# Ultra-Small, Low-Ron, Beyond-the-Rails™ DPDT Analog Switches

#### **General Description**

The MAX14689 ultra-small, low-on-resistance (R<sub>ON</sub>) double-pole/double-throw (DPDT) analog switches feature Beyond-the-Rails <sup>TM</sup> capability that allows signals from -5.5V to +5.5V to pass without distortion, even when the power supply is below the signal range. The low on-resistance (0.25 $\Omega$ ) also makes the device ideal for low-distortion switching applications, such as audio or video.

The MAX14689 is fully specified to operate from a single +1.6V to +5.5V power supply. Because of the low supply current requirement,  $V_{CC}$  can be provided by a GPIO. When power is not applied, the switches go to a high-impedance mode and all analog signal ports can withstand signals from -5.5V to +5.5V. The switch is controlled with a single control bit, CB.

The MAX14689 is available in a 1.2mm x 1.2mm, 0.4mm pitch, 9-bump wafer-level package (WLP), and operate over the -40°C to +85°C extended temperature range.

#### **Applications**

- Smartphones
- Tablets
- Portable Audio/Video Equipment
- Low-Distortion Signal Switches

Beyond-the-Rails $^{\text{TM}}$  is a trademark of Maxim Integrated Products, Inc.

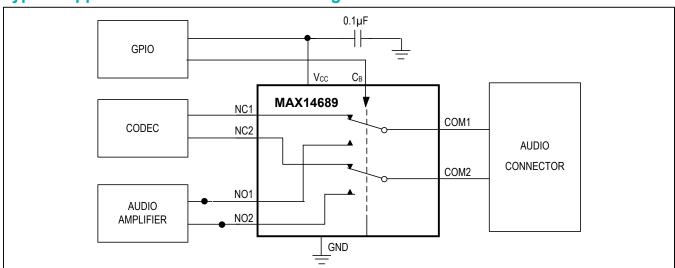
#### **Benefits and Features**

- Distortion-Free Beyond-the-Rails Signaling
  - Negative Voltage Audio and Video Signal Capable
  - -5.5V to +5.5V Analog Signal Range Independent from V<sub>CC</sub>
  - On-Resistance 0.25Ω (typ)
  - +1.6V to +5.5V Single-Supply Range
  - Total Harmonic Distortion Plus Noise 0.001% (typ)
  - On-Resistance Flatness 0.001Ω (typ)
- Low Supply Current 40µA (typ) at 1.6V
  - · Can be Powered by GPIO
  - High-Impedance Mode when V<sub>CC</sub> Not Applied
- ESD Protection on COM
  - · ±15kV Human Body Model
  - ±10kV IEC 61000-4-2 Air Gap
  - ±8kV IEC 61000-4-2 Contact
- ESD Protection on NC and NO
  - ±15kV Human Body Model
- Design Flexibility
  - · Break-Before-Make Operation
  - 9-Bump WLP (1.2mm x 1.2mm) Package
  - -40°C to +85°C Operating Temperature Range

#### Ordering Information appears at end of data sheet.

For related parts and recommended products to use with this part, refer to www.maximintegrated.com/MAX14689.related.

## **Typical Application Circuit/Functional Diagram**





# Ultra-Small, Low-R<sub>ON</sub>, Beyond-the-Rails™ DPDT Analog Switches

## **Absolute Maximum Ratings**

(All voltages referenced to GND.)	Continuous Power Dissipation (T <sub>A</sub> = +70°C)
V <sub>CC</sub> , CB0.3V to +6V	9-Bump WLP (derate 12mW/°C above +70°C)963.8mW
NC_, NO_, COM6V to +6V	Operating Temperature Range40°C to +85°C
Continuous Current NC_, NO_, COM±500mA	Junction Temperature+150°C
Peak Current NC_, NO_, COM_ (50% duty cycle)±850mA	Storage Temperature Range65°C to +150°C
	Soldering Temperature (reflow) +260°C

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.

