MAXIM

8-Channel/Dual 4-Channel, Low-Leakage, CMOS Analog Multiplexers

MAX338/MAX339

General Description

The MAX338/MAX339 are monolithic, CMOS analog multiplexers (muxes). The 8-channel MAX338 is designed to connect one of eight inputs to a common output by control of a 3-bit binary address. The dual, 4-channel MAX339 is designed to connect one of four inputs to a common output by control of a 2-bit binary address. Both devices can be used as either a mux or a demux. On-resistance is 400Ω max, and the devices conduct current equally well in both directions.

These muxes feature extremely low off leakages (less than 20pA at +25°C), and extremely low on-channel leakages (less than 50pA at +25°C). The new design offers guaranteed low charge injection (1.5pC typ) and electrostatic discharge (ESD) protection greater than 2000V, per method 3015.7. These improved muxes are pin-compatible upgrades for the industry-standard DG508A and DG509A. For similar Maxim devices with lower leakage and charge injection but higher on-resistance, see the MAX328 and MAX329.

The MAX338/MAX339 operate from a single +4.5V to +30V supply or from dual supplies of ±4.5V to ±20V. All control inputs (whether address or enable) are TTL compatible (+0.8V to +2.4V) over the full specified temperature range and over the ±4.5V to ±18V supply range. These parts are fabricated with Maxim's 44V silicon-gate process.

Applications

Data-Acquisition Systems	Sample-and-Hold Circuits
Test Equipment	Heads-Up Displays
Military Radios	Communications Systems
Guidance and Control Systems	PBX, PABX

Features

♦ **On-Resistance, <400Ω max**

♦ **Transition Time, <500ns**

♦ **On-Resistance Match, <10Ω**

♦ **NO-Off Leakage Current, <20pA at +25°C**

♦ **1.5pC Charge Injection**

♦ **Single-Supply Operation (+4.5V to +30V)**
  Bipolar-Supply Operation (±4.5V to ±20V)

♦ **Plug-In Upgrade for Industry-Standard**
  DG508A/DG509A

♦ **Rail-to-Rail Signal Handling**

♦ **TTL/CMOS-Logic Compatible**

♦ **ESD Protection >2000V, per Method 3015.7**

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX338CEE+	0°C to +70°C	16 QSOP
MAX338CPE+	0°C to +70°C	16 PDIP
MAX338CSE+	0°C to +70°C	16 Narrow SO
MAX338C/D	0°C to +70°C	Dice*
MAX338EEE+	-40°C to +85°C	16 QSOP
MAX338ETE+	-40°C to +85°C	16 TQFN-EP** (5mm x 5mm)

Ordering Information continued at end of data sheet.

*Contact factory for dice specifications.
**EP = Exposed Pad
***Contact factory for availability.
+Denotes a lead(Pb)-free/RoHS-compliant package.

Pin Configurations/Functional Diagrams/Truth Tables

DIP/SO/QSOP

Pin Configurations/Functional Diagrams/Truth Tables continued at end of data sheet.

MAX338 8-CHANNEL SINGLE-ENDED MULTIPLEXER

For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

8-Channel/Dual 4-Channel, Low-Leakage, CMOS Analog Multiplexers

ABSOLUTE MAXIMUM RATINGS

Voltage Referenced to V-
V+ ....-0.3V, 44V
GND ....-0.3V, 25V
Digital Inputs, NO, COM (Note 1)...........(V- - 2V) to (V+ + 2V) or
30mA (whichever occurs first)
Continuous Current (any terminal).......................................30mA
Peak Current, NO or COM
(pulsed at 1ms, 10% duty cycle max) 100mA
Continuous Power Dissipation (TA = +70°C)
Plastic DIP (derate 10.53mW/°C above +70°C) 842mW
Narrow SO (derate 8.70mW/°C above +70°C) 696mW
16 QSOP (derate 8.3mW/°C above +70°C)..............666.7mW

16-Pin TQFN (derate 20.8mW/°C above +70°C) 1666.7mW
CERDIP (derate 10.00mW/°C above +70°C)...............800mW
Operating Temperature Ranges
MAX33_C__ ....0°C to +70°C
MAX33_E__..-40°C to +85°C
MAX33_MJE, MSE ....-55°C to +125°C
Storage Temperature Range ....-65°C to +150°C
Lead Temperature (soldering, 10sec) ....+300°C
Soldering Temperature (reflow)
Lead(Pb)-free packages...+260°C
Packages containing lead(Pb)....................................+240°C

Note 1: Signals on NO, COM, EN, A0, A1, or A2 exceeding V+ or V- are clamped by internal diodes. Limit forward current to maximum current ratings.

