0.7Ω, Low-Voltage, Quad 2:1 Analog Multiplexers

ABSOLUTE MAXIMUM RATINGS

Voltages Referenced to GND
V+, A_, $\overline{EN}$ .....-0.3V to +4.6V
COM_, NO_, NC_ (Note 1) .....-0.3V to (V+ + 0.3V)
Continuous Current COM_ , NO_, NC_ .....±300mA
Peak Current COM_, NO_, NC_
(pulsed at 1ms 10% duty cycle).....±500mA

Continuous Power Dissipation (T_A = +70°C)
16-Pin Thin QFN (derate 14.7mW/°C above +70°C).....1176.5mW
16-Pin TSSOP (derate 9.4mW/°C above +70°C) 755mW
Operating Temperature Range .....-40°C to +85°C
Maximum Junction Temperature .....+150°C
Storage Temperature Range .....-65°C to +150°C
Lead Temperature (soldering, 10s) .....+300°C

Note 1: Signals on COM_, NO_, or NC_ exceeding V+ or GND are clamped by internal diodes. Limit forward current to maximum current rating.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS—Single +3V Supply

(V+ = +2.7V to +4.2V, V_{IH} = +1.4V, V_{IL} = +0.5V, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at V+ = +3.0V, T_A = +25°C.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS	T_A	MIN	TYP	MAX	UNITS
ANALOG SWITCH							
Analog Signal Range	$V_{COM\_}$, $V_{NO\_}$, $V_{NC\_}$			0		V+	V
On-Resistance (Note 4)	R_{ON}	V+ = 2.7V, $I_{COM\_}$ = 100mA, $V_{NO\_}$ or $V_{NC\_}$ = 1.5V	+25°C		0.7	1	Ω
			T_{MIN} to T_{MAX}			1.2	
On-Resistance Match Between Channels (Notes 4, 5)	ΔR_{ON}	V+ = 2.7V, $I_{COM\_}$ = 100mA, $V_{NO\_}$ or $V_{NC\_}$ = 1.5V	+25°C		0.1	0.15	Ω
			T_{MIN} to T_{MAX}			0.2	
On-Resistance Flatness (Note 6)	$R_{FLAT(ON)}$	V+ = 2.7V, $I_{COM\_}$ = 100mA; $V_{NO\_}$ or $V_{NC\_}$ = 1V, 1.5V, 2V	+25°C		0.1	0.2	Ω
			T_{MIN} to T_{MAX}			0.3	
NO_ or NC_ Off-Leakage Current (Note 7)	$I_{NO\_(OFF)}$, $I_{NC\_(OFF)}$	V+ = 3.6V; $V_{COM\_}$ = 0.3V, 3.3V; $V_{NO\_}$ or $V_{NC\_}$ = 3.3V, 0.3V	+25°C	-1	±0.002	+1	nA
			T_{MIN} to T_{MAX}	-5		+5	
COM_ Off-Leakage Current (MAX4784 Only) (Note 7)	$I_{COM\_(OFF)}$	V+ = 3.6V; $V_{COM\_}$ = 0.3V, 3.3V; $V_{NO\_}$ or $V_{NC\_}$ = 3.3V, 0.3V, or unconnected	+25°C	-1	±0.002	+1	nA
			T_{MIN} to T_{MAX}	-5		+5	
COM_ On-Leakage Current (Note 7)	$I_{COM\_(ON)}$	V+ = 3.6V; $V_{COM\_}$ = 3.3V, 0.3V; $V_{NO\_}$ or $V_{NC\_}$ = 3.3V, 0.3V, or unconnected	+25°C	-2	±0.002	+2	nA
			T_{MIN} to T_{MAX}	-10		+10	

ELECTRICAL CHARACTERISTICS—Single +3V Supply (continued)

