



Quad SPST, High-Bandwidth, Signal Line Protection Switch

MAX4854H

General Description

The MAX4854H analog switch operates from a single 2V to 5.5V supply and can handle signals greater than the supply rail. The device features four low on-resistance (7Ω), single-pole/single-throw (SPST) switches, with 27.5pF on-capacitance, making it ideal for data signals. If the input signal exceeds the supply rail, the switch becomes high impedance and prevents the signal from feeding through to the output.

The MAX4854H is available in the space-saving (3mm x 3mm), 16-pin thin QFN package and operates over the extended temperature range of -40°C to $+85^{\circ}\text{C}$.

Applications

USB Switching
High-Bandwidth Data Switching
Cellular Phones
Notebook Computers
PDAs and Other Handheld Devices

Features

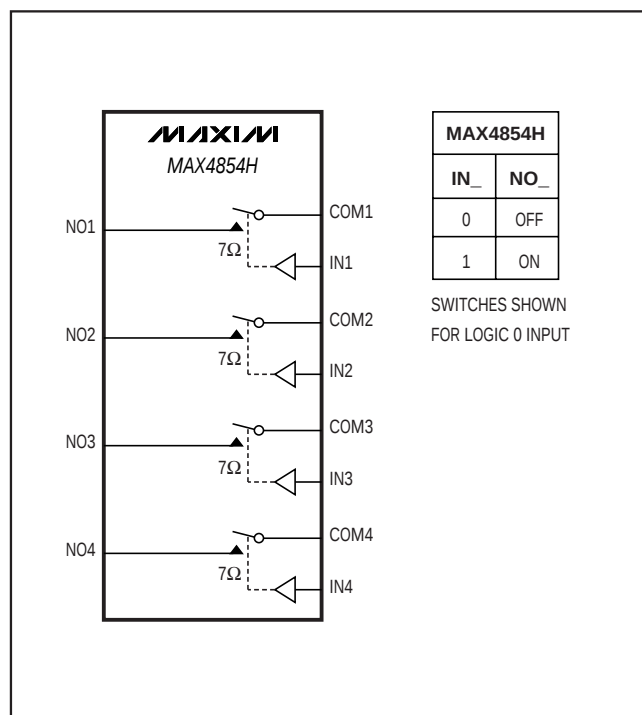
- ◆ USB 2.0 Full Speed (12MB) and USB 1.1 Signal Switching Compliant
- ◆ Overvoltage Protection if Signal Exceeds V_{CC}
- ◆ 150MHz -3dB Bandwidth
- ◆ 27.5pF On-Capacitance
- ◆ +2V to +5.5V Supply Range
- ◆ 7Ω On-Resistance
- ◆ Low 10 μA Supply Current
- ◆ 1.8V Logic Compatible
- ◆ Available in a Space-Saving (3mm x 3mm), 16-Pin TQFN Package

Ordering Information

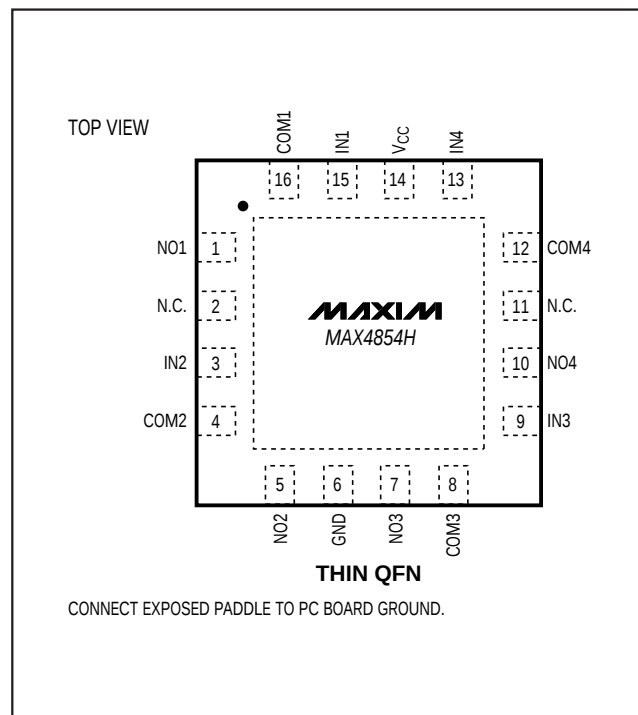
PART	TEMP RANGE	PIN-PACKAGE	TOP MARK
MAX4854HETE	-40°C to $+85^{\circ}\text{C}$	16 TQFN-EP*	ACD

*EP = Exposed paddle.