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—Dual Supplies

(V+ = +15V, V- = -15V, V_{GND} = 0V, V_{AH} = +2.4V, V_{AL} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS			MIN	TYP (Note 2)	MAX	UNITS
SWITCH								
Analog Signal Range	V_{NO}, V_{COM}	(Note 3)			-15		15	V
On-Resistance	R_{ON}	I_{NO} = 0.2mA, V_{COM} = ±10V	T_A = +25°C			220	400	Ω
			T_A = T_{MIN} to T_{MAX}				500	
On-Resistance Matching Between Channels	ΔR_{ON}	I_{NO} = 0.2mA, V_{COM} = ±10V (Note 4)	T_A = +25°C			4	10	Ω
			T_A = T_{MIN} to T_{MAX}				15	
NO-Off Leakage Current (Note 5)	$I_{NO(OFF)}$	V_{COM} = +10V, V_{NO} = ±10V, V_{EN} = 0V	T_A = +25°C		-0.02	0.001	0.02	nA
			T_A = T_{MIN} to T_{MAX}	C, E	-1.25		1.25	
				M	-20		20	
COM-Off Leakage Current (Note 5)	$I_{COM(OFF)}$	V_{NO} = ±10V, V_{COM} = +10V, V_{EN} = 0V	MAX338	T_A = +25°C	-0.05	0.005	0.05	nA
				T_A = T_{MIN} to T_{MAX} C, E	-3.25		3.25	
				M	-40		40	
		V_{NO} = +10V, V_{COM} = ±10V, V_{EN} = 0V	MAX339	T_A = +25°C	-0.05	0.005	0.05	
				T_A = T_{MIN} to T_{MAX} C, E	-1.65		1.65	
				M	-20		20	
COM-On Leakage Current (Note 5)	$I_{COM(ON)}$	V_{COM} = ±10V, V_{NO} = ±10V, sequence each switch on	MAX338	T_A = +25°C	-0.05	0.006	0.05	nA
				T_A = T_{MIN} to T_{MAX} C, E	-3.25		3.25	
				M	-40		40	
			MAX339	T_A = +25°C	-0.05	0.008	0.05	
				T_A = T_{MIN} to T_{MAX} C, E	-1.65		1.65	
				M	-20		20	

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ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

(V+ = +15V, V- = -15V, V_{GND} = 0V, V_{AH} = +2.4V, V_{AL} = +0.8V, $T_A = T_{MIN}$ to T_{MAX}, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP (Note 2)	MAX	UNITS
INPUT							
Input Current with Input Voltage High	I_{AH}	V_A = 2.4V or 15V		-1.0	0.001	1.0	µA
Input Current with Input Voltage Low	I_{AL}	V_{EN} = 0V or 2.4V, V_A = 0V		-1.0		1.0	µA
SUPPLY							
Power-Supply Range				±4.5		±20	V
Positive Supply Current	I+	$V_{EN} = V_A$ = 0V	T_A = +25°C		50	100	µA
			$T_A = T_{MIN}$ to T_{MAX}			150	
		V_{EN} = 2.4V, $V_{A(ALL)}$ = 2.4V	T_A = +25°C		290	500	µA
			$T_A = T_{MIN}$ to T_{MAX}			600	
Negative Supply Current	I-	V_{EN} = 0V or 2.4V, $V_{A(ALL)}$ = 0V, 2.4V or 5V	T_A = +25°C	-1		1	µA
			$T_A = T_{MIN}$ to T_{MAX}	-10		10	
DYNAMIC							
Transistion Time	t_{TRANS}	Figure 2	T_A = +25°C		200	500	ns
Break-Before-Make Interval	t_{OPEN}	Figure 4	T_A = +25°C	10	140		ns
Enable Turn-On Time	$t_{ON(EN)}$	Figure 3	T_A = +25°C		160	500	ns
			$T_A = T_{MIN}$ to T_{MAX}			750	
Enable Turn-Off Time	$t_{OFF(EN)}$	Figure 3	T_A = +25°C		100	500	ns
			$T_A = T_{MIN}$ to T_{MAX}			750	
Charge Injection (Note 3)	Q	C_L = 100pF, V_{NO} = 0V, R_S = 0Ω, Figure 6	T_A = +25°C		1.5	5	pC
Off Isolation (Note 6)	V_{ISO}	V_{EN} = 0V, R_L = 1kΩ, f = 100kHz	T_A = +25°C		-75		dB
Crosstalk Between Channels	V_{CT}	V_{EN} = 2.4V, f = 100kHz, V_{GEN} = 1V_{P-P}, R_L = 1kΩ, Figure 7	T_A = +25°C		-92		dB
Logic Input Capacitance	C_{IN}	f = 1MHz	T_A = +25°C		2		pF
NO-Off Capacitance	$C_{NO(OFF)}$	f = 1MHz, $V_{EN} = V_{NO}$ = 0V, Figure 8	T_A = +25°C		3		pF
COM-Off Capacitance	$C_{COM(OFF)}$	f = 1MHz, V_{EN} = 0.8V, V_{COM} = 0V, Figure 8	MAX338 / T_A = +25°C		11		pF
			MAX339		6		
COM-On Capacitance	$C_{COM(ON)}$	f = 1MHz, V_{EN} = 2.4V, V_{COM} = 0V, Figure 8	MAX338 / T_A = +25°C		16		pF
			MAX339		9		

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ELECTRICAL CHARACTERISTICS—Single Supply

(V+ = +12V, V- = 0V, V_{GND} = 0V, V_{AH} = +2.4V, V_{AL} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP (Note 2)	MAX	UNITS
SWITCH							
Analog Signal Range	V_{NO}, V_{COM}	(Note 3)		0		12	V
On-Resistance	R_{ON}	I_{NO} = 0.2mA V_{COM} = 3V or 10V	T_A = +25°C		460	650	Ω
DYNAMIC							
Transition Time (Note 3)	t_{TRANS}	V_{NO1} = 8V, V_{NO8} = 0V, V_{IN} = 2.4V, Figure 1	T_A = +25°C		210	500	ns
Enable Turn-On Time (Note 3)	$t_{ON(EN)}$	V_{INH} = 2.4V, V_{INL} = 0V, V_{NO1} = 5V, Figure 3	T_A = +25°C		280	500	ns
Enable Turn-Off Time (Note 3)	$t_{OFF(EN)}$	V_{INH} = 2.4V, V_{INL} = 0V, V_{NO1} = 5V, Figure 3	T_A = +25°C		110	500	ns
Charge Injection (Note 3)	Q	C_L = 100pF, V_{NO} = 0V, R_S = 0Ω	T_A = +25°C		1.8	5	pC

Note 2: The algebraic convention where the most negative value is a minimum and the most positive value a maximum is used in this data sheet.

Note 3: Guaranteed by design.