(V+ = +2.7V to +4.2V, V_{IH} = +1.4V, V_{IL} = +0.5V, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at V+ = +3.0V, T_A = +25°C.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS	T_A	MIN	TYP	MAX	UNITS
SWITCH DYNAMIC CHARACTERISTICS							
Turn-On Time	t_{ON}	$V_{NO\_}$, $V_{NC\_}$ = 1.5V, R_L = 50Ω, C_L = 35pF, Figure 1	+25°C		20	25	ns
			T_{MIN} to T_{MAX}			30	
Turn-Off Time	t_{OFF}	$V_{NO\_}$, $V_{NC\_}$ = 1.5V, R_L = 50Ω, C_L = 35pF, Figure 1	+25°C		8	10	ns
			T_{MIN} to T_{MAX}			18	
Break-Before-Make (Note 8)	t_{BBM}	$V_{NO\_}$, $V_{NC\_}$ = 1.5V, R_L = 50Ω, C_L = 35pF, Figure 2	+25°C		7		ns
			T_{MIN} to T_{MAX}	1			
Charge Injection	Q	V_{GEN} = 0, R_{GEN} = 0, C_L = 1.0nF, Figure 3	+25°C		5		pC
NO_ or NC_ Off-Capacitance	C_{OFF}	f = 1MHz, Figure 4	+25°C		33		pF
COM_ Off-Capacitance	$C_{COM\_(OFF)}$	f = 1MHz, Figure 4	+25°C		60		pF
COM_ On-Capacitance	$C_{COM\_(ON)}$	f = 1MHz, Figure 4	+25°C		85		pF
-3dB On-Channel Bandwidth	BW	Signal = 0, R_{IN} = R_{OUT} = 50Ω, C_L = 5pF, Figure 5			123		MHz
Off-Isolation (Note 9)	V_{ISO}	f = 1MHz, $V_{COM\_}$ = $1V_{P-P}$, R_L = 50Ω, C_L = 5pF, Figure 5	+25°C		-67		dB
Crosstalk (Note 10)	V_{CT}	f = 1MHz, $V_{COM\_}$ = $1V_{P-P}$, R_L = 50Ω, C_L = 5pF, Figures 4, 5	+25°C		-95		dB
Total Harmonic Distortion	THD	f = 20Hz to 20kHz, $V_{COM\_}$ = $2V_{P-P}$, R_L = 32Ω	+25°C		0.008		%
LOGIC INPUT (A_, $\overline{EN}$)							
Input Logic-High	V_{IH}			1.8			V
Input Logic-Low	V_{IL}					0.5	V
Input Leakage Current	I_{IN}	$V_{\overline{EN}}$ = 0 or +3.6V, V_{A0} = 0 or +3.6V		-1	0.005	+1	µA
POWER SUPPLY							
Power-Supply Range	V+			1.6		3.6	V
Positive Supply Current	I+	V+ = 3.6V, $\overline{EN}$, A0 = 0 or V+, all channels on or off	T_{MIN} to T_{MAX}			2	µA

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ELECTRICAL CHARACTERISTICS—Single +1.8V Supply

(V+ = +1.8V, V_{IH} = +1.0V, V_{IL} = +0.4V, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at T_A = +25°C.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS	T_A	MIN	TYP	MAX	UNITS
ANALOG SWITCH							
Analog Signal Range	$V_{COM\_}$, $V_{NO\_}$, $V_{NC\_}$			0		V+	V
On-Resistance	R_{ON}	$I_{COM\_}$ = 10mA, $V_{NO\_}$ or $V_{NC\_}$ = 1.0V	+25°C		2	3	Ω
			T_{MIN} to T_{MAX}			5	
NO_ or NC_ Off-Leakage Current (Note 7)	$I_{NO\_(OFF)}$, $I_{NC\_(OFF)}$	$V_{COM\_}$ = 0.3V, 1.5V; $V_{NO\_}$ or $V_{NC\_}$ = 1.5V, 0.3V	+25°C	-1		+1	nA
			T_{MIN} to T_{MAX}	-5		+5	
COM_ Off-Leakage Current (MAX4784 Only) (Note 7)	$I_{COM\_(OFF)}$	$V_{COM\_}$ = 0.3V, 1.5V; $V_{NO\_}$ or $V_{NC\_}$ = 1.5V, 0.3V	+25°C	-1		+1	nA
			T_{MIN} to T_{MAX}	-5		+5	
COM_ On-Leakage Current (Note 7)	$I_{COM\_(ON)}$	$V_{COM\_}$ = 0.3V, 1.5V; $V_{NO\_}$ or $V_{NC\_}$ = 0.3V, 1.5V, or unconnected	+25°C	-2		+2	nA
			T_{MIN} to T_{MAX}	-10		+10	
SWITCH DYNAMIC CHARACTERISTICS							
Turn-On Time	t_{ON}	$V_{NO\_}$, $V_{NC\_}$ = 1.0V, R_L = 50Ω, C_L = 35pF, Figure 1	+25°C		25	30	ns
			T_{MIN} to T_{MAX}			35	
Turn-Off Time	t_{OFF}	$V_{NO\_}$, $V_{NC\_}$ = 1.0V, R_L = 50Ω, C_L = 35pF, Figure 1	+25°C		10	15	ns
			T_{MIN} to T_{MAX}			20	
Break-Before-Make (Note 8)	t_{BBM}	$V_{NO\_}$, $V_{NC\_}$ = 1.0V, R_L = 50Ω, C_L = 35pF, Figure 2	+25°C		10		ns
			T_{MIN} to T_{MAX}	1			
Charge Injection	Q	V_{GEN} = 0, R_{GEN} = 0, C_L = 1nF, Figure 3	+25°C		5		pC