Block Diagram/Truth Table



Pin Configuration



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ABSOLUTE MAXIMUM RATINGS

V_{CC} , IN_{-} , COM_{-} , NO_{-} to GND (Note 1)-0.3V to +6.0V
 Closed Switch Continuous Current COM_{-} , NO_{-} ±50mA
 Peak Current COM_{-} , NO_{-}
 (pulsed at 1ms, 50% duty cycle)±100mA
 Peak Current COM_{-} , NO_{-}
 (pulsed at 1ms, 10% duty cycle)±120mA

Continuous Power Dissipation ($T_A = +70^{\circ}\text{C}$)
 16-Pin Thin QFN (derate 20.8mW/ $^{\circ}\text{C}$ above $+70^{\circ}\text{C}$)1667mW
 Operating Temperature Range-40 $^{\circ}\text{C}$ to +85 $^{\circ}\text{C}$
 Junction Temperature+150 $^{\circ}\text{C}$
 Storage Temperature Range-65 $^{\circ}\text{C}$ to +150 $^{\circ}\text{C}$
 Lead Temperature (soldering, 10s)+300 $^{\circ}\text{C}$

Note 1: Signals on NO or COM exceeding GND are clamped by internal diodes. Signals on IN exceeding GND are clamped by an internal diode. Limit the forward-diode current to the 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

($V_{CC} = +2.7\text{V}$ to $+5.5\text{V}$, $T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$, unless otherwise noted. Typical values are at $V_{CC} = +3.0\text{V}$, $T_A = +25^{\circ}\text{C}$, unless otherwise noted.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Supply Voltage	V _{CC}			2.0		5.5	V
Supply Current	I _{CC}	V _{CC} = 5.5V, V _{IN_} = 0V or V _{CC}			10	20	μA
ANALOG SWITCH							
Analog Signal Range	V _{NO_} , V _{COM_}			0		V _{CC}	V
On-Resistance	R _{ON}	V _{CC} = 3V, I _{COM_} = 10mA, V _{NO_} = 0 to V _{CC}	T _A = +25°C	7	9	Ω	
			T _A = -40°C to +85°C	10			
On-Resistance Match Between Channels (Notes 3, 4)	ΔR _{ON}	V _{CC} = 3V, I _{COM} = 10mA, V _{NO_} = 1.5V	T _A = +25°C	0.2	0.4	Ω	
			T _A = -40°C to +85°C	0.5			
On-Resistance Flatness (Note 5)	R _{FLAT}	V _{CC} = 3V, I _{COM_} = 10mA, V _{NO_} = 1V, 2V, 3V	T _A = +25°C	2.5	3.75	Ω	
			T _A = -40°C to +85°C	4			
NO_ Off-Leakage Current	I _{OFF}	V _{CC} = 5.5V, V _{NO_} = 1V or 4.5V, V _{COM_} = 4.5V or 1V	T _A = +25°C	-2	+2	nA	
			T _A = -40°C to +85°C	-10	+10		
COM_ On-Leakage Current	I _{ON}	V _{CC} = 5.5V; V _{NO_} = 1V, 4.5V, or floating; V _{COM_} = 1V, 4.5V, or floating	T _A = +25°C	-2	+2	nA	
			T _A = -40°C to +85°C	-12.5	+12.5		
DYNAMIC CHARACTERISTICS							
Signal Over-Rail to High-Z Switching Time		V _{NO_} = V _{CC} to (V _{CC} + 0.5V), V _{CC} < 5V (Figure 1)		0.5	1	μs	
High-Z to Low-Z Switching Time		V _{NO_} = (V _{CC} + 0.5V) to V _{CC} , V _{CC} < 5V (Figure 1)		0.5	1	μs	
Skew (Note 3)	t _{SKEW}	R _S = 39Ω, C _L = 50pF (Figure 2)		0.15	1	ns	
Propagation Delay (Note 3)	t _{PD}	R _S = 39Ω, C _L = 50pF (Figure 2)		0.9	2	ns	
Turn-On Time	t _{ON}	V _{CC} = 3V, V _{NO_} = 1.5V, R _L = 300Ω, C _L = 50pF (Figure 1)	T _A = +25°C	40	60	ns	
			T _A = -40°C to +85°C	100			
Turn-Off Time	t _{OFF}	V _{CC} = 3V, V _{NO_} = 1.5V, R _L = 300Ω, C _L = 50pF (Figure 1)	T _A = +25°C	30	40	ns	
			T _A = -40°C to +85°C	60			
Charge Injection	Q	V _{COM_} = 1.5V, R _S = 0Ω, C _L = 1nF (Figure 3)		8		pC	

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ELECTRICAL CHARACTERISTICS (continued)

