19-0563; Rev 1; 11/06

MAXIM

低电压、双路SPDT音频开关，无喀嗒声，可处理负信号

概述

MAX4744/MAX4744H/MAX4745/MAX4745H/MAX4746H是双路SPDT (单刀/双掷)音频开关，可处理负信号，允许低至V_{CC} - 5.5V的信号无失真通过。该系列模拟开关具有低导通电阻、低电源电流，工作在+1.8V至+5.5V单电源。

MAX4744/MAX4744H内置旁路电阻，在常开(NO)端和常闭(NC)端未连通时，能够自动为这两个端子的电容放电，MAX4746H在内部的NC_端连接了旁路电阻。这样，当开关在预先充有电荷的两个端点之间切换音频信号时，能够抑制咔嗒声。先断后合功能进一步降低咔嗒声。MAX4744/MAX4745通过两个控制位CB1和CB2来控制开关。MAX4744H/MAX4745H/MAX4746H采用一个控制位来切换两个开关，使能输入引脚$\overline{EN}$可控制开关进入高阻模式。MAX4744H/MAX4745H/MAX4746H还具有内部保护网络，防止V_{CC} = 0V时电压加载到COM_端。

该系列器件采用节省空间的10引脚µDFN封装(2mm x 2mm)，工作在-40°C至+85°C扩展级温度范围。

特性

- ♦ 允许低至V_{CC} - 5.5V的负信号无失真通过
- ♦ 内部旁路电阻降低了喀嗒声(MAX4744/MAX4744H)
- ♦ 0.6Ω (典型值)低导通电阻
- ♦ 0.1Ω (最大值)的通道间匹配度
- ♦ 0.55Ω (典型值)导通电阻平坦度
- ♦ +1.8V至+5.5V单电源电压
- ♦ 0.01% (典型值)总谐波失真
- ♦ -75dB (典型值)串扰(100kHz)
- ♦ -68dB (典型值)关断隔离(100kHz)
- ♦ 采用10引脚µDFN封装(2mm x 2mm)

应用

扬声器开关

电源切换

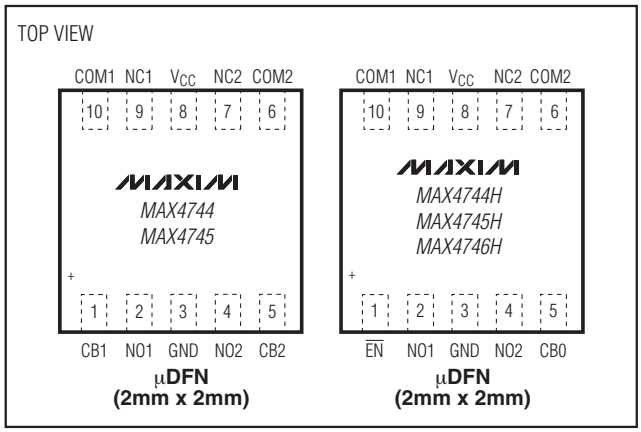
蜂窝电话

MP3播放器

PDA及其它手持式设备

笔记本电脑

引脚配置



定购信息/选型指南

PART	PIN-PACKAGE	TOP MARK	CLICKLESS	COM PROTECTION	PKG CODE
MAX4744ELB+T	10 µDFN-10	+AAF	Yes	No	L1022-1
MAX4744HELB+T	10 µDFN-10	+AAG	Yes	Yes	L1022-1
MAX4745ELB+T	10 µDFN-10	+AAH	No	No	L1022-1
MAX4745HELB+T	10 µDFN-10	+AAI	No	Yes	L1022-1
MAX4746HELB+T	10 µDFN-10	+AAM	Yes, on NC_	Yes	L1022-1

注：所有器件工作在-40°C至+85°C温度范围。
+表示无铅封装。

ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND.)
V_{CC}, CB_, $\overline{EN}$ .....-0.3V to +6.0V
NC_, NO_ .....(V_{CC} - 6V) to (V_{CC} + 0.3V)
COM_ (MAX4744/MAX4745).....(V_{CC} - 6V) to (V_{CC} + 0.3V)
COM_ (MAX4744H/MAX4745H/MAX4746H) .....(Note 1)
Continuous Current NO_, NC_, COM_. .....±300mA
Peak Current NO_, NC_, COM_ (pulsed at 1ms, 50% duty cycle).....±400mA
Peak Current NO_, NC_, COM_ (pulsed at 1ms, 10% duty cycle).....±500mA
ESD Protection per Method 3015.7
NO_, NC_, COM_, V_{CC}, GND, CB_, $\overline{EN}$.....±2kV
Continuous Power Dissipation (T_A = +70°C)
10-Pin µDFN (derate 5mW/°C above +70°C) 403mW
Operating Temperature Range .....-40°C to +85°C
Storage Temperature Range .....-65°C to +150°C

Note 1: If V_{CC} > 0.5V, limits are (V_{CC} - 6V) to (V_{CC} + 0.3V). If V_{CC} < 0.5V, limits are (V_{CC} - 6.0V) to +6.0V.