ELECTRICAL CHARACTERISTICS—Single +1.8V Supply (continued)

(V+ = +1.8V, V_{IH} = +1.0V, V_{IL} = +0.4V, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at T_A = +25°C.) (Notes 2, 3)

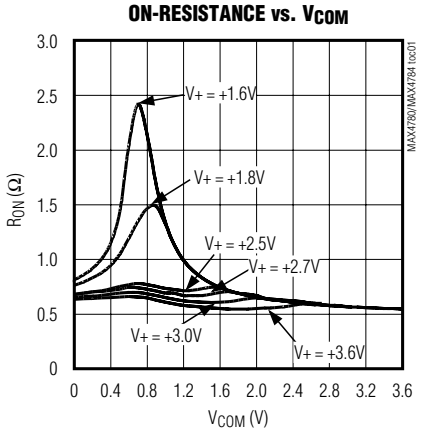
PARAMETER	SYMBOL	CONDITIONS	T_A	MIN	TYP	MAX	UNITS
LOGIC INPUT (A_, $\overline{EN}$)							
Input Logic-High	V_{IH}			1			V
Input Logic-Low	V_{IL}					0.4	V
Input Leakage Current	I_{IN}	$V_{\overline{EN}}$ = 0 or +3.6V, V_{A0} = 0 or +3.6V		-1		+1	µA

Note 2: The algebraic convention, where the most negative value is a minimum and the most positive value is a maximum, is used in this data sheet.
Note 3: -40°C specifications are guaranteed by design.
Note 4: R_{ON} and ΔR_{ON} matching specifications for QFN packaged parts are guaranteed by design.
Note 5: $\Delta R_{ON} = R_{ON(MAX)} - R_{ON(MIN)}$.
Note 6: Flatness is defined as the difference between the maximum and the minimum value of on-resistance as measured over the specified analog signal ranges.
Note 7: Leakage parameters are 100% tested at T_A = +85°C, and guaranteed by correlation over the full rated temperature range.
Note 8: Guaranteed by design.
Note 9: Off-isolation = $20\log_{10}(V_{COM\_}/V_{NO\_})$, $V_{COM\_}$ = output, $V_{NO\_}$ = input to off switch.
Note 10: Between two switches.
Note 11: Parts are guaranteed to 1 million cycles of operation. (Cycle = switch on → switch off → switch on.)
Note 12: The minimum load resistance is 8Ω. (See the *Typical Application Circuit*.)

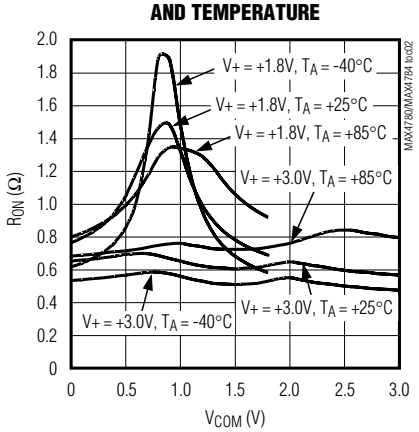
Typical Operating Characteristics

(T_A = +25°C, unless otherwise noted.)