($V_{CC} = +2.7V$ to $+5.5V$, $T_A = -40^{\circ}C$ to $+85^{\circ}C$, unless otherwise noted. Typical values are at $V_{CC} = +3.0V$, $T_A = +25^{\circ}C$, unless otherwise noted.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Off-Isolation (Note 6)	V_{ISO}	$f = 100kHz$, $V_{COM_} = 1V_{RMS}$, $R_L = 50\Omega$, $C_L = 5pF$ (Figure 4)		-80		dB
Crosstalk	V_{CT}	$f = 1MHz$, $V_{COM_} = 1V_{RMS}$, $R_L = 50\Omega$, $C_L = 5pF$ (Figure 4)		-95		dB
-3dB Bandwidth	BW	Signal = 0dBm, $R_L = 50\Omega$, $C_L = 5pF$ (Figure 4)		150		MHz
Total Harmonic Distortion	THD	$f = 20Hz$ to $20kHz$, $V_{COM_} = 1V + 2V_{P-P}$, $R_L = 600\Omega$		0.04		%
NO_ Off-Capacitance	C_{OFF}	$f = 1MHz$ (Figure 5)		12		pF
COM On-Capacitance	C_{ON}	$f = 1MHz$ (Figure 5)		27.5		pF
DIGITAL I/O (IN_)						
Input-Logic High Voltage	V_{IH}	$V_{CC} = 2V$ to $3.6V$	1.4			V
		$V_{CC} = 3.6V$ to $5.5V$	1.8			
Input-Logic Low Voltage	V_{IL}	$V_{CC} = 2V$ to $3.6V$			0.5	V
		$V_{CC} = 3.6V$ to $5.5V$			0.8	
Input Leakage Current	I_{IN}	$V_{IN_} = 0$ or $5.5V$	-0.5		+0.5	μA

Note 2: Specifications are 100% tested at $T_A = +85^{\circ}C$ only, and guaranteed by design and characterization over the specified temperature range.

Note 3: Guaranteed by design and characterization; not production tested.

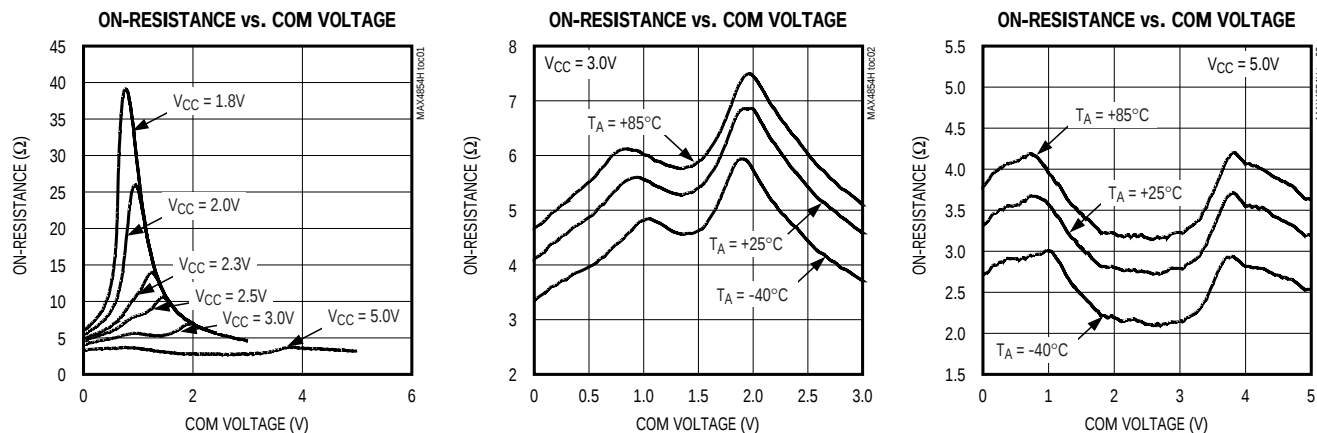
Note 4: $\Delta R_{ON} = R_{ON}(MAX) - R_{ON}(MIN)$.

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

Note 6: Off-Isolation = $20\log_{10}(V_{COM_} / V_{NO_})$, $V_{COM_}$ = output, $V_{NO_}$ = input to off switch.

