19-3797; Rev 2; 1/07

MAXIM

高速/全速USB 2.0开关

概述

MAX4906/MAX4906F/MAX4907/MAX4907F模拟开关具有较低的导通电容(C_{ON})和导通电阻(R_{ON})，能够满足系统对开关性能的严格要求。适合在480Mbps高速USB 2.0应用中提供高性能切换，这些开关可处理USB低速和全速信号。

MAX4906/MAX4906F具有两个单刀/双掷(SPDT)开关；MAX4907/MAX4907F具有两个单刀/单掷开关(SPST)。MAX4907/MAX4907F具有较低的7Ω (最大值)导通电阻和7pF (最大值)导通电容。这些器件工作在+3.0V至+3.6V单电源，COM1和COM2具有+5.5V电压保护。这一特性完全符合USB 2.0的+5.5V故障保护规范。这些器件具有较低的逻辑门限电压，V_{IH}为+1.4V，支持低电压逻辑。MAX4906/MAX4906F/MAX4907/MAX4907F的静态工作电流为300µA (最大值)，关断功能将静态电流降低至2µA (最大值)以下。

MAX4906/MAX4906F/MAX4907/MAX4907F采用节省空间的2mm x 2mm、µDFN封装，工作在-40°C至+85°C温度范围。

应用

- 蜂窝电话
- PDA
- 数码相机
- GPS
- 笔记本电脑
- 继电器替代产品
- USB开关
- 以太网交换机
- 视频开关
- 总线切换
- T3/E3冗余保护开关

特性

- ♦ 工作在+3.0V至+3.6V单电源
- ♦ 4Ω (典型值)、7Ω (最大值)导通电阻(R_{ON})
- ♦ MAX4907/MAX4907F具有低至4pF (典型值)、7pF (最大值)的导通电容(C_{ON})
- ♦ -3dB带宽为1GHz (典型值)
- ♦ 码间偏移≤ 100ps
- ♦ 关断模式将功耗降至2µA (最大值)
- ♦ 兼容于3.3V、1.8V和1.4V逻辑
- ♦ COM_具有模拟输入故障保护，防止与+5.5V USB电源短路时损坏器件
- ♦ 节省空间的封装

  8引脚和10引脚、2mm x 2mm µDFN封装

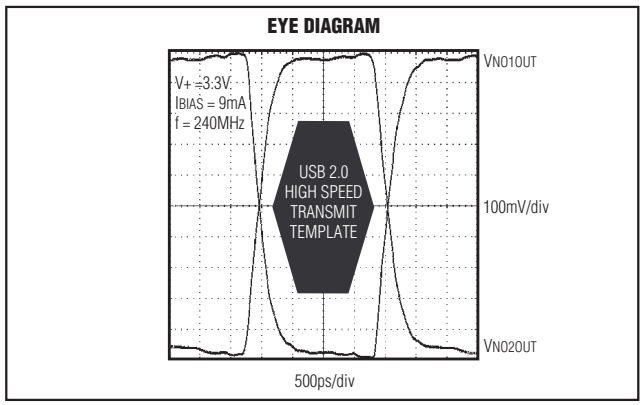
定购信息

PART	PIN-PACKAGE	PKG CODE
MAX4906ELB	10 µDFN	L1022-1
MAX4906FELB	10 µDFN	L1022-1
MAX4907ELA	8 µDFN	L822-1
MAX4907FELA	8 µDFN	L822-1

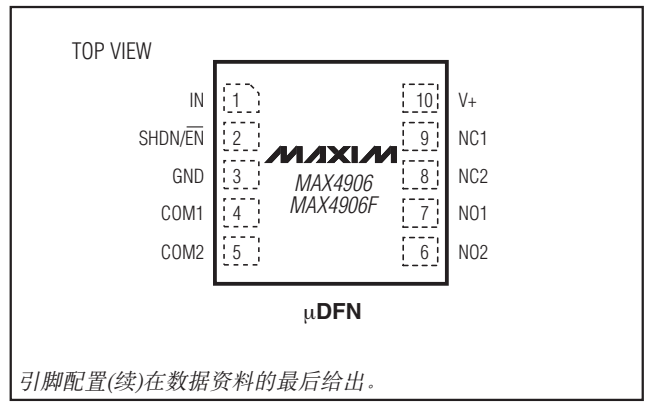
注：所有器件指定工作在-40°C至+85°C温度范围。

选型指南在数据资料的最后给出。

典型工作特性



引脚配置



引脚配置(续)在数据资料的最后给出。

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ABSOLUTE MAXIMUM RATINGS

Voltages Referenced to GND
V+ .....-0.3V to +4V
IN, SHDN, SHDN/$\overline{EN}$ (Note 1) .....-0.3V to (V+ + 0.3V)
COM_, NO_, NC_ .....-0.5V to +5.5V
Continuous Current (COM_ to NO_/NC_) .....±120mA
Peak Current, (COM_ to NO_/NC_)
(pulsed at 1ms 10% duty cycle).....±240mA

Continuous Power Dissipation (T_A = +70°C)
8-Pin µDFN (derate 5.0mW/°C above +70°C) 400mW
10-Pin µDFN (derate 5.3mW/°C above +70°C) 423.7mW
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 IN, SHDN or SHDN/$\overline{EN}$ 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