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

(V_{CC} = +2.7V to +5.5V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V_{CC} = 3.3V, T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
POWER SUPPLY							
Supply-Voltage Range	V_{CC}			1.8		5.5	V
Supply Current	I_{CC}	V_{CC} = 5.5V, $V_{CB\_}$ = 0V or V_{CC}			0.3	1	µA
		V_{CC} = 5.5V, $V_{CB\_}$ = 0.5V or 1.4V				8	
		V_{CC} = 2.7V, $V_{CB\_}$ = 0.5V or 1.4V				4	
ANALOG SWITCH							
Analog Signal Range	$V_{NC\_}$, $V_{NO\_}$, $V_{COM\_}$	(Note 3)		V_{CC} - 5.5V		V_{CC}	V
On-Resistance (Note 4)	R_{ON}	V_{CC} = +2.7V; $V_{NC\_}$ or $V_{NO\_}$ = V_{CC} - 5.5V, -1V, 0V, 1V, 2V, V_{CC}; $I_{COM\_}$ = 100mA	T_A = +25°C		0.6	0.95	Ω
			T_A = T_{MIN} to T_{MAX}			1.0	
On-Resistance Match Between Channels (Notes 4 and 5)	ΔR_{ON}	V_{CC} = 2.7V, $V_{NC\_}$ or $V_{NO\_}$ = 0V, $I_{COM\_}$ = 100mA	T_A = +25°C			0.1	Ω
			T_A = T_{MIN} to T_{MAX}			0.1	
On-Resistance Flatness (Note 6)	R_{FLAT}	V_{CC} = +2.7V, $V_{NC\_}$ or $V_{NO\_}$ = V_{CC} - 5.5V, - 1V, 0V, 1V, 2V, V_{CC}; $I_{COM\_}$ = 100mA	T_A = +25°C			0.55	Ω
			T_A = T_{MIN} to T_{MAX}			0.6	
Shunt Switch Resistance	R_{SH}	MAX4744/MAX4744H/MAX4746H only, V_{CC} = 2.7V		2		5	kΩ
NC_, NO_ Off-Leakage Current (Note 3)	$I_{NO\_(OFF)}$, $I_{NC\_(OFF)}$	V_{CC} = +2.7V switch open; $V_{NC\_}$ or $V_{NO\_}$ = -2.5V, +2.5V (MAX4745/MAX4745H only) (MAX4746H - $I_{NO\_(OFF)}$ only)	T_A = +25°C	-15		+15	nA
			T_A = T_{MIN} to T_{MAX}	-50		+50	
COM_ On-Leakage Current (Note 3)	$I_{COM\_(ON)}$	V_{CC} = 2.7V switch closed; $V_{NC\_}$ or $V_{NO\_}$ = -2.5V, +2.5V; $V_{COM\_}$ = -2.5V, +2.5V	T_A = +25°C	-15		+15	nA
			T_A = T_{MIN} to T_{MAX}	-100		+100	

ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = +2.7V to +5.5V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V_{CC} = 3.3V, T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
COM_ Leakage Under Protection Conditions	$I_{L(PROT)}$	V_{CC} = 0V; $V_{COM\_}$ = +5.5V; $V_{NC\_}$ and $V_{NO\_}$ are unconnected or connected to GND; $V_{CB\_}$ = 0V (MAX4744H/MAX4745H/MAX4746H only)	T_A = +25°C		30		nA
			T_A = T_{MIN} to T_{MAX}		500		
DYNAMIC CHARACTERISTICS							
Turn-On Time	t_{ON}	V_{CC} = 2.7V, R_L = 32Ω, C_L = 35pF, Figure 2	For NO_, $V_{NO\_}$ = 1.5V, $V_{CB\_}$ = 0V to V_{CC}		55		ns
			For NC_, $V_{NC\_}$ = 1.5V, $V_{CB\_}$ = V_{CC} to 0V		560		
Turn-Off Time	t_{OFF}	V_{CC} = 2.7V, R_L = 32Ω, C_L = 35pF, Figure 2	For NO_, $V_{NO\_}$ = 1.5V, $V_{CB\_}$ = V_{CC} to 0V		540		ns
			For NC_, $V_{NC\_}$ = 1.5V, $V_{CB\_}$ = 0V to V_{CC}		36		
Break-Before-Make Delay Time	t_D	V_{CC} = 2.7V, $V_{NC\_}$ = $V_{NO\_}$ = 1.5V; for NO_, $V_{CB\_}$ = V_{CC} to 0V; for NC_, $V_{CB\_}$ = 0V to V_{CC}; R_L = 32Ω; C_L = 35pF; Figure 3			20		ns
Power-Supply Rejection Ratio	PSRR	f = 100kHz, $V_{COM\_}$ = $1V_{RMS}$, R_L = 50Ω, C_L = 5pF			52		dB
Charge Injection	Q	$V_{GEN\_}$ = 0V; R_{GEN} = 0Ω, C_L = 1nF, Figure 4			450		pC
Off-Isolation	V_{ISO}	C_L = 5pF; R_L = 50Ω; f = 100kHz; $V_{COM\_}$ = $1V_{RMS}$; Figure 5 (Note 7)			-68		dB
Crosstalk	V_{CT}	C_L = 5pF; R_L = 50Ω; f = 100kHz; $V_{COM\_}$ = $1V_{RMS}$; Figure 5			-75		dB
Total Harmonic Distortion	THD	f = 20Hz to 20kHz, $V_{COM\_}$ = $0.5V_{P-P}$, R_L = 50Ω			0.01		%
NO_, NC_ Off-Capacitance	$C_{NO\_(OFF)}$, $C_{NC\_(OFF)}$	f = 1MHz, Figure 6			90		pF
COM On-Capacitance	$C_{COM\_(ON)}$	f = 1MHz, Figure 6			300		pF

ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = +2.7V to +5.5V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V_{CC} = 3.3V, T_A = +25°C.) (Note 2)

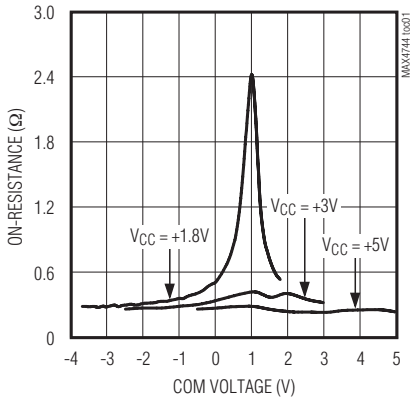
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
DIGITAL INPUTS (CB_, $\overline{EN}$)						
Input-Logic High	V_{IH}		1.4			V
Input-Logic Low	V_{IL}				0.5	V
Input Leakage Current	I_{LEAK}	$V_{CB\_}$ or $V_{\overline{EN}}$ = 0V or V_{CC}	-1		+1	µA

Note 2: All parameters are production tested at T_A = +25°C and guaranteed by design over the specified temperature range.
Note 3: Signals on COM_, NO_, or NC_ exceeding V_{CC} are clamped by internal diodes. Limit forward-diode current to maximum current ratings.
Note 4: Guaranteed by design; not production tested.
Note 5: $\Delta R_{ON} = R_{ON(MAX)} - R_{ON(MIN)}$.
Note 6: Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal ranges.
Note 7: Off-isolation = $20\log_{10}[V_{COM\_} / V_{NO\_}]$, $V_{COM\_}$ = output, $V_{NO\_}$ = input to off switch.

