



Low-Voltage, Single-Supply Multiplexer and Switch

MAX4524/MAX4525

General Description

The MAX4524/MAX4525 are low-voltage, single-supply CMOS analog switches configured as a 4-channel multiplexer/demultiplexer (MAX4524) and a double-pole/double-throw (DPDT) switch (MAX4525). Both have an inhibit input to simultaneously open all signal paths.

These devices operate from a single supply of +2V to +12V and are optimized for operation with +3V or +5V supplies. On-resistance is 200Ω with a +5V supply and 500Ω with a +3V supply. Each switch can handle Rail-to-Rail analog signals. The off-leakage current is only 2nA at +25°C or 20nA at +85°C.

All digital inputs have 0.8V to 2.4V logic thresholds, ensuring TTL/CMOS-logic compatibility when using a single +5V supply.

Applications

- Battery-Operated Equipment
- Audio and Video Signal Routing
- Low-Voltage Data-Acquisition Systems
- Communications Circuits

Features

- ◆ Tiny 10-Pin TDFN Package
- ◆ Single-Supply Operation from +2V to +12V
- ◆ 200Ω On-Resistance with +5V Supply
- ◆ 500Ω On-Resistance with +3V Supply
- ◆ Guaranteed 8Ω On-Resistance Match at +5V
- ◆ Guaranteed 2nA Max On-Leakage at +5V
- ◆ TTL/CMOS-Logic Compatible

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	TOP MARK
MAX4524CUB	0°C to +70°C	10 μMAX	—
MAX4524C/D	0°C to +70°C	Dice*	—
MAX4524EUB	-40°C to +85°C	10 μMAX	—
MAX4524ETB	-40°C to +85°C	10 TDFN-EP** (3mm x 3mm)	AAP
MAX4525CUB	0°C to +70°C	10 μMAX	—
MAX4525C/D	0°C to +70°C	Dice*	—
MAX4525EUB	-40°C to +85°C	10 μMAX	—
MAX4525ETB	-40°C to +85°C	10 TDFN-EP** (3mm x 3mm)	AAQ

*Contact factory for availability.

**EP = Exposed Pad.

Pin Configurations/Functional Diagrams/Truth Tables

TOP VIEW

MAX4524
μMAX

MAX4525
μMAX

TDFN

TDFN

MAX4525

INH	ADD	ON SWITCH
1	X	NONE
0	0	COMA-NCA, COMB-NCB
0	1	COMA-NOA, COMB-NOB

MAX4524

INH	ADDB	ADDA	ON SWITCH
1	X	X	NONE
0	0	0	COM-NO0
0	0	1	COM-NO1
0	1	0	COM-NO2
0	1	1	COM-NO3

X = DON'T CARE



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ELECTRICAL CHARACTERISTICS—Single +5V Supply (continued)

(V+ = 4.5V to 5.5V, GND = 0V, V_{AH} = 2.4V, V_{AL} = 0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Notes 2, 7)

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP (Note 2)	MAX	UNITS
SWITCH DYNAMIC CHARACTERISTICS							
Inhibit Turn-On Time	t _(ON)	V _{NO-} = 3V, R _L = 300Ω, C _L = 35pF, Figure 2	+25°C		90	150	ns
			C, E			200	
Inhibit Turn-Off Time	t _(OFF)	V _{NO-} = 3V, R _L = 300Ω, C _L = 35pF, Figure 2	+25°C		40	120	ns
			C, E			180	
Address Transition Time	t _{TRANS}	V _{NO-} = 3V/0V, R _L = 300Ω, C _L = 35pF, Figure 1	+25°C		90	150	ns
			C, E			200	
Break-Before-Make Time	t _{BBM}	V _{NO-} = 3V, R _L = 300Ω, C _L = 35pF, Figure 3	+25°C	5	20		ns
Charge Injection (Note 6)	Q	C = 1nF, R _S = 0Ω, V _S = 2.5V, Figure 4	+25°C		0.8	5	pC
NO/NC Off-Capacitance	C _{NO(OFF)}	V _{NO-} = 0V, f = 1MHz, Figure 6	+25°C		4		pF
COM Off-Capacitance	C _{COM(OFF)}	V _{NO-} = 0V, f = 1MHz, Figure 6	MAX4524	+25°C		14	pF
			MAX4525	+25°C		6	
COM On-Capacitance	C _{COM(ON)}	V _{NO-} = 0V, f = 1MHz, Figure 6	MAX4524	+25°C		20	pF
			MAX4525	+25°C		12	
Off-Isolation	V _{ISO}	R _L = 50Ω, f = 1MHz, Figure 5	+25°C		-75		dB
Channel-to-Channel Crosstalk (MAX4525)	V _{CT}	R _L = 50Ω, f = 1MHz, Figure 5	+25°C		-74		dB
Total Harmonic Distortion	THD	R _L = 600Ω, V _{COM} = 2.5Vp-p, 20Hz to 20kHz	+25°C		0.2		%
POWER SUPPLY							
Power-Supply Range	V+		C, E	2		12	V
Power-Supply Current	I+	V+ = 5.5V, V _{ADD} = V _{INH} = V+ or 0V	+25°C		-1	+1	μA
			C, E		-10	+10	