(V+ = +3V to +3.6V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V+= 3.3V, T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
ANALOG SWITCH							
Analog Signal Range	$V_{COM\_}$,$V_{NO\_}$, $V_{NC\_}$	SHDN or SHDN/$\overline{EN}$ = 0 (Note 3)		0		V+	V
Fault-Protection Trip Threshold	V_{FP}			3.6		4.0	V
On-Resistance	R_{ON}	$I_{COM\_}$ = -40mA, 0V ≤ $V_{COM\_}$ ≤ V+, SHDN or SHDN/$\overline{EN}$ = 0	T_A = +25°C		4	7	Ω
			T_A = T_{MIN} to T_{MAX}			8	
On-Resistance During Shutdown	R_{ONSH}	$I_{COM\_}$ = -40mA, 0V ≤ $V_{COM\_}$ ≤ 1.5V, SHDN = V+ (MAX4907/MAX4907F)	T_A = +25°C		4	10	Ω
			T_A = T_{MIN} to T_{MAX}			13	
On-Resistance Match Between Channels	ΔR_{ON}	V+ = 3.0V, $I_{COM\_}$= -40mA, $V_{COM\_}$ = 1.5V (Note 4)	T_A = +25°C		0.7	1.2	Ω
			T_A = T_{MIN} to T_{MAX}			1.5	
On-Resistance Flatness	$R_{FLAT (ON)}$	V+ = 3.0V, $I_{COM\_}$ = -40mA, $V_{COM\_}$ = 1.5V, 3.0V (Note 5)			1.0		Ω
Off-Leakage Current	$I_{COM\_(OFF)}$	V+ = 3.6V, $V_{COM\_}$ = 0.3V, 3.3V; $V_{NO\_}$ or $V_{NC\_}$ = 3.3V, 0.3V		-1		+1	µA
On-Leakage Current	$I_{COM\_(ON)}$	V+ = 3.6V, V_{COM} = 0.3V, 3.3V; $V_{NO\_}$ or $V_{NC\_}$ = 0.3V, 3.3V, or floating		-1		+1	µA
SWITCH AC PERFORMANCE							
On-Channel -3dB Bandwidth	BW	R_L = R_S = 50Ω, signal = 0dBm, Figure 1			1000		MHz
Off-Isolation	V_{ISO}	f = 10MHz; $V_{NO\_}$, $V_{NC\_}$ = $1V_{P-P}$; R_L = R_S = 50Ω, Figure 1			-60		dB
		f = 250MHz; $V_{NO\_}$, $V_{NC\_}$ = $1V_{P-P}$; R_L = R_S = 50Ω, Figure 1			-32		
		f = 500MHz; $V_{NO\_}$, $V_{NC\_}$ = $1V_{P-P}$; R_L = R_S = 50Ω, Figure 1			-26		

ELECTRICAL CHARACTERISTICS (continued)

(V+ = +3V to +3.6V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V+ = 3.3V, T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Crosstalk (Note 6)	V_{CT}	f = 10MHz; $V_{NO\_}$, $V_{NC\_}$ = $1V_{P-P}$; R_L = R_S = 50Ω, Figure 1			-59		dB
		f = 250MHz; $V_{NO\_}$, $V_{NC\_}$ = $1V_{P-P}$; R_L = R_S = 50Ω, Figure 1			-31		
		f = 500MHz; $V_{NO\_}$, $V_{NC\_}$ = $1V_{P-P}$; R_L = R_S = 50Ω, Figure 1			-25		
SWITCH DYNAMICS							
NO_, NC_ Off-Capacitance	$C_{(OFF)}$	f = 1MHz, Figure 2 (Note 7)			2	4	pF
Switch On-Capacitance	$C_{(ON)}$	f = 1MHz, Figure 2 (Note 7)	MAX4906ELB, MAX4906FELB		6	9	pF
			MAX4907ELA, MAX4907FELA		4	7	
Switch On-Capacitance Matching	C_{ONM}	f = 1MHz (Note 7)	MAX4906ELB, MAX4906FELB		0.4		pF
			MAX4907ELA, MAX4907FELA		0.3		
Turn-On Time	t_{ON}	$V_{NO\_}$, $V_{NC\_}$ = 1.5V; R_L = 300Ω, C_L = 35pF, V_{IH} = V+, V_{IL} = 0V, SHDN or SHDN/$\overline{EN}$ = 0V, Figure 3				60	ns
Turn-Off Time	t_{OFF}	$V_{NO\_}$, $V_{NC\_}$ = 1.5V; R_L = 300Ω, C_L = 35pF, V_{IH} = V+, V_{IL} = 0V, SHDN or SHDN/$\overline{EN}$ = 0V, Figure 3; T_A = +25°C				30	ns
Propagation Delay	$t_{PLH\_}$,t_{PHL}	R_L = R_S = 50Ω, Figure 4			0.25		ns
Fault-Protection Response Time	t_{FP}	$V_{COM\_}$ = 0 to 5V step, R_L = R_S = 50Ω, Figure 5				3.0	µs
Fault-Protection Recovery Time	t_{FPR}	$V_{COM\_}$ = 5V to 3V step, R_L = R_S = 50Ω, Figure 5				2	µs
Output Skew Between Switches	$t_{SK(o)}$	Skew between switch 1 and switch 2, R_L = R_S = 50Ω, Figure 4 (Note 7)			50	100	ps
Output Skew Same Switch	$t_{SK(p)}$	Skew between opposite transitions in same switch, R_L = R_S = 50Ω, Figure 4 (Note 7)			50	100	ps

ELECTRICAL CHARACTERISTICS (continued)

(V+ = +3V to +3.6V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V+ = 3.3V, T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Total Harmonic Distortion Plus Noise	THD+N	$V_{COM\_}$ = $2V_{P-P}$, R_L = 600Ω, f = 20Hz to 20kHz		0.03		%
Charge Injection	Q	V_{GEN} = 1.5V, R_{GEN} = 0Ω, C_L = 100pF, Figure 6		5		pC
SWITCH LOGIC						
Logic-Input-Voltage Low	V_{IL}				0.4	V
Logic-Input-Voltage High	V_{IH}		1.1			V
Input-Logic Hysteresis	V_{HYST}			100		mV
Input Leakage Current	I_{IN}	V+ = 3.6V, V_{IN} = 0 or V+	-1		+1	µA
Operating Supply-Voltage Range	V+		3.0		3.6	V
Quiescent Supply Current	I+	V+ = 3.6V, V_{IN} = 0 or V+, SHDN or SHDN/$\overline{EN}$ = 0		120	300	µA
Quiescent Supply Current During Shutdown	I+	V+ = 3.6V, V_{IN} = 0 or V+, SHDN or SHDN/$\overline{EN}$ = V+			2	µA

Note 2: All units are 100% production tested at T_A = +25°C. Limits over the operating temperature range are guaranteed by design and not production tested.

Note 3: The switch will turn off for voltages above (V_{FP}); therefore, protecting downstream circuits in case of a fault condition (MAX4906F/MAX4907F).

Note 4: $\Delta R_{ON(MAX)} = | R_{ON(CH1)} - R_{ON(CH2)} |$

Note 5: Flatness is defined as the difference between the maximum and minimum value of on-resistance, as measured over specified analog signal ranges.

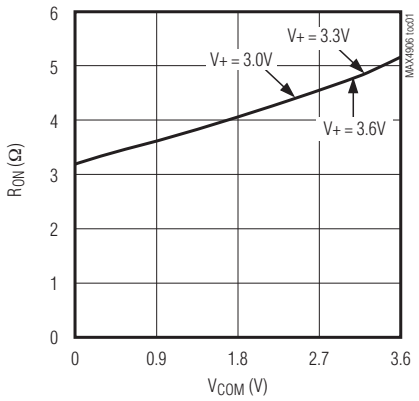
Note 6: Between any two switches.