Typical Operating Characteristics

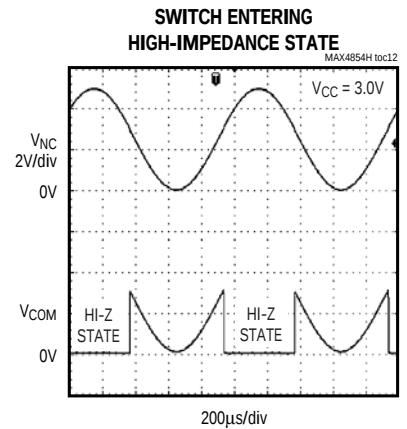
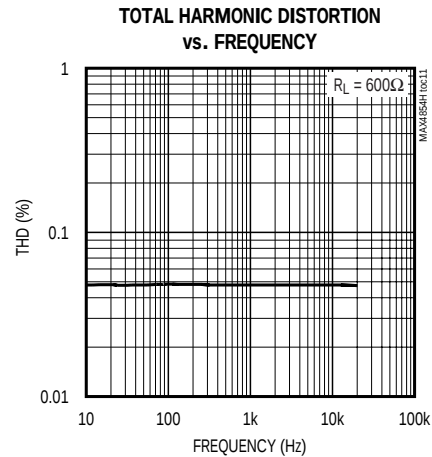
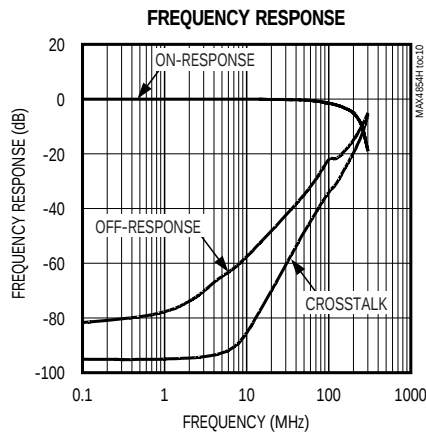
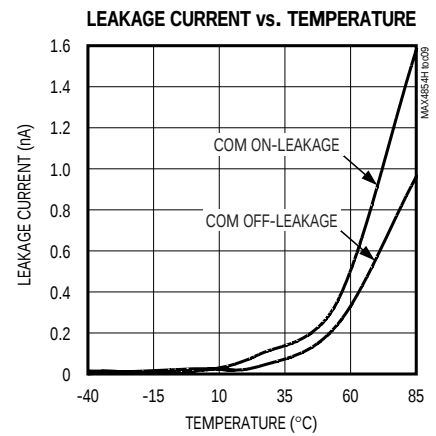
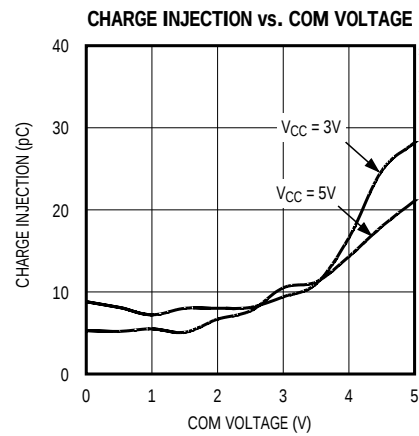
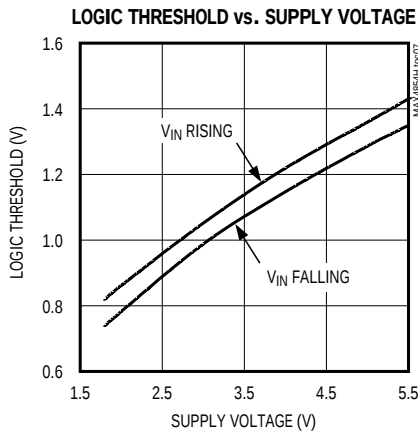
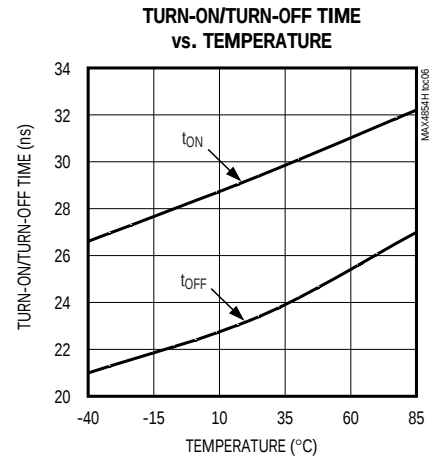
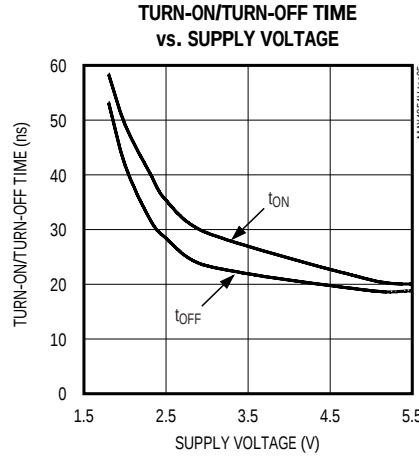
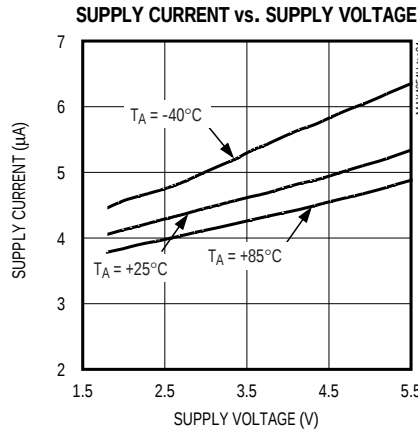
($V_{CC} = 3.0V$, $T_A = +25^{\circ}C$, unless otherwise noted.)



