MAXIM

High-Speed, Low-Voltage, 4Ω, Dual SPST CMOS Analog Switches

MAX4641/MAX4642/MAX4643

General Description

The MAX4641/MAX4642/MAX4643 are monolithic, dual, single-pole/single-throw (SPST) switches that can operate from a single supply ranging from +1.8V to +5.5V. The MAX4641/MAX4642/MAX4643 provide low 4Ω on-resistance (R_{ON}), 0.6Ω R_{ON} matching between channels, and 1Ω R_{ON} flatness over the entire analog signal range. These devices offer fast switching times of less than 20ns while consuming less than 0.01μW of quiescent power.

The MAX4641 has two normally open (NO) switches, and the MAX4642 has two normally closed (NC) switches. The MAX4643 has one NO switch and one NC switch. All three devices have low 0.35nA leakage currents over the entire temperature range. The MAX4641/MAX4642/MAX4643 are available in small 8-pin μMAX and 8-pin QFN packages.

Applications

Battery-Operated Equipment

Audio and Video Signal Routing

Low-Voltage Data-Acquisition Systems

Sample-and-Hold Circuits

Communications Circuits

Rail-to-Rail is a trademark of Nippon Motorola, Ltd.

Features

♦ **+1.8V to +5.5V Single-Supply Operation**
♦ **Rail-to-Rail™ Analog Signal Range**
♦ **Guaranteed R_{ON}**
    4Ω max (+5V supply)
    8Ω max (+3V supply)
♦ **+1.8V Operation**
    R_{ON} 30Ω typ Over Temperature
    t_{ON} 18ns typ, t_{OFF} 12ns typ
♦ **Guaranteed R_{ON} Flatness: 1Ω (+5V supply)**
♦ **Guaranteed R_{ON} Match Between Channels**
    0.6Ω (+5V supply)
♦ **Low Leakage (<0.35nA) Over Entire Temperature Range**
♦ **Excellent AC Characteristics**
    Low Crosstalk: -97dB at 1MHz
    High Off-Isolation: -80dB at 1MHz
    0.018% Total Harmonic Distortion
♦ **Low Power Consumption: < 0.01μW**

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX4641EUA	-40°C to +85°C	8 μMAX
MAX4641EGA	-40°C to +85°C	8 QFN 3 x 3
MAX4642EUA	-40°C to +85°C	8 μMAX
MAX4642EGA	-40°C to +85°C	8 QFN 3 x 3
MAX4643EUA	-40°C to +85°C	8 μMAX
MAX4643EGA	-40°C to +85°C	8 QFN 3 x 3

Pin Configurations/Functional Diagrams/Truth Tables

TOP VIEW

MAXIM *MAX4641*

μMAX

MAX4641	
IN_	NO_
0	OFF
1	ON

MAXIM *MAX4642*

μMAX

MAX4642	
IN_	NC_
0	ON
1	OFF

MAXIM *MAX4643*

μMAX

MAX4643		
IN_	NO1	NC2
0	OFF	ON
1	ON	OFF

MAXIM

_____ **Maxim Integrated Products 1**

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.

High-Speed, Low-Voltage, 4Ω, Dual SPST CMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS

(All Voltages Referenced to GND)
V+ ....-0.3V to +6V
IN_, COM_, NO_, NC_ (Note 1)....................-0.3V to (V+ + 0.3V)
Continuous Current (any terminal)....................................±20mA
Continuous Current (NO_, NC_, COM_)..........................±50mA
Peak Current (NO_, NC_, COM_, pulsed at 1ms,
    10% duty cycle)... ±100mA

Continuous Power Dissipation (T$_A$ = +70°C)
    8-Pin µMAX (derate 4.5mW/°C above +70°C) 362mW
    8-Pin QFN (derate 24.4mW/°C above +70°C) 1951mW
Operating Temperature Range ....-40°C to +85°C
Junction Temperature..+150°C
Storage Temperature Range ....-65°C to +150°C
Lead Temperature (soldering, 10s) ....+300°C

Note 1: Signals on NO_, NC_, COM_, or IN_ exceeding V+ or GND are clamped by internal diodes. Limit forward-diode 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 +5V Supply

(V+ = +4.5V to +5.5V, V$_{INH}$ = 2.4V, V$_{INL}$ = 0.8V, T$_A$ = T$_{MIN}$ to T$_{MAX}$, unless otherwise noted. Typical values are at T$_A$ = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
ANALOG SWITCH							
Analog Signal Range	V$_{COM\_}$, V$_{NO\_}$, V$_{NC\_}$			0		V+	V
On-Resistance	R$_{ON}$	V+ = 4.5V, I$_{COM\_}$ = 10mA, V$_{NO\_}$ or V$_{NC\_}$ = 0 to V+	T$_A$ = +25°C		2.5	4	Ω
			T$_A$ = T$_{MIN}$ to T$_{MAX}$			5	
On-Resistance Match Between Channels (Notes 2, 8)	ΔR$_{ON}$	V+ = 4.5V, I$_{COM\_}$ = 10mA, V$_{NO\_}$ or V$_{NC\_}$ = 0 to V+	T$_A$ = +25°C		0.2	0.6	Ω
			T$_A$ = T$_{MIN}$ to T$_{MAX}$			0.8	
On-Resistance Flatness (Note 3)	R$_{FLAT}$	V+ = 4.5V, I$_{COM\_}$ = 10mA, V$_{NO\_}$ or V$_{NC\_}$ = 0 to V+	T$_A$ = +25°C		0.85	1	Ω
			T$_A$ = T$_{MIN}$ to T$_{MAX}$			1.5	
NO_, NC_ Off-Leakage Current (Note 4)	I$_{NO\_(OFF)}$, I$_{NC\_(OFF)}$	V+ = 5.5V, V$_{COM\_}$ = 1V or 4.5V, V$_{NO\_}$ or V$_{NC\_}$ = 4.5V or 1V	T$_A$ = +25°C	-0.25	0.01	0.25	nA
			T$_A$ = T$_{MIN}$ to T$_{MAX}$	-0.35		0.35	
COM_ Off-Leakage Current (Note 4)	I$_{COM\_(OFF)}$	V+ = 5.5V, V$_{COM\_}$ = 1V or 4.5V, V$_{NO\_}$ or V$_{NC\_}$ = 4.5V or 1V	T$_A$ = +25°C	-0.25	0.01	0.25	nA
			T$_A$ = T$_{MIN}$ to T$_{MAX}$	-0.35		0.35	
COM_ On-Leakage Current (Notes 4, 5)	I$_{COM\_(ON)}$	V+ = 5.5V, V$_{COM\_}$ = 1V or 4.5V	T$_A$ = +25°C	-0.25	0.01	0.25	nA
			T$_A$ = T$_{MIN}$ to T$_{MAX}$	-0.35		0.35	
DIGITAL INPUTS							
IN_ Input Logic High	V$_{IH}$			2.4			V
IN_ Input Logic Low	V$_{IL}$					0.8	V
IN_ Input Current	I$_{IN}$	V$_{IN\_}$ = 0.8V or 2.4V		-0.1	0.005	0.1	µA

