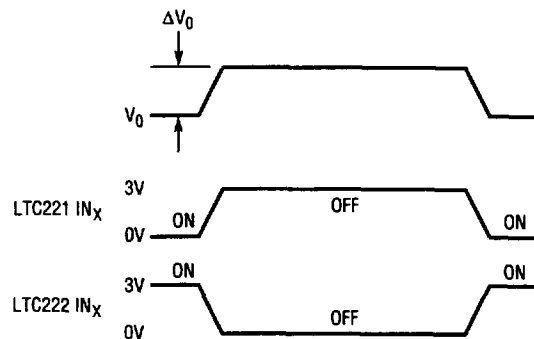
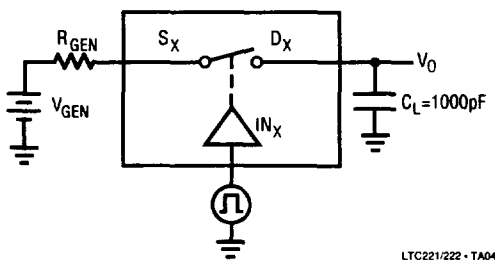
state output switch on. Feedthrough via gate capacitance may result in spikes at leading and trailing edge of output waveform.



Switching Time Test Circuit



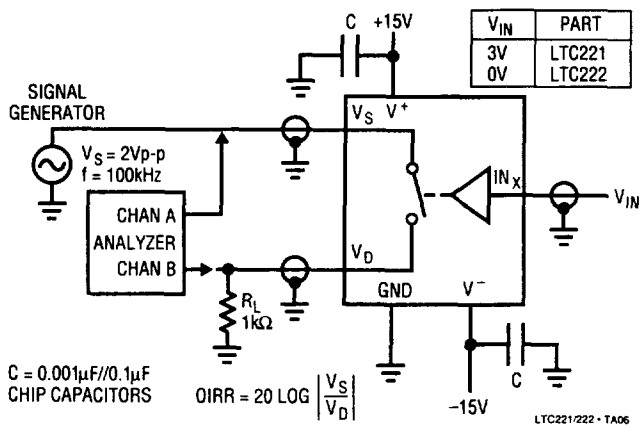
## Charge Injection Test Circuit



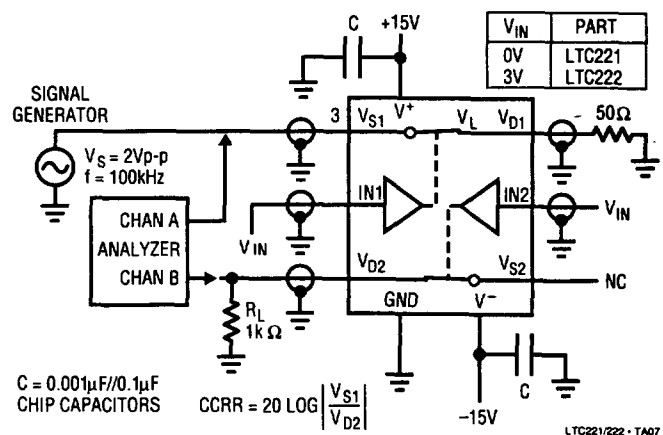
$\Delta V_O$  IS THE MEASURED VOLTAGE ERROR DUE TO CHARGE INJECTION. THE ERROR VOLTAGE IN COULOMBS IS  $\Delta Q = C_L \times \Delta V_O$ .

LTC221/222 - TA05

## OIRR-Off Isolation Test Circuit



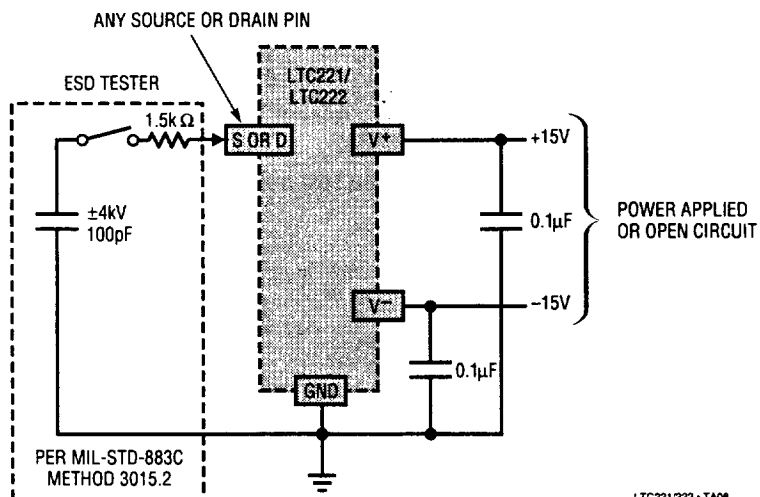
## CCRR-Channel to Channel Crosstalk Test Circuit