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Typical Operating Characteristics (continued)

($V_{CC} = 3.0V$, $T_A = +25^\circ C$, unless otherwise noted.)



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Pin Description

PIN	NAME	FUNCTION
1	NO1	Normally Open Terminal for Analog Switch 1
2, 11	N.C.	No Connection. Internally not connected.
3	IN2	Digital Control Input for Analog Switch 2. A logic LOW on IN2 opens switch 2 and a logic HIGH on IN2 connects COM2 to NO2.
4	COM2	Common Terminal for Analog Switch 2
5	NO2	Normally Open Terminal for Analog Switch 2
6	GND	Ground
7	NO3	Normally Open Terminal for Analog Switch 3
8	COM3	Common Terminal for Analog Switch 3
9	IN3	Digital Control Input for Analog Switch 3. A logic LOW on IN3 opens switch 3 and a logic HIGH on IN3 connects COM3 to NO3.
10	NO4	Normally Open Terminal for Analog Switch 4
12	COM4	Common Terminal for Analog Switch 4
13	IN4	Digital Control Input for Analog Switch 4. A logic LOW on IN4 opens switch 4 and a logic HIGH on IN4 connects COM4 to NO4.
14	V _{CC}	Supply Voltage. Bypass V _{CC} to GND with a 0.01μF capacitor as close to the pin as possible.
15	IN1	Digital Control Input for Analog Switch 1. A logic LOW on IN1 opens switch 1 and a logic HIGH on IN1 connects COM1 to NO1.
16	COM1	Common Terminal for Analog Switch 1
—	EP	Exposed Paddle. Connect to PC board ground plane.

Detailed Description

The MAX4854H quad SPST switch has low on-resistance, operates from a +2V to +5.5V supply, and is fully specified for nominal 3.0V applications. The device features overvoltage protection by putting the switch into high-impedance mode when the switch input exceeds V_{CC}.

This switch has low 27.5pF on-channel capacitance, which allows for 12Mbps switching of the data signals for USB 2.0 full speed/1.1 applications. The MAX4854H is designed to switch D+ and D- USB signals with a guaranteed skew of less than 1ns (see Figure 2) as measured from 50% of the input signal to 50% of the output signal.

Applications Information

Digital Control Inputs

The logic inputs (IN_n) accept up to +5.5V even if the supply voltages are below this level. For example, with a +3.3V V_{CC} supply, IN_n can be driven low to GND and

high to +5.5V, allowing for mixing of logic levels in a system. Driving IN_n rail-to-rail minimizes power consumption. For a +2V supply voltage, the logic thresholds are 0.5V (low) and 1.4V (high); for a +5V supply voltage, the logic thresholds are 0.8V (low) and 1.8V (high).

Analog Signal Levels

The on-resistance of these switches changes very little for analog input signals across the entire supply voltage range (see the *Typical Operating Characteristics*). The switches are bidirectional, so the NO_n and COM_n pins can be either inputs or outputs.

Power-Supply Sequencing

Caution: Do not exceed the absolute maximum ratings because stresses beyond the listed ratings may cause permanent damage to the device.

Proper power-supply sequencing is recommended for all CMOS devices. Always apply V_{CC} before applying analog signals, especially if the analog signal is not current-limited.

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Test Circuits/Timing Diagrams