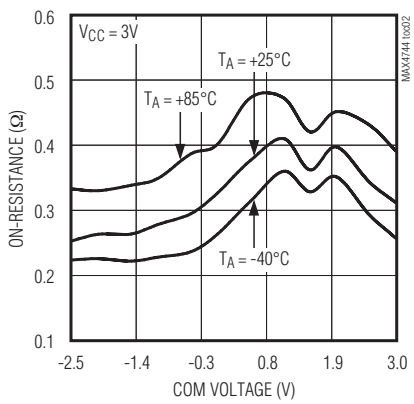
典型工作特性

(V_{CC} = +3.3V, T_A = +25°C, unless otherwise noted.)

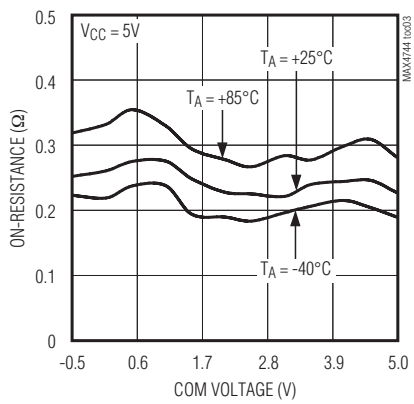
ON-RESISTANCE vs. COM VOLTAGE



ON-RESISTANCE vs. COM VOLTAGE



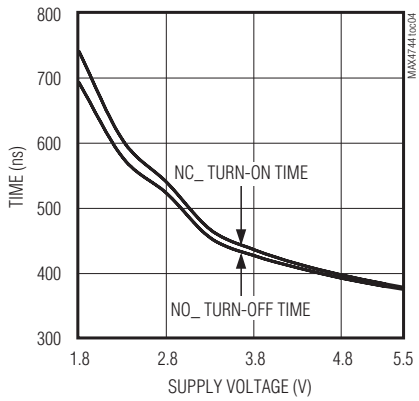
ON-RESISTANCE vs. COM VOLTAGE



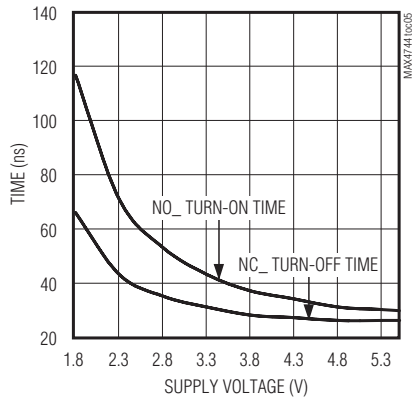
典型工作特性(续)

(V_{CC} = +3.3V, T_A = +25°C, unless otherwise noted.)

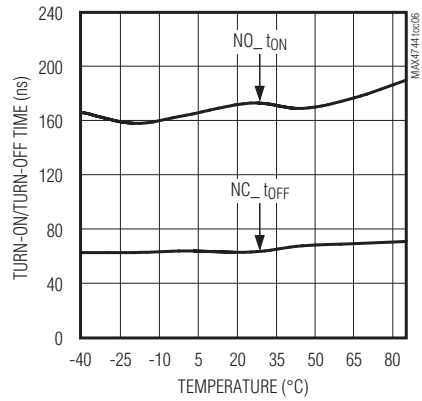
NC_ TURN-ON/NO_ TURN-OFF TIME vs. SUPPLY VOLTAGE



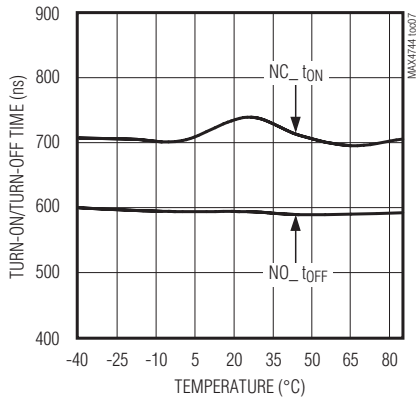
NO_ TURN-ON/NC_ TURN-OFF TIME vs. SUPPLY VOLTAGE



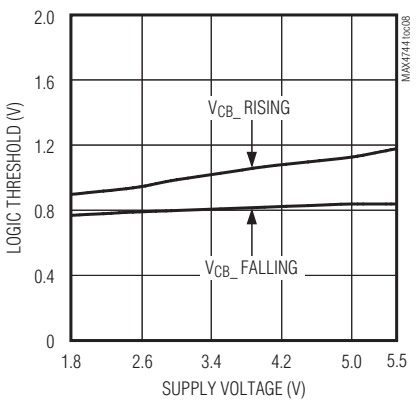
NO_ TURN-ON/NC_ TURN-OFF TIME vs. TEMPERATURE



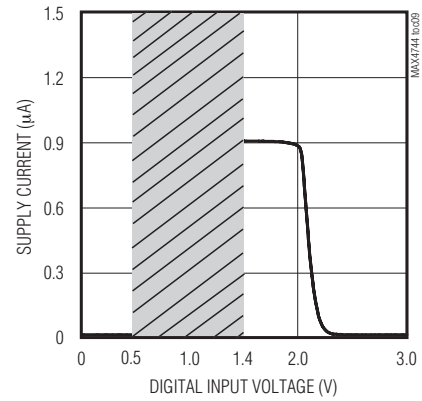
NO_ TURN-ON/NC_ TURN-OFF TIME vs. TEMPERATURE