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MAX4641/MAX4642/MAX4643

ELECTRICAL CHARACTERISTICS—Single +5V Supply (continued)

(V+ = +4.5V to +5.5V, V_{INH} = 2.4V, V_{INL} = 0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
DYNAMIC							
Turn-On Time (Note 4)	t_{ON}	R_L = 300Ω, C_L = 35pF, $V_{NO\_}$ = $V_{NC\_}$ = 3V, Figure 2	T_A = +25°C		9	15	ns
			T_A = T_{MIN} to T_{MAX}			18	
Turn-Off Time (Note 4)	t_{OFF}	R_L = 300Ω, C_L = 35pF, $V_{NO\_}$ = $V_{NC\_}$ = 3V, Figure 2	T_A = +25°C		5	8	ns
			T_A = T_{MIN} to T_{MAX}			10	
Break-Before-Make (Note 4) (MAX4643 only)	t_{BBM}	R_L = 300Ω, C_L = 35pF, $V_{NO\_}$ = $V_{NC\_}$ = 3V, Figure 2	T_A = +25°C		7		ns
			T_A = T_{MIN} to T_{MAX}	1			
Charge Injection	Q	V_{GEN} = 0, R_{GEN} = 0, C_L = 1nF, Figure 4			2		pC
NO_, NC_ Off-Capacitance	$C_{NO\_ (OFF)}$, $C_{NC\_ (OFF)}$	NO_ or NC_ = GND, f = 1MHz, Figure 5			7		pF
COM_ Off-Capacitance	$C_{COM\_ (OFF)}$	f = 1MHz, Figure 5			7		pF
Switch On-Capacitance	$C_{(ON)}$	f = 1MHz, Figure 5			18		pF
Off-Isolation (Note 6)	V_{ISO}	C_L = 5pF, R_L = 50Ω, Figure 3	f = 10MHz		-56		dB
			f = 1MHz		-80		
Crosstalk (Note 7)	V_{CT}	C_L = 5pF, R_L = 50Ω, Figure 3	f = 10MHz		-77		dB
			f = 1MHz		-97		
Total Harmonic Distortion	THD	R_L = 600Ω, 0.5Vp-p, f = 20Hz to 20kHz			0.018		%
SUPPLY							
Positive Supply Current	I+	V+ = 5.5V, $V_{IN\_}$ = 0 or V+			0.001	1.0	µA

ELECTRICAL CHARACTERISTICS—Single +3V Supply

(V+ = +2.7V to +3.3V, V_{INH} = 2.0V, V_{INL} = 0.4V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
ANALOG SWITCH							
Analog Signal Range	$V_{COM\_}$, $V_{NO\_}$, $V_{NC\_}$			0		V+	V
On-Resistance	R_{ON}	V+ = 2.7V, $I_{COM\_}$ = 10mA, $V_{NO\_}$ or $V_{NC\_}$ = 0 to V+	T_A = +25°C		6	8	Ω
			T_A = T_{MIN} to T_{MAX}			9	
On-Resistance Match Between Channels (Notes 2, 8)	ΔR_{ON}	V+ = 2.7V, $I_{COM\_}$ = 10mA, $V_{NO\_}$ or $V_{NC\_}$ = 0 to V+	T_A = +25°C		0.2	0.6	Ω
			T_A = T_{MIN} to T_{MAX}			0.8	
On-Resistance Flatness (Note 3)	R_{FLAT}	V+ = 2.7V, $I_{COM\_}$ = 10mA, $V_{NO\_}$ or $V_{NC\_}$ = 0 to V+	T_A = +25°C		1.5	3.0	Ω
			T_A = T_{MIN} to T_{MAX}			3.5	

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MAX4641/MAX4642/MAX4643

ELECTRICAL CHARACTERISTICS—Single +3V Supply (continued)

