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ADVANCED
LINEAR
DEVICES, INC.

ALD4211/ALD4212
ALD4213

CMOS LOW VOLTAGE HIGH SPEED QUAD PRECISION ANALOG SWITCHES

GENERAL DESCRIPTION

The ALD4211/ALD4212/ALD4213 are quad SPST CMOS analog switches specifically designed for low voltage, high speed applications where 0.2pC charge injection, 200pf sampling capacitor, and picoamp leakage current are important analog switch operating characteristics. These analog switches feature fast switching, low on-resistance and micropower consumption.

TheALD4211/4212/4213 are designed for precision applications such as charge amplifiers, sample and hold amplifiers, data converter switches, and programmable gain amplifiers. These switches are also excellent for low voltage micropower general purpose switching applications.

APPLICATIONS INFORMATION

The ALD4211/4212/4213 operate with a standard single power supply from +3V to +12Volts. Functionality extends down to a +2 volt power supply making it suitable for lithium battery or rechargeable battery operated systems where power, efficiency, and performance are important design considerations. Break-before-make switching is guaranteed with single supply operation. The ALD4211/4212/4213 may also be used with dual power supplies from ±1.5 to ±6 volts.

With special charge balancing and charge cancellation circuitry on chip the ALD4211/ALD4212/ALD4213 were developed for ultra low charge injection applications. Using a 200pF sampling capacitor, very fast precise signal acquisition may be achieved. With ultra low quiescent current, these switches interface directly to CMOS logic levels from microprocessor or logic circuits. On the board level, low charge injection and fast operation may be achieved by using short leads, minimizing input and output capacitances, and by adequate bypass capacitors placed on the board at the supply nodes. For more information, see Application Note AN4200.

The ALD4211/ALD4212/ALD4213 are manufactured with Advanced Linear Devices enhanced ACMOS silicon gate CMOS process. They are designed also as linear cell elements in Advanced Linear Devices' "Function-Specific" ASIC.

ORDERING INFORMATION

Operating Temperature Range		
-55°C to +125°C	-40°C to +85°C	-40°C to +85°C
16-Pin CERDIP Package	16-Pin Plastic Dip Package	16-Pin SOIC Package
ALD4211 DC	ALD4211 PC	ALD4211 SC
ALD4212 DC	ALD4212 PC	ALD4212 SC
ALD4213 DC	ALD4213 PC	ALD4213 SC

LOGIC TABLE

Input Logic	Switch State			
	ALD4211	ALD4212	ALD4213	
			Switch 1 / Switch 4	Switch 2 / Switch 3
0	On	Off	Off	On
1	Off	On	On	Off

* Contact factory for industrial temperature range.

FEATURES

- 3V, 5V and ±5V supply operation
- 0.2pC charge injection
- 200pF sampling capacitor
- pA leakage current
- 0.1µW power dissipation
- High precision
- Rail to rail signal range
- Low On-resistance
- Break-before-make switching

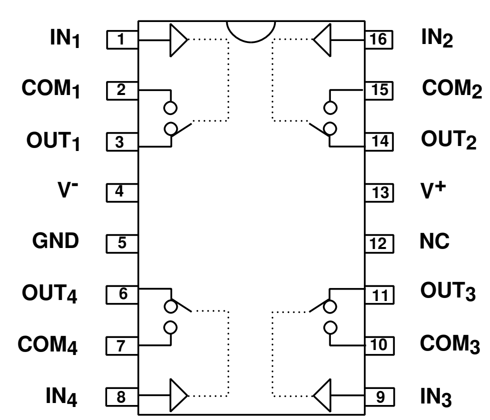
BENEFITS

- Five times faster signal capture
- Low switching transients
- Low signal loss
- Essentially no DC power consumption
- Full analog signal range from rail to rail
- Flexible power supply range for battery operated systems

APPLICATIONS

- Fast sample and hold
- Computer peripherals
- PCMCIA
- Low level signal conditioning circuits
- Portable battery operated systems
- Analog signal multiplexer
- Programmable gain amplifiers
- Switched capacitor circuits
- Micropower based systems
- Video/audio switches
- Feedback control systems