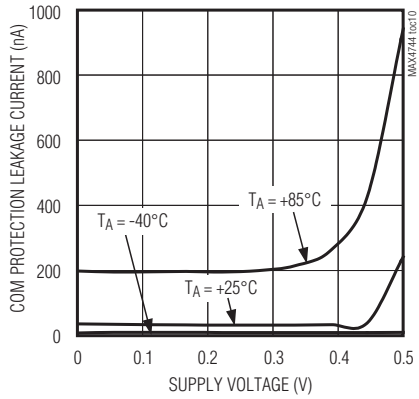
LOGIC THRESHOLD vs. SUPPLY VOLTAGE



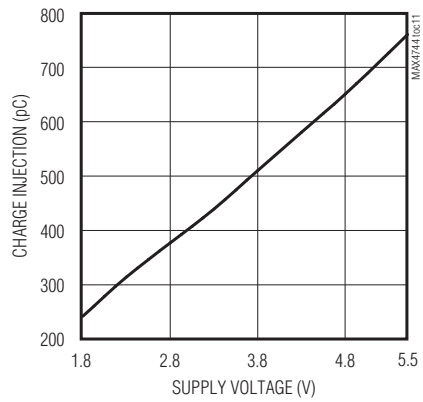
SUPPLY CURRENT vs. LOGIC-INPUT VOLTAGE



COM PROTECTION LEAKAGE CURRENT vs. SUPPLY VOLTAGE



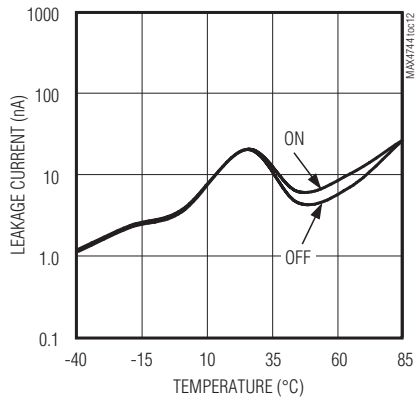
CHARGE INJECTION vs. SUPPLY VOLTAGE



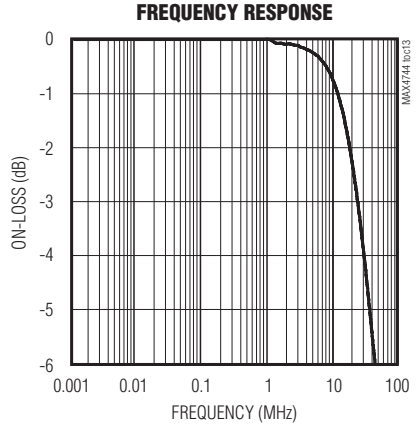
典型工作特性(续)

(V_{CC} = +3.3V, T_A = +25°C, unless otherwise noted.)