Note 7: Switch off-capacitance, switch on-capacitance, output skew between switches, and output skew same-switch limits are not production tested; design guaranteed by bench characterization.

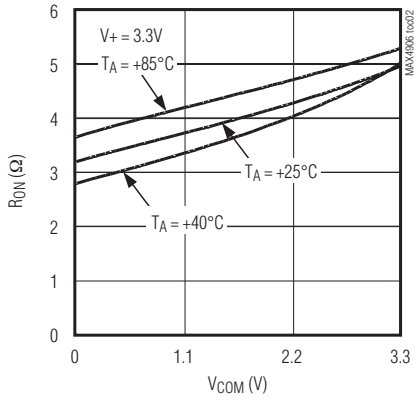
典型工作特性

(T_A = +25°C, unless otherwise noted.)

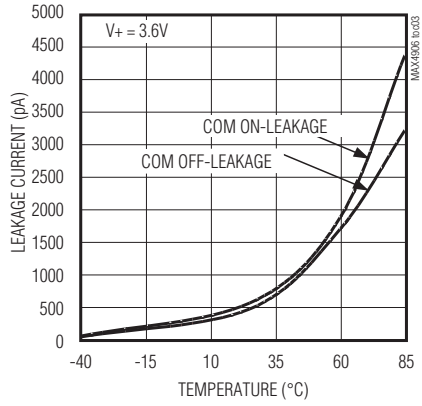
ON-RESISTANCE vs. V_{COM}



ON-RESISTANCE vs. V_{COM}



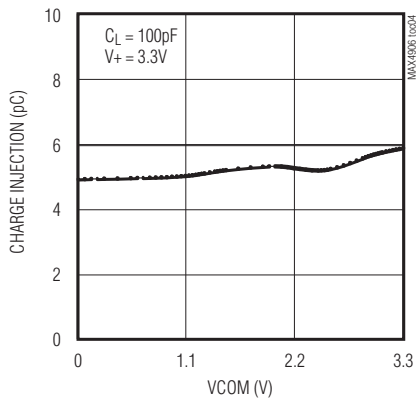
LEAKAGE CURRENT vs. TEMPERATURE



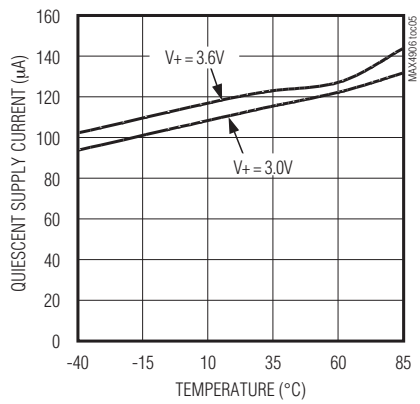
典型工作特性(续)

(T_A = +25°C, unless otherwise noted.)

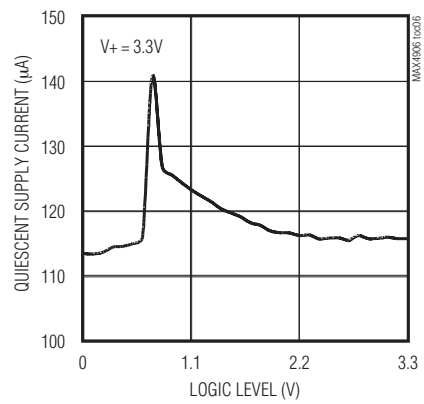
CHARGE INJECTION vs. V_{COM}



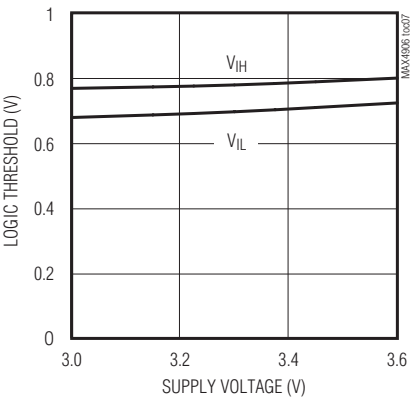
QUIESCENT SUPPLY CURRENT vs. TEMPERATURE



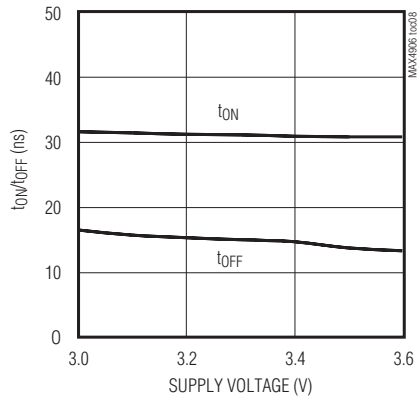
QUIESCENT SUPPLY CURRENT vs. LOGIC LEVEL