PIN CONFIGURATION/ BLOCK DIAGRAM



DC, PC, SC PACKAGE

ABSOLUTE MAXIMUM RATINGS

Supply voltage, V+ referenced to V-		-0.3V to +13.2V
GND		-0.3V to +13.2V
Terminal voltage range (any terminal) Note 1		(V- -0.3)V to (V+ +0.3)V
Power dissipation		600 mW
Operating temperature range	PC, SC package	-40°C to +85°C
	DC package	-55°C to +125°C
Storage temperature range		-65°C to +150°C
Lead temperature, 10 seconds		+260°C
DC current (any terminal)		10mA

POWER SUPPLY RANGE

Parameter	Symbol	4211/4212/4213 (PC,SC)			4211/4212/4213 (DC)			Unit	
		Min	Typ	Max	Min	Typ	Max		
Supply Voltage	V_{SUPPLY}	±1.5 3.0		±6.0 12.0	±1.5 3.0		±6.0 12.0	V V	Dual Supply Single Supply

DC ELECTRICAL CHARACTERISTICS
T_A = 25°C V+ = +5.0V, V- = -5.0V GND = 0.0V unless otherwise specified

Parameter	Symbol	4211/4212/4213 (PC,SC)			4211/4212/4213 (DC)			Unit	Test Conditions
		Min	Typ	Max	Min	Typ	Max		
Analog Signal Range	V_A	-5.0		5.0	-5.0		5.0	V	
On - Resistance	R_{ON}		90 120	135 190		90 140	135 210	Ω	V_A = 0V I_A = 1mA -40°C to +85°C -55°C to +125°C
Change of On-Resistance from $-V_S$ to $+V_S$	ΔR_{ON}		16			16		%	
Change of On-Resistance with Temperature	$\Delta R_{ON}/\Delta T$		0.43			0.43		%/°C	
R_{ON} Match between Switches			2			2		%	
Off Com Leakage Current	I_{COML}		50	100 500		50	100 4000	pA pA pA	V_{COM} = ±4.0V, V_{OUT} = -/+4.0V -40°C to +85°C -55°C to +125°C
Off Out Leakage Current	I_{OUTL}		50	100 500		50	100 4000	pA pA pA	V_{OUT} = ±4.0V, V_{COM} = -/+4.0V -40°C to +85°C -55°C to +125°C
On Channel Leakage Current	$I_{D(ON)}$		50	100 500		50	100 4000	pA pA pA	 -40°C to +85°C -55°C to +125°C
Input High Voltage	V_{IH}	4.0			4.0				Logic "1"
Input Low Voltage	V_{IL}			0.8			0.8	V	Logic "0"
Input High or Input Low Current	I_H I_{IL}			10			10	nA	
Supply Current	I_{SUPPLY}		0.01	1		0.01	1	µA	

AC ELECTRICAL CHARACTERISTICS
T_A = 25°C V+ = +5.0V, V- = -5.0V, GND = 0.0V unless otherwise specified

Parameter	Symbol	4211/4212/4213(PC) Min	Typ	Max	4211/4212/4213(DC) Min	Typ	Max	4211/4212/4213(SC) Min	Typ	Max	Unit	Test Conditions
Turn On Delay time	t_{ON}		60	130		60	130		60	130	ns	(Note 2)
Turn Off Delay time	t_{OFF}		60	130		60	130		60	130	ns	(Note 2)
Charge Injection	Q_{INJ}		0.2	1.0		0.2	1.0		0.2	1.0	pC	(Note 3) (Note 4)
Off Isolation			75			75			75		dB	At f = 100KHz, (Note 5)
Crosstalk			90			90			90		dB	At f = 100KHz, (Note 6)
Total Harmonic Distortion	T_{HD}		0.05 0.01			0.05 0.01			0.05 0.01		%	R_L = 10K R_L = 100K
Com/Out Off Capacitance	$COM_{(OFF)}$ $OUT_{(OFF)}$		3.0			3.0			3.0		pF	
Channel On Capacitance	$C_{DS\ (ON)}$		5.7			5.7			5.7		pF	
Pin to Pin Capacitance	C_{PP}		0.5			0.6			0.25		pF	

DC ELECTRICAL CHARACTERISTICS
T_A = 25°C V+ = +5.0V, V- = GND = 0.0V unless otherwise specified