## **Package Thermal Characteristics (Note 1)**

WI P

Junction-to-Ambient Thermal Resistance (θ<sub>JA</sub>)......83°C/W

**Note 1:** Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to <a href="https://www.maximintegrated.com/thermal-tutorial">www.maximintegrated.com/thermal-tutorial</a>.

#### **Electrical Characteristics**

 $(V_{CC} = +1.6V \text{ to } +5.5V, T_A = -40^{\circ}\text{C} \text{ to } +85^{\circ}\text{C}, \text{ unless otherwise noted.})$  (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNIT
POWER SUPPLY							
Power-Supply Range	Vcc			1.6		5.5	V
Power-Supply Rejection Ratio	PSRR	R <sub>COM</sub> = 32Ω, f = 20kHz			80		dB
Cumply Cumpant	1	V <sub>CC</sub> = +1.6V, V <sub>CB</sub> = 0V or V <sub>CC</sub>			40	65	
Supply Current	Icc	V <sub>CC</sub> = +4.2V, V <sub>CB</sub> = 0V or	VCC		70	125	μA
ANALOG SWITCH							
Analog Signal Range	V <sub>NC_</sub> , V <sub>NO_</sub> , V <sub>COM_</sub>			-5.5		+5.5	V
On-Resistance	Davi	V <sub>COM</sub> = 0V,	V <sub>CC</sub> = 2.5V		0.25	0.45	0
On-Resistance	RON	I <sub>COM</sub> _= 100mA (Note 3)	V <sub>CC</sub> = 1.8V		0.325	0.55	
On-Resistance Match Between Channels	ΔRON	V <sub>CC</sub> = 2.5V, V <sub>NC</sub> = 0V, I <sub>COM</sub> = 100mA, between same NC_ and NO_ channel (Note 4)			0.005	0.05	Ω
On-Resistance Flatness	R <sub>FLAT)</sub>	V <sub>CC</sub> = 2.5V, I <sub>COM</sub> = 100mA, V <sub>COM</sub> = -5.5V to 5.5V (Notes 5,6)			0.001	0.01	Ω
NC_ or NO_ Off-Leakage Current	INC_(OFF),	V <sub>CC</sub> = 2.5V, switch open, V <sub>NO</sub> _ or V <sub>NC</sub> _ = -5.5 or +5.5V V <sub>COM</sub> _ = +5.5V, -5.5V, unconnected		-100		+100	nA
COM_ Off-Leakage Current	ICOM_(OFF)	V <sub>CC</sub> = 0V V <sub>COM</sub> = -5.5V, 0V, +5.5 V <sub>NO</sub> or V <sub>NC</sub> = -5.5V, +5.5V, unconnected		-100		+100	nA

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# **Electrical Characteristics (continued)**