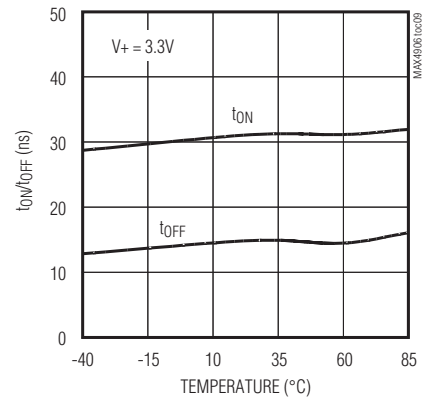
LOGIC THRESHOLD vs. SUPPLY VOLTAGE



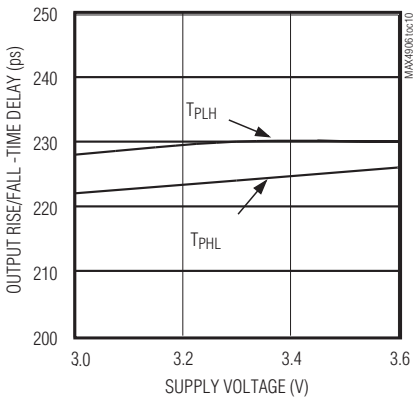
TURN-ON/OFF TIME vs. SUPPLY VOLTAGE



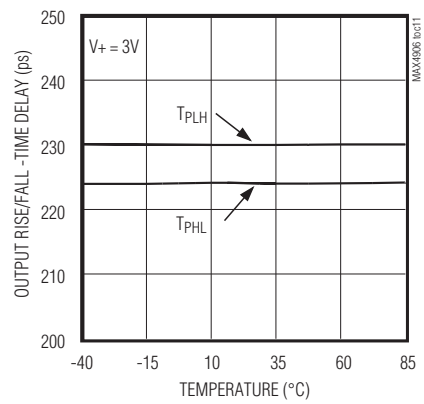
TURN-ON/OFF TIME vs. TEMPERATURE



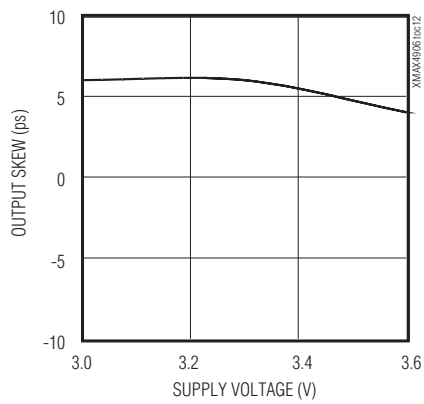
RISE/FALL-TIME PROPAGATION DELAY vs. SUPPLY VOLTAGE



RISE/FALL-TIME PROPAGATION DELAY vs. TEMPERATURE



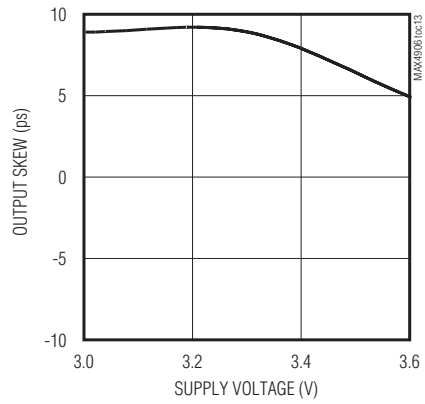
SAME SWITCH OUTPUT SKEW vs. SUPPLY VOLTAGE



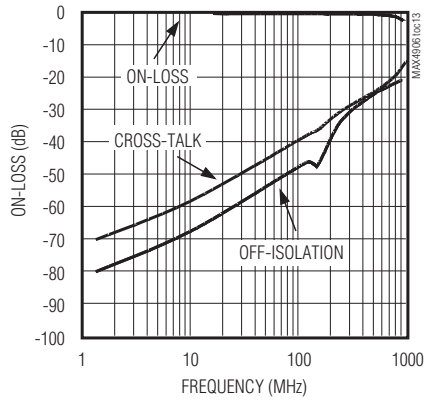
典型工作特性(续)

(T_A = +25°C, unless otherwise noted.)

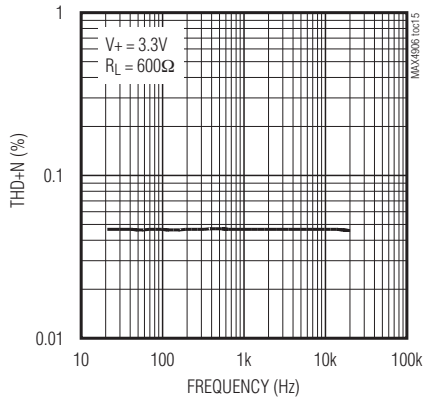
OUTPUT SKEW BETWEEN SWITCHES vs. SUPPLY VOLTAGE



FREQUENCY RESPONSE



TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY



引脚说明

引脚		名称	功能
MAX4906/ MAX4906F	MAX4907/ MAX4907F		
1	8	IN	数字控制输入，IN控制开关1和开关2。
2	—	SHDN/$\overline{EN}$	关断和使能输入，驱动SHDN/$\overline{EN}$至高电平时，电流损耗最小，器件处于高阻模式。在正常工作模式下，SHDN/$\overline{EN}$为低电平。
3	2	GND	地。
4	3	COM1	模拟开关1—公共端。
5	4	COM2	模拟开关2—公共端。
6	5	NO2	模拟开关2—常开端。
7	6	NO1	模拟开关1—常开端。
8	—	NC2	模拟开关2—常闭端。
9	—	NC1	模拟开关1—常闭端。
10	7	V+	正电源输入，V+连接到3.0V至3.6V电源。采用一只0.1µF电容旁路V+至GND。
—	1	SHDN	关断输入，驱动SHDN至高电平，器件进入关断模式。在正常工作模式下，SHDN为低电平。

测试电路/时序图

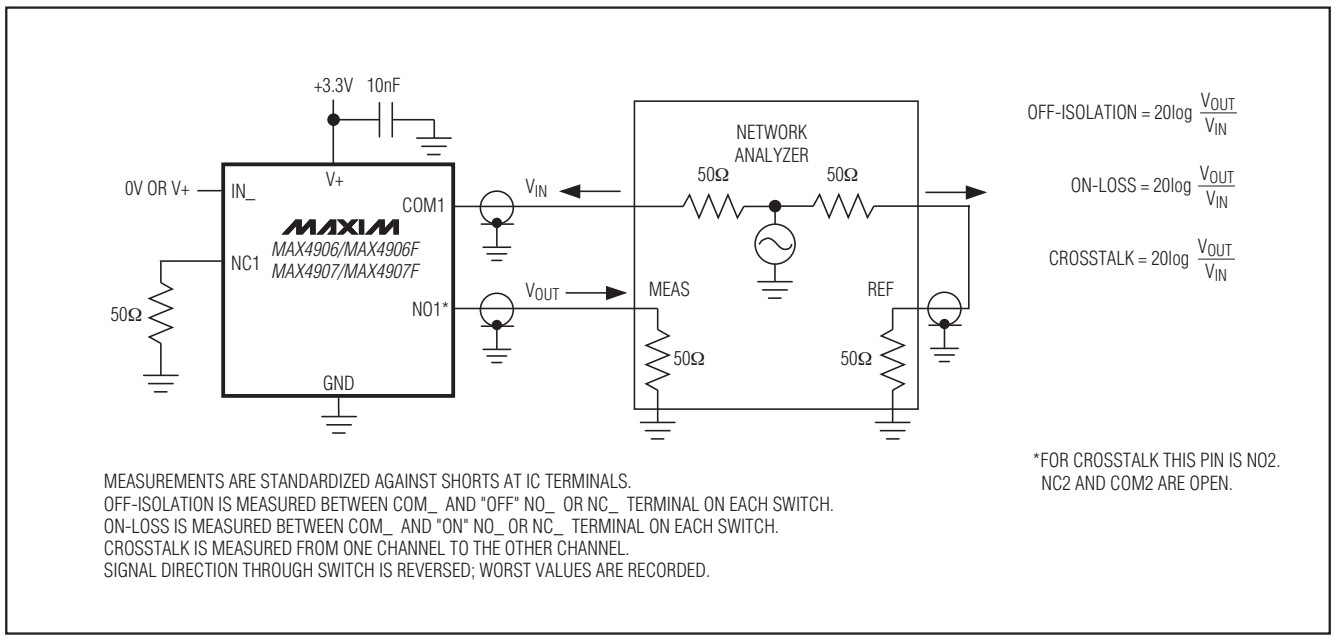


图1. 导通损耗、关断隔离和串扰

测试电路/时序图(续)