Note 4: ΔR_{ON} = $R_{ON(MAX)}$ - $R_{ON(MIN)}$.

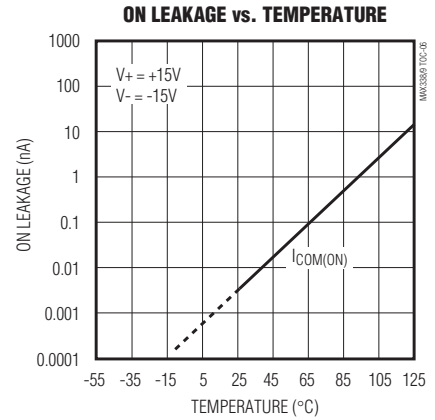**Note 5:** Leakage parameters are 100% tested at the maximum rated hot temperature and guaranteed by correlation at +25°C.
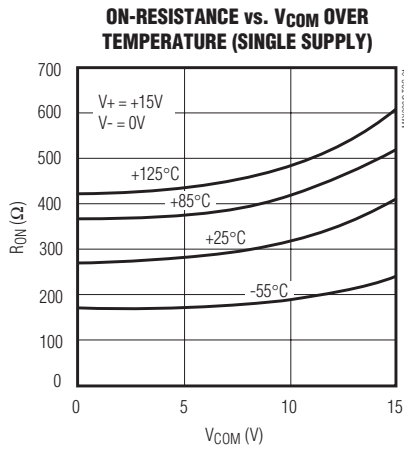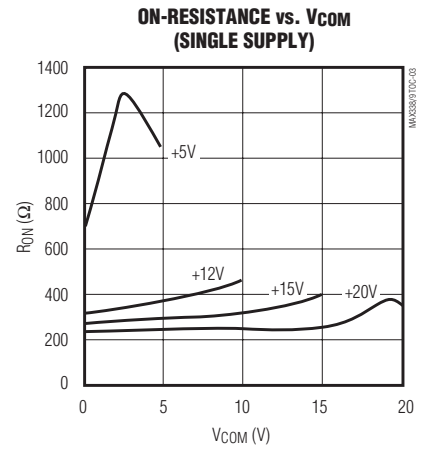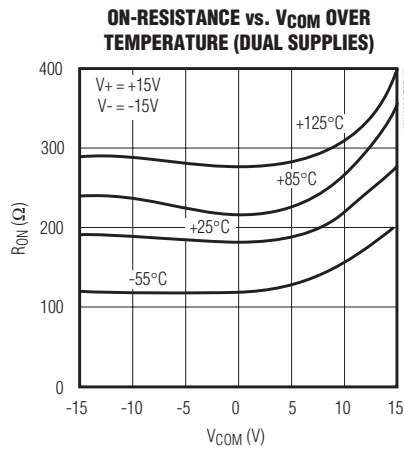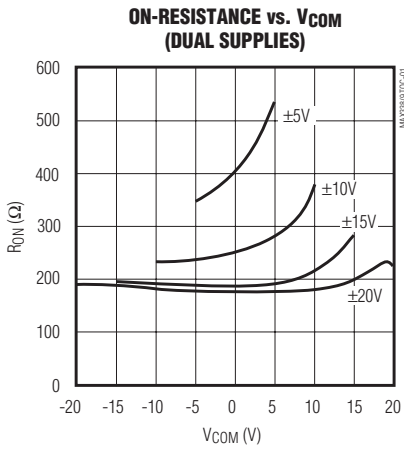
Note 6: Worst-case isolation is on channel 4 because of its proximity to the drain pin. Off isolation = 20log V_{COM}/V_{NO}, where V_{COM} = output and V_{NO} = input to off switch.

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_____Typical Operating Characteristics

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

ON-RESISTANCE vs. V_{COM} (DUAL SUPPLIES)

R_{ON} (Ω) vs. V_{COM} (V)

±5V, ±10V, ±15V, ±20V

ON-RESISTANCE vs. V_{COM} OVER TEMPERATURE (DUAL SUPPLIES)

V+ = +15V
V- = -15V

+125°C, +85°C, +25°C, -55°C

R_{ON} (Ω) vs. V_{COM} (V)

ON-RESISTANCE vs. V_{COM} (SINGLE SUPPLY)

+5V, +12V, +15V, +20V

R_{ON} (Ω) vs. V_{COM} (V)

ON-RESISTANCE vs. V_{COM} OVER TEMPERATURE (SINGLE SUPPLY)

V+ = +15V
V- = 0V

+125°C, +85°C, +25°C, -55°C

R_{ON} (Ω) vs. V_{COM} (V)

OFF LEAKAGE vs. TEMPERATURE

V+ = +15V
V- = -15V

$I_{COM (OFF)}$, $I_{NO (OFF)}$

OFF LEAKAGE (nA) vs. TEMPERATURE (°C)

ON LEAKAGE vs. TEMPERATURE

V+ = +15V
V- = -15V

$I_{COM(ON)}$

ON LEAKAGE (nA) vs. TEMPERATURE (°C)

CHARGE INJECTION vs. V_{COM}

C_L = 100pF
V- = 0V

±15V, +5V, +12V

Q_J (pC) vs. V_{COM} (V)

SUPPLY CURRENT vs. TEMPERATURE

I+, $V_{A(ALL)}$ = 2.4V
I+, V_A = 0V
I-

I+, I- (µA) vs. TEMPERATURE (°C)

TRANSITION TIME vs. POWER SUPPLIES

R_L = 1kΩ

SINGLE SUPPLY
DUAL SUPPLIES

t_{TRANS} (nS) vs. SUPPLY VOLTAGE (V)