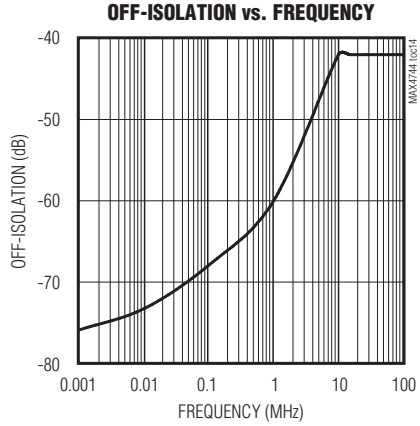
LEAKAGE CURRENT vs. TEMPERATURE



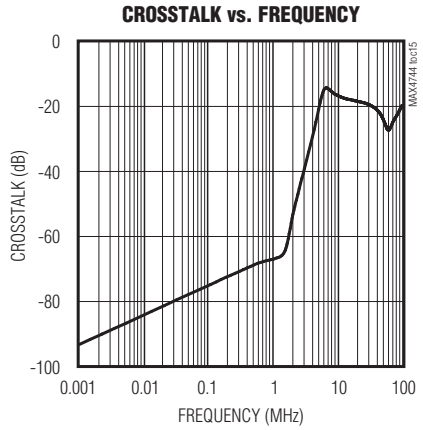
FREQUENCY RESPONSE



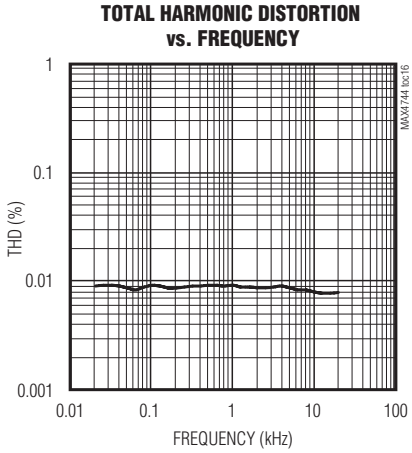
OFF-ISOLATION vs. FREQUENCY



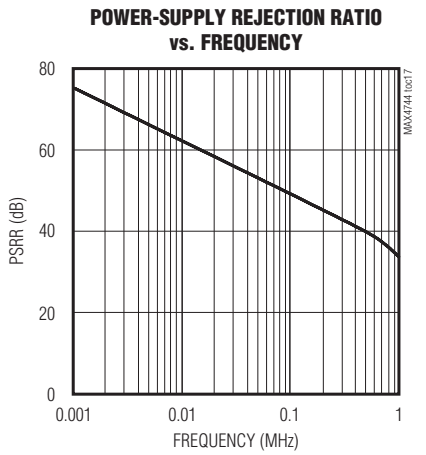
CROSSTALK vs. FREQUENCY



TOTAL HARMONIC DISTORTION vs. FREQUENCY



POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



引脚说明

引脚		名称	功能
MAX4744/MAX4745	MAX4744H/MAX4745H/MAX4746H		
1	—	CB1	模拟开关1的数字控制输入。
—	1	$\overline{EN}$	使能输入。驱动$\overline{EN}$至高电平时，所有开关进入高阻态；拉低$\overline{EN}$时，器件正常工作。
2	2	NO1	模拟开关1—常开端。
3	3	GND	地。
4	4	NO2	模拟开关2—常开端。
5	—	CB2	模拟开关2的数字控制输入。
—	5	CB0	模拟开关1和2的数字控制输入。
6	6	COM2	模拟开关2—公共端。
7	7	NC2	模拟开关2—常闭端。
8	8	V_{CC}	+1.8V至+5.5V的正电源电压。
9	9	NC1	模拟开关1—常闭端。
10	10	COM1	模拟开关1—公共端。

详细说明

MAX4744/MAX4744H/MAX4745/MAX4745H/MAX4746H是低导通电阻、低电压的双路SPDT模拟开关，工作在+1.8V至+5.5V单电源下。该系列器件可处理负信号，允许低至V_{CC} - 5.5V的信号无失真通过。

MAX4744/MAX4745具有两个数字控制位，用于独立控制每个开关(见表1)。MAX4744H/MAX4745H/MAX4746H则采用一个控制位来切换两个开关，并具有使能引脚$\overline{EN}$，用来控制开关进入高阻模式。驱动$\overline{EN}$至低电平时，使开关退出高阻模式，CB0同时控制两个开关(见表2)。

MAX4744/MAX4744H在所有NO端和NC端上接有内部旁路电阻，MAX4746H在内部的NC端连接了旁路电阻。这样，当开关在预先充有电荷的两个端点之间切换音频信号时，能够抑制咔嗒声。

应用信息

数字控制输入

MAX4744/MAX4744H/MAX4745/MAX4745H/MAX4746H逻辑输入可以接受高达+5.5V的电压，与电源电压无关。例如，+3.3V电源时，CB0、CB1、CB2和$\overline{EN}$可低至GND，最高可达+5.5V，这样就允许多种逻辑电平共存于同一系统中。满摆幅驱动CB0、CB1、CB2和$\overline{EN}$可使功耗降至最低。

表1. MAX4744/MAX4745真值表

CONTROL		SWITCH STATE	
CB1	CB2	Switch 1	Switch 2
0	0	Connected to NC1	Connected to NC2
0	1	Connected to NC1	Connected to NO2
1	0	Connected to NO1	Connected to NC2
1	1	Connected to NO1	Connected to NO2

表2. MAX4744H/MAX4745H/MAX4746H真值表

CONTROL		SWITCH STATE	
$\overline{EN}$	CB0	Switch 1	Switch 2
0	0	Connected to NC1	Connected to NC2
0	1	Connected to NO1	Connected to NO2
1	X	High Impedance	High Impedance