(V+ = +2.7V to +3.3V, V_{INH} = 2.0V, V_{INL} = 0.4V, $T_A = T_{MIN}$ to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
DIGITAL INPUTS							
IN_ Input Logic High	V_{IH}			2.0			V
IN_ Input Logic Low	V_{IL}					0.4	V
IN_ Input Current	I_{IN}	$V_{IN\_}$ = 0.4V or 2.0V		-0.1	0.005	0.1	µA
DYNAMIC							
Turn-On Time (Note 4)	t_{ON}	R_L = 300Ω, C_L = 35pF, $V_{NO\_}$ = $V_{NC\_}$ = 2V, Figure 2	T_A = +25°C		14	20	ns
			$T_A = T_{MIN}$ to T_{MAX}			22	
Turn-Off Time (Note 4)	t_{OFF}	R_L = 300Ω, C_L = 35pF, $V_{NO\_}$ = $V_{NC\_}$ = 2V, Figure 2	T_A = +25°C		6	10	ns
			$T_A = T_{MIN}$ to T_{MAX}			11	
Break-Before-Make (Note 4) (MAX4643 only)	t_{BBM}	R_L = 300Ω, C_L = 35pF, $V_{NO\_}$ = $V_{NC\_}$ = 2V, Figure 2	T_A = +25°C		7		ns
			$T_A = T_{MIN}$ to T_{MAX}	1			
Charge Injection	Q	V_{GEN} = 0, R_{GEN} = 0, C_L = 1nF, Figure 4			2		pC
NO_, NC_ Off-Capacitance	$C_{NO\_(OFF)}$, $C_{NC\_(OFF)}$	NO_ or NC_ = GND, f = 1MHz, Figure 5			7		pF
COM_ Off-Capacitance	$C_{COM\_(OFF)}$	f =1MHz, Figure 5			7		pF
Switch On-Capacitance	$C_{(ON)}$	f =1MHz, Figure 5			18		pF
Off-Isolation (Note 6)	V_{ISO}	C_L = 5pF, R_L = 50Ω, Figure 3	f = 10MHz		-56		dB
			f = 1MHz		-80		
Crosstalk (Note 7)	V_{CT}	C_L = 5pF, R_L = 50Ω, Figure 3	f = 10MHz		-77		dB
			f = 1MHz		-97		
SUPPLY							
Positive Supply Current	I+	V+ = 3.3V, $V_{IN\_}$ = 0 or V+			0.001	1.0	µA

Note 2: $\Delta R_{ON} = R_{ON(MAX)} - R_{ON(MIN)}$.
Note 3: R_{ON} Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal range.
Note 4: Guaranteed by design.
Note 5: On-Leakage performed with voltage applied to COM_, with NO_ and NC_ left floating.
Note 6: Off-Isolation = $20\log_{10}(V_{O\_}/V_{I\_})$, where V_O is $V_{COM\_}$ and V_I is $V_{NC\_}$ or $V_{NO\_}$ from the network analyzer.
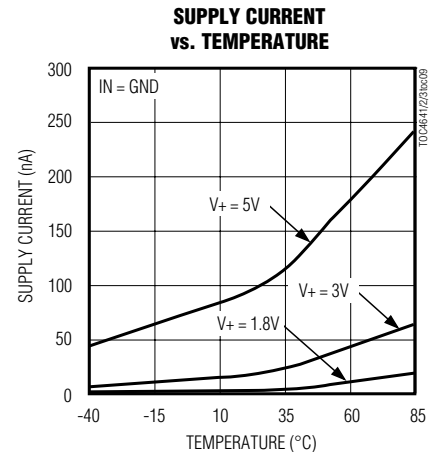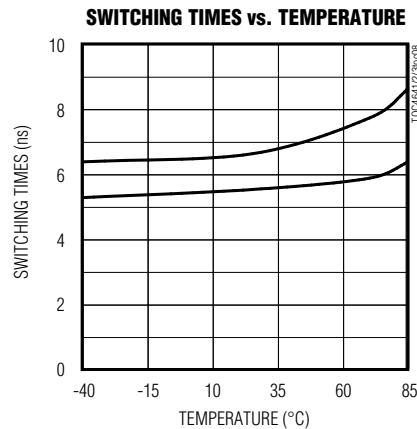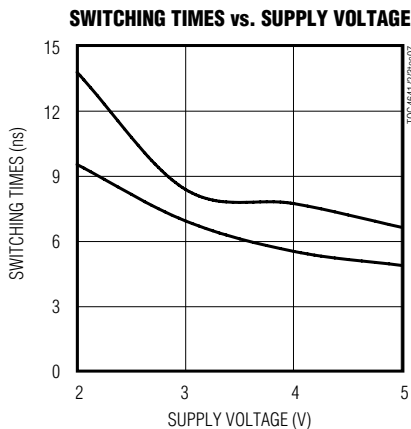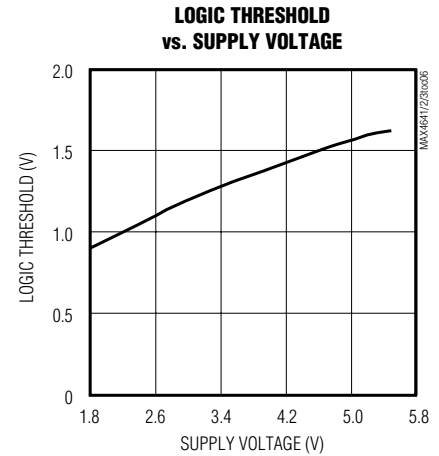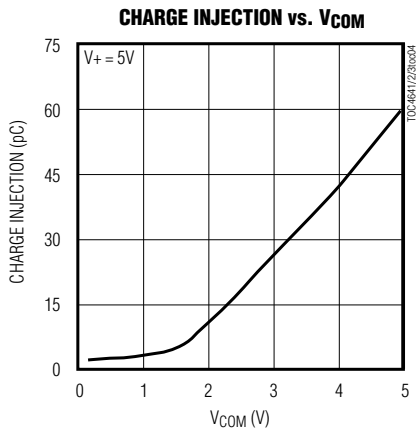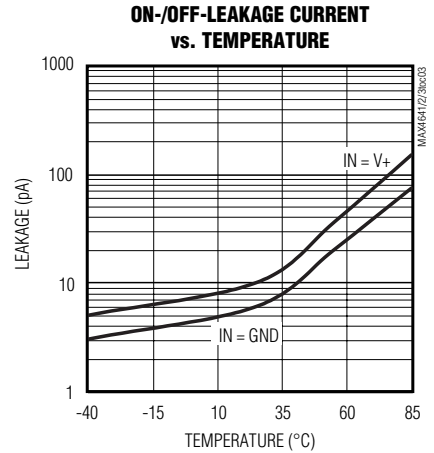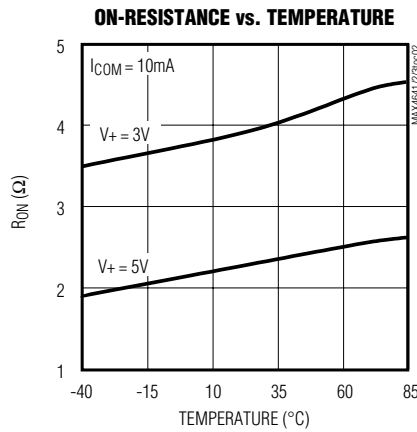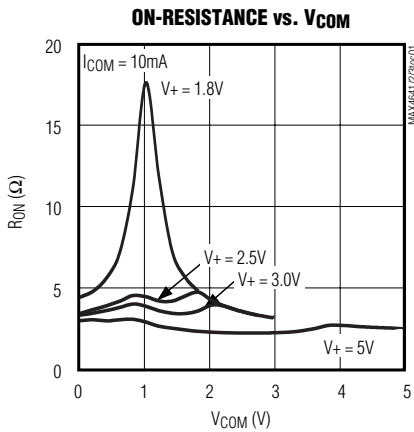**Note 7:** Crosstalk is measured between the two switches.
Note 8: R_{ON} and ΔR_{ON} matching specifications for QFN-packaged parts are guaranteed by design.

