# Ultra-Low Resistance Dual SPDT Analog Switch

The NS5A4684S is an advanced CMOS analog switch fabricated in Sub–micron silicon gate CMOS technology. The device is a dual Independent Single Pole Double Throw (SPDT) switch featuring Ultra–Low  $R_{ON}$  of 0.6  $\Omega$ .

The part also features guaranteed Break Before Make (BBM) switching, assuring the switches never short the driver.

#### **Features**

- Ultra–Low  $R_{ON}$  of 0.6  $\Omega$  Max
- Interfaces with 2.8 V Chipset
- Single Supply Operation from 1.65–5.5 V
- Full 0-V<sub>CC</sub> Signal Handling Capability
- High Isolation; -68 dB at 100 kHz
- Low Standby Current, <50 nA
- Low Distortion; < 0.08% THD
- Low Crosstalk; < -70 dB at 100 kHz
- High Continuous Current Capability
   ± 300 mA Through Each Switch
- Large Current Clamping Diodes at Analog Inputs ±300 mA Continuous Current Capability
- Package:
  - ◆ 1.4 x 1.8 x 0.75 mm WQFN10 Package
- This is a Pb-Free Device

# **Applications**

- Cell Phone Audio Block
- Speaker and Earphone Switching
- Ring-Tone Chip / Amplifier Switching
- Modems



# ON Semiconductor®

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#### MARKING DIAGRAM



WQFN10 CASE 488AQ

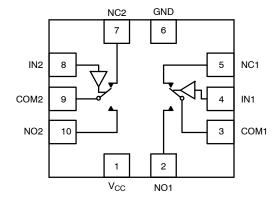


AG = Specific Device Code

= Date Code/Assembly Location

= Pb–Free Device

(Note: Microdot may be in either location)



#### **FUNCTION TABLE**

IN 1, 2	NO 1, 2	NC 1, 2
0	OFF	ON
1	ON	OFF

### **ORDERING INFORMATION**

See detailed ordering and shipping information in the package dimensions section on page 7 of this data sheet.

1

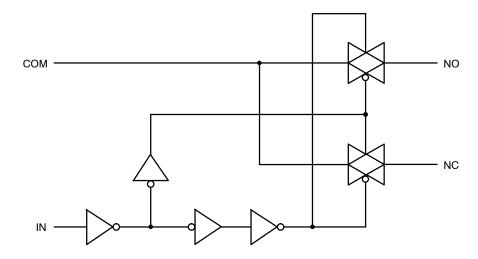


Figure 1. Logic Equivalent Circuit

# **PIN DESCRIPTION**

QFN PIN #	Symbol	Name and Function
2, 5, 7, 10	NC1 to NC2, NO1 to NO2	Independent Channels
4, 8	IN1 and IN2	Controls
3, 9	COM1 and COM2	Common Channels
6	GND	Ground (V)
1	V <sub>CC</sub>	Positive Supply Voltage

#### **MAXIMUM RATINGS**

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Positive DC Supply Voltage	-0.5 to +6.5	V
V <sub>IS</sub>	Analog Input Voltage (V <sub>NO</sub> , V <sub>NC</sub> , or V <sub>COM</sub> )	$-0.5 \le V_{IS} \le V_{CC} + 0.5$	V
V <sub>IN</sub>	Digital Select Input Voltage	$-0.5 \le V_{IN} \le +5.5$	V
I <sub>anl1</sub>	Continuous DC Current from COM to NC/NO	±300	mA
I <sub>anl-pk1</sub>	Peak Current from COM to NC/NO, 10 Duty Cycle (Note 1)	±500	mA
I <sub>clmp</sub>	Continuous DC Current into COM/NO/NC with Respect to V <sub>CC</sub> or GND	±100	mA

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. Defined as 10% ON, 90% OFF Duty Cycle.

### **RECOMMENDED OPERATING CONDITIONS**

Symbol	Parameter	Min	Max	Unit
V <sub>CC</sub>	DC Supply Voltage	1.65	5.5	٧
V <sub>IN</sub>	Digital Select Input Voltage (OVT) Overvoltage Tolerance	GND	5.5	V
V <sub>IS</sub>	Analog Input Voltage (NC, NO, COM)	GND	V <sub>CC</sub>	V
T <sub>A</sub>	Operating Temperature Range	-40	+85	°C
t <sub>r</sub> , t <sub>f</sub>	Input Rise or Fall Time, SELECT $ V_{CC} = 1.6 \text{ V} - 2.7 \text{ V} $ $ V_{CC} = 3.0 \text{ V} - 5.0 \text{ V} $		20 10	ns/V