X = 无关。

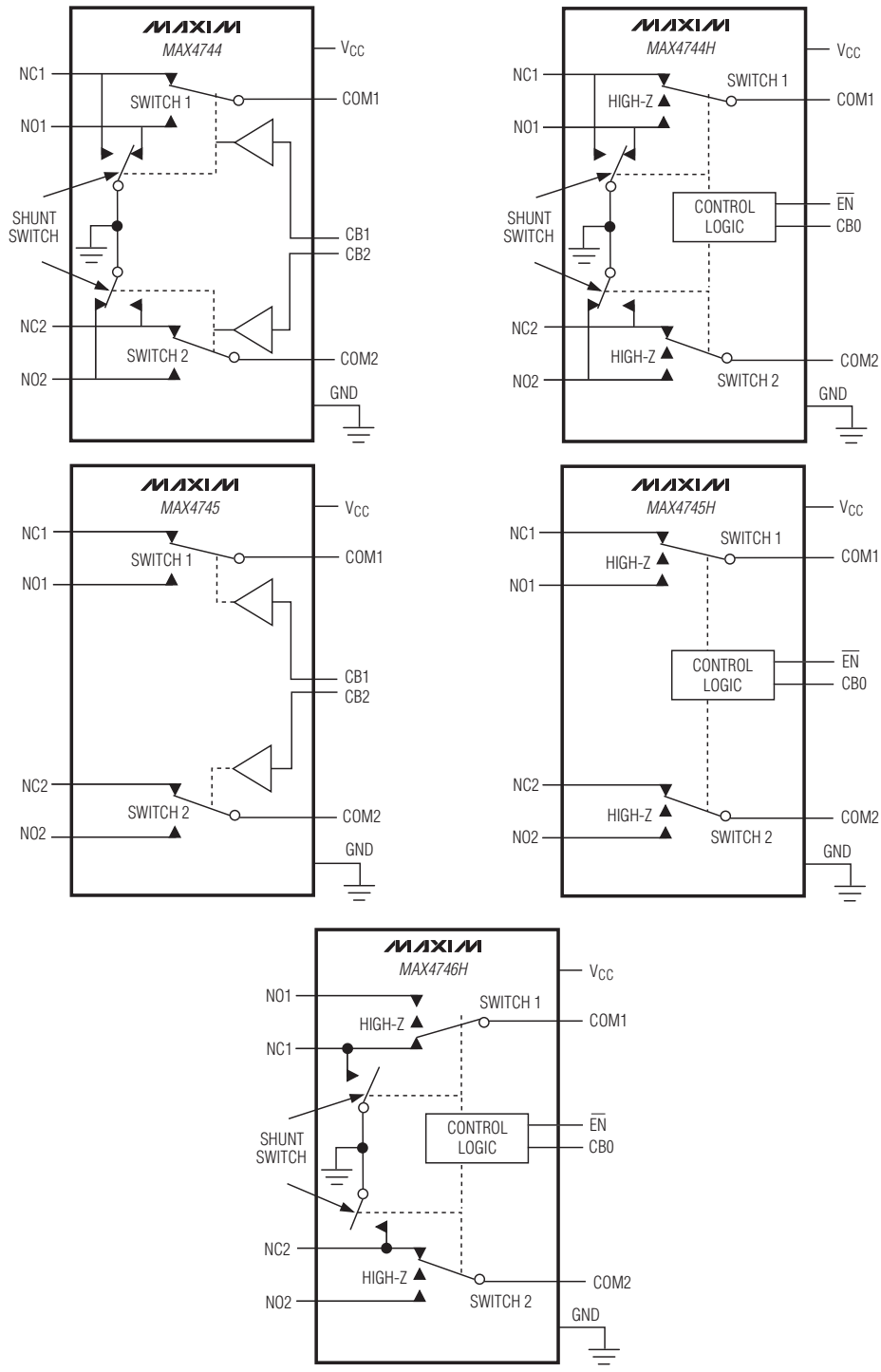

MAX4744
VCC
NC1
SWITCH 1
COM1
NO1
SHUNT SWITCH
CB1
CB2
NC2
SWITCH 2
COM2
NO2
GND
MAX4744H
HIGH-Z
CONTROL LOGIC
EN
CB0
MAX4745
MAX4745H
MAX4746H

图1. 功能框图

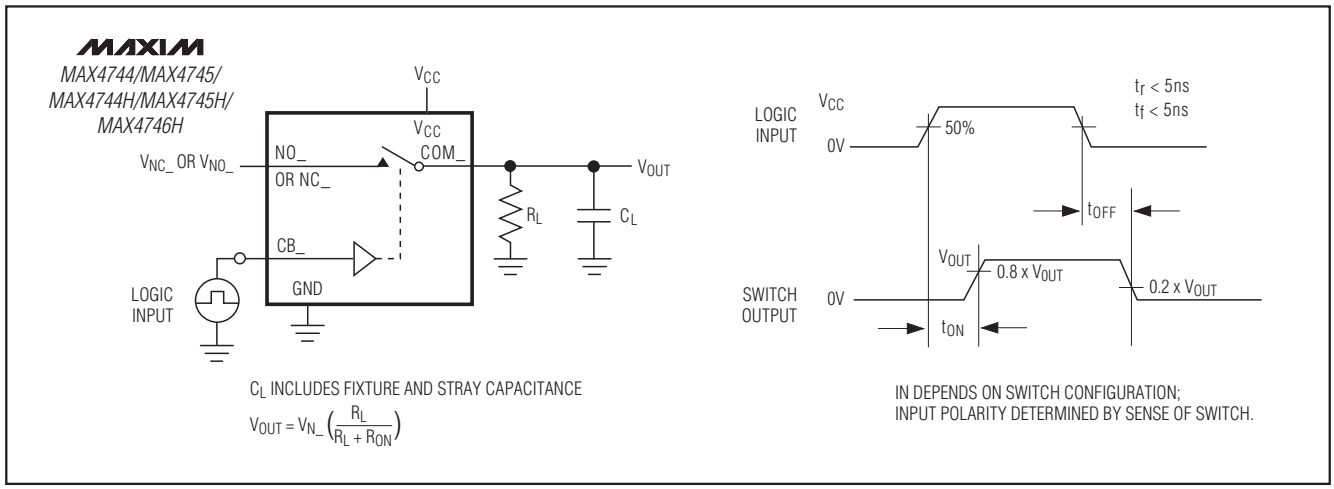


图2. 开关时间

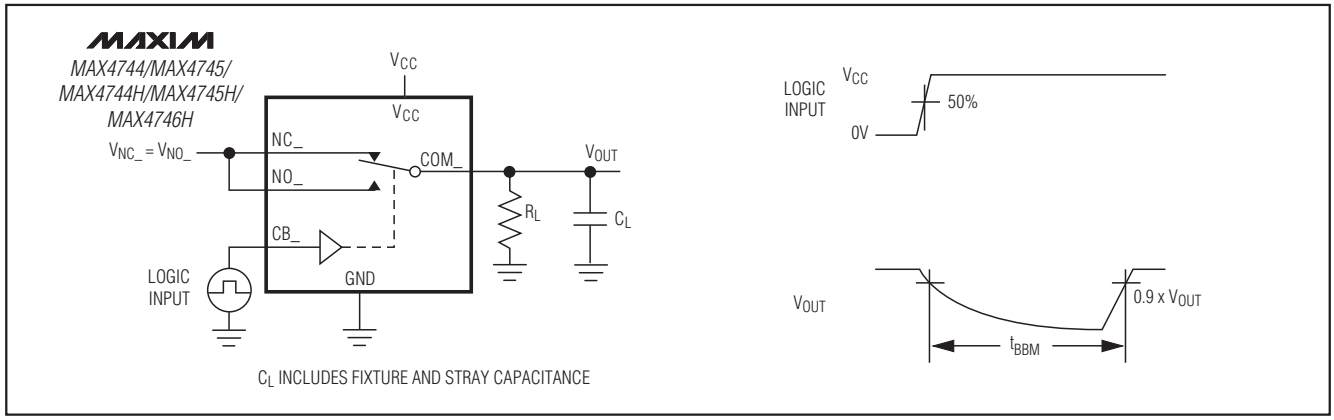


图3. 先断后合的间隔

模拟信号电平

当通过开关的模拟输入信号在V_{CC}至V_{CC} - 5.5V范围内(包括低于地的电平信号)变化时，只会出现极小的失真，同时开关的导通电阻变化极小(见*典型工作特性*)。这些开关可双向工作，因此NO_、NC_和COM_既可作为输入，也可以作为输出。

V_{CC} = 0V时的COM_保护 (MAX4744H/MAX4745H/MAX4746H)