MAXIM

High-Speed, Low-Voltage, 4Ω, Dual SPST CMOS Analog Switches

_____Typical Operating Characteristics

(V+ = +5V or +3V, V_{INH} = V+, V_{INL} = GND, T_A = +25°C, unless otherwise noted.)

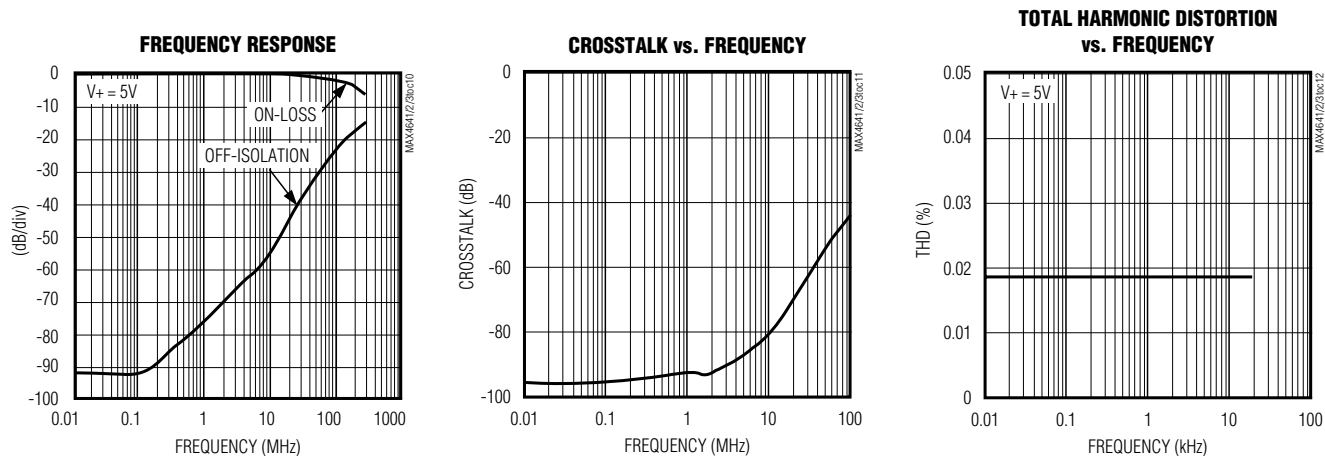**ON-RESISTANCE vs. V_{COM}**

ON-RESISTANCE vs. TEMPERATURE

ON-/OFF-LEAKAGE CURRENT vs. TEMPERATURE

CHARGE INJECTION vs. V_{COM}

SUPPLY CURRENT vs. SUPPLY VOLTAGE

LOGIC THRESHOLD vs. SUPPLY VOLTAGE

SWITCHING TIMES vs. SUPPLY VOLTAGE

SWITCHING TIMES vs. TEMPERATURE

SUPPLY CURRENT vs. TEMPERATURE

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Typical Operating Characteristics (continued)