Parameter	Symbol	4211/4212/4213 (PC,SC) Min	Typ	Max	4211/4212/4213 (DC) Min	Typ	Max	Unit	Test Conditions
Analog Signal Range	V_A	0.0		+5.0	0.0		+5.0	V	
On - Resistance	R_{ON}		195 250	280 365		195 270	280 390	Ω	V_A = 0V I_A = 1mA -40°C to +85°C -55°C to +125°C
Change of On-Resistance from $-V_S$ to $+V_S$	ΔR_{ON}		20			20		%	
Change of On-Resistance with Temperature	$\Delta R_{ON}/\Delta T$		0.43			0.43		%/°C	
R_{ON} Match Between Switches			2			2		%	
Off Com Leakage Current	I_{COML}		50	100 500		50	100 4000	pA pA pA	V_{COM} = 1 to 4V,V_{OUT} = 4 to 1V -40°C to +85°C -55°C to +125°C
Off Out Leakage Current	I_{OUTL}		50	100 500		50	100 4000	pA pA pA	V_{OUT} = 1 to 4V,V_{COM} = 4 to 1V -40°C to +85°C -55°C to +125°C
On Channel Leakage Current	$I_{D(ON)}$		50	100 500		50	100 4000	pA pA pA	-40°C to +85°C -55°C to +125°C
Input High Voltage	V_{IH}	4.0			4.0				Logic "1"
Input Low Voltage	V_{IL}			0.8			0.8	V	Logic "0"
Input High or Input Low Current	I_{IH} I_{IL}			10			10	nA	
Supply Current	I_{SUPPLY}		0.01	1		0.01	1	µA	

Notes: **1.** Voltage on any terminal must be less than (V+) + 0.3V and greater than (V-) - 0.3V, at all times including before power is applied and V+ =V- = 0.0V. Vsupply power supply needs to be sequenced on first on power turn-on and sequenced off last during power turn-off. **2.** See Switching Time Test Circuit. Break-before-make time is not guaranteed. Turn on and turn off time may overlap. **3.** Guaranteed by design. **4.** See Charge Injection Test Circuit **5.** See Off Isolation Test Circuit **6.** See Crosstalk Test Circuit. **7**. See switching time test circuit.

AC ELECTRICAL CHARACTERISTICS

T_A = 25°C V+ = +5.0V, V- = GND = 0.0V unless otherwise specified

Parameter	Symbol	4211/4212/4213 (PC)			4211/4212/4213 (DC)			4211/4212/4213 (SC)			Unit	Test Conditions
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max		
Turn On Delay time	t_{ON}		85	170		85	170		85	170	ns	(Note 7)
Turn Off Delay time	t_{OFF}		46	90		46	90		46	90	ns	(Note 7)
Break-Before-Make Delay Time	t_{BD}	15	40		15	40		15	40		ns	
Charge Injection	Q_{INJ}		0.2	1.0		0.2	1.0		0.2	1.0	pC	(Note 3) (Note 4)
Off Isolation			75			75			75		dB	At f = 100KHz, (Note 5)
Crosstalk			90			90			90		dB	At f = 100KHz, (Note 6)
Total Harmonic Distortion	T_{HD}		0.05 0.01			0.05 0.01			0.05 0.01		%	R_L = 10K R_L = 100K
Com/Out Off Capacitance	$COM_{(OFF)}$ $OUT_{(OFF)}$		3.0			3.0			3.0		pF	
Channel On Capacitance	$C_{DS\ (ON)}$		5.7			5.7			5.7		pF	
Pin to Pin Capacitance	C_{PP}		0.5			0.6			0.25		pF	

The ALD4211/ALD4212/ALD4213 feature very high precision due to these factors:

1. The analog switch has ultra low capacitive charge coupling so that the charge stored on a 200pF sampling capacitor is minimally affected.

2. With special charge balancing and charge cancellation circuitry designed on chip, the ALD4211/ALD4212/ ALD4213 achieves ultra low charge injection of typically only 0.2pC resulting in extremely low signal distortion to the external circuit.