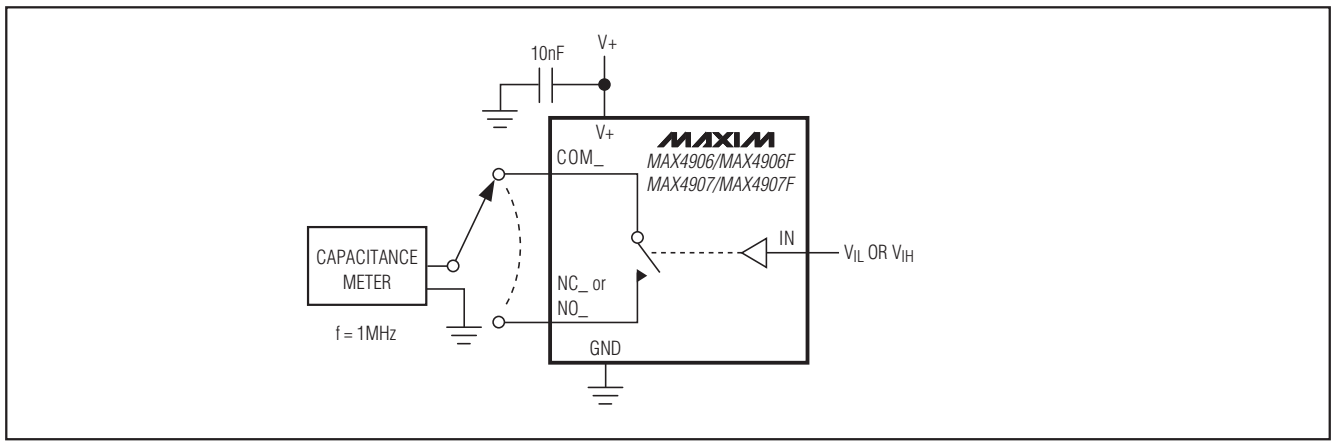


图2. 通道断开/导通电容

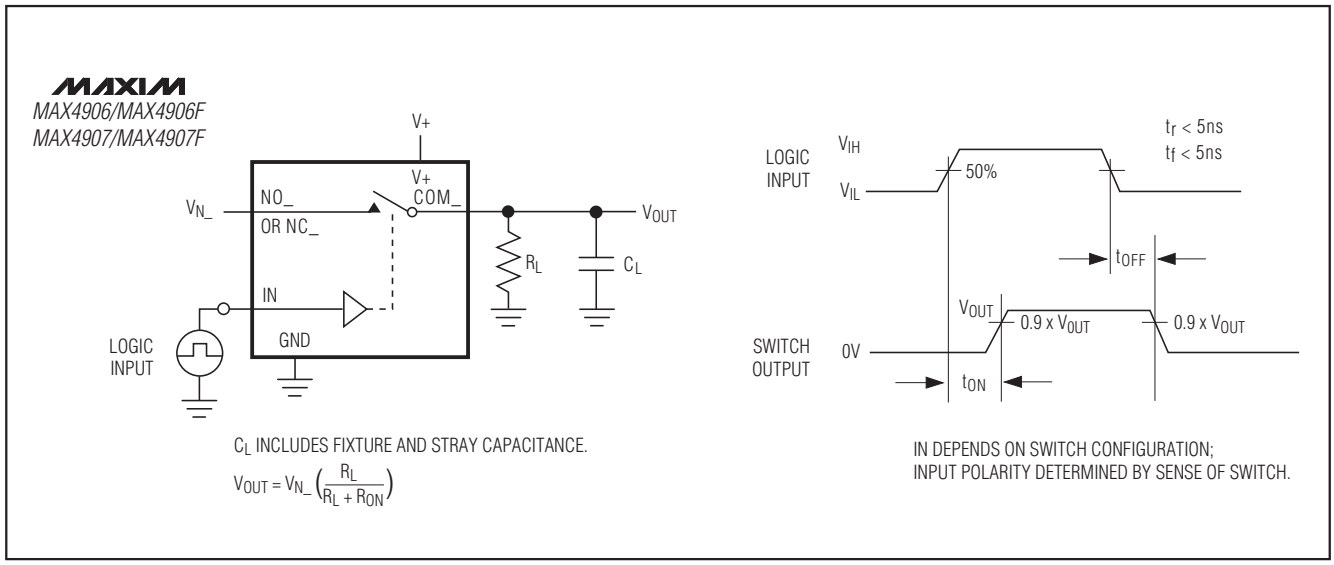


图3. 开关时间

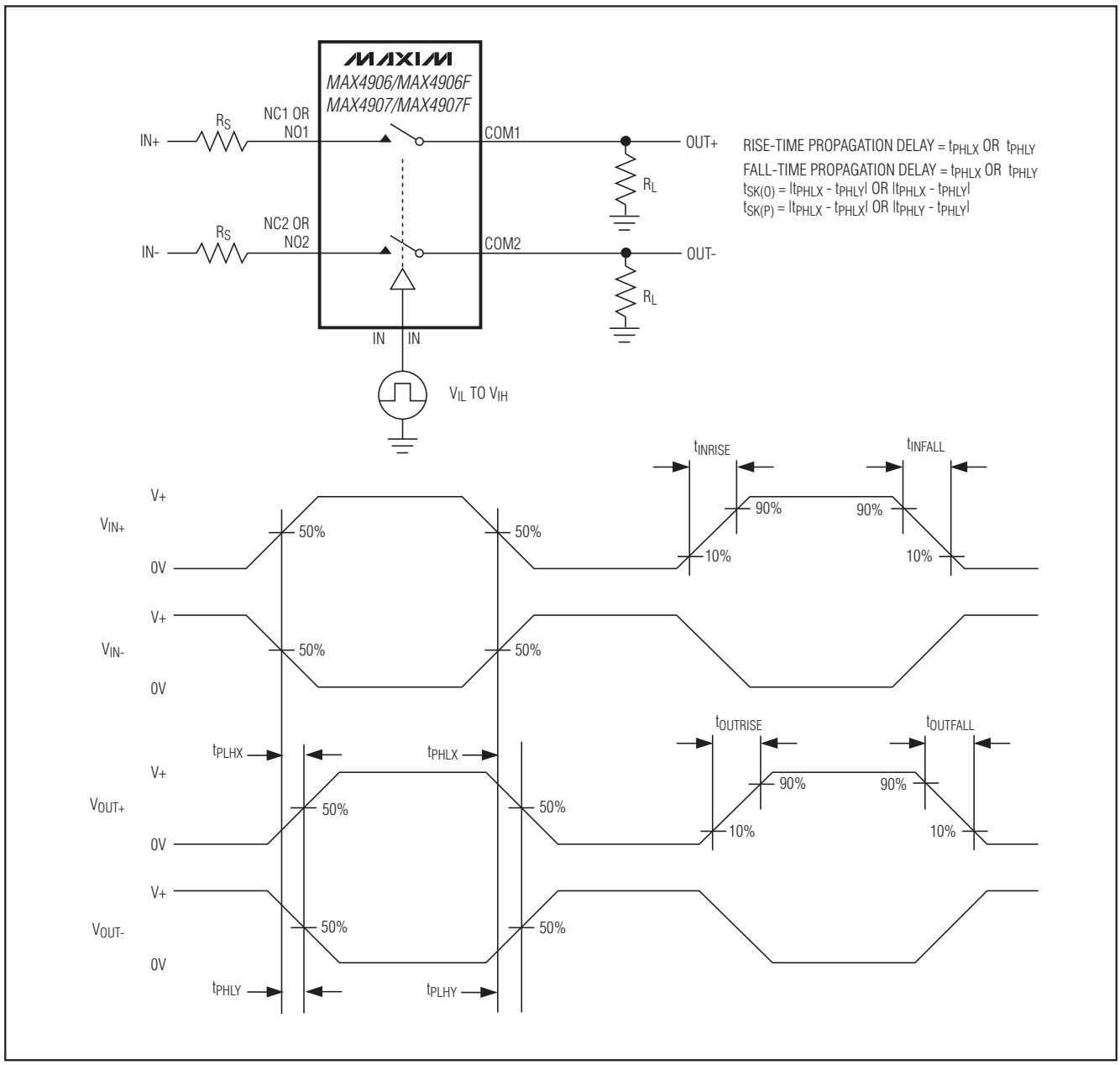


图4. 输出信号偏差、上升/下降时间、传输延迟

测试电路/时序图(续)