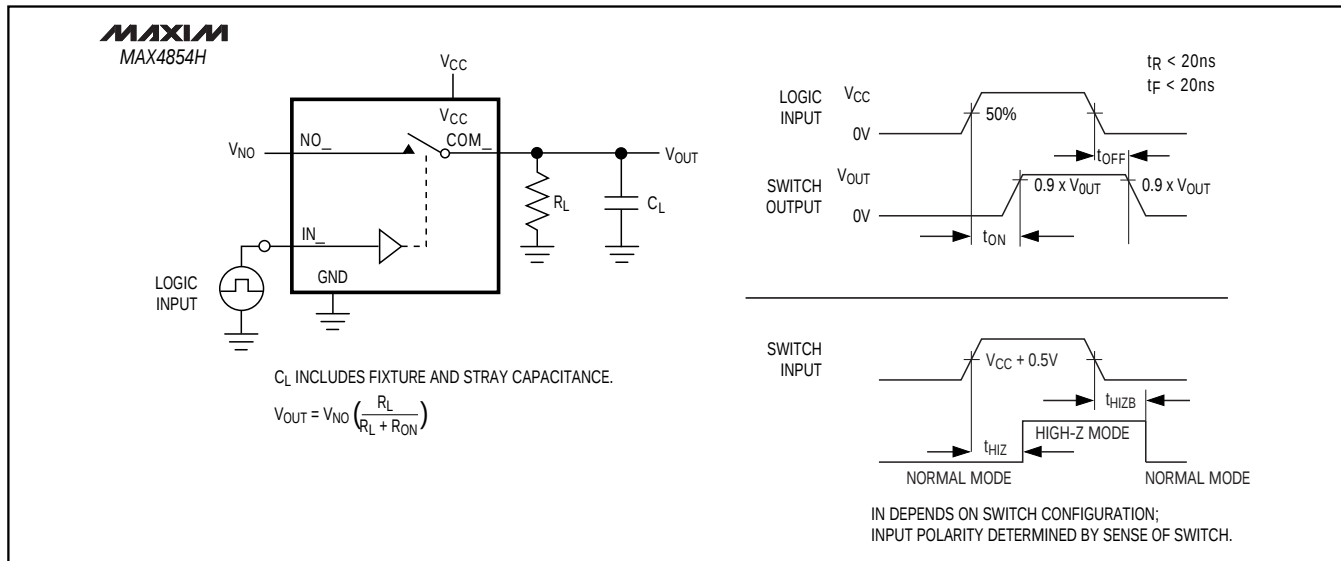


Figure 1. Switching Time

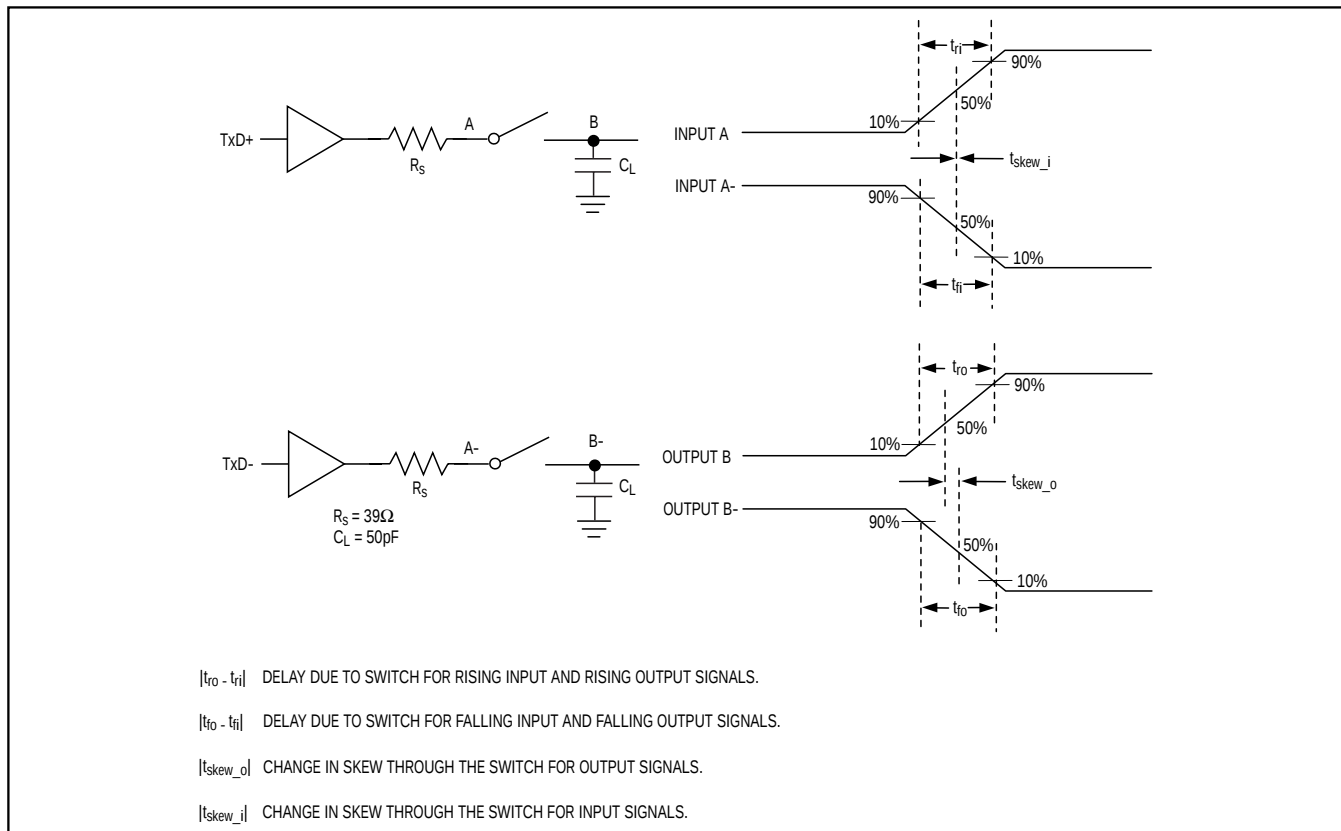