3. The analog switch switching transistors have pA leakage currents minimizing the droop rate of the sampling circuit.

4. The internal switch timing allows for the analog switch to turn off internally without producing any residual transistor channel charge injection, which may affect external circuits. With a low loss polystyrene or polypropylene sampling capacitor, long data retention times are possible without significant signal loss.

The ALD4211/ALD4212/ALD4213 CMOS analog switches, when used with industry standard pinout connection, have the input and output pins reversed with the signal source input connected to OUT pins and COM pins used as output pins. In this connection and when used with 1,000pF or greater value capacitors, or when connected to a DC current or resistive load, the switch would not be operating in an ultra low charge injection mode. Typical charge injection, in this case, would be 5pC as the pin to pin capacitive coupling effect would dominate. In this connection, all the other characteristics of the ALD4211/ALD4212/ALD4213 CMOS analog switches remain the same.

DC ELECTRICAL CHARACTERISTICS

T_A = 25°C V+ = +3.0V, V- = GND = 0.0V unless otherwise specified

Parameter	Symbol	4211/4212/4213 (PC,SC) Min	Typ	Max	4211/4212/4213 (DC) Min	Typ	Max	Unit	Test Conditions
Analog Signal Range	V_A	0.0		3.0	0.0		3.0	V	
On - Resistance	R_{ON}		500 620	700 880		500 680	700 1000	Ω	V_A = 0V I_A = 1mA -40°C to +85°C -55°C to +125°C
Change of On-Resistance from $-V_S$ to $+V_S$	ΔR_{ON}		43			43		%	
Change of On-Resistance with Temperature	$\Delta R_{ON}/\Delta T$		0.27			0.27		%/°C	
R_{ON} Match Between Switches			2			2		%	
Off Com Leakage Current	I_{COML}		50	100 500		50	100 4000	pA pA pA	V_{COM} = 1 to 2V, V_{OUT} = 2 to 1V -40°C to +85°C -55°C to +125°C
Off Out Leakage Current	I_{OUTL}		50	100 500		50	100 4000	pA pA pA	V_{OUT} = 1 to 2V, V_{COM} = 2 to 1V -40°C to +85°C -55°C to +125°C
Channel On Leakage Current	$I_{D(ON)}$		50	100 500		50	100 4000	pA pA pA	 -40°C to +85°C -55°C to +125°C
Input High Voltage	V_{IH}	2.4			2.4				Logic "1"
Input Low Voltage	V_{IL}			0.8			0.8	V	Logic "0"
Input High or Input Low Current	I_{IH} I_{IL}			 10			 10	 nA	
Supply Current	I_{SUPPLY}		0.01	1		0.01	1	µA	