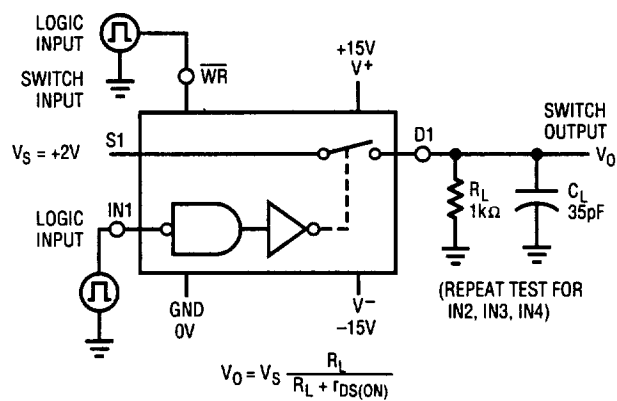
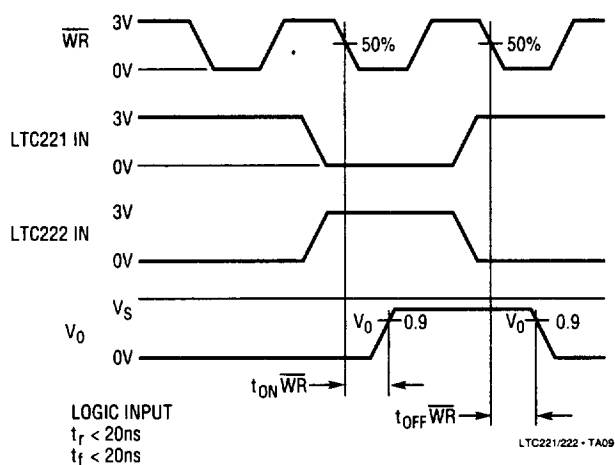
# LTC221/LTC222

## APPLICATIONS INFORMATION

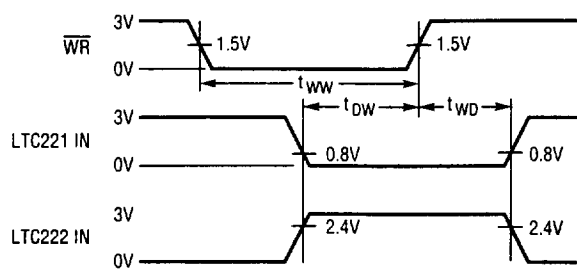
### In-Circuit ESD Test Circuit



### WR Switching Time Test Circuit



### WR Setup Conditions

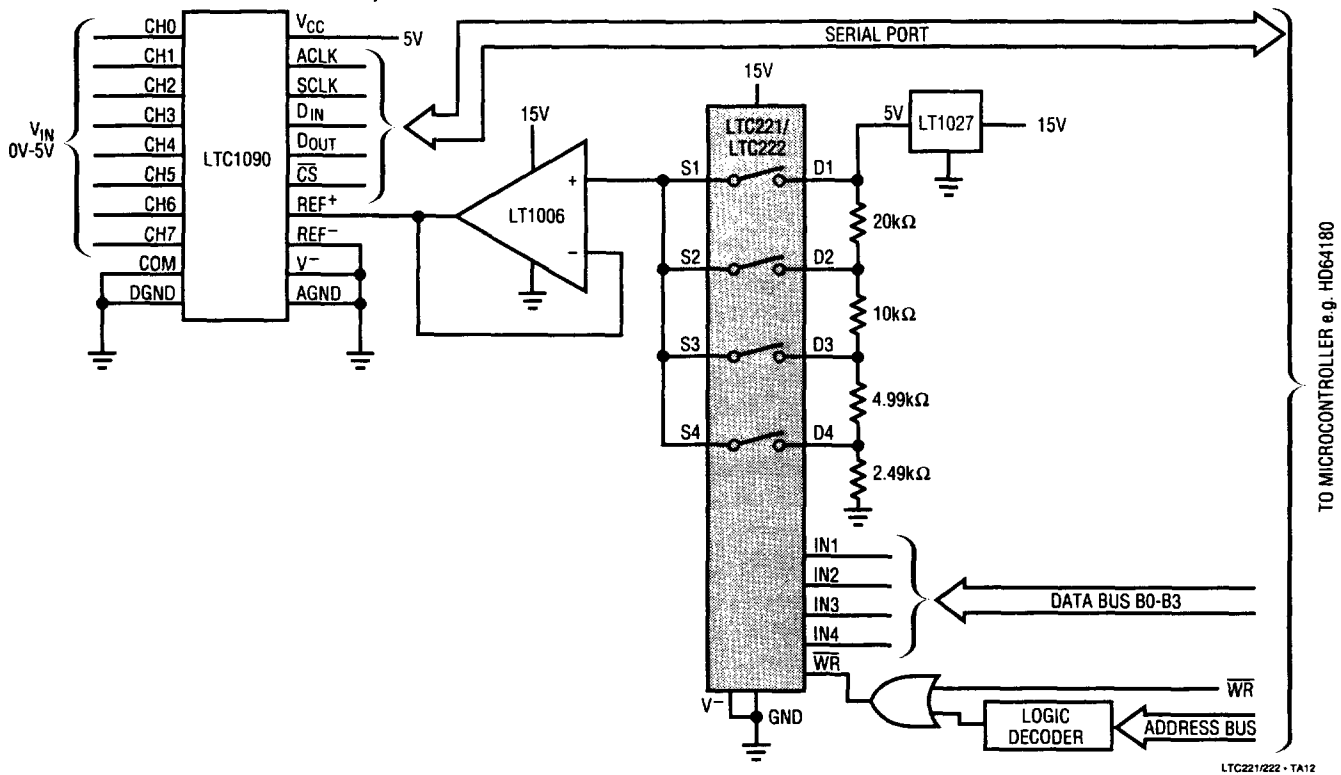


### WR/Input Minimum Timing Requirements

PARAMETER	MIN LIMIT	UNITS
t <sub>WW</sub>	230	ns
t <sub>DW</sub>	180	
t <sub>WD</sub>	30	

# APPLICATIONS INFORMATION

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



## 8-Channel, 14-Bit A/D Converter