 $(V_{CC} = +1.6V \text{ to } +5.5V, T_A = -40^{\circ}\text{C} \text{ to } +85^{\circ}\text{C}, \text{ unless otherwise noted.})$  (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNIT
COM_ On Leakage-Current	ICOM_(ON)	V <sub>CC</sub> = 2.5V, switch closed, V <sub>COM</sub> = +5.5V, -5.5V V <sub>NO</sub> or V <sub>NC</sub> = +5.5V, -5.5V, unconnected		-100		+100	nA
DYNAMIC TIMING							
Turn-Off Time	tOFF	V <sub>NO</sub> or V <sub>NC</sub> = 0V, R <sub>L</sub> = 5 Figure 1 (Note 6)	50Ω,		5	30	μs
Break-Before-Make Time	topus	$R_L$ = 50Ω. Time that both NC_/NO_ switches are	V <sub>CC</sub> = 2.5V	0	80	150	110
Bleak-Belole-Wake Tillle	<sup>t</sup> BBM	open during transition, Figure 2 (Note 6)	V <sub>CC</sub> = 1.8V	0		250	μs
		V <sub>NO</sub> or V <sub>NC</sub> = 0V, Figure 1 (Note 6)	V <sub>CC</sub> = 2.5V		85	200	
Turn-On Time	ton		V <sub>CC</sub> = 1.8V			250	μs
AUDIO PERFORMANCE							
Total Harmonic Distortion Plus Noise	THD+N	$f$ = 20Hz to 20kHz, $V_{COM}$ = 0.5Vp-p, R <sub>S</sub> = R <sub>L</sub> = 50Ω; DC bias = 0V			0.001		%
Off-Isolation	VISO	$R_S = R_L = 50\Omega$ ; $V_{COM} = 0.5V_{P-P}$ , $f = 100kHz$ , $V_{CC} = 0V$ , DC bias = 0.25V, Figure 3			-60		dB
Crosstalk	VCT	$R_S = R_L = 50\Omega$ ; $V_{COM} = 0.5V_{P-P}$ , $f = 100kHz$ (Note 7), Figure 3			-100		dB
-3dB Bandwidth	BW	$R_S = R_L = 50\Omega$			110		MHz
NC_ or NO_ Off-Capacitance	C <sub>NC_(OFF)</sub> C <sub>NO_(OFF)</sub>	V <sub>NC</sub> / V <sub>NO</sub> = 0.5V <sub>P-P</sub> , f = 1MHz			25		pF
COM_ On-Capacitance	CCOM_(ON)	V <sub>NC</sub> /V <sub>NO</sub> _ = 0.5V <sub>P-P</sub> , f =	1MHz		50		pF
DIGITAL I/O							
Input Logic High Voltage	VIH			1.4			V
Input Logic Low Voltage	VIN					0.325	V
Input Leakage Current	I <sub>IN</sub>	V <sub>CB</sub> = 0V or V <sub>CC</sub>		-1		+1	μΑ
THERMAL PROTECTION							
Thermal Shutdown					+150		°C
Thermal Shutdown Hysteresis					25		°C

#### **Electrical Characteristics (continued)**

 $(V_{CC} = +1.6V \text{ to } +5.5V, T_A = -40^{\circ}\text{C} \text{ to } +85^{\circ}\text{C}, \text{ unless otherwise noted.}$  Typical values are at  $V_{CC} = +2.5V, T_A = +25^{\circ}\text{C}, \text{ unless otherwise noted.}$ noted.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN TYP MAX		MAX	UNIT
ESD PROTECTION						
		Human Body Model		±15		
COM_		IEC 61000-4-2 Air-Gap		±10	,	kV
		IEC 61000-4-2 Contact Discharge		±8		
NC_, NO_		Human Body Model	±15		kV	
All Other Pins		Human Body Model	±2		kV	

- Note 2: All specifications are 100% production tested at  $T_A = +25$ °C, unless otherwise noted. Specifications over  $T_A = -40$ °C to +85°C are guaranteed by design.
- **Note 3:** The same limits apply for  $V_{COM} = -5.5V$  to +5.5V and are guaranteed by design.
- Note 4:  $\Delta R_{ON} = |R_{ON(CH1)} R_{ON(CH2)}|$ . Note 5: Flatness is defined as the difference between the maximum and minimum value of on-resistance, as measured over specified analog signal ranges.
- Note 6: Guaranteed by design; not production tested.
- Note 7: Between two switches.