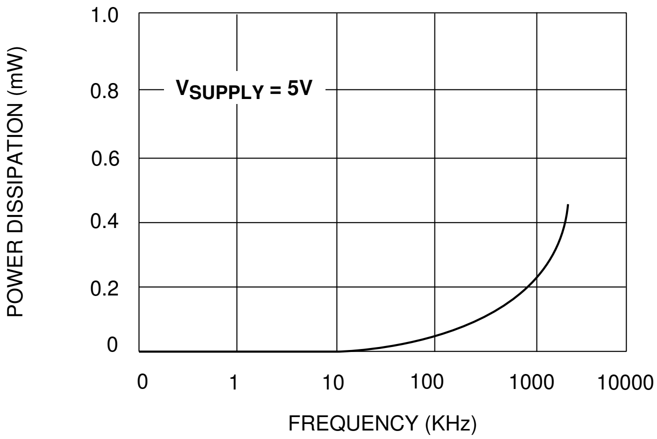
AC ELECTRICAL CHARACTERISTICS

T_A = 25°C V+ = +3.0V, V- = GND = 0.0V unless otherwise specified

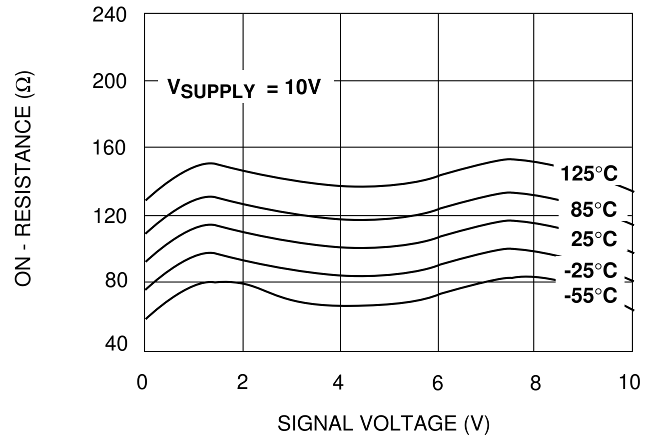
Parameter	Symbol	4211/4212/4213 (PC) Min	Typ	Max	4211/4212/4213 (DC) Min	Typ	Max	4211/4212/4213 (SC) Min	Typ	Max	Unit	Test Conditions
Turn On Delay time	t_{ON}		160	300		160	300		160	300	ns	(Note 7)
Turn Off Delay time	t_{OFF}		78	1500		78	150		78	150	ns	(Note 7)
Break-Before-Make Delay Time	t_{BD}	20	82		20	82		20	82		ns	
Charge Injection	Q_{INJ}		0.2	0.5		0.2	0.5		0.2	0.5	pC	(Note 3) (Note 4)
Off Isolation			75			75			75			dB At f = 100KHz, (Note 5)
Crosstalk			90			90			90			dB At f = 100KHz, (Note 6)
Total Harmonic Distortion	T_{HD}		0.05 0.01			0.05 0.01			0.05 0.01		%	R_L = 10K R_L = 100K
Com/Out Off Capacitance	$COM_{(OFF)}$ $OUT_{(OFF)}$		3.0			3.0			3.0		pF	
Channel On Capacitance	$C_{DS\ (ON)}$		5.7			5.7			5.7		pF	
Pin to Pin Capacitance	C_{PP}		0.5			0.6			0.25		pF	

TYPICAL PERFORMANCE CHARACTERISTICS

POWER DISSIPATION AS A FUNCTION OF FREQUENCY



ON RESISTANCE AS A FUNCTION OF SIGNAL VOLTAGE



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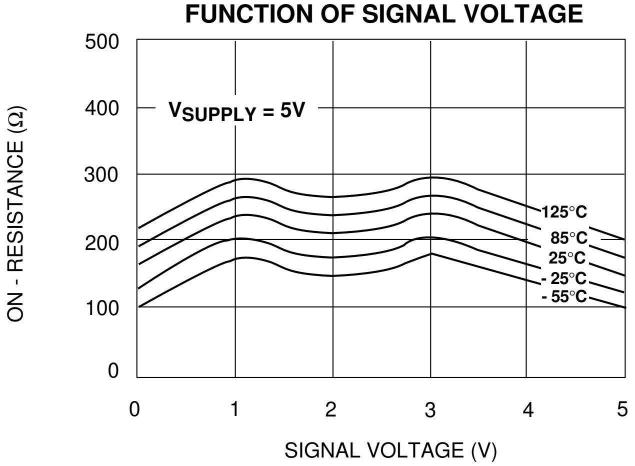
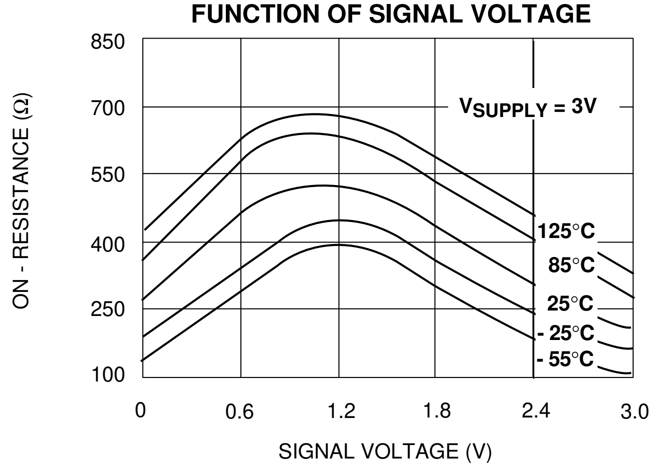
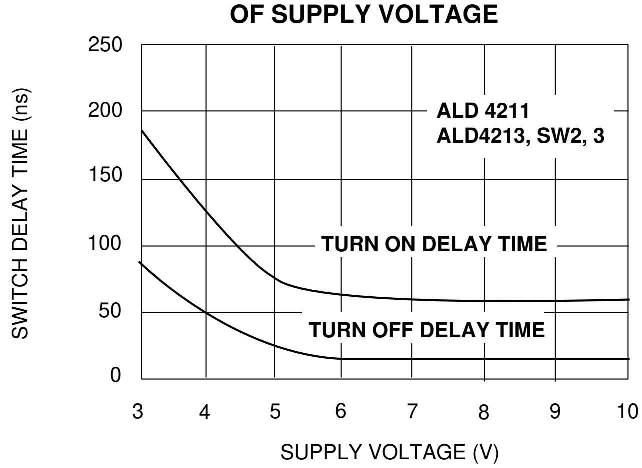