Figure 2. Output Signal Skew

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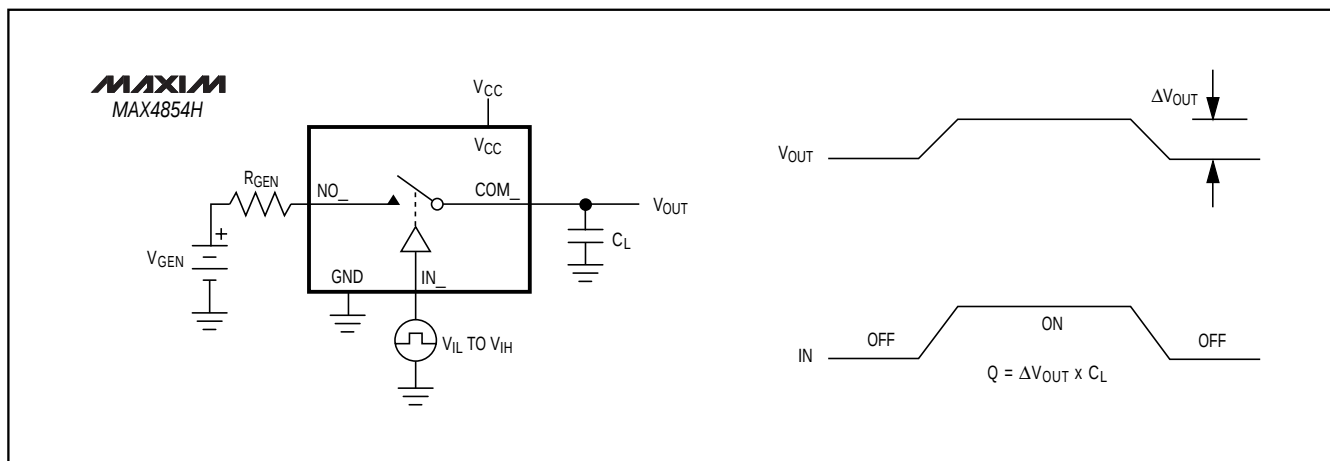