ELECTRICAL CHARACTERISTICS—Single +3V Supply

(V+ = 2.7V to 3.6V, GND = 0V, V_{AH} = 2.0V, V_{AL} = 0.5V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Notes 2, 7)

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP (Note 2)	MAX	UNITS	
ANALOG SWITCH								
Analog Signal Range	V _{COM} , V _{NO}		C, E	V-		V+	V	
COM-NO/NC On-Resistance	R _{ON}	V+ = 2.7V, I _{COM} = 0.1mA, V _{COM} = 1.5V	+25°C		190	400	Ω	
			C, E			500		
NO/NC Off-Leakage (Note 6)	I _{NO(OFF)} , I _{NC(OFF)}	V+ = 3.6V; V _{NO} = 1V, 3V; V _{COM} = 3V, 1V	+25°C		-1	+1	nA	
			C, E		-10	+10		
COM Off-Leakage (Note 6)	I _{COM(OFF)}	V+ = 3.6V; V _{NO} = 1V, 3V; V _{COM} = 3V, 1V	MAX4524	+25°C		-2	+2	nA
				C, E		-50	+50	
			MAX4525	+25°C		-1	+1	
				C, E		-25	+25	

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ELECTRICAL CHARACTERISTICS—Single +3V Supply (continued)

(V₊ = 2.7V to 3.6V, GND = 0V, V_{AH} = 2.0V, V_{AL} = 0.5V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Notes 2, 7)

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP (Note 2)	MAX	UNITS
COM On-Leakage (Note 6)	I _{COM(ON)}	V ₊ = 3.6V; V _{COM} = 3V, 1V	MAX4524	+25°C	-2	+2	nA
				C, E	-50	+50	
			MAX4525	+25°C	-1	+1	
				C, E	-25	+25	
DIGITAL I/O							
Logic Input Logic Threshold High	V _{IH}		C, E		1.0	2.0	V
Logic Input Logic Threshold Low	V _{IL}		C, E	0.5	1.0		V
Input Current High	I _{IH}	V _A = V _{INH} = 2.0V	C, E	-1		+1	μA
Input Current Low	I _{IH}	V _A = V _{INH} = 0.5V	C, E	-1		+1	μA
SWITCH DYNAMIC CHARACTERISTICS (Note 6)							
Inhibit Turn-On Time	t _(ON)	V _{NO_} = 1.5V, R _L = 300Ω, C _L = 35pF, Figure 2	+25°C		170	300	ns
			C, E			400	
Inhibit Turn-Off Time	t _(OFF)	V _{NO_} = 1.5V, R _L = 300Ω, C _L = 35pF, Figure 2	+25°C		50	200	ns
			C, E			300	
Address Transition Time	t _{TRANS}	V _{NO_} = 1.5V/0V, R _L = 300Ω, C _L = 35pF, Figure 1	+25°C		130	300	ns
			C, E			400	
Break-Before-Make Time	t _{BBM}	Figure 3, V _{NO_} = 1.5V, R _L = 300Ω, C _L = 35pF	+25°C	5	40		ns
POWER SUPPLY							
Power-Supply Current	I ₊	V ₊ = 3.6V, V _{ADD} = V _{INH} = V ₊ or 0V	+25°C	-1		+1	μA
			C, E	-10		+10	

Note 2: The algebraic convention is used in this data sheet; the most negative value is shown in the minimum column.