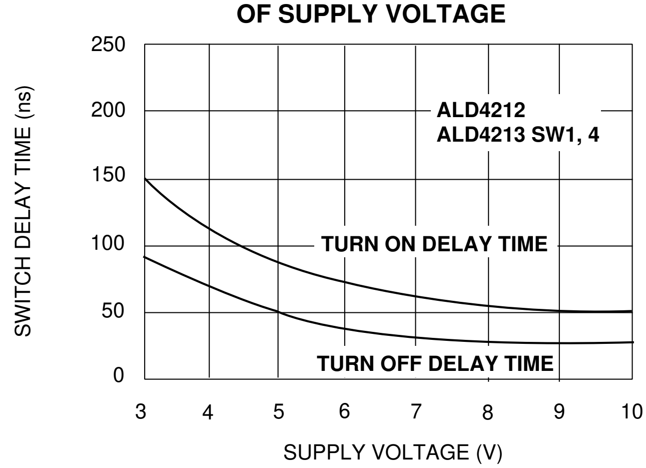
ON RESISTANCE AS A FUNCTION OF SIGNAL VOLTAGE



SWITCH DELAY TIME AS A FUNCTION OF SUPPLY VOLTAGE

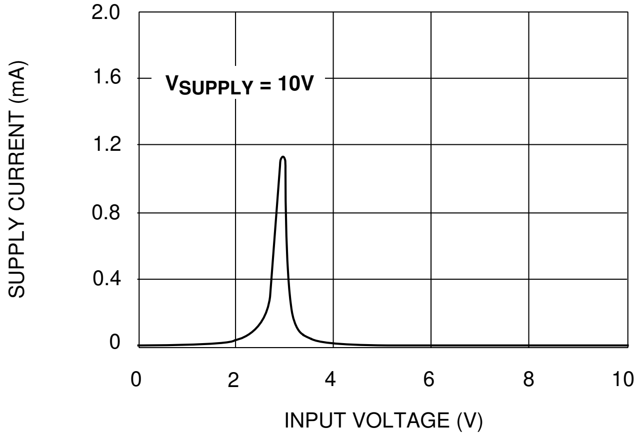


SWITCH DELAY TIME AS A FUNCTION OF SUPPLY VOLTAGE

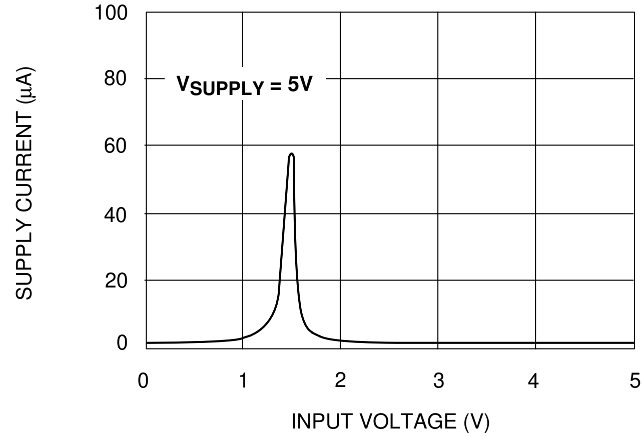


TYPICAL PERFORMANCE CHARACTERISTICS

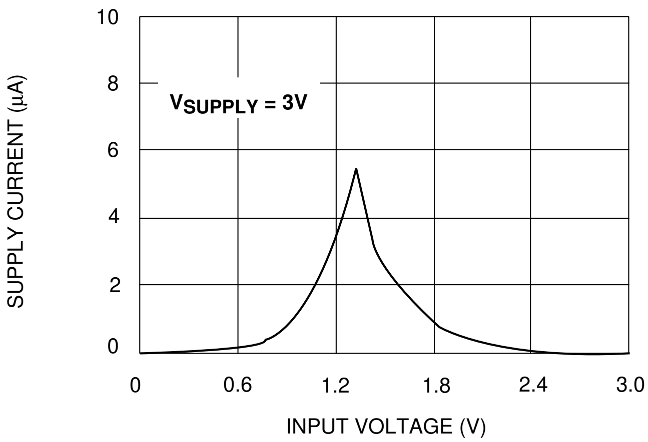
SUPPLY CURRENT AS A FUNCTION OF INPUT VOLTAGE