Figure 3. Charge Injection

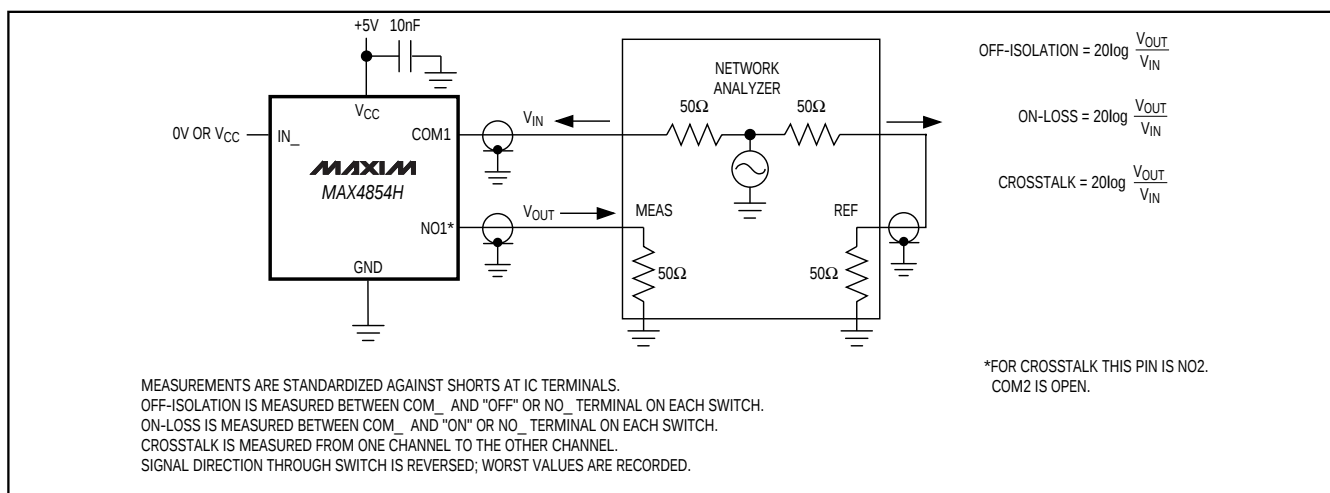


Figure 4. On-Loss, Off-Isolation, and Crosstalk

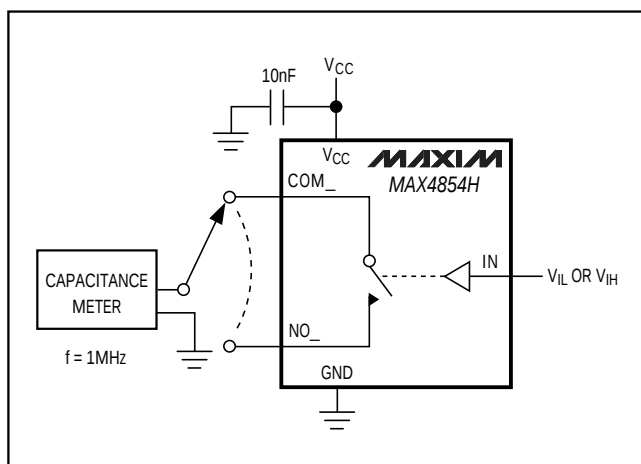


Figure 5. Channel Off-/On-Capacitance

Chip Information

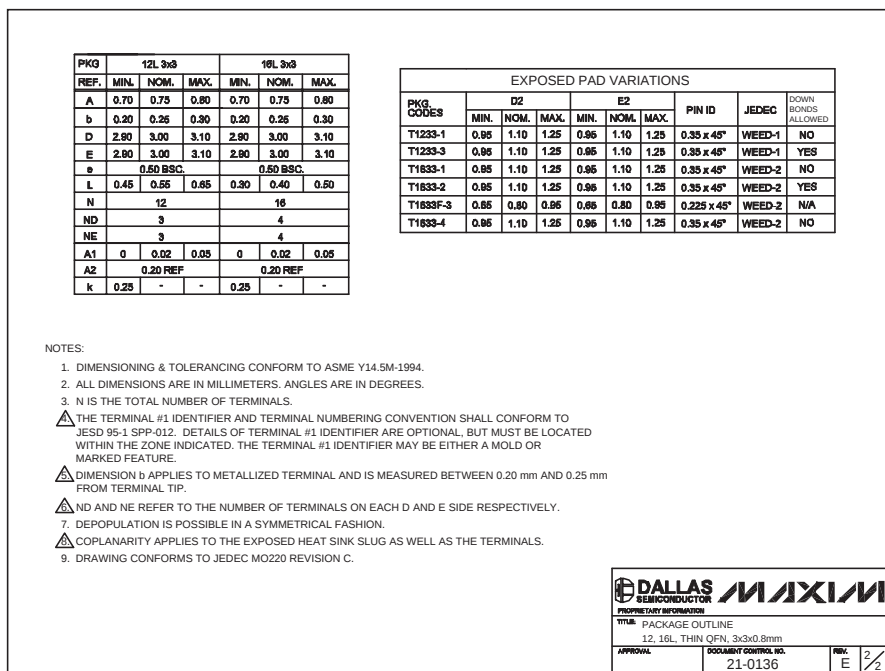
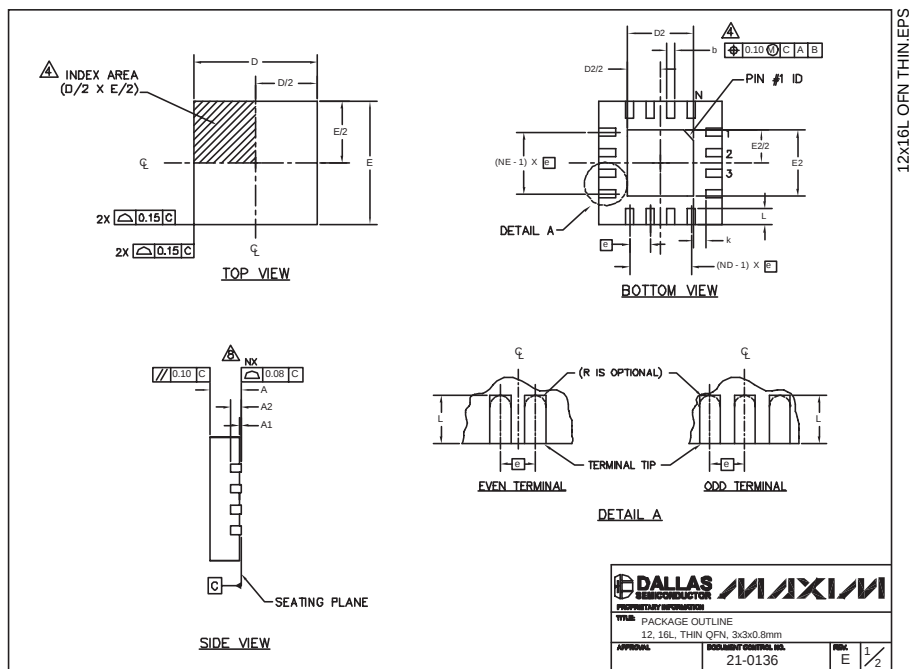
TRANSISTOR COUNT: 735

PROCESS: CMOS

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Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to www.maxim-ic.com/packages.)



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