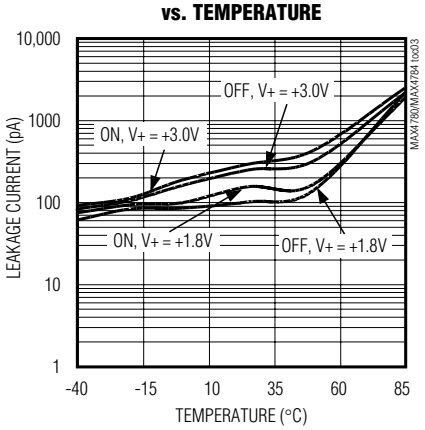
ON-RESISTANCE vs. V_{COM}



ON-RESISTANCE vs. V_{COM} AND TEMPERATURE



ON/OFF-LEAKAGE CURRENT vs. TEMPERATURE

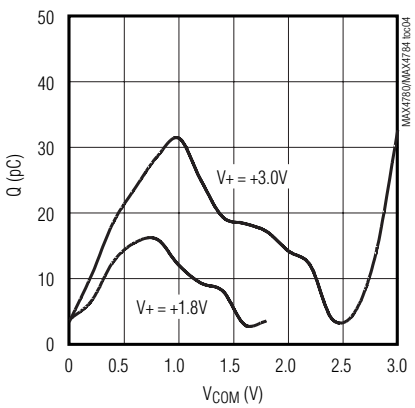


0.7Ω, Low-Voltage, Quad 2:1 Analog Multiplexers

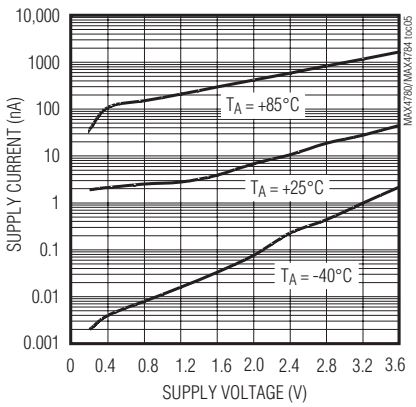
Typical Operating Characteristics (continued)

(T_A = +25°C, unless otherwise noted.)

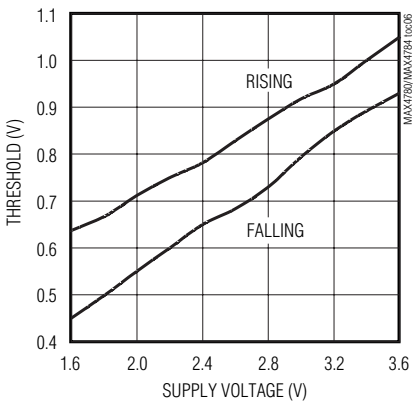
CHARGE INJECTION vs. V_{COM}



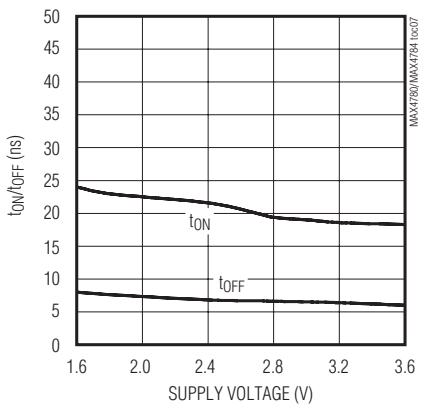
SUPPLY CURRENT vs. SUPPLY VOLTAGE AND TEMPERATURE



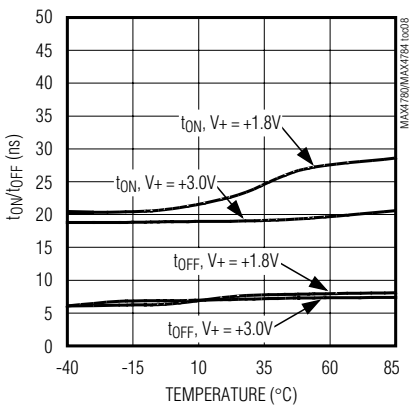
LOGIC-LEVEL THRESHOLD vs. SUPPLY VOLTAGE