±5 OR 5V (SINGLE), ±10 OR 10V (SINGLE), ±15, ±20

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PIN				NAME	FUNCTION
MAX338		**MAX339**			
DIP/SO/QSOP	TQFN-EP	DIP/SO/QSOP	TQFN-EP		
1, 15, 16,	15, 14, 13	—	—	A0, A2, A1	Address Inputs
—	—	1, 16	15, 14	A0, A1	Address Inputs
2	16	2	16	EN	Enable
3	1	3	1	V-	Negative-Supply Voltage Input
4–7	2–5	—	—	NO1–NO14	Analog Inputs—Bidirectional
—	—	4–7	2–5	NO1A–NO4A	Analog Inputs—Bidirectional
8	6	—	—	COM	Analog Output—Bidirectional
—	—	8, 9	6, 7	COMA, COMB	Analog Outputs—Bidirectional
9–12	7–10	—	—	NO8–NO5	Analog Inputs—Bidirectional
—	—	10–13	8–11	NO4B–NO1B	Analog Inputs—Bidirectional
13	11	14	12	V+	Positive-Supply Voltage Input
14	12	15	13	GND	Ground
—	—	—	—	Exposed Pad	Exposed Pad (TQFN only). Connect EP to V+.

_____Applications Information

Operation with
Supply Voltages Other than 15V

Using supply voltages less than ±15V will reduce the analog signal range. The MAX338/MAX339 switches operate with ±4.5V to ±20V bipolar supplies or with a +4.5V to +30V single supply. Connect V- to GND when operating with a single supply. Both device types can also operate with unbalanced supplies such as +24V and -5V. The _Typical Operating Characteristics_ graphs show typical on-resistance with 20V, 15V, 10V, and 5V supplies. (Switching times increase by a factor of two or more for operation at 5V.)

Overvoltage Protection

Proper power-supply sequencing is recommended for all CMOS devices. Do not exceed the absolute maximum ratings, because stresses beyond the listed ratings may cause permanent damage to the devices. Always sequence V+ on first, then V-, followed by the logic inputs NO and COM. If power-supply sequencing is not possible, add two small signal diodes in series with supply pins for overvoltage protection (Figure 1). Adding diodes reduces the analog signal range to 1V below V+ and 1V above V-, but does not affect the devices' low switch resistance and low leakage characteristics. Device operation is unchanged, and the difference between V+ and V- should not exceed 44V.
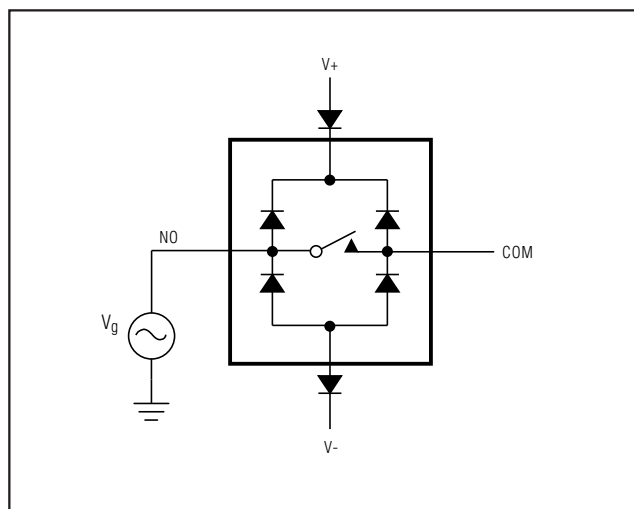