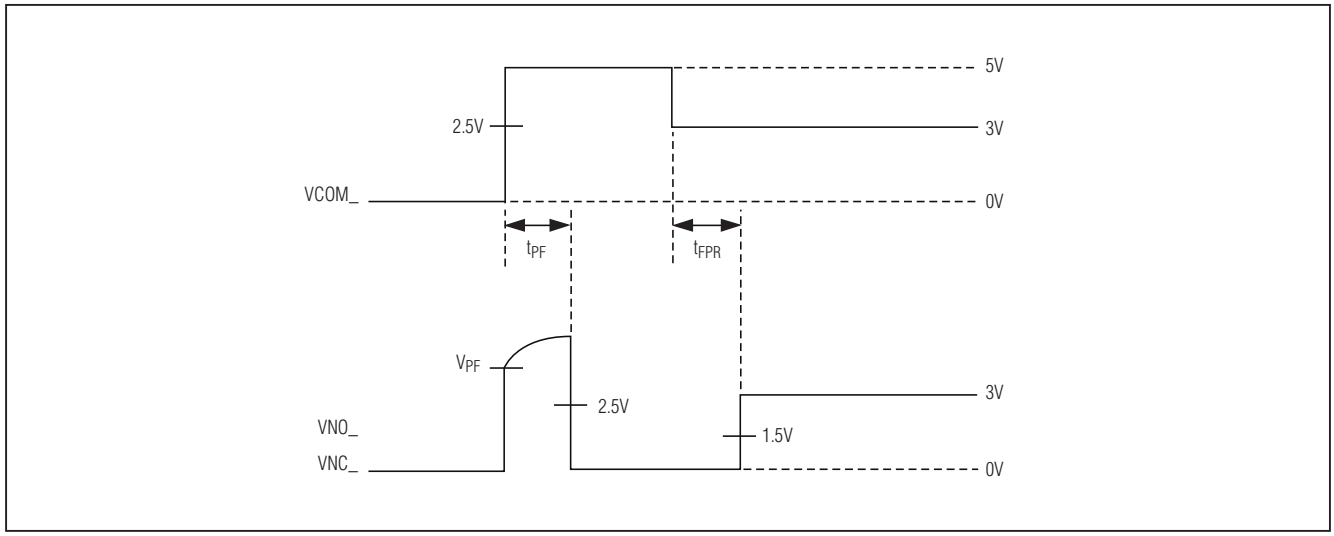


图5. MAX4906F/MAX4907F故障保护响应/恢复时间

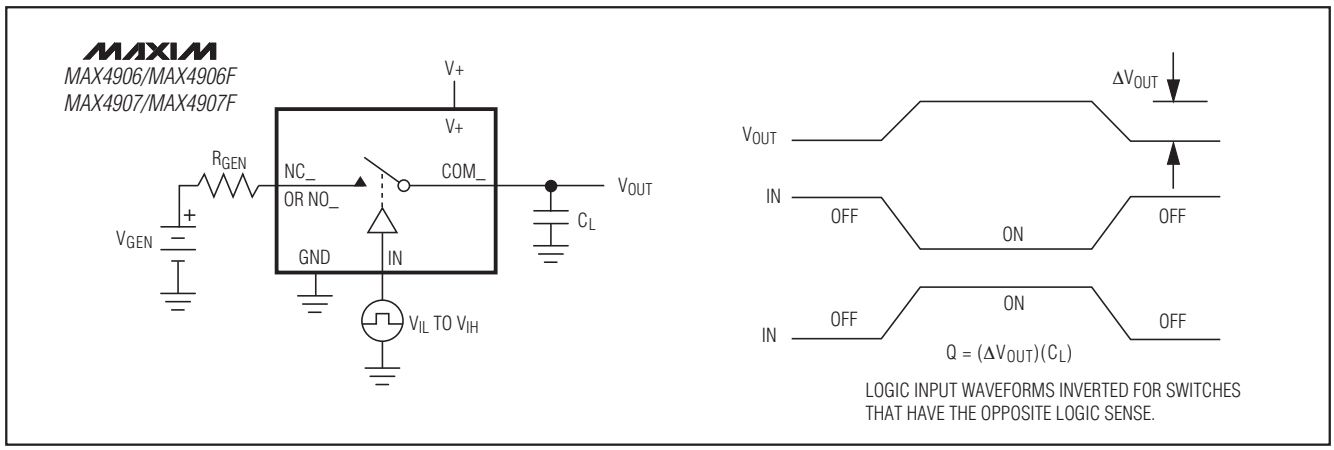
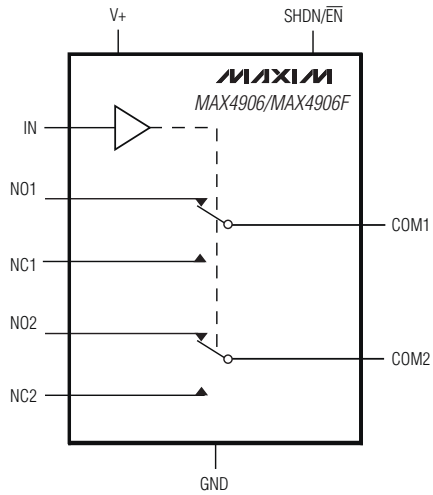


图6. 电荷注入

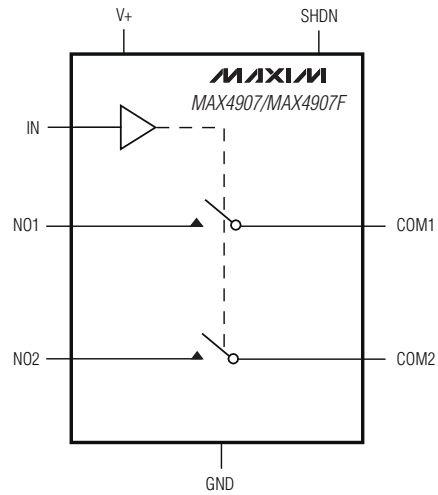
详细说明

MAX4906/MAX4906F/MAX4907/MAX4907F模拟开关专为USB 2.0高速(480Mbps)开关应用设计。这些器件可满足USB低速和全速要求，非常适合10/100以太网开关。MAX4906/MAX4906F具有两个SPDT开关；而MAX4907/MAX4907F具有两个SPST开关。MAX4907/MAX4907F开关配置具有较低的7Ω (最大值)导通电阻和7pF (最大值)导通电容。MAX4906/MAX4906F/MAX4907/MAX4907F工作在+3.0V至+3.6V单电源，并提供+5.5V故障保护(MAX4906F/MAX4907F)。当工作在+3.0V至+3.6V电源范围时，这些器件的门限电压支持低至1.4V的逻辑电平。MAX4906/MAX4906F/MAX4907/MAX4907F基于n沟道架构(由电荷泵驱动)，具有300µA (最大值)的静态工作电流。这些器件都带有关断输入，关断模式下使静态电流降低至2µA (最大值)以下。

功能框图/真值表



MAX4906/MAX4906F			
SHDN/$\overline{EN}$	IN	NO1 NO2	NC1 NC2