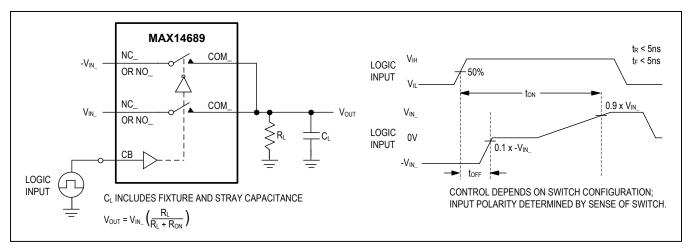


Figure 1. Switching Time

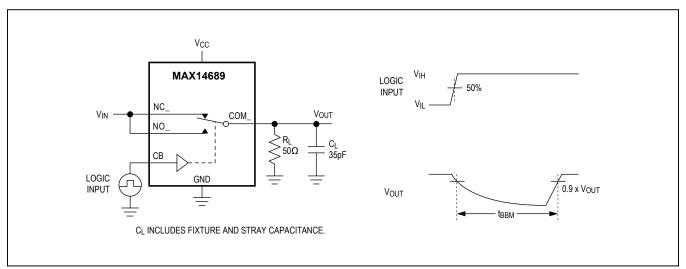


Figure 2. Break-Before-Make Interval

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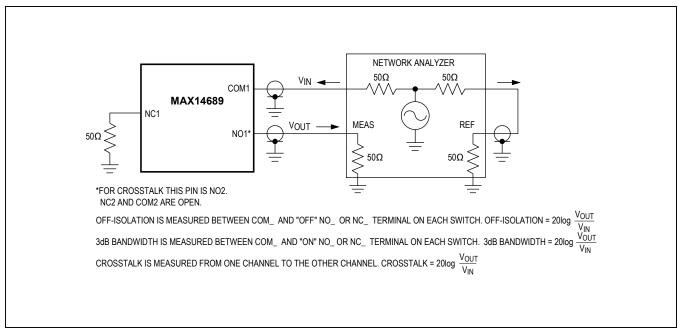
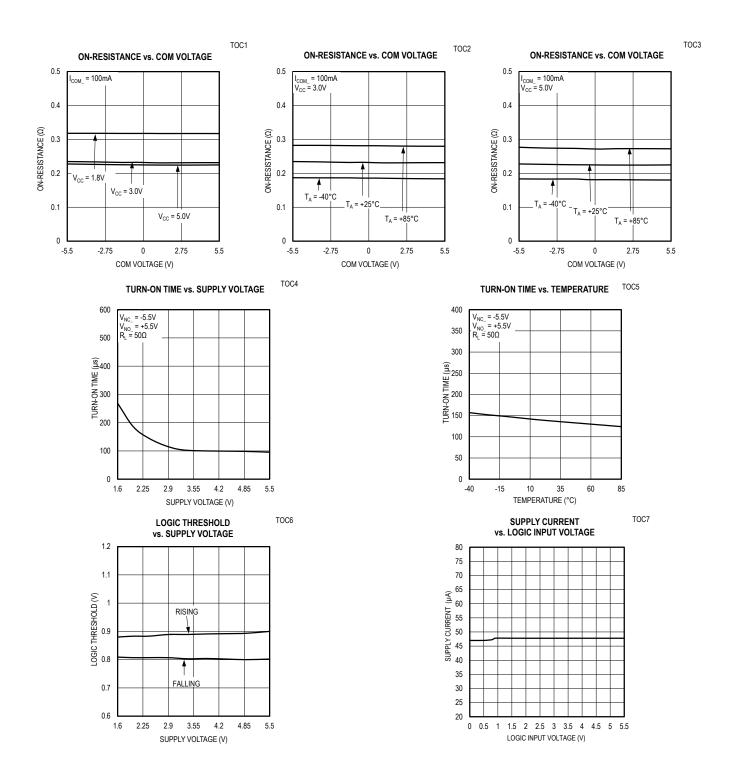


Figure 3. 3dB Bandwidth, Off-Isolation, and Crosstalk

# **Typical Operating Characteristics**

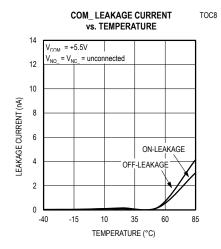
 $(VCC = 2.5V, TA = +25^{\circ}C, unless otherwise noted.)$ 

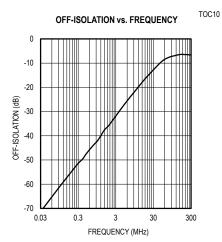


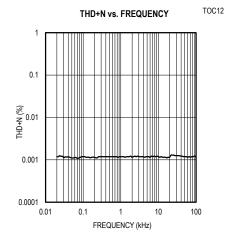
# Ultra-Small, Low-RON, Beyond-the-Rails™ DPDT Analog Switches

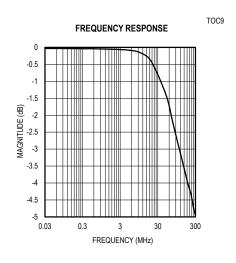
# **Typical Operating Characteristics (continued)**

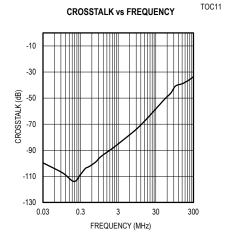
(VCC = 2.5V, T<sub>A</sub> = +25°C, unless otherwise noted.)