Note 3: $\Delta R_{ON} = R_{ON(MAX)} - R_{ON(MIN)}$

Note 4: Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal ranges; i.e., V_{NO} = 3V to 0V and 0V to 3V.

Note 5: Leakage parameters are 100% tested at maximum-rated hot operating temperature, and guaranteed by correlation at T_A = +25°C.

Note 6: Guaranteed by design, not production tested.

Note 7: TDFN parts are tested at +25°C and are guaranteed by design and correlation over the entire temperature range.

Low-Voltage, Single-Supply Multiplexer and Switch

Typical Operating Characteristics

($V_+ = 5V$, $GND = 0V$, $T_A = +25^\circ C$, unless otherwise noted.)

MAX4524/MAX4525



Low-Voltage, Single-Supply Multiplexer and Switch

Typical Operating Characteristics (continued)

(V+ = +5V, GND = 0V, TA = +25°C, unless otherwise noted.)



Pin Description

MAX4524	MAX4525	NAME	FUNCTION
1	—	NO2	Analog Switch Normally Open Input 2
—	1	NOA	Analog Switch “A” Normally Open Input
2	—	NO3	Analog Switch Normally Open Input 3
—	2	COMA	Analog Switch “A” Common
3	—	NO1	Analog Switch Normally Open Input 1
—	3	NCA	Analog Switch “A” Normally Closed Input
4	4	INH	Inhibit. Connect to GND for normal operation. Connect to logic-level high to turn all switches off.
5	5	GND	Ground. Connect to digital ground (analog signals have no ground reference, but are limited to V+ and GND).
6	—	ADDB	Logic-Level Address Input (see <i>Truth Tables</i>)
—	6	ADD	Logic-Level Address Input (see <i>Truth Tables</i>)
7	—	ADDA	Logic-Level Address Input (see <i>Truth Tables</i>)
—	7	NCB	Analog Switch “B” Normally Closed Input
8	—	NO0	Analog Switch Normally Open Input 0
—	8	NOB	Analog Switch “B” Normally Open Input
9	—	COM	Analog Switch Common
—	9	COMB	Analog Switch “A” Common
10	10	V+	Positive Analog and Digital Supply-Voltage Input
EP	EP	EP	TDFN Package Only. Exposed pad, connect to V+.

Note: NO_, NC_, and COM_ analog signal pins are identical and interchangeable. Any may be considered an input or output; signals pass equally well in both directions.

Low-Voltage, Single-Supply Multiplexer and Switch

MAX4524/MAX4525

Applications Information

Power-Supply Considerations

The MAX4524/MAX4525's construction is typical of most CMOS analog switches. They have two supply pins: V+ and GND. V+ and GND are used to drive the internal CMOS switches and set the limits of the analog voltage on any switch. Reverse ESD-protection diodes are internally connected between each analog signal pin and both V+ and GND. If any analog signal exceeds V+ or GND, one of these diodes will conduct. During normal operation, these (and other) reverse-biased ESD diodes leak, forming the only current drawn from V+ or GND.

Virtually all the analog leakage current comes from the ESD diodes. Although the ESD diodes on a given signal pin are identical, and therefore fairly well balanced, they are reverse-biased differently. Each is biased by either V+ or GND and the analog signal. This means that leakage will vary as the signal varies. The difference in the two diode leakages to the V+ and GND pins constitutes the analog signal-path leakage current. All analog leakage current flows between each pin and one of the supply terminals, not to the other switch terminal. This is why both sides of a given switch can show leakage currents of either the same or opposite polarity.

Test Circuits/Timing Diagrams



Figure 1. Address Transition Time

Low-Voltage, Single-Supply Multiplexer and Switch

There is no connection between the analog signal paths and GND. V+ and GND power the internal logic and logic-level translators, and set both the input and output logic limits. The logic-level translators convert the logic levels into switched V+ and GND signals to drive the gates of the analog signals. This drive signal is the only connection between the logic supplies (and signals) and the analog supplies. V+ has an ESD-protection diode to GND.