Figure 1. Overvoltage Protection Using External Blocking Diodes

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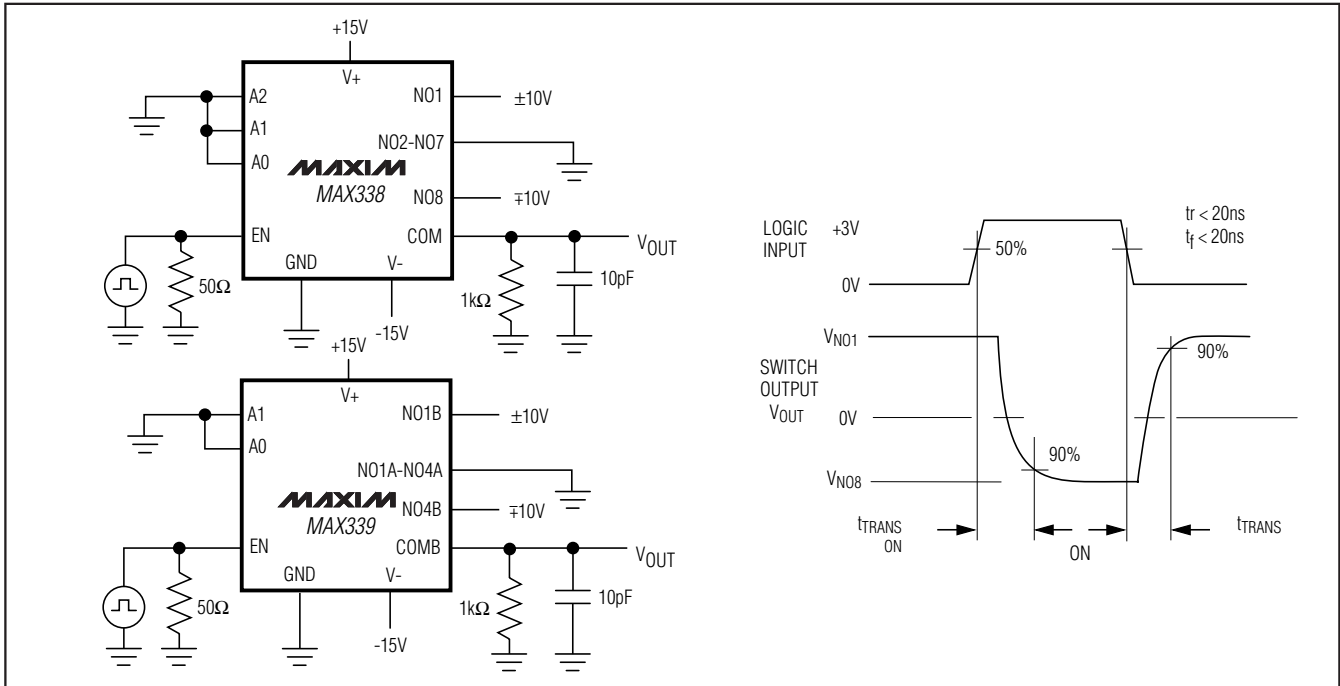
Figure 2. Transition Time
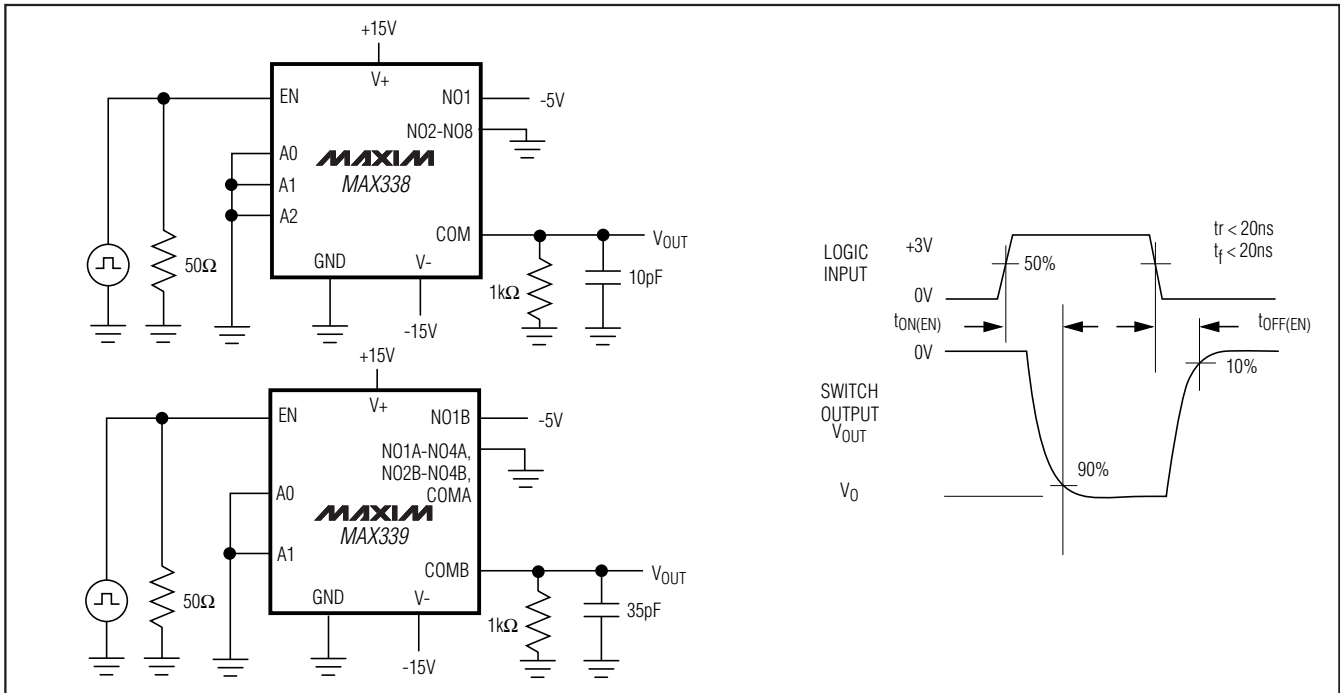
Figure 3. Enable Switching Time
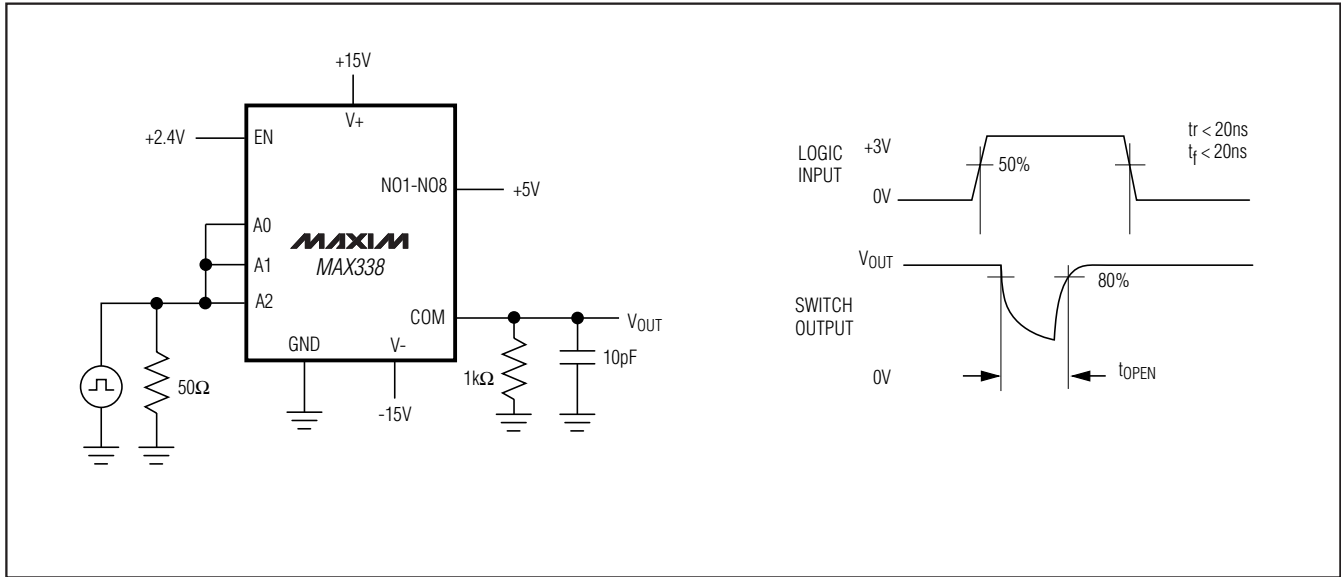
MAX338/MAX339