#### DC CHARACTERISTICS - DIGITAL SECTION (Voltages Referenced to GND)

				Guar	ranteed Limit	
Symbol	Parameter	Condition	V <sub>CC</sub>	25°C	-40°C to +85°C	Unit
V <sub>IH</sub>	Minimum High-Level Input Voltage, Select Inputs		3.0 5.0	1.4 2.4	1.4 2.4	V
V <sub>IL</sub>	Maximum Low-Level Input Voltage, Select Inputs		3.0 5.0	0.7 0.8	0.7 0.8	V
I <sub>IN</sub>	Maximum Input Leakage Current, Select Inputs	V <sub>IN</sub> = V <sub>CC</sub> or GND	5.0	±0.1	±1.0	μΑ
I <sub>OFF</sub>	Power Off Leakage Current	V <sub>IN</sub> = V <sub>CC</sub> or GND	0	±0.5	±2.0	μΑ
Icc	Maximum Quiescent Supply Current (Note 2)	Select and V <sub>IS</sub> = V <sub>CC</sub> or GND	1.65 to 5.0	±1.0	±2.0	μΑ

<sup>2.</sup> Guaranteed by design. Resistance measurements do not include test circuit or package resistance.

#### DC ELECTRICAL CHARACTERISTICS - ANALOG SECTION

				Guaranteed Maximum Limit				
				25	°C	-40°C to	o +85°C	
Symbol	Parameter	Condition	V <sub>CC</sub>	Min	Max	Min	Max	Unit
R <sub>ON</sub>	NC/NO On-Resistance (Note 3)	$\begin{aligned} &V_{IN} = V_{IL} \text{ or } V_{IN} = V_{IH} \\ &V_{IS} = GND \text{ to } V_{CC} \\ &I_{COM} = 100 \text{ mA} \end{aligned}$	3.0 4.3 5.0		0.55 0.45 0.4		0.6 0.5 0.5	Ω
R <sub>FLAT</sub>	NC/NO On–Resistance Flatness (Notes 3 and 4)	I <sub>COM</sub> = 100 mA V <sub>IS</sub> = 0 to V <sub>CC</sub>	3.0 4.3 5.0		0.16 0.11 0.11		0.20 0.14 0.14	Ω
ΔR <sub>ON</sub>	On-Resistance Match Between Channels (Notes 3 and 5)	$V_{ S} = 1.5 \text{ V};$ $I_{COM} = 100 \text{ mA}$ $V_{ S} = 2.2 \text{ V};$ $I_{COM} = 100 \text{ mA}$	3.0 4.3 5.0		0.10 0.10 0.10		0.11 0.11 0.11	Ω
I <sub>NC(OFF)</sub> I <sub>NO(OFF)</sub>	NC or NO Off Leakage Current (Note 3)	$ \begin{aligned} &V_{IN} = V_{IL} \text{ or } V_{IH} \\ &V_{NO} \text{ or } V_{NC} = 0.3 \text{ V} \\ &V_{COM} = 4.0 \text{ V} \end{aligned} $	5.0	-5.0	5.0	-50	50	nA
I <sub>COM(ON)</sub>	COM ON Leakage Current (Note 3)	$\begin{aligned} &V_{IN} = V_{IL} \text{ or } V_{IH} \\ &V_{NO} \text{ 0.3 V or 4.0 V with} \\ &V_{NC} \text{ floating or} \\ &V_{NC} \text{ 0.3 V or 4.0 V with} \\ &V_{NO} \text{ floating} \\ &V_{COM} = \text{ 0.3 V or 4.0 V} \end{aligned}$	5.0	-10	10	-100	100	nA

<sup>3.</sup> Guaranteed by design. Resistance measurements do not include test circuit or package resistance.
4. Flatness is defined as the difference between the maximum and minimum value of On–resistance as measured over the specified analog signal ranges. 5.  $\Delta R_{ON} = R_{ON(MAX)} - R_{ON(MIN)}$  between NC1 and NC2 or between NO1 and NO2.