Low-Voltage Operation

These devices operate from a single supply between +2V and +12V. At room temperature, they actually “work” with a single supply at near or below +1.7V, although as supply voltage decreases, switch on-resistance and switching times become very high.

High-Frequency Performance

In 50Ω systems, signal response is reasonably flat up to 50MHz (see *Typical Operating Characteristics*). Above 20MHz, the on-response has several minor peaks, which are highly layout dependent. The problem is not turning the switch on, but turning it off. The off-state switch acts like a capacitor, and passes higher frequencies with less attenuation. At 10MHz, off-isolation is about -50dB in 50Ω systems, becoming worse (approximately 20dB per decade) as frequency increases. Higher circuit impedances also degrade off-isolation. Adjacent channel attenuation is about 3dB above that of a bare IC socket, and is entirely due to capacitive coupling.

Test Circuits/Timing Diagrams (continued)



Figure 2. Inhibit Switching Times

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Test Circuits/Timing Diagrams (continued)

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Figure 3. Break-Before-Make Interval



Figure 4. Charge Injection

Low-Voltage, Single-Supply Multiplexer and Switch

Test Circuits/Timing Diagrams (continued)

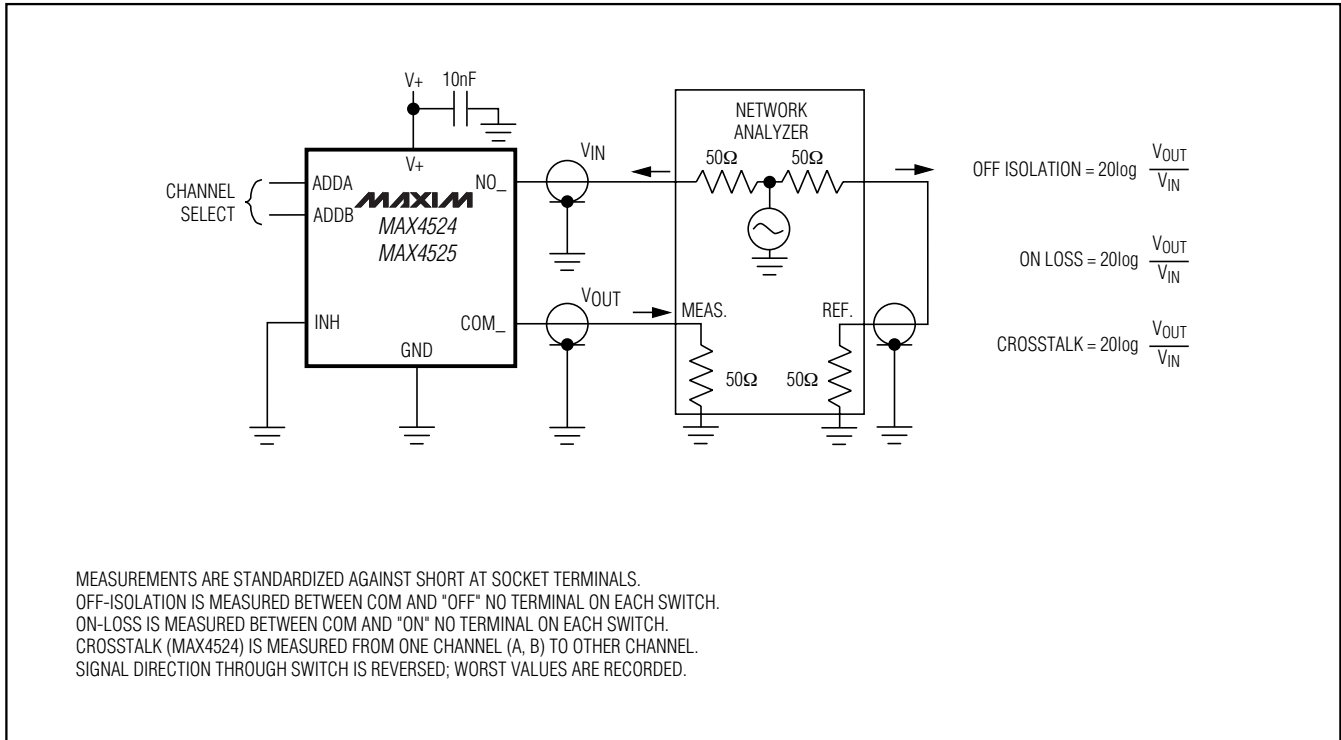


Figure 5. Off-Isolation, On-Loss, and Crosstalk

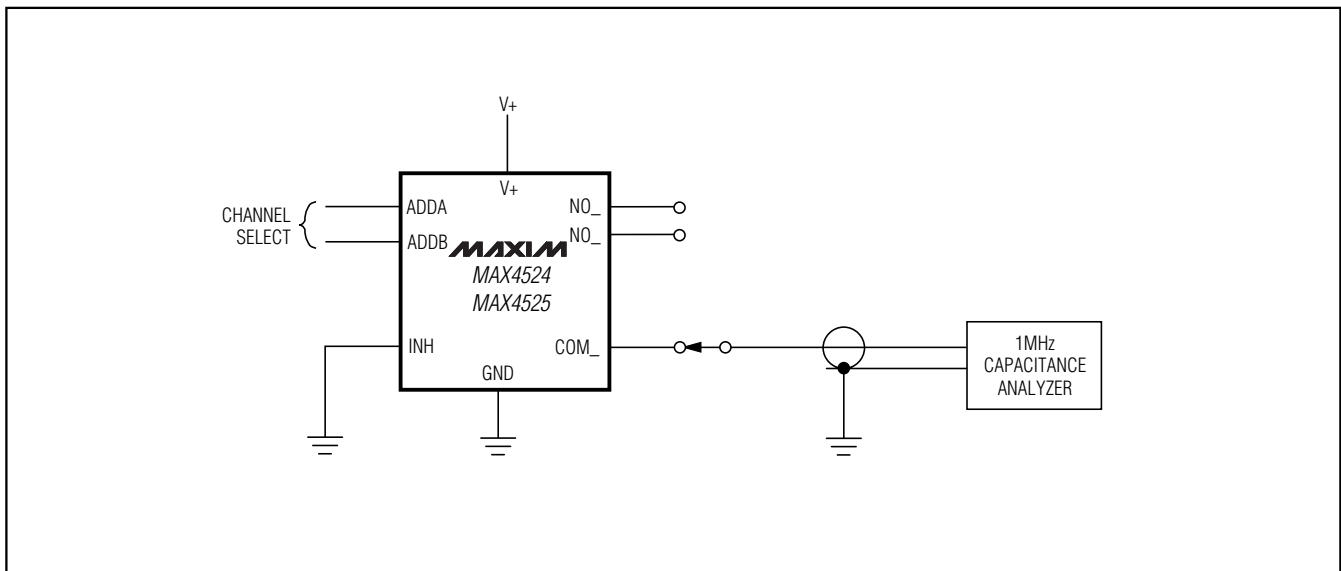


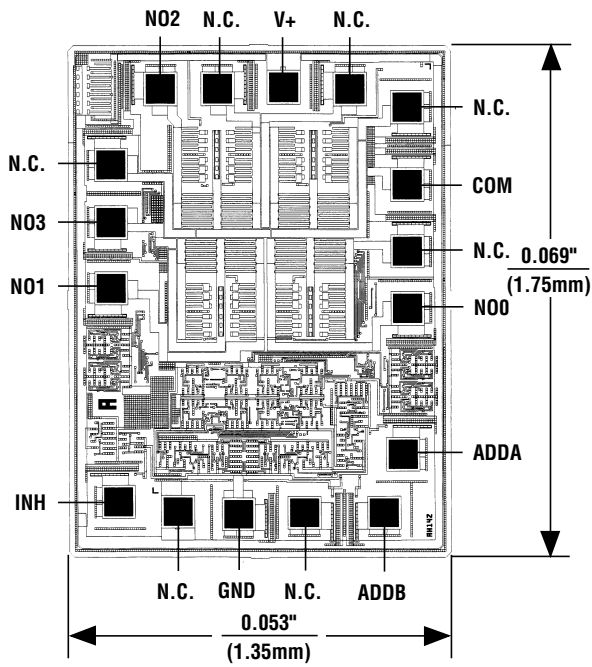
Figure 6. NO/COM Capacitance

Low-Voltage, Single-Supply Multiplexer and Switch

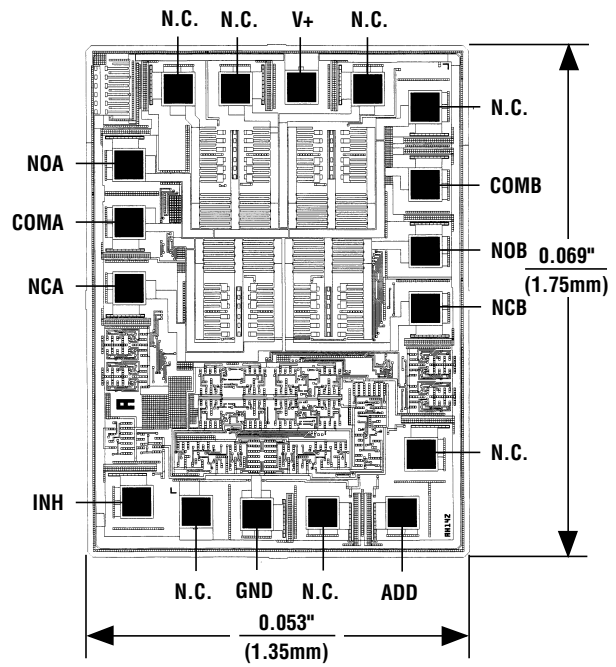
Chip Topographies

MAX4524/MAX4525

MAX4524



MAX4525



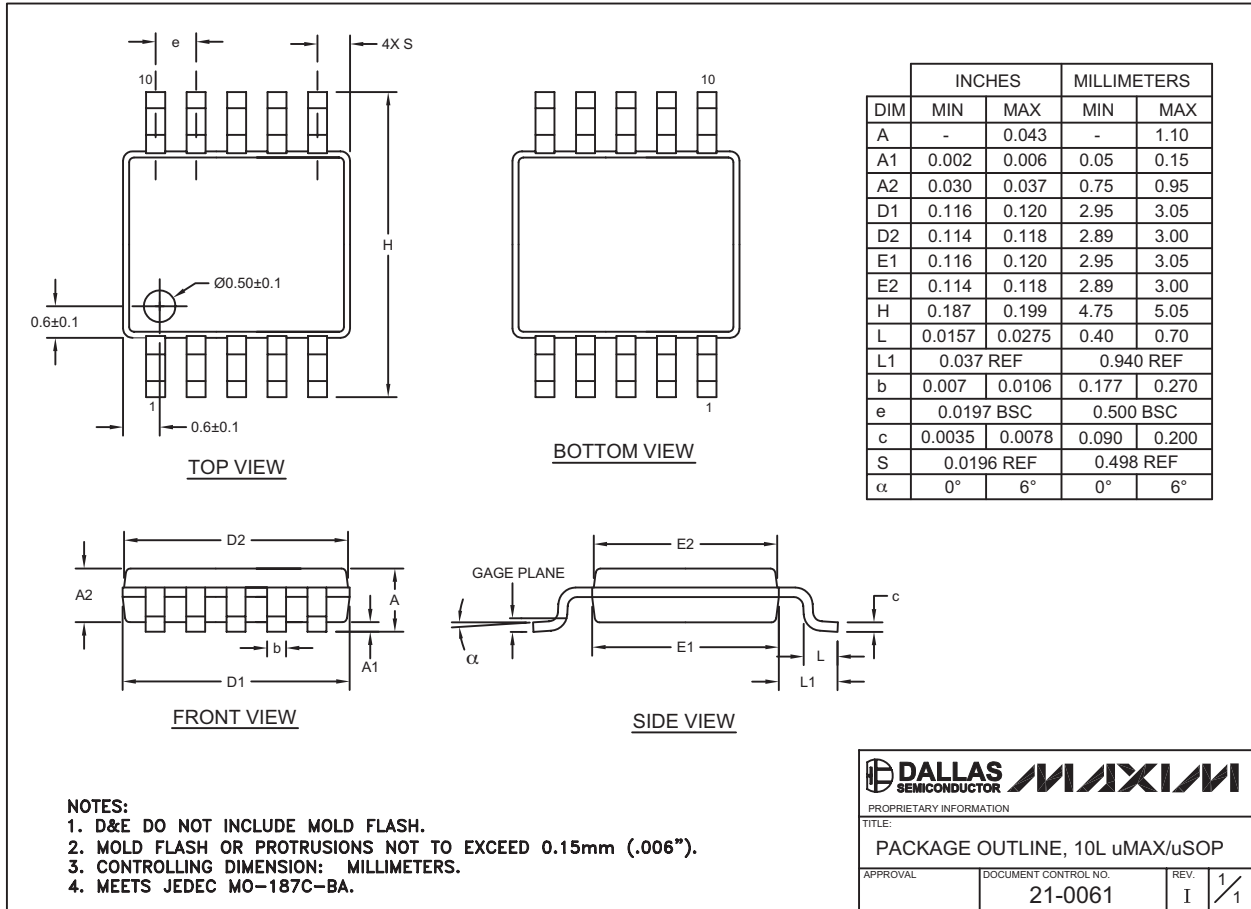
N.C. = No Connection

TRANSISTOR COUNT: 219
SUBSTRATE CONNECTED TO V+

Low-Voltage, Single-Supply Multiplexer and Switch

Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to www.maxim-ic.com/packages.)



10LUMAX.EPS

Low-Voltage, Single-Supply Multiplexer and Switch

Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to www.maxim-ic.com/packages.)

MAX4524/MAX4525



Low-Voltage, Single-Supply Multiplexer and Switch

Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to www.maxim-ic.com/packages.)

COMMON DIMENSIONS		
SYMBOL	MIN.	MAX.
A	0.70	0.80
D	2.90	3.10
E	2.90	3.10
A1	0.00	0.05
L	0.20	0.40
k	0.25 MIN.	
A2	0.20 REF.	

PACKAGE VARIATIONS							
PKG. CODE	N	D2	E2	e	JEDEC SPEC	b	[(N/2)-1] x e
T633-2	6	1.50±0.10	2.30±0.10	0.95 BSC	MO229 / WEEA	0.40±0.05	1.90 REF
T833-2	8	1.50±0.10	2.30±0.10	0.65 BSC	MO229 / WEEC	0.30±0.05	1.95 REF
T833-3	8	1.50±0.10	2.30±0.10	0.65 BSC	MO229 / WEEC	0.30±0.05	1.95 REF
T1033-1	10	1.50±0.10	2.30±0.10	0.50 BSC	MO229 / WEED-3	0.25±0.05	2.00 REF
T1033-2	10	1.50±0.10	2.30±0.10	0.50 BSC	MO229 / WEED-3	0.25±0.05	2.00 REF