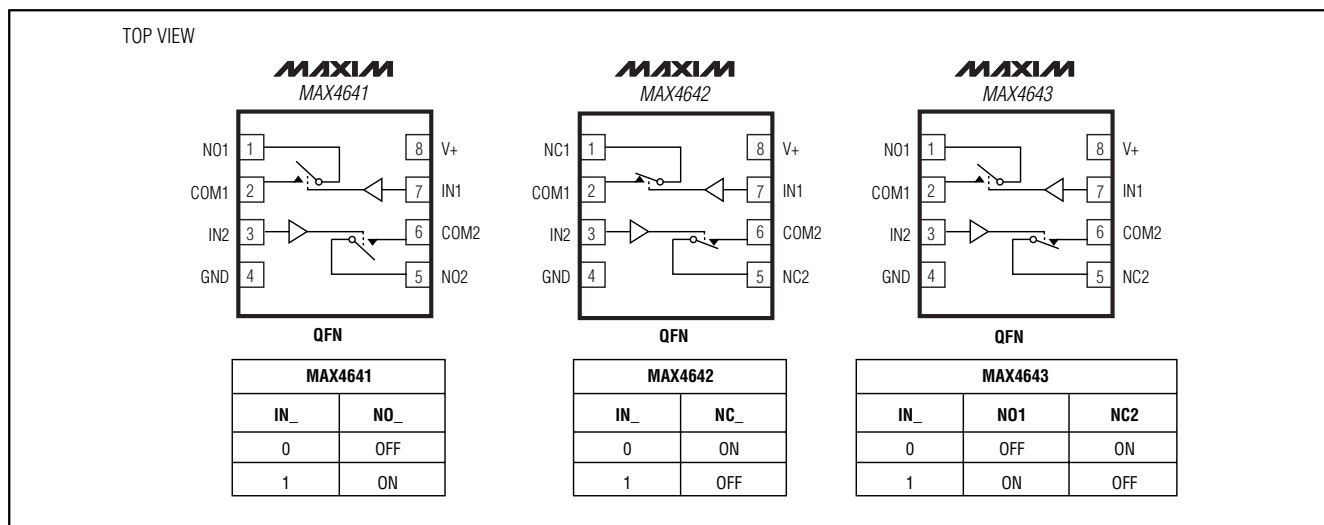(V+ = +5V or +3V, V$_{INH}$ = V+, V$_{INL}$ = GND, T$_A$ = +25°C, unless otherwise noted.)

FREQUENCY RESPONSE

CROSSTALK vs. FREQUENCY

TOTAL HARMONIC DISTORTION vs. FREQUENCY

Pin Description

PIN			NAME	FUNCTION
MAX4641	**MAX4642**	**MAX4643**		
1, 5	–	–	NO1, NO2	Analog Switch Normally Open Terminals
–	1, 5	–	NC1, NC2	Analog Switch Normally Closed Terminals
–	–	1	NO1	Analog Switch Normally Open Terminal
–	–	5	NC2	Analog Switch Normally Closed Terminal
2, 6	2, 6	2, 6	COM1, COM2	Analog Switch Common Terminals
3, 7	3, 7	3, 7	IN2, IN1	Logic-Controlled Inputs
4	4	4	GND	Ground
8	8	8	V+	Positive Supply Input. Bypass with a 0.1µF capacitor to GND.

Note: NO_, NC_, and COM_ pins are identical and interchangeable. Signals can be passed through either side of these bidirectional switches. However, the typical off-capacitances differ, as shown in the *Electrical Characteristics.*

_____Pin Configurations/Functional Diagrams/Truth Tables (continued)_

TOP VIEW

MAXIM
MAX4641

NO1	1		8	V+
COM1	2		7	IN1
IN2	3		6	COM2
GND	4		5	NO2

QFN

MAX4641	
IN_	NO_
0	OFF
1	ON

MAXIM
MAX4642

NC1	1		8	V+
COM1	2		7	IN1
IN2	3		6	COM2
GND	4		5	NC2

QFN

MAX4642	
IN_	NC_
0	ON
1	OFF

MAXIM
MAX4643

NO1	1		8	V+
COM1	2		7	IN1
IN2	3		6	COM2
GND	4		5	NC2

QFN

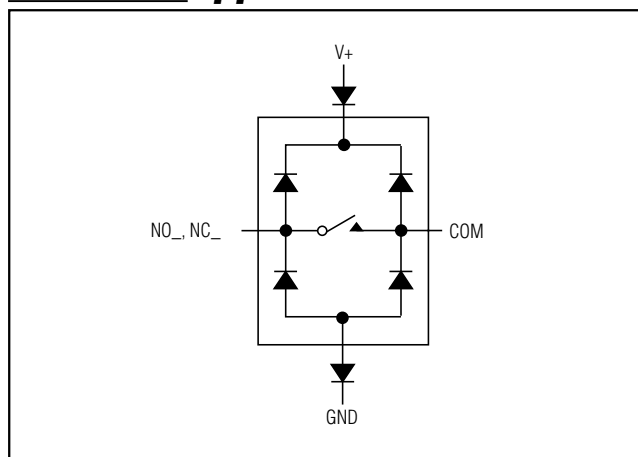| MAX4643		
IN_	NO1	NC2
0	OFF	ON
1	ON	OFF

_____Applications Information

Figure 1. Overvoltage Protection Using External Blocking
Diodes

The MAX4641/MAX4642/MAX4643 operate from a single supply ranging from +1.8V to +5.5V. The devices are guaranteed to be functional over that supply range, but TTL/CMOS compatibility is only valid for operation using a +5V supply. All voltage levels are referenced to GND. Positive and negative DC analog inputs or AC signals can be accommodated by shifting V+ and GND.

ESD-protection diodes are internally connected between each analog-signal pin and both V+ and GND. One of these diodes conducts if any analog signal exceeds V+ or GND (Figure 1). Virtually all of the analog leakage current comes from the ESD diodes to V+ or GND. 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 their leakages 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 the same or opposite polarity.

There is no normal current path between the analog-signal paths and V+ or GND. V+ and GND also power the internal logic and logic-level translators. The logic-level translators convert the logic level into switched V+ and GND signals to drive the analog signal gates.