Figure 4. Break-Before-Make Interval

ΔV_{OUT} IS THE MEASURED VOLTAGE DUE TO CHARGE TRANSFER ERROR Q WHEN THE CHANNEL TURNS OFF.

$Q = C_L \times \Delta V_{OUT}$
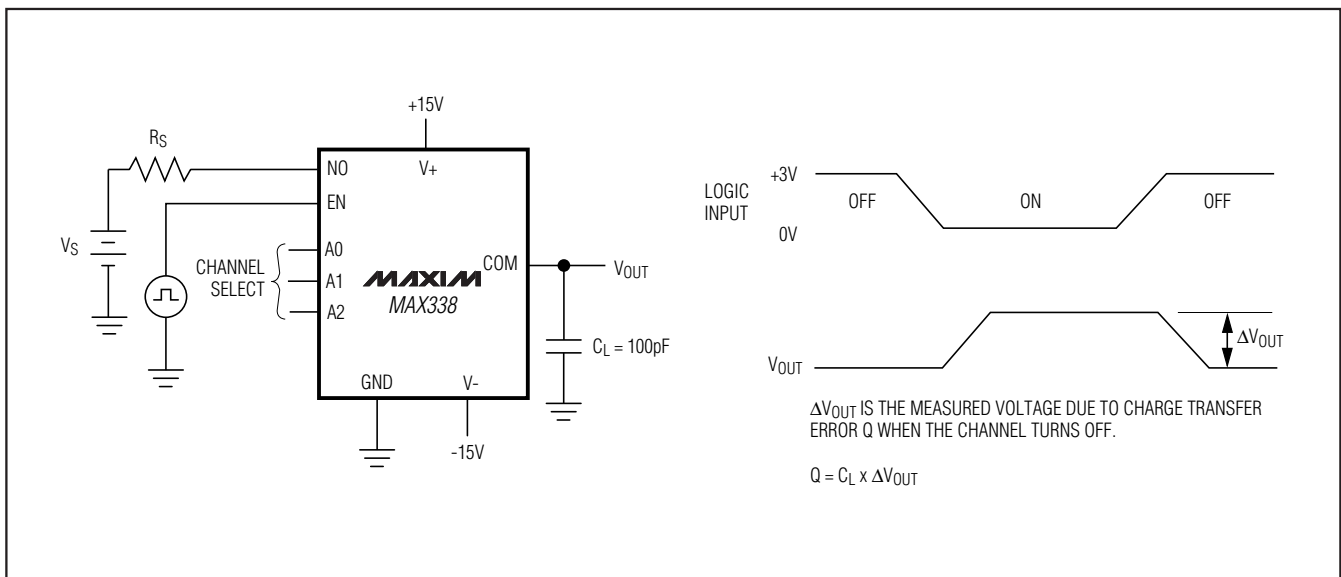
Figure 5. Charge Injection

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Figure 6. Off-Isolation
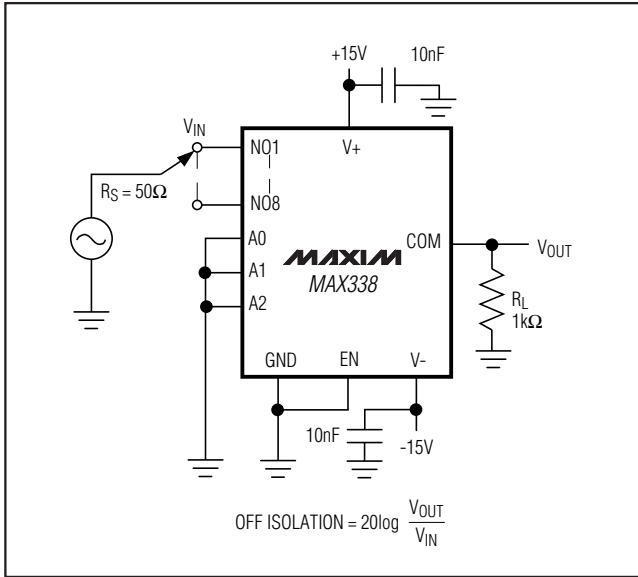
$$\text{OFF ISOLATION} = 20\log \frac{V_{OUT}}{V_{IN}}$$
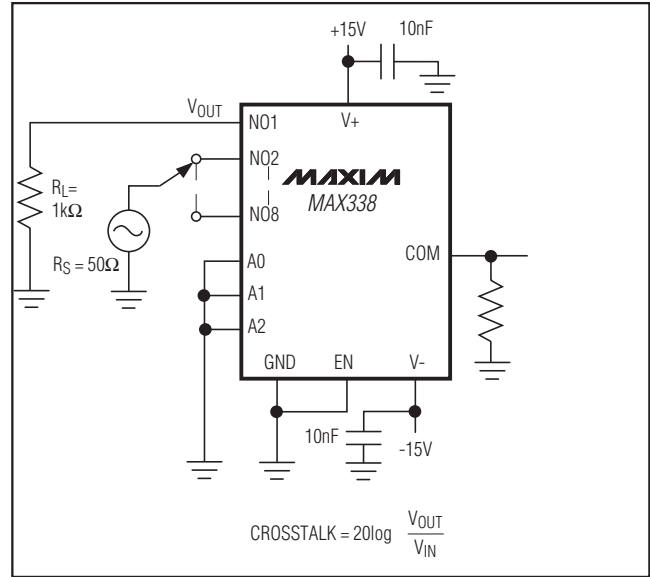
Figure 7. Crosstalk