T1433-1	14	1.70±0.10	2.30±0.10	0.40 BSC	----	0.20±0.05	2.40 REF
T1433-2	14	1.70±0.10	2.30±0.10	0.40 BSC	----	0.20±0.05	2.40 REF

NOTES:

1. ALL DIMENSIONS ARE IN mm. ANGLES IN DEGREES.
 2. COPLANARITY SHALL NOT EXCEED 0.08 mm.
 3. WARPAGE SHALL NOT EXCEED 0.10 mm.
 4. PACKAGE LENGTH/PACKAGE WIDTH ARE CONSIDERED AS SPECIAL CHARACTERISTIC(S).
 5. DRAWING CONFORMS TO JEDEC MO229, EXCEPT DIMENSIONS "D2" AND "E2", AND T1433-1 & T1433-2.
 6. "N" IS THE TOTAL NUMBER OF LEADS.
 7. NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.
- MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.

—DRAWING NOT TO SCALE—

MAXIM	
TITLE: PACKAGE OUTLINE, 6,8,10 & 14L, TDFN, EXPOSED PAD, 3x3x0.80 mm	
APPROVAL	DOCUMENT CONTROL NO. 21-0137
REV. I	2/2

Revision History

Pages changed at Rev 2: 1, 2, 4, 6, 13,14

Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

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