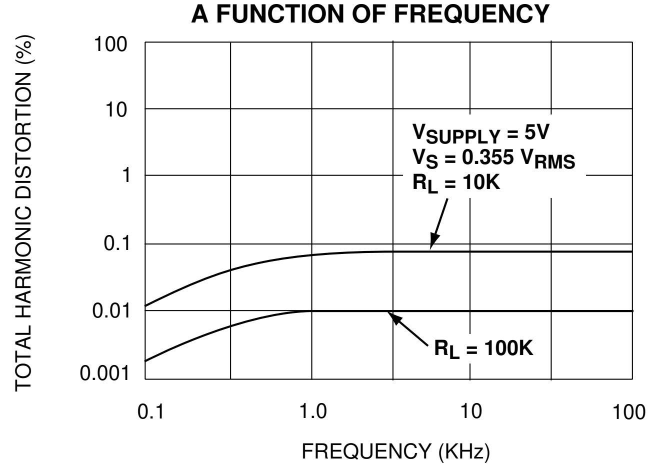
SUPPLY CURRENT AS A FUNCTION OF INPUT VOLTAGE



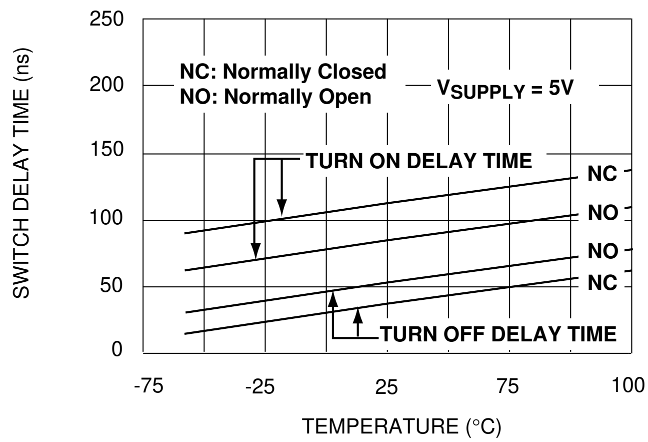
SUPPLY CURRENT AS A FUNCTION OF INPUT VOLTAGE



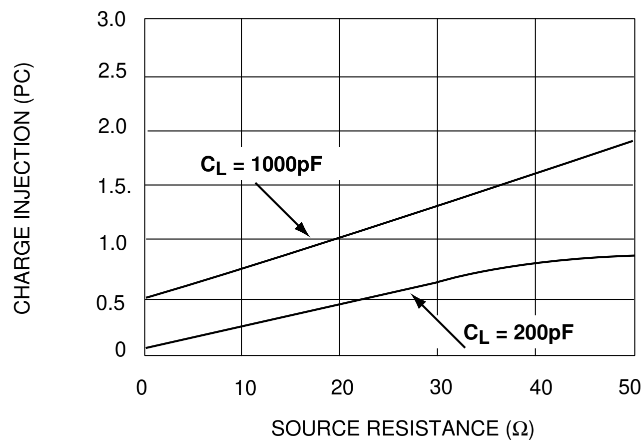
TOTAL HARMONIC DISTORTION AS A FUNCTION OF FREQUENCY



SWITCH DELAY TIME AS A FUNCTION OF TEMPERATURE

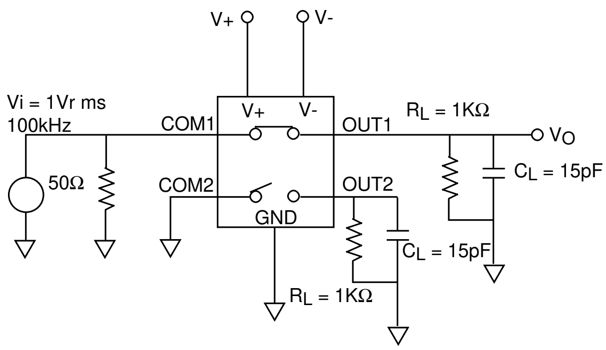


CHARGE INJECTION AS A FUNCTION OF SOURCE RESISTANCE