MAX4641/MAX4642/MAX4643
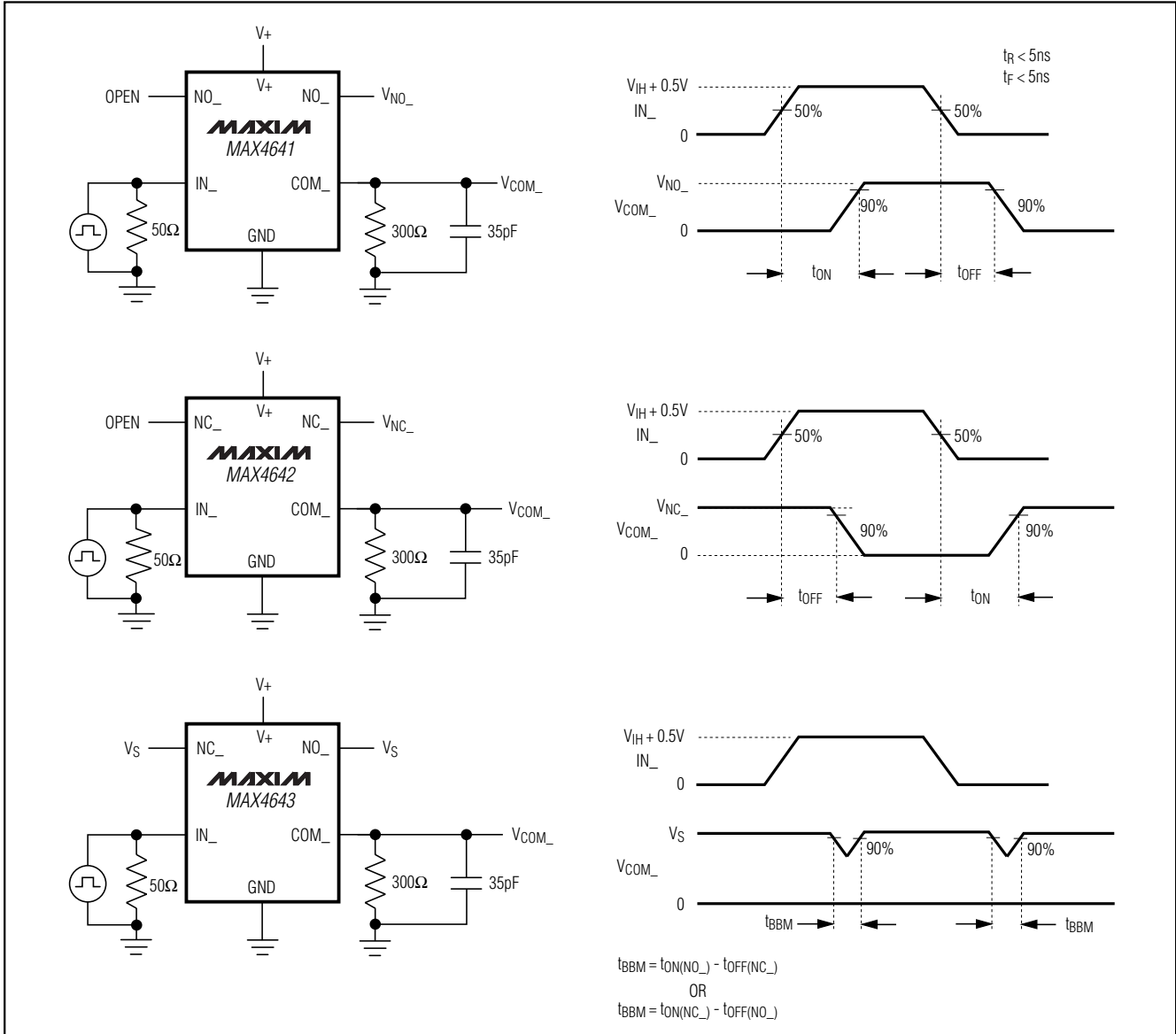
Figure 2. Switching Times

MAXIM

MAX4641/MAX4642/MAX4643

MEASUREMENTS ARE STANDARDIZED AGAINST SHORT AT SOCKET TERMINALS. OFF-ISOLATION IS MEASURED BETWEEN COM AND "OFF" TERMINAL ON EACH SWITCH. ON-LOSS IS MEASURED BETWEEN COM AND "ON" TERMINAL ON EACH SWITCH. SIGNAL DIRECTION THROUGH SWITCH IS REVERSED; WORST VALUES ARE RECORDED.

$$\text{OFF-ISOLATION} = 20\log \frac{V_{OUT}}{V_{IN}}$$

$$\text{ON-LOSS} = 20\log \frac{V_{OUT}}{V_{IN}}$$

* ADD 50Ω TERMINATION FOR OFF-ISOLATION
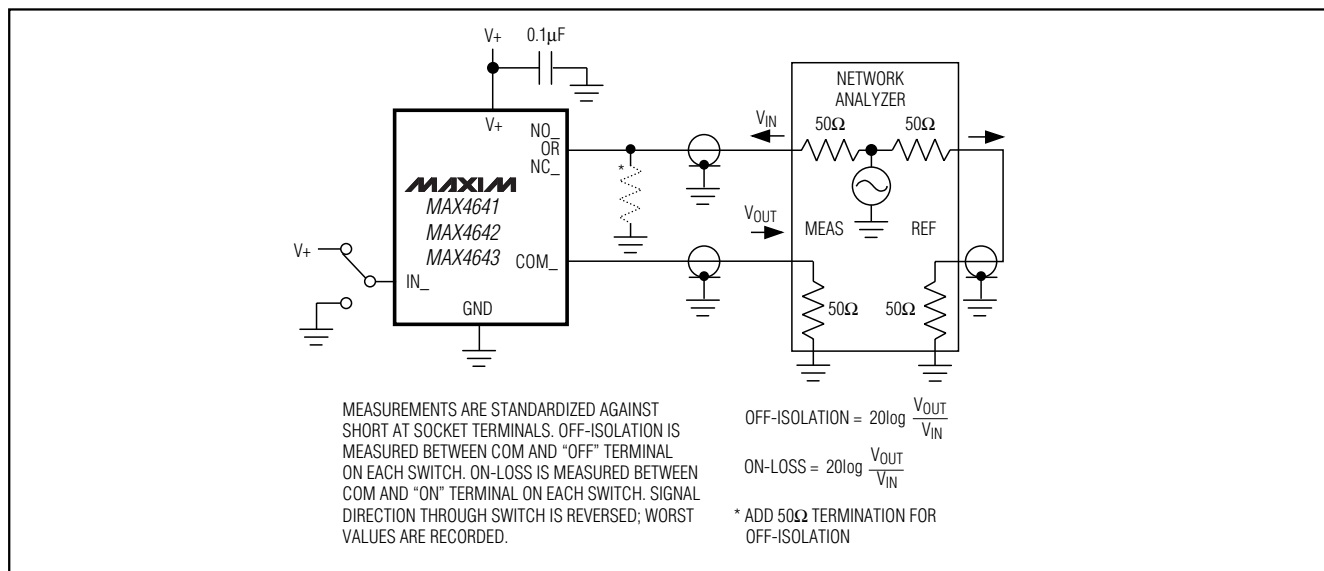
Figure 3. Off-Isolation, On-Loss, and Crosstalk