该特性可防止由于不正确的上电顺序导致的器件损坏。在V_{CC}低于0.5V时，如果有信号加载到COM_上，该保护起作用。如果V_{CC}高于0.5V，由于寄生电容耦合或者COM_和V_{CC}之间有泄漏，开关没有保护。COM_上的信号处于(V_{CC} - 0.6V)至6.0V时处于保护状态。

咔嗒声抑制

MAX4744/MAX4744H在其所有的NO端和NC端上接有内部旁路电阻，这样当它们未连接到COM端时，能够自动对这两个端点上的电容放电。旁路电阻降低了音频信号源切换时产生的咔嗒声。音频喀嗒声是由切换到扬声器的直流阶跃电压引起的。通过对未连接到COM端自动放电，可降低直流阶跃瞬变，进而减少残留的直流电压，并降低咔嗒声。

低电压、双路SPDT音频开关，无喀嗒声，可处理负信号

检测电路/时序图

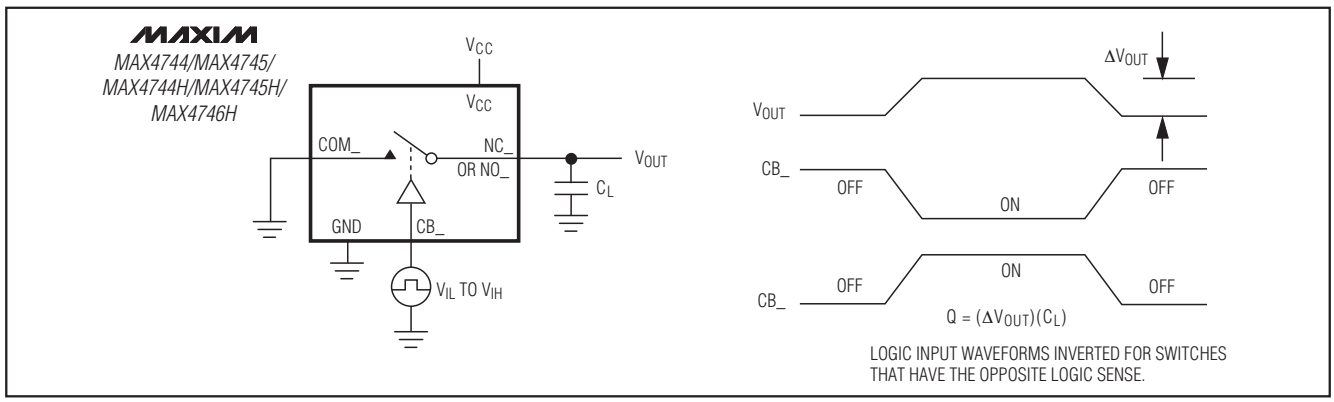


图4. 电荷注入

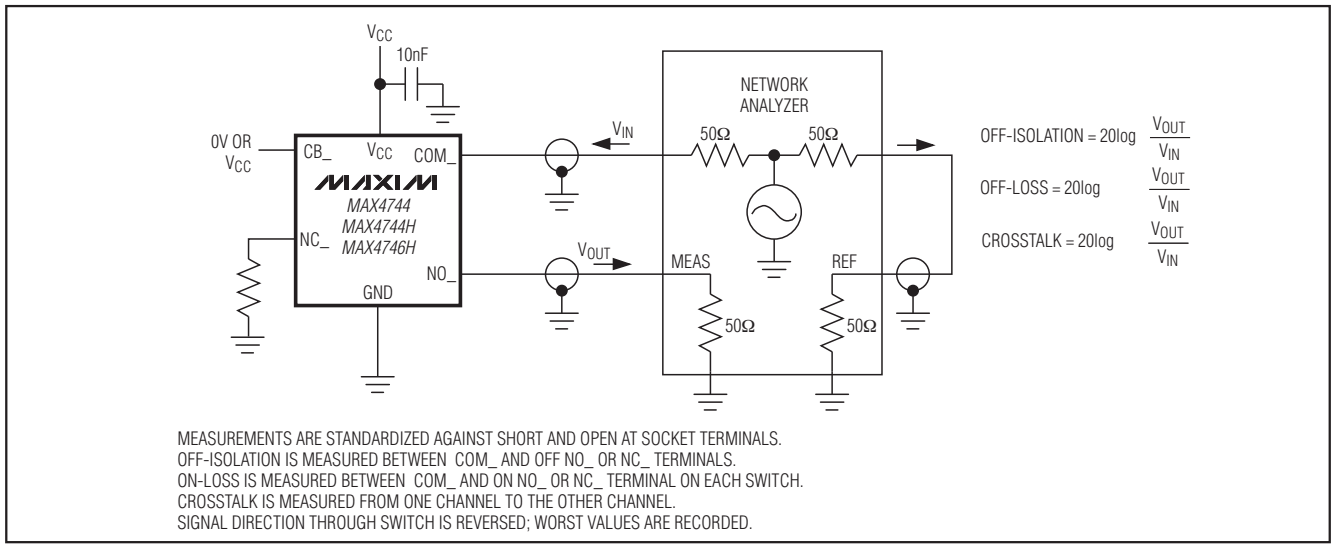


图5. 关断隔离、导通损耗和串扰

先断后合的切换

所有这些器件均具有先断后合切换功能，设置为在接通(关闭)新触点之前断开原来的触点。这样可确保新、旧信号通道不会在输出端出现瞬间导通，降低了咔嗒声。

供电顺序和过压保护

警告：不要超过Absolute Maximum Ratings规定的额定值，因为超过规定的额定值可能导致器件永久损坏。

对于所有CMOS器件都推荐使用正确的供电顺序。不恰当的上电顺序会使开关进入闭锁状态，导致芯片吸取过大的电源电流。跳出闭锁的唯一办法就是重新上电并以正确的顺序加载信号。首先连接所有接地引脚，然后加载电源V_{CC}，最后加载信号至NO_、NC_和COM_。断电时采用相反的顺序。