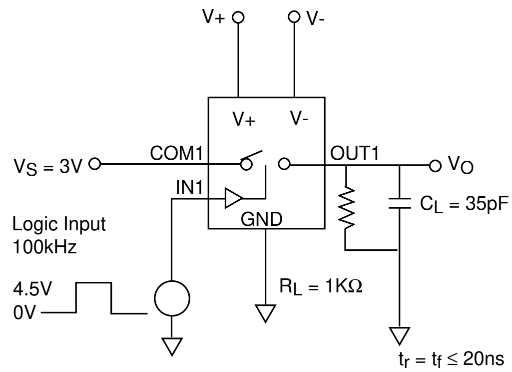
TEST CIRCUITS

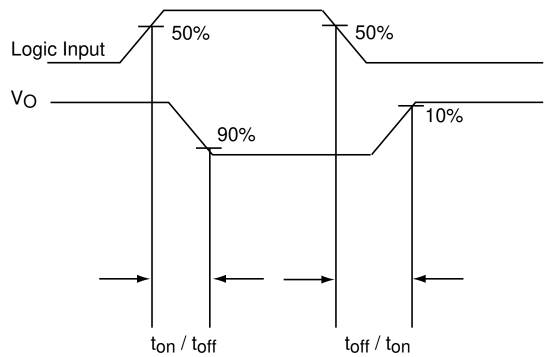
CROSSTALK TEST CIRCUIT



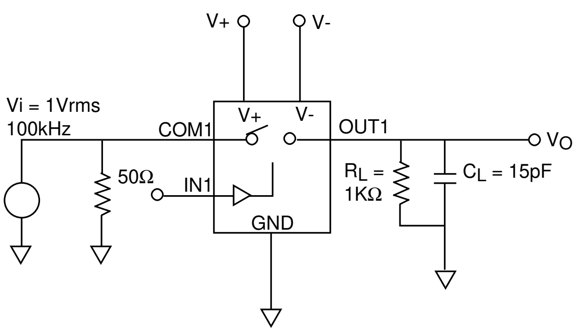
CCRR = 20 log [V_O/Vi]

SWITCHING TIME TEST CIRCUIT



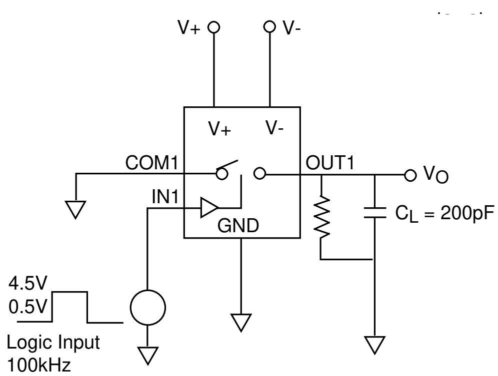


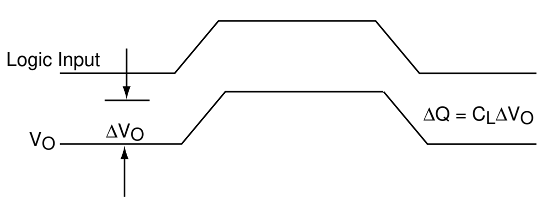
OFF ISOLATION TEST CIRCUIT



Q_{IRR} = 20 log (V_O/Vi)

CHARGE INJECTION TEST CIRCUIT





TOTAL HARMONIC DISTORTION TEST CIRCUIT