ΔV_{OUT} IS THE MEASURED VOLTAGE DUE TO CHARGE TRANSFER ERROR Q WHEN THE CHANNEL TURNS OFF.
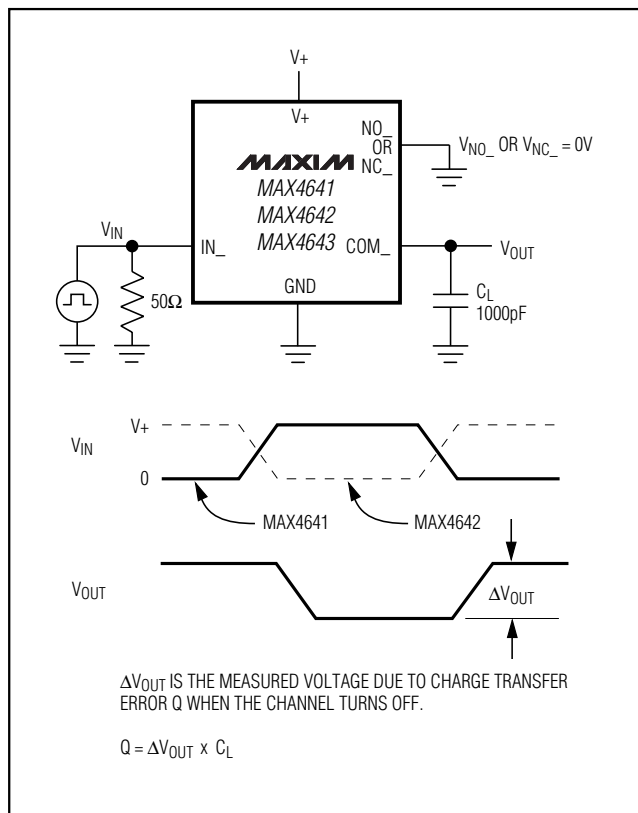
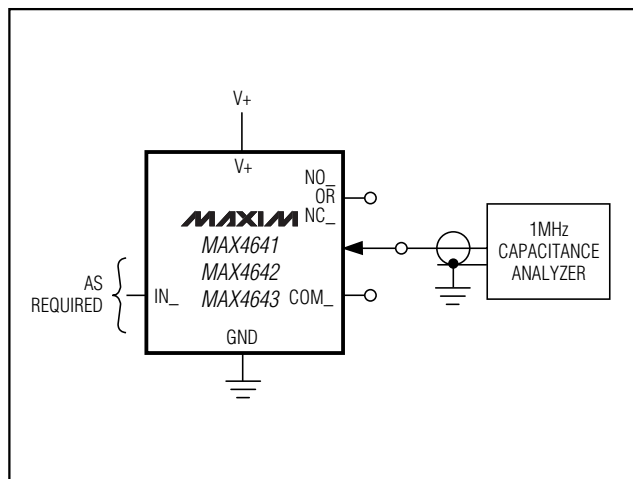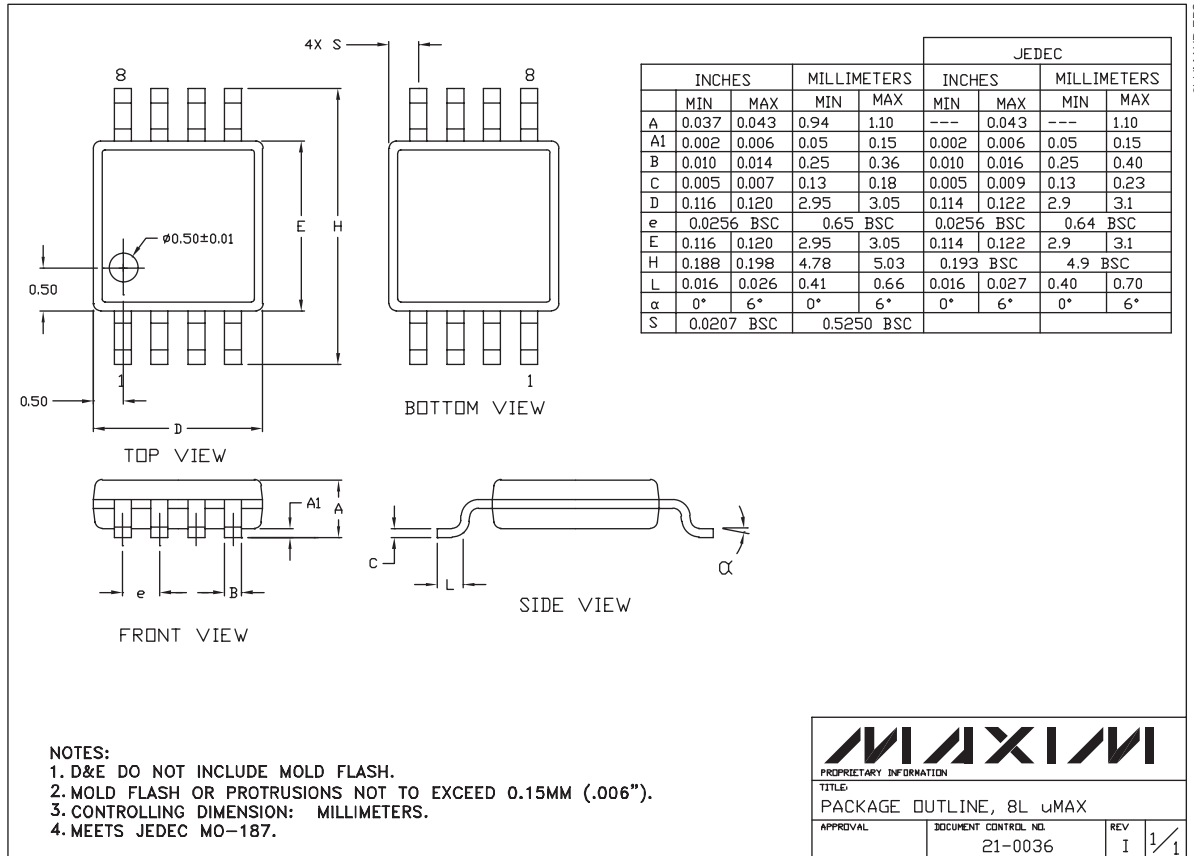$$Q = \Delta V_{OUT} \times C_L$$