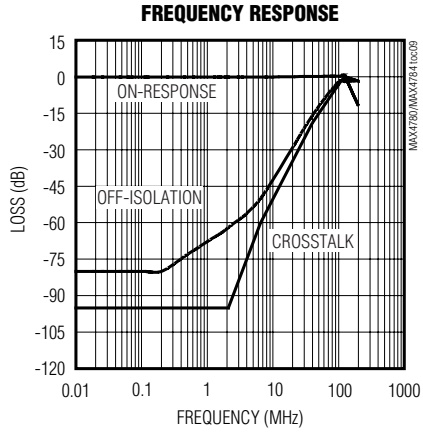
TURN-ON/OFF TIME vs. SUPPLY VOLTAGE



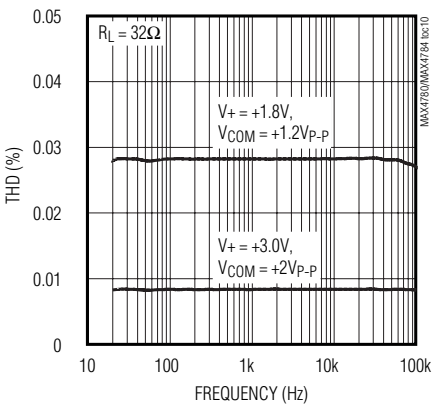
TURN-ON/OFF TIMES vs. TEMPERATURE



FREQUENCY RESPONSE



TOTAL HARMONIC DISTORTION vs. FREQUENCY



Pin Description

PIN				NAME	FUNCTION
MAX4780		MAX4784			
TSSOP	THIN QFN-EP	TSSOP	THIN QFN-EP		
1	15	1	15	A0	Address Input
2	16	2	16	NC1	Normally Closed Terminal
3	1	3	1	NO1	Normally Open Terminal
4	2	4	2	COM1	Analog Switch Common Terminal
5	3	5	3	NC2	Normally Closed Terminal
6	4	6	4	NO2	Normally Open Terminal
7	5	7	5	COM2	Analog Switch Common Terminal
8	6	8	6	GND	Ground
9	7	9	7	COM3	Analog Switch Common Terminal
10	8	10	8	NO3	Normally Open Terminal
11	9	11	9	NC3	Normally Closed Terminal
12	10	12	10	COM4	Analog Switch Common Terminal
13	11	13	11	NO4	Normally Open Terminal
14	12	14	12	NC4	Normally Closed Terminal
15	13	—	—	A1	Address Input
—	—	15	13	$\overline{EN}$	Enable. Connect to GND for normal operation. Connect to logic-level high to turn all switches off.
16	14	16	14	V+	Positive Supply Voltage
—	—	—	—	EP	Exposed Pad. Internally connected to GND. Connect to a large ground plane to maximize thermal performance. Not intended as an electrical connection point. (Thin QFN package only.)

Detailed Description

The MAX4780/MAX4784 are low 0.7Ω (at V+ = +2.7V) on-resistance, low-voltage, quad 2:1 analog multiplexers/demultiplexers that operate from a +1.6V to +4.2V single supply. CMOS switch construction allows switching analog signals that are within the supply voltage range (GND to V+).

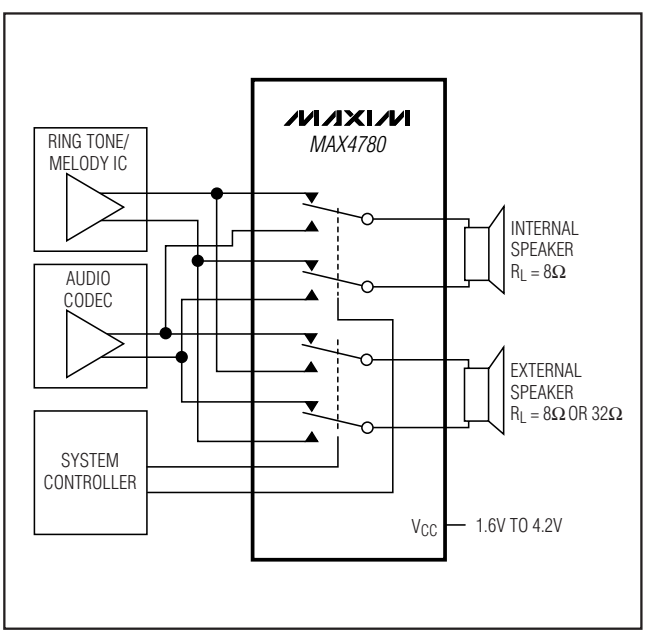
When powered from a +2.7V supply, the 0.7Ω R_{ON} allows high continuous currents to be switched in a variety of applications.

Applications Information

Proper power-supply sequencing is recommended for all CMOS devices. Do not exceed the absolute maximum ratings, because stresses beyond the listed ratings can cause permanent damage to the devices. Always sequence V+ on first, followed by NO_, NC_, or COM_.

Although it is not required, power-supply bypassing improves noise margin and prevents switching noise propagation from the V+ supply to other components. A 0.1µF capacitor, connected from V+ to GND, is adequate for most applications.