$$\text{CROSSTALK} = 20\log \frac{V_{OUT}}{V_{IN}}$$
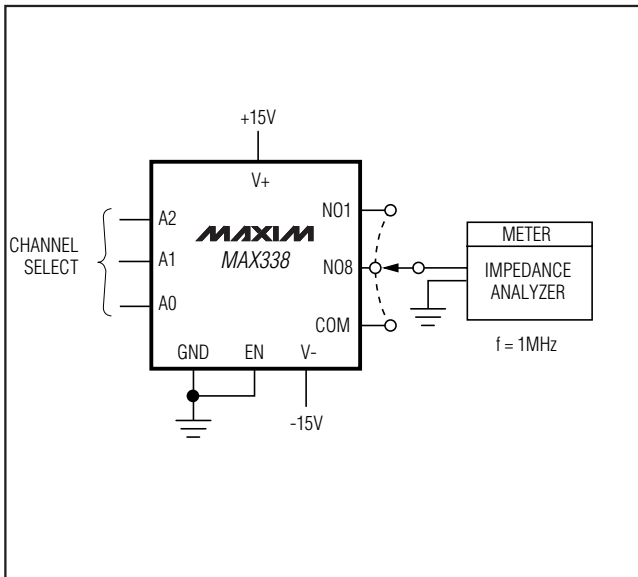
Figure 8. NO/COM Capacitance

_____Pin Configurations/Functional Diagrams/Truth Tables (continued)

TOP VIEW

```
         +
A0   1         16   A1
EN   2         15   GND
V-   3  MAXIM  14   V+
NO1A 4  MAX339 13   NO1B
NO2A 5         12   NO2B
NO3A 6         11   NO3B
NO4A 7         10   NO4B
COMA 8          9   COMB
```

DIP/SO/QSOP

MAX339 DUAL 4-CHANNEL MULTIPLEXER
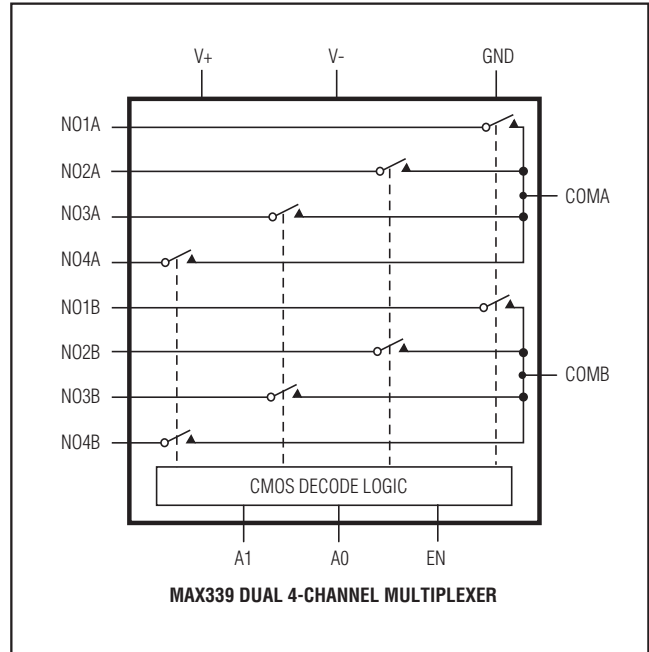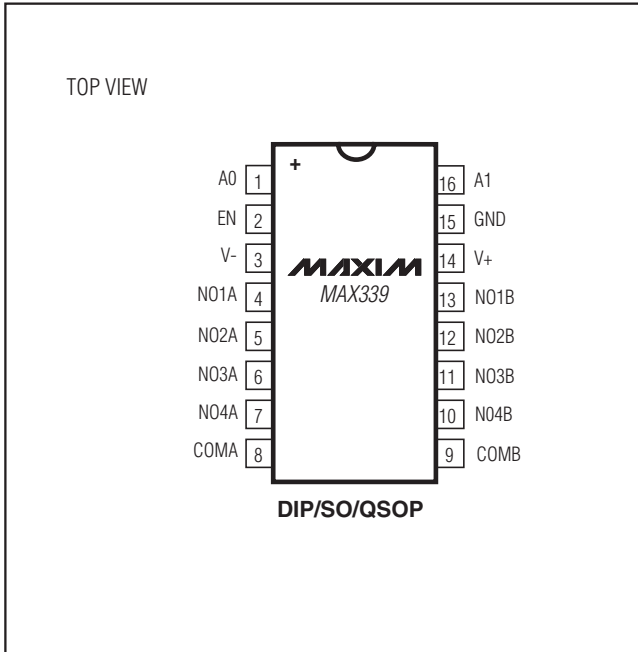
A2	A1	A0	EN	ON SWITCH
X	X	X	0	None
0	0	0	1	1
0	0	1	1	2
0	1	0	1	3
0	1	1	1	4
1	0	0	1	5
1	0	1	1	6
1	1	0	1	7
1	1	1	1	8