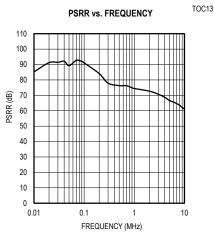




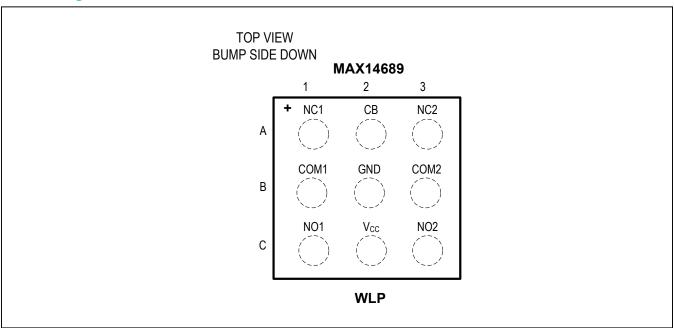








# **Pin Configuration**



# **Pin Description**

PIN	NAME	FUNCTION
A1	NC1	Normally Closed Terminal for Switch 1
A2	СВ	Digital Control Input. Drive CB low to connect COM_ to NC Drive CB high to connect COM_ to NO
A3	NC2	Normally Closed Terminal for Switch 2
B1	COM1	Common Terminal for Switch 1
B2	GND	Ground
В3	COM2	Common Terminal for Switch 2
C1	NO1	Normally Open Terminal for Switch 1
C2	V <sub>CC</sub>	Supply Voltage Input. Bypass V <sub>CC</sub> to GND with a 0.1µF capacitor as close to the device as possible.
C3	NO2	Normally Open Terminal for Switch 2

# Ultra-Small, Low-Ron, Beyond-the-Rails™ DPDT Analog Switches

#### **Detailed Description**

The MAX14689 is an ultra-small, low on-resistance, high ESD-protected DPDT switch that operates from a +1.6V to +5.5V supply, and is designed to pass analog signals such as AC-biased or DC-biased audio and video signals. These switches feature the low on-resistance ( $R_{ON}$ ) necessary for high-performance switching applications. The Beyond-the-Rails signal capability of the MAX14689 allows signals below ground and above  $V_{CC}$  to pass without distortion.

## **Analog Signal Levels**

The MAX14689 is bidirectional, allowing NO\_, NC\_, and COM\_ to be configured as either inputs or outputs. The topology of the switches allows the signal to drop below ground without the need of an external negative voltage supply. Note: The devices can also withstand analog signal levels of -5.5V to +5.5V when the device is not powered.

#### **Digital Control Input**

The MAX14689 provides a single-bit control logic input, CB. CB controls the switch position, as shown in the *Typical Application Circuit/Functional Diagram*.

## **Applications Information**

#### **Extended ESD Protection**

ESD-protection structures are incorporated on all pins to protect against electrostatic discharges up to ±2kV (HBM) encountered during handling and assembly. COM1 and COM2 are further protected against ESD up to ±15kV (HBM), ±10kV (Air-Gap Discharge), and ±8kV (Contact Discharge) without damage. NO\_ and NC\_ are protected against ESD up to ±15kV (HBM) without damage. The ESD structures withstand high ESD both in normal operation and when the device is powered down. After an ESD event, the devices continue to function without latchup.

#### **ESD Test Conditions**

ESD performance depends on a variety of conditions. Contact Maxim for a reliability report that documents test methodology and test results.