Typical Application Circuit



0.7Ω, Low-Voltage, Quad 2:1 Analog Multiplexers

Logic Inputs

The MAX4780/MAX4784 logic inputs can be driven up to +4.2V regardless of the supply voltage. For example, with a +1.8V supply, A_ and $\overline{EN}$ may be driven low to GND and high to +4.2V. Driving A_ and $\overline{EN}$ rail-to-rail minimizes power consumption. Drive $\overline{EN}$ low to enable the COM_ outputs. When $\overline{EN}$ is high, the COM_ outputs are high impedance.

Analog Signal Levels

Analog signals that range over the entire supply voltage (V+ to GND) can be passed with very little change in on-resistance (see the *Typical Operating Characteristics*). The switches are bidirectional, so the NO_, NC_, and COM_ pins can be used as either inputs or outputs.

Layout

High-speed switches require proper layout and design procedures for optimum performance. Reduce stray inductance and capacitance by keeping traces short and wide. Ensure that bypass capacitors are as close to the device as possible. Use large ground planes where possible.

Test Circuits/Timing Diagrams

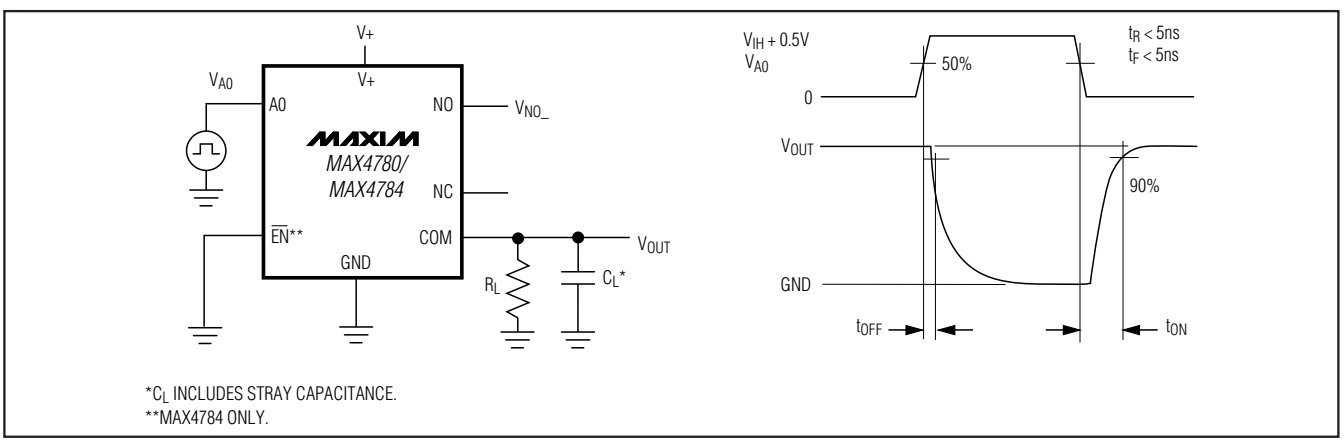


Figure 1. Turn-On and Turn-Off Times

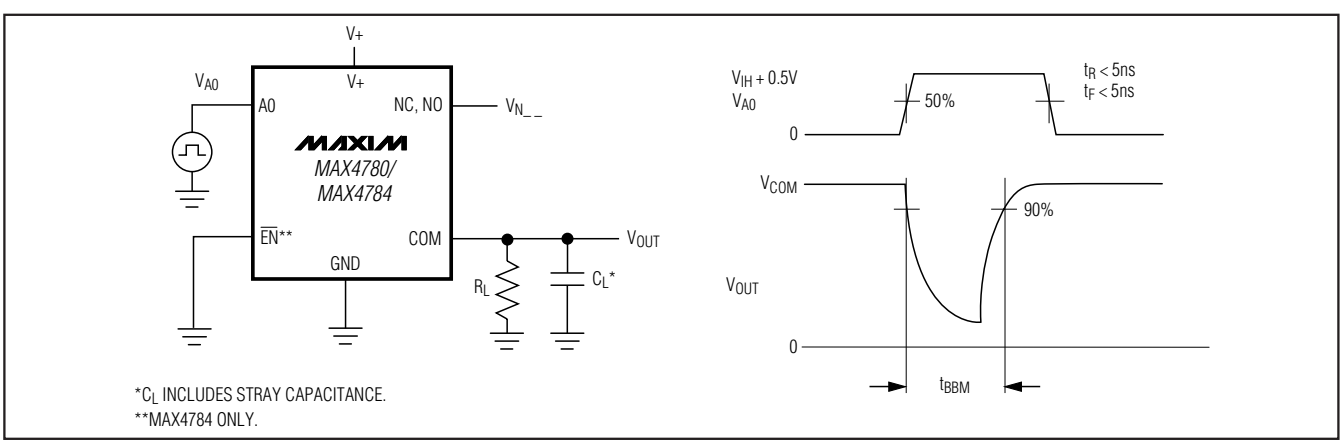


Figure 2. Break-Before-Make Interval

Test Circuits/Timing Diagrams (continued)