0	0	OFF	ON
0	1	ON	OFF
1	x	OFF	OFF



MAX4907/MAX4907F		
SHDN	IN	COM1- NO1 COM2- NO1
0	0	OFF
0	1	ON
1	0	OFF
1	1	ON

数字控制输入

MAX4906/MAX4906F/MAX4907/MAX4907F具有单数字控制逻辑输入(IN)。IN端控制开关位置，参见*功能框图/真值表*。满摆幅驱动IN可使功耗降至最低。采用+3.0V至+3.6V电源供电，这些器件兼容于+1.4V逻辑电平。

模拟信号电平

当模拟输入信号在地电位与V+之间变化时，MAX4906/MAX4906F/MAX4907/MAX4907F的导通电阻非常低，并且稳定(参见*典型工作特性*)。这些开关可双向工作，因此NO_、NC_和COM_既可作为输入也可作为输出。

过压故障保护

MAX4906F和MAX4907F的COM1和COM2具有+5.5V故障保护，可防止开关与USB总线电源短路时损坏器件。

关断模式

MAX4906/MAX4906F具有关断模式，可将静态电流降低至2μA以下。将SHDN/$\overline{EN}$输入驱动至高电平时，器件处于高阻模式；SHDN/$\overline{EN}$引脚为低电平时，器件正常工作。

MAX4907/MAX4907F具有SHDN输入，能够使静态电流降至2μA以内。SHDN驱动至高电平时，器件处于低电流模式；器件可以工作在低电流模式，但模拟输入电压范围降至$0 < V_{ANALOG} < 1.5V$，性能降低。当SHDN驱动至低电平时，MAX4907/MAX4907F处于正常工作模式。