MAX338

LOGIC "0" $V_{AL} \leq 0.8V$, LOGIC "1" $V_{AH} \geq 2.4V$

A1	A0	EN	ON SWITCH
X	X	0	None
0	0	1	1
0	1	1	2
1	0	1	3
1	1	1	4

MAX339

LOGIC "0" $V_{AL} \leq 0.8V$, LOGIC "1" $V_{AH} \geq 2.4V$

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MAX338/MAX339

TOP VIEW

MAX338
TQFN-EP

MAX339
TQFN-EP

*CONNECT EP TO V+
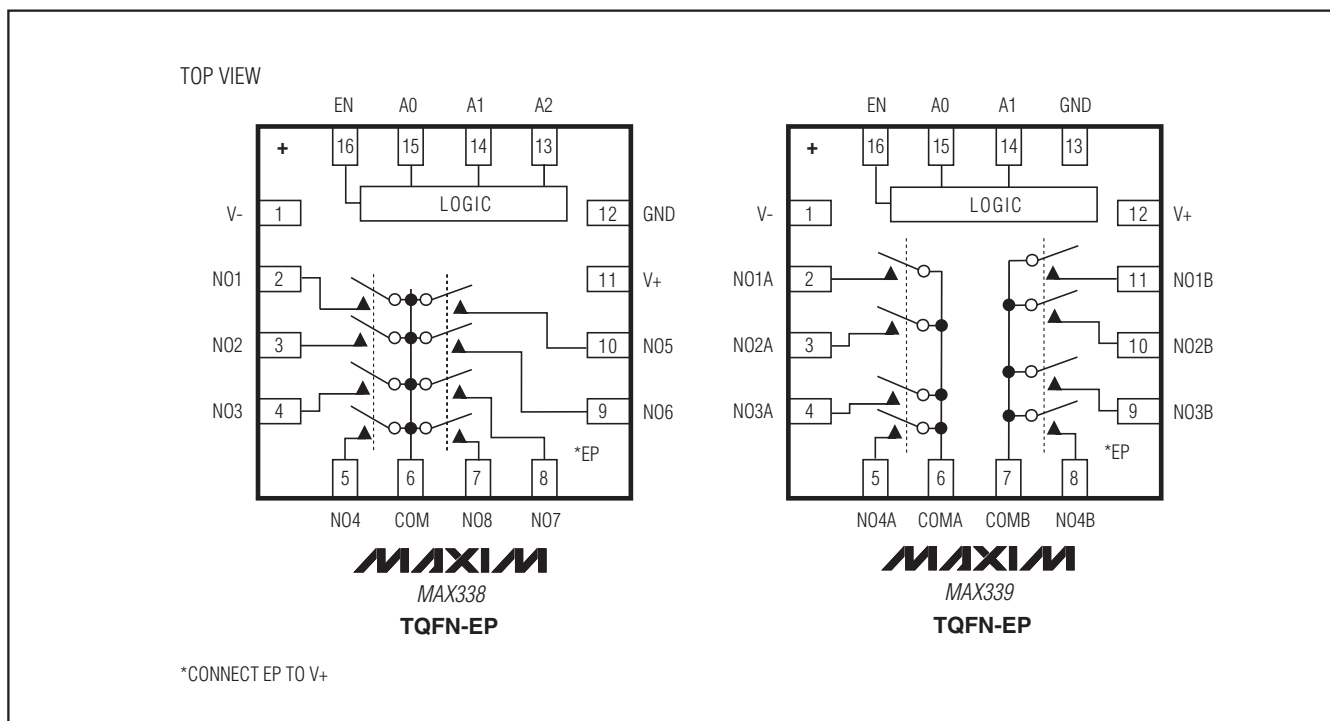
_____**Ordering Information (continued)**

PART	TEMP RANGE	PIN-PACKAGE
MAX338EPE+	-40°C to +85°C	16 PDIP
MAX338ESE+	-40°C to +85°C	16 Narrow SO
MAX338EJE	-40°C to +85°C	16 CERDIP
MAX338MJE	-55°C to +125°C	16 CERDIP***
MAX338MSE/PR3	-55°C to +125°C	16 Narrow SO
MAX339CEE+	0°C to +70°C	16 QSOP
MAX339CPE+	0°C to +70°C	16 PDIP
MAX339CSE+	0°C to +70°C	16 Narrow SO
MAX339C/D	0°C to +70°C	Dice*

PART	TEMP RANGE	PIN-PACKAGE
MAX339EEE+	-40°C to +85°C	16 QSOP
MAX339ETE+	-40°C to +85°C	16 TQFN-EP** (5mm x 5mm)
MAX339EPE+	-40°C to +85°C	16 PDIP
MAX339ESE+	-40°C to +85°C	16 Narrow SO
MAX339EJE	-40°C to +85°C	16 CERDIP
MAX339MJE	-55°C to +125°C	16 CERDIP***
MAX339MSE/PR3	-55°C to +125°C	16 Narrow SO

*Contact factory for dice specifications.
**EP = Exposed Pad
***Contact factory for availability.
+Denotes a lead(Pb)-free/RoHS-compliant package.

8-Channel/Dual 4-Channel, Low-Leakage, CMOS Analog Multiplexers

Package Information

For the latest package outline information and land patterns (footprints), go to **www.maxim-ic.com/packages**. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

PACKAGE TYPE	PACKAGE CODE	OUTLINE NO.	LAND PATTERN NO.
16 PDIP	P16+1	**21-0043**	—
16 Narrow SO	S16+1	**21-0041**	**90-0097**
16 QSOP	E16+5	**21-0055**	**90-0167**
16 TQFN-EP	T1655+3	**21-0140**	**90-0073**
16 CDIP	J16+4	**21-0045**	—

MAXIM

8-Channel/Dual 4-Channel, Low-Leakage, CMOS Analog Multiplexers

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
4	4/12	Added the MAX338CEE+ / MAX338EEE+/ MAX338MSE /PR3 / MAX339CEE+ / MAX339EEE+ part and packaging information	1, 2, 6, 10, 11

MAX338/MAX339