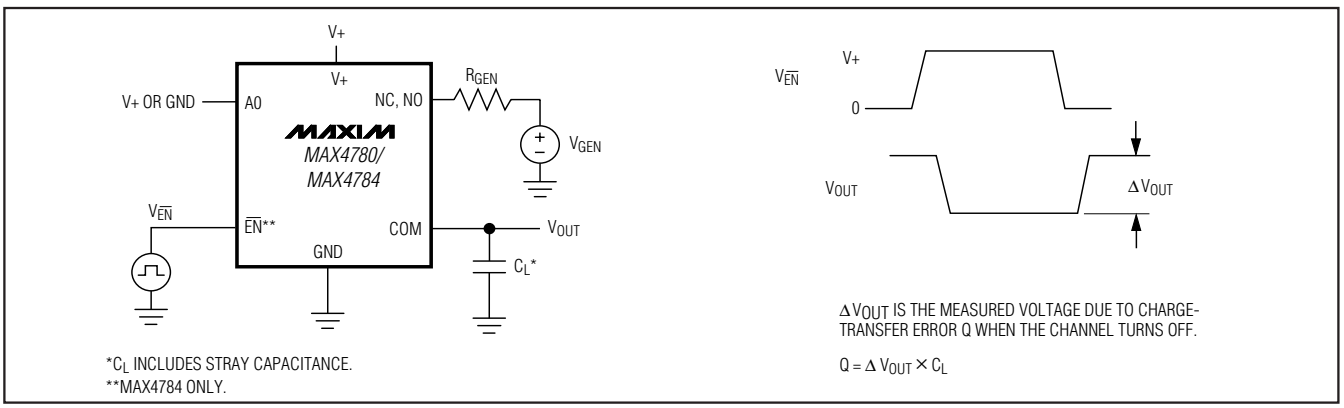


Figure 3. Charge Injection

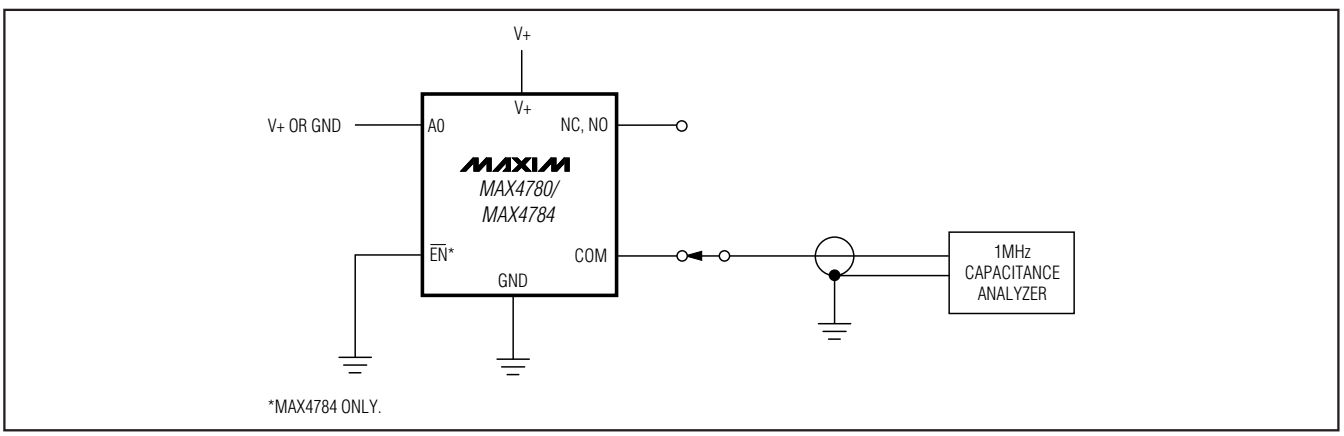


Figure 4. Capacitance

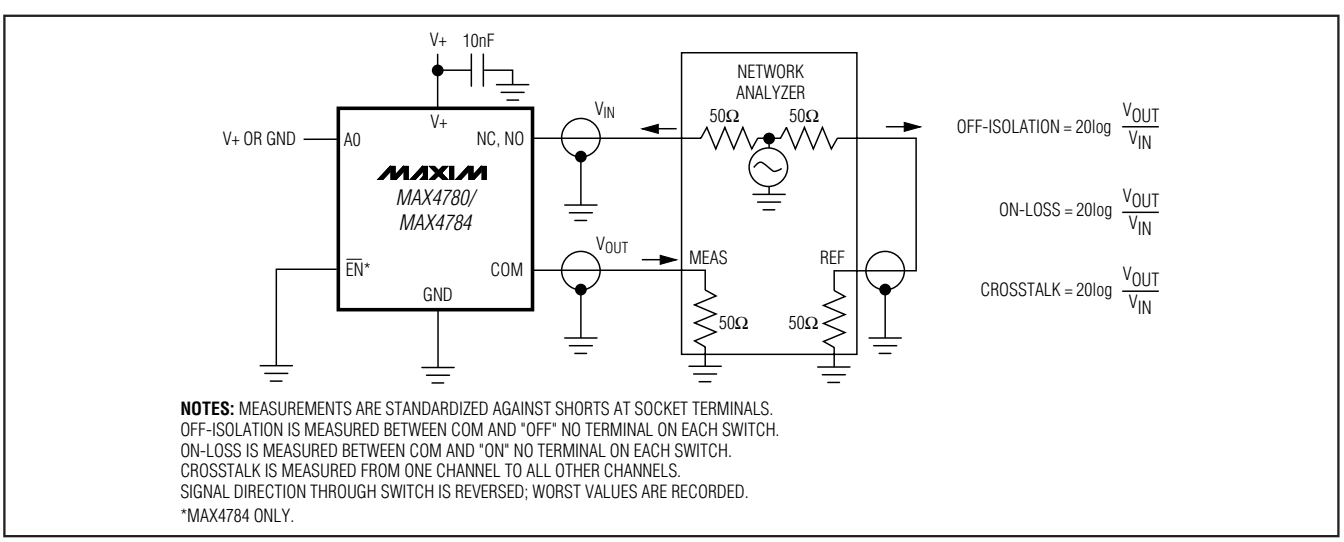
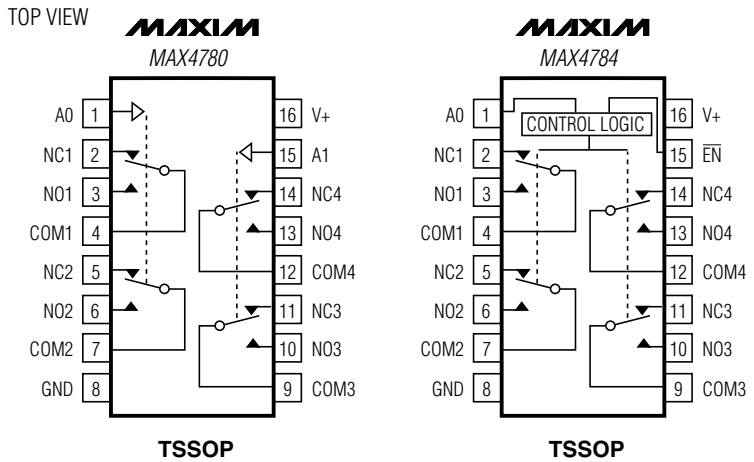


Figure 5. Off-Isolation, On-Loss, and Crosstalk

0.7Ω, Low-Voltage, Quad 2:1 Analog Multiplexers

Pin Configurations/Functional Diagrams/Truth Tables (continued)



Chip Information

PROCESS: CMOS

Package Information

For the latest package outline information and land patterns, go to **www.maxim-ic.com/packages**.

PACKAGE TYPE	PACKAGE CODE	DOCUMENT NO.
16 TQFN	T1633+4	**21-0136**
16 TSSOP	U16+2	**21-0066**

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	4/02	Initial release	—
1	1/04	Added MAX4780	—
2	9/04	Changed Ab max voltage	—
3	12/04	Change operation to 4.2V	—
4	3/09	Added exposed pad information	1, 2, 4, 7, 10,