#### **Human Body Model**

<u>Figure 4</u> shows the Human Body Model. <u>Figure 5</u> shows the current waveform it generates when discharged into a low impedance. This model consists of a 100pF capacitor charged to the ESD voltage of interest that is then discharged into the device through a  $1.5k\Omega$  resistor.

#### IEC 61000-4-2

The IEC 61000-4-2 standard covers ESD testing and performance of finished equipment. It does not specifically refer to integrated circuits. The major difference between tests done using the HBM and IEC 61000-4-2 is higher peak current in IEC 61000-4-2, because series resistance is lower in the IEC 61000-4-2 model. Hence, the ESD withstand voltage measured to IEC 61000-4-2 is generally lower than that measured using the HBM. Figure 6 shows the IEC 61000-4-2 model and Figure 7 shows the current waveform for the ±8kV, IEC 61000-4-2, Level 4, ESD Contact-Discharge Method.

# Ultra-Small, Low-RON, Beyond-the-Rails™ DPDT Analog Switches

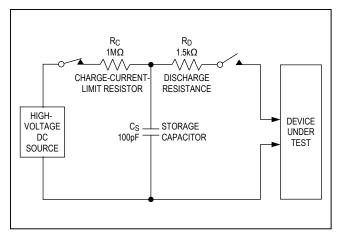


Figure 4. Human Body ESD Test Model

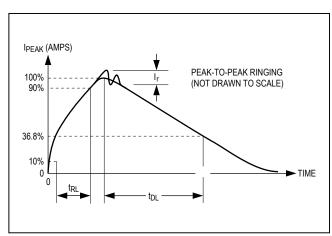


Figure 5. Human Body Current Waveform

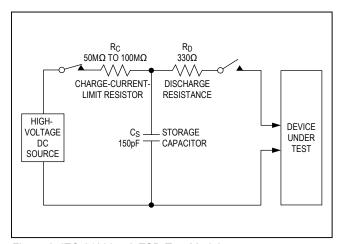


Figure 6. IEC 61000-4-2 ESD Test Model

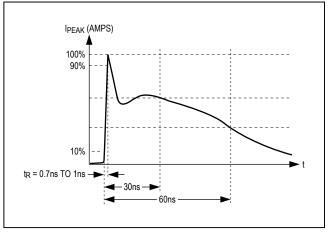


Figure 7. IEC 61000-4-2 ESD Generator Current Waveform

## **Ordering Information**

PART	PIN-PACKAGE	TOP MARK
MAX14689EWL+T	9 WLP	AKL

<sup>+</sup>Denotes lead(Pb)-free/RoHS-compliant package.

# **Chip Information**

PROCESS: BiCMOS

## **Package Information**

For the latest package outline information and land patterns (footprints), go to <a href="www.maximintegrated.com/packages">www.maximintegrated.com/packages</a>. 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	PACKAGE	OUTLINE	LAND
TYPE	CODE	NO.	PATTERN NO.
9 WLP	W91J1+1	<u>21-0459</u>	Refer to Application Note 1891

T = Tape and reel.

## MAX14689

# Ultra-Small, Low-R<sub>ON</sub>, Beyond-the-Rails™ **DPDT Analog Switches**

# **Revision History**

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	9/13	Initial release	_
1	1/14	Added MAX14689EWL+ to Ordering Information	11
2	12/14	Corrected package code	11

For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim Integrated's website at www.maximintegrated.com.

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MAX14689

Ultra-Small, Low-R<sub>ON</sub>, Beyond-the-Rails™ DPDT Analog Switches

## **ПОСТАВКА** ЭЛЕКТРОННЫХ КОМПОНЕНТОВ

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#### Офис по работе с юридическими лицами:

105318, г. Москва, ул. Щербаковская д. 3, офис 1107, 1118, ДЦ «Щербаковский»

Телефон: +7 495 668-12-70 (многоканальный)

Факс: +7 495 668-12-70 (доб.304)

E-mail: info@moschip.ru

Skype отдела продаж:

moschip.ru moschip.ru\_6 moschip.ru\_4 moschip.ru\_9