应用信息

USB开关

MAX4906/MAX4906F/MAX4907/MAX4907F模拟开关完全符合USB 2.0规范。这些开关具有较低的导通电阻和导通电

高速/全速USB 2.0开关

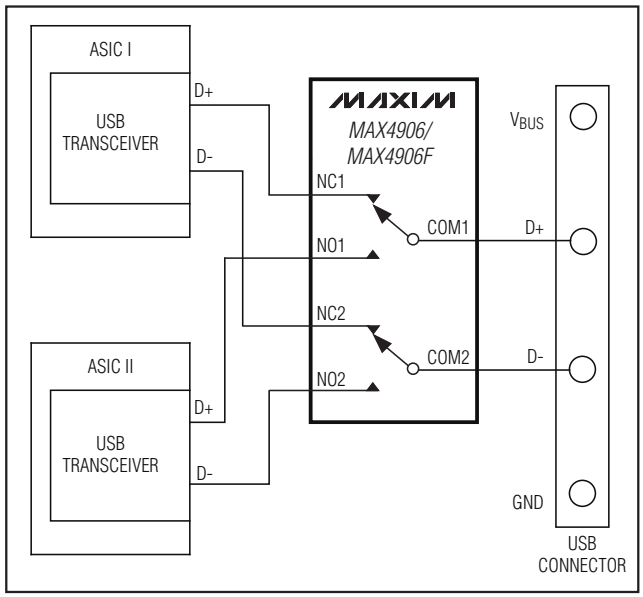


图7. MAX4906/MAX4906F用于USB数据线切换

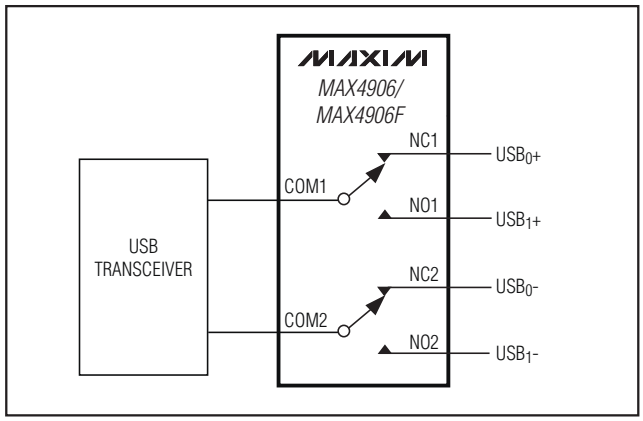


图8. MAX4906/MAX4906F用于多个USB主机之间的数据切换

容，使其非常适合高性能开关应用。MAX4906/MAX4906F可理想切换USB数据线(图7)以及多个USB主机之间数据切换(图8)。MAX4907/MAX4907F能够用于那些不同类型的数据共用同一引脚的系统(图9)；当然，共用引脚的器件一定具有三态模式。同时，MAX4906F/MAX4907F还具有+5.5V故障保护，防止系统与USB总线电源短路时损坏。对于USB应用，建议使用具有故障保护功能的器件。

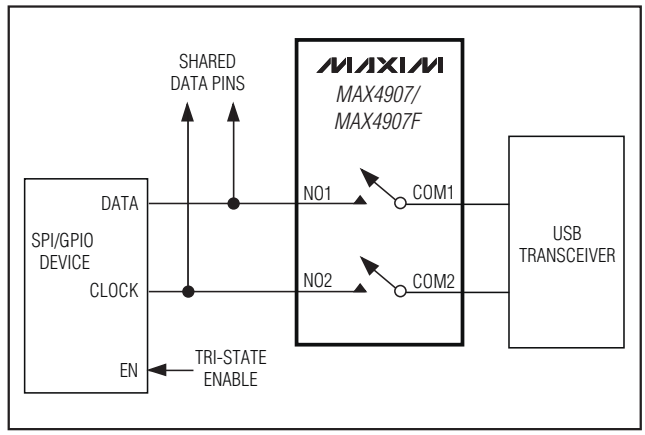


图9. MAX4907/MAX4907F USB/SPI/GPIO开关

以太网开关

MAX4906/MAX4906F/MAX4907/MAX4907F所具有的宽带特性可满足10/100以太网开关的需求。这些器件可用于切换来自两个接口变压器的信号，将信号连接到单个10/100 Base-T以太网PHY，从而简化了坞站设计，降低制造成本。

供电顺序

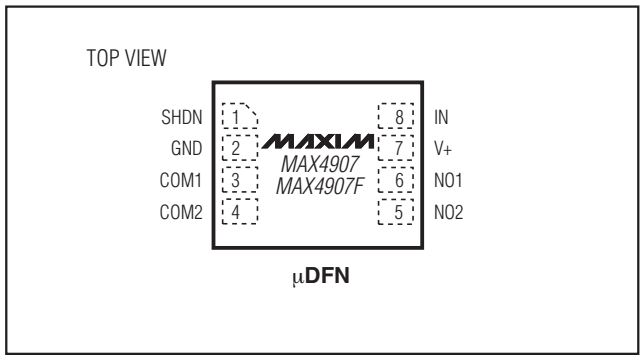
警告：不要超过器件的极限参数，一旦超出表中所列的极限参数将可能导致器件永久性损坏。

对于所有CMOS器件，推荐使用正确的供电顺序。总是在加模拟信号之前先加V+，尤其是在模拟信号没有限流的情况下。

电路板布局

高速开关要求正确的电路板布局和设计步骤，以获得最佳性能。要使阻抗受控的PCB引线尽可能短。确保旁路电容靠近器件安装，使用大面积接地层。

引脚配置(续)



选型指南

PART	CONFIGURATION	FAULT PROTECTION	TOP MARK
MAX4906ELB	Dual SPDT	NO	AAB
MAX4906FELB	Dual SPDT	YES	AAA
MAX4907ELA	Dual SPST	NO	AAE
MAX4907FELA	Dual SPST	YES	AAD

修订历史

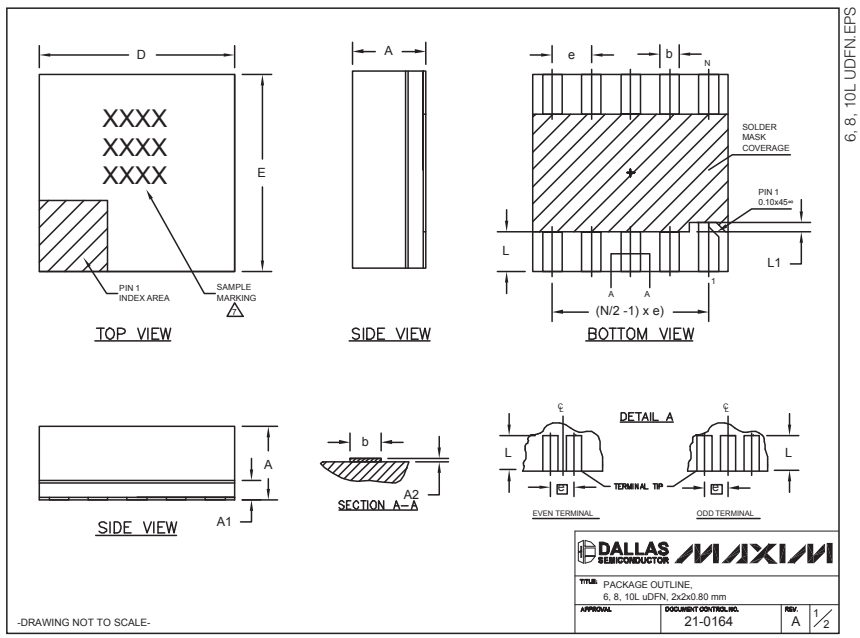
Rev 2中的修改页：1、2、3、7、11、14。

芯片信息

PROCESS: BiCMOS

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.
7. 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

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