# AC ELECTRICAL CHARACTERISTICS (Input $t_r = t_f = 3.0 \text{ ns}$ )

					G	uarant	eed Ma	aximum L	imit	
			V <sub>cc</sub>	V <sub>IS</sub>		25°C		-40°C to	o +85°C	
Symbol	Parameter	Test Conditions	(V)	(V)	Min	Тур*	Max	Min	Max	Unit
t <sub>ON</sub>	Turn-On Time	$R_L = 50 \Omega$ , $C_L = 35 pF$ (Figures 3 and 4)	2.3 – 5.0	1.5			50		60	ns
t <sub>OFF</sub>	Turn-Off Time	$R_L = 50 \Omega$ , $C_L = 35 pF$ (Figures 3 and 4)	2.3 – 5.0	1.5			30		40	ns
t <sub>BBM</sub>	Minimum Break-Before-Make Time	$V_{ S}$ = 3.0 R <sub>L</sub> = 50 $\Omega$ , C <sub>L</sub> = 35 pF (Figure 2)	3.0	1.5	2	15				ns

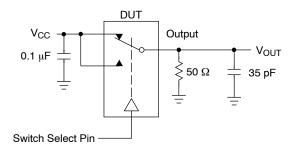
		Typical @ 25, V <sub>CC</sub> = 3.6 V	
C <sub>IN</sub>	Control Pin Input Capacitance	3.5	pF
C <sub>NO/NC</sub>	NO, NC Port Capacitance	60	pF
C <sub>COM</sub>	COM Port Capacitance When Switch is Enabled	200	pF

<sup>\*</sup>Typical Characteristics are at 25°C.

# ADDITIONAL APPLICATION CHARACTERISTICS (Voltages Referenced to GND Unless Noted)

			V <sub>CC</sub>	25°C	
Symbol	Parameter	Condition	(V)	Typical	Unit
BW	Maximum On-Channel -3 dB Bandwidth or Minimum Frequency Response	V <sub>IN</sub> centered between V <sub>CC</sub> and GND (Figure 5)	1.65 – 5.0	19	MHz
V <sub>ONL</sub>	Maximum Feed-through On Loss	$V_{IN}$ = 0 dBm @ 100 kHz to 50 MHz $V_{IN}$ centered between $V_{CC}$ and GND (Figure 5)	1.65 – 5.0	-0.06	dB
V <sub>ISO</sub>	Off-Channel Isolation	$f$ = 100 kHz; $V_{IS}$ = 1 V RMS; $C_L$ = 5.0 pF $V_{IN}$ centered between $V_{CC}$ and GND (Figure 5)	1.65 – 5.0	-68	dB
Q	Charge Injection Select Input to Common I/O	$V_{IN} = V_{CC \text{ to}}$ GND, $R_{IS} = 0 \Omega$ , $C_L = 1.0 \text{ nF}$ $Q = C_L \times DV_{OUT}$ (Figure 6)	1.65 – 5.0	38	pC
THD	Total Harmonic Distortion THD + Noise	$F_{IS}$ = 20 Hz to 20 kHz, $R_L$ = $R_{gen}$ = 600 $\Omega,C_L$ = 50 pF $V_{IS}$ = 2.0 V RMS	3.0	0.08	%
VCT	Channel-to-Channel Crosstalk	f = 100 kHz; $V_{IS}$ = 1.0 V RMS, $C_L$ = 5.0 pF, $R_L$ = 50 $\Omega$ $V_{IN}$ centered between $V_{CC}$ and GND (Figure 5)	1.65 – 5.0	-70	dB

<sup>6.</sup> Off-Channel Isolation =  $20log10 (V_{COM}/V_{NO})$ ,  $V_{COM}$  = output,  $V_{NO}$  = input to off switch.



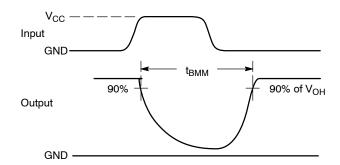
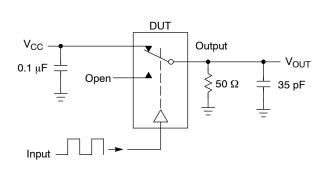


Figure 2. t<sub>BBM</sub> (Time Break-Before-Make)



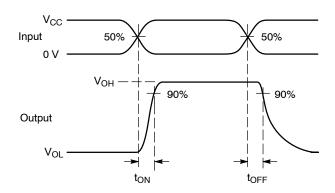
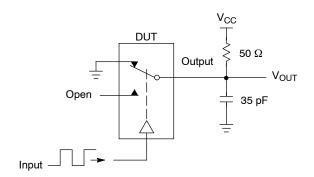


Figure 3. t<sub>ON</sub>/t<sub>OFF</sub>



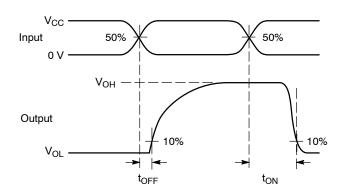
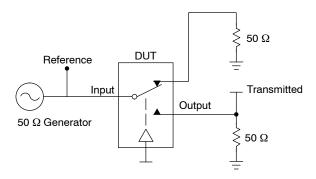