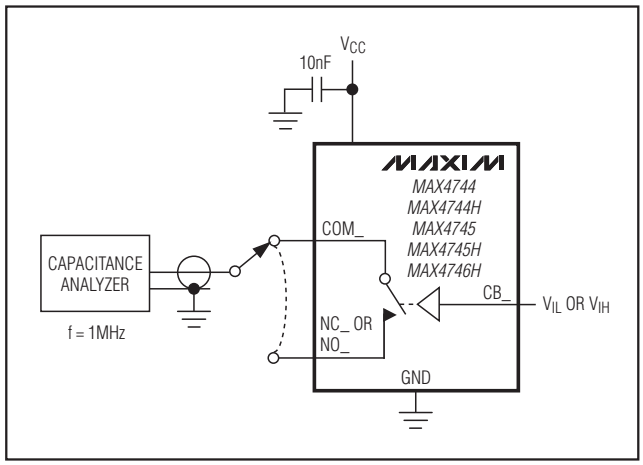
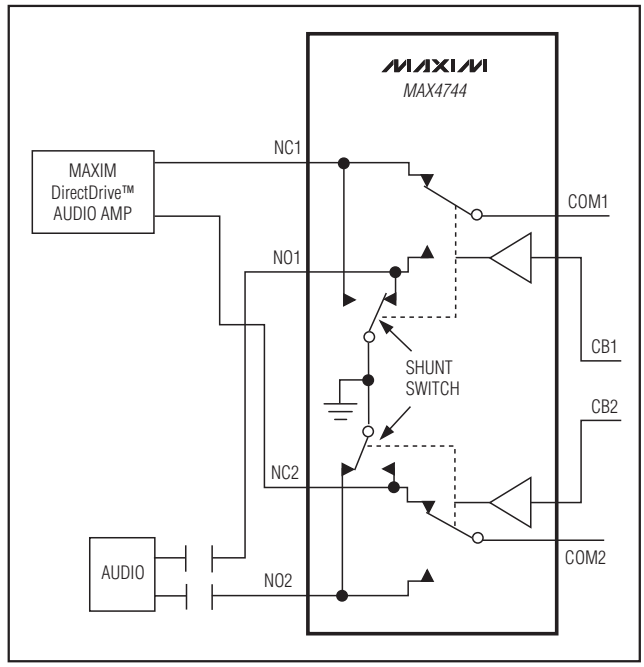


图6. 通道开/关电容

芯片信息

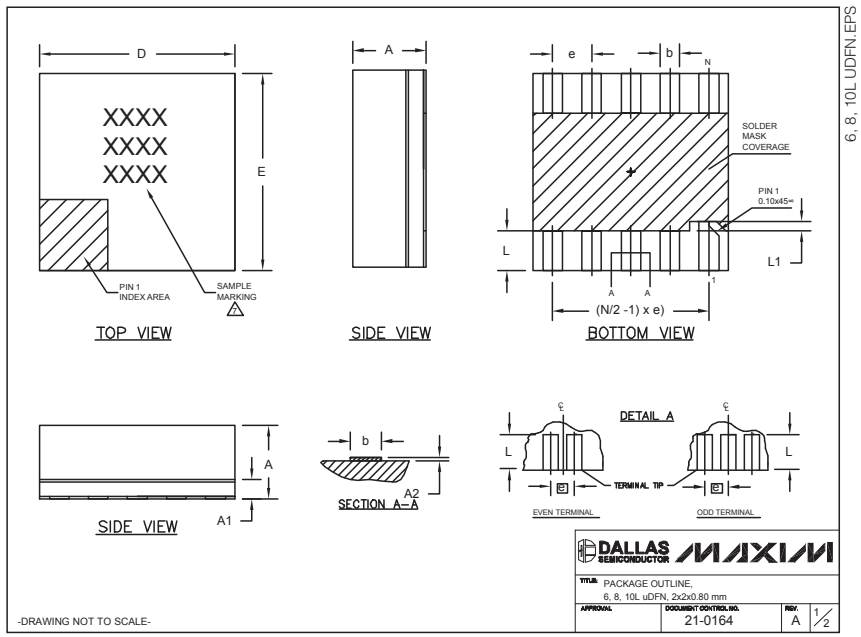
PROCESS: BiCMOS

典型工作电路



封装信息

(本数据资料提供的封装图可能不是最近的规格，如需最近的封装外形信息，请查询 **www.maxim-ic.com.cn/packages**。)



COMMON DIMENSIONS			
SYMBOL	MIN.	NOM.	MAX.
A	0.70	0.75	0.80
A1	0.15	0.20	0.25
A2	0.020	0.025	0.035
D	1.95	2.00	2.05
E	1.95	2.00	2.05
L	0.30	0.40	0.50
L1	0.10 REF.		

PACKAGE VARIATIONS				
PKG. CODE	N	e	b	(N/2 -1) x e
L622-1	6	0.65 BSC	0.30±0.05	1.30 REF.
L822-1	8	0.50 BSC	0.25±0.05	1.50 REF.
L1022-1	10	0.40 BSC	0.20±0.03	1.60 REF.

NOTES:
1. ALL DIMENSIONS ARE IN mm. ANGLES IN DEGREES.
2. COPLANARITY SHALL NOT EXCEED 0.08mm.
3. WARPAGE SHALL NOT EXCEED 0.10mm.
4. PACKAGE LENGTH/PACKAGE WIDTH ARE CONSIDERED AS SPECIAL CHARACTERISTIC(S).
5. "N" IS THE TOTAL NUMBER OF LEADS.
6. NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.
⚠ MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.

-DRAWING NOT TO SCALE-

DALLAS SEMICONDUCTOR MAXIM
PACKAGE OUTLINE,
6, 8, 10L uDFN, 2x2x0.80 mm
21-0164
A
2/2