Figure 4. Charge Injection

Figure 5. NO_, NC_, and COM_ Capacitance

_____Chip Information

TRANSISTOR COUNT: 105

High-Speed, Low-Voltage, 4Ω, Dual SPST CMOS Analog Switches

_____Package Information

8LUMAXD.EPS

	INCHES		MILLIMETERS		INCHES		MILLIMETERS	
					JEDEC			
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
A	0.037	0.043	0.94	1.10	---	0.043	---	1.10
A1	0.002	0.006	0.05	0.15	0.002	0.006	0.05	0.15
B	0.010	0.014	0.25	0.36	0.010	0.016	0.25	0.40
C	0.005	0.007	0.13	0.18	0.005	0.009	0.13	0.23
D	0.116	0.120	2.95	3.05	0.114	0.122	2.9	3.1
e	0.0256 BSC		0.65 BSC		0.0256 BSC		0.64 BSC	
E	0.116	0.120	2.95	3.05	0.114	0.122	2.9	3.1
H	0.188	0.198	4.78	5.03	0.193 BSC		4.9 BSC	
L	0.016	0.026	0.41	0.66	0.016	0.027	0.40	0.70
α	0°	6°	0°	6°	0°	6°	0°	6°
S	0.0207 BSC		0.5250 BSC					

TOP VIEW

BOTTOM VIEW

FRONT VIEW

SIDE VIEW

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15MM (.006").
3. CONTROLLING DIMENSION: MILLIMETERS.
4. MEETS JEDEC MO-187.

MAXIM

PROPRIETARY INFORMATION

TITLE:
PACKAGE OUTLINE, 8L uMAX

APPROVAL

DOCUMENT CONTROL NO.
21-0036

REV
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MAXIM

| WHAT'S NEW | PRODUCTS | SOLUTIONS | DESIGN | APPNOTES | SUPPORT | BUY | COMPANY | MEMBERS |

MAX4642

Part Number Table

Notes:

1. See the MAX4642 QuickView Data Sheet for further information on this product family or download the MAX4642 full data sheet (PDF, 208kB).
2. Other options and links for purchasing parts are listed at: http://www.maxim-ic.com/sales.
3. Didn't Find What You Need? Ask our applications engineers. Expert assistance in finding parts, usually within one business day.
4. Part number suffixes: T or T&R = tape and reel; + = RoHS/lead-free; # = RoHS/lead-exempt. More: See full data sheet or Part Naming Conventions.
5. * Some packages have variations, listed on the drawing. "PkgCode/Variation" tells which variation the product uses.

Part Number	Free Sample	Buy Direct	Package: TYPE PINS SIZE DRAWING CODE/VAR *	Temp	RoHS/Lead-Free? Materials Analysis
MAX4642EUA+			uMAX;8 pin;3 x 3mm Dwg: 21-0036J (PDF) Use pkgcode/variation: U8+1*	-40C to +85C	RoHS/Lead-Free: Yes Materials Analysis
MAX4642EUA+G104			uMAX;8 pin;3 x 3mm Dwg: 21-0036J (PDF) Use pkgcode/variation: U8+1*	-40C to +85C	RoHS/Lead-Free: Yes Materials Analysis
MAX4642EUA+T			uMAX;8 pin;3 x 3mm Dwg: 21-0036J (PDF) Use pkgcode/variation: U8+1*	-40C to +85C	RoHS/Lead-Free: Yes Materials Analysis
MAX4642EUA+TG104			uMAX;8 pin;3 x 3mm Dwg: 21-0036J (PDF) Use pkgcode/variation: U8+1*	-40C to +85C	RoHS/Lead-Free: Yes Materials Analysis
MAX4642EUA			uMAX;8 pin;3 x 3mm Dwg: 21-0036J (PDF) Use pkgcode/variation: U8-1*	-40C to +85C	RoHS/Lead-Free: No Materials Analysis
MAX4642EUA-T			uMAX;8 pin;3 x 3mm Dwg: 21-0036J (PDF) Use pkgcode/variation: U8-1*	-40C to +85C	RoHS/Lead-Free: No Materials Analysis

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