Figure 4. t<sub>ON</sub>/t<sub>OFF</sub>



Channel switch control/s test socket is normalized. Off isolation is measured across an off channel. On loss is the bandwidth of an On switch.  $V_{\rm ISO}$ , Bandwidth and  $V_{\rm ONL}$  are independent of the input signal direction.

$$V_{ISO} = Off Channel Isolation = 20 Log \left(\frac{V_{OUT}}{V_{IN}}\right)$$
 for  $V_{IN}$  at 100 kHz

$$V_{ONL}$$
 = On Channel Loss = 20 Log $\left(\frac{V_{OUT}}{V_{IN}}\right)$  for  $V_{IN}$  at 100 kHz to 50 MHz

Bandwidth (BW) = the frequency 3 dB below  $V_{ONL}$ 

 $V_{CT}$  = Use  $V_{ISO}$  setup and test to all other switch analog input/outputs terminated with 50  $\Omega$ 

Figure 5. Off Channel Isolation/On Channel Loss (BW)/Crosstalk (On Channel to Off Channel)/V<sub>ONL</sub>

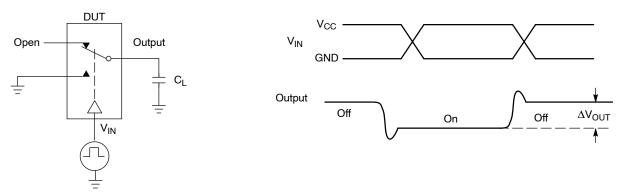


Figure 6. Charge Injection: (Q)

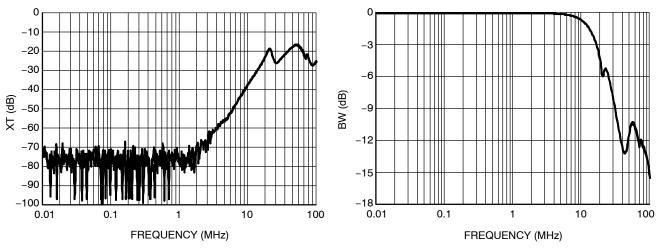


Figure 7. Cross Talk vs. Frequency @ V<sub>CC</sub> = 4.3 V

Figure 8. Bandwidth vs. Frequency

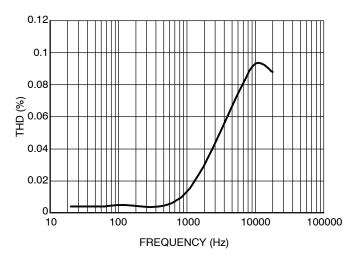


Figure 9. Total Harmonic Distortion

### **ORDERING INFORMATION**

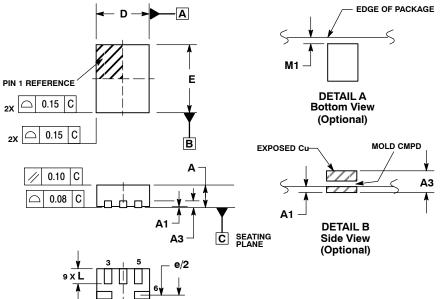
Device	Package	Shipping <sup>†</sup>
NS5A4684SMNTBG	WQFN10 (Pb-Free)	3000 / Tape & Reel

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

#### PACKAGE DIMENSIONS

#### WQFN10, 1.4x1.8, 0.4P CASE 488AQ-01

**ISSUE C** 



0.10 C A B

NOTE 3

0.05 C

10 X

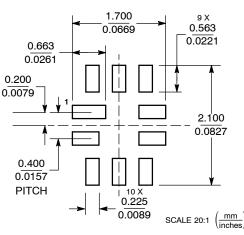
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#### NOTES:

- DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
  CONTROLLING DIMENSION: MILLIMETERS
- DIMENSION 6 APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.25 AND 0.30 MM
- COPLANARITY APPLIES TO THE EXPOSED PAD
- AS WELL AS THE TERMINALS.
  EXPOSED PADS CONNECTED TO DIE FLAG.
  USED AS TEST CONTACTS.

	MILLIN	MILLIMETERS			
DIM	MIN	MAX			
Α	0.70	0.80			
A1	0.00	0.050			
A3	0.20	REF			
b	0.15	0.25			
D	1.40	BSC			
E	1.80	BSC			
е	0.40	BSC			
L	0.30	0.50			
L1	0.40	0.60			
M1	0.00	0.05			

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