Precision Wide Bandwidth Quad Analog Switches

Features

- Single-Supply Operation (+2V to +6V)
- Rail-to-Rail Analog Signal Range
- Low On-Resistance (7Ω typ @ 5V)
  Minimizes Distortion and Error Voltages
- R_{ON} Matching Between Channels, 0.4 Ω typ
- On-Resistance Flatness, 3Ω typ
- Low Charge Injection. Q = 6pC typ.
  Reduces Step errors, "clicking, popping" noise
- High Speed. t_{ON}, 8ns typ
- Very Low Crosstalk: -75dB @ 30 MHz
- Wide -3dB Bandwidth: 250 MHz
- High-Current Channel Capability: >100mA
- TTL/CMOS Logic Compatible
- Low Power Consumption (0.5µW typ)
- Pin-compatible with DG3XX, DG4XX, MAX39X

Applications

- Audio, Video Switching and Routing
- Battery-Powered Communication Systems
- Computer Peripherals
- Telecommunications
- Portable Instrumentation
- Mechanical Relay Replacement

Description

The PI5A391A/392A/393A are monolithic analog switches designed for low-voltage, single-supply operation. These high-precision devices are ideal for low-distortion audio, video, signal switching and routing applications.

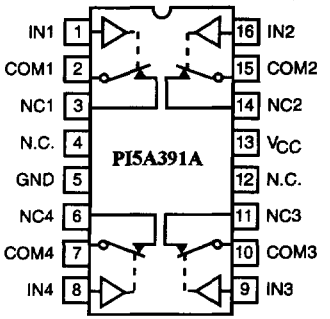
The PI5A391A is a quad single-pole single-throw (SPST), normally closed (NC) switch. The PI5A392A has four normally open (NO) switches. The PI5A393A has two NC and two NO switches per package.

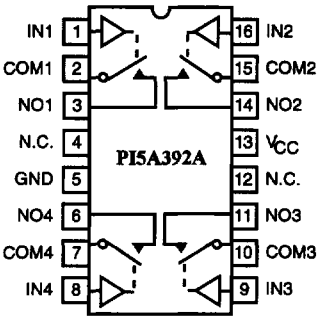
Each switch conducts current equally well in either direction when on. When off they block voltages up to the power-supply rails.

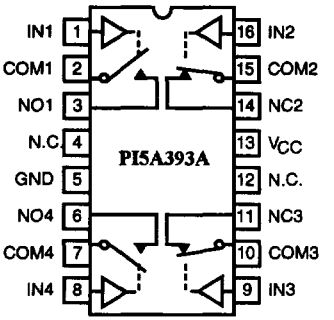
The PI5A391A/392A/393A are fully specified with +5V, and +3.3V supplies. With +5V, they guarantee <11Ω on-resistance. On-resistance matching between channels is within 2Ω. On-resistance flatness is less than 5Ω over the full temperture range. The PI5A39X family guarantees fast switching speeds (t_{ON} < 15ns).

These products are available in the 16-pin narrow-body SOIC, QSOP, and PDIP packages for operation over the industrial (-40°C to +85°C) temperature range.

Functional Diagram, Pin Configuration and Truth Tables







PI5A391A	
Logic	**Switch**
0	ON
1	OFF

PI5A392A	
Logic	**Switch**
0	OFF
1	ON

PI5A393A		
Logic	**Switches 1,4**	**Switches 2,3**
0	OFF	ON
1	ON	OFF

Switches are shown with logic "0" input.

Absolute Maximum Ratings

Voltages Referenced to GND

V_{CC} ..... -0.5V to +7V

V_{IN}, V_{COM}, V_{NC}, V_{NO} (Note 1) ..... -0.5V to V_{CC} +2V
or 30mA, whichever occurs first

Current (any terminal except COM, NO, NC) 30mA

Current, COM, NO, NC 100mA

(pulsed at 1ms, 10% duty cycle) 120mA

Thermal Information

Continuous Power Dissipation

PDIP (derate 10.5mW/°C above 70°C) 800mW

Narrow SO & QSOP

(derate 8.7mW/°C above +70°C) 650mW

Storage Temperature ..... -65°C to +150°C

Lead Temperature (soldering, 10s) ..... +300°C

Note 1: Signals on NC, NO, COM, or IN exceeding V_{CC} or GND are clamped by internal diodes. Limit forward diode current to 30mA.

Caution: Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied.

Electrical Characteristics-Single 5.0V Supply

(VCC = 5V ± 10%, GND = 0V, VINH = 2.4V, VINL = 0.8V)

Parameter	Symbol	Test Conditions	Temp(°C)	Min[2]	Typ[2]	Max[2]	Unit
Analog Switch							
Analog Signal Range[3]	V_{ANALOG}		Full	0		V_{CC}	V
ON-Resistance	R_{ON}	V_{CC} = 4.5V, I_{COM} = 30mA, V_{NO} or V_{NC} = +2.5V	25		7	11	Ω
			Full			13	
On-Resistance Match Between Channels[4]	ΔR_{ON}		25		0.4		
			Full			2	
On-ResistanceFlatness[5]	$R_{FLAT(ON)}$	V_{CC} = 5V, I_{COM} = -30mA, V_{NO} or V_{NC} = 1V, 2.5V, 4V	25		3	4	
			Full			5	
NO or NC Off LeakageCurrent[6]	$I_{NO(OFF)}$ $I_{NC(OFF)}$	V_{CC} = 5.5V, V_{COM} = 0V, V_{NO} or V_{NC} = 4.5V	25		0.07		nA
			Full	-80		80	
COMOff Leakage Current[6]	$I_{COM(OFF)}$	V+ = 5.5V, V_{COM} = +4.5V, V_{NO} or V_{NC} = ±0V	25		0.07		
			Full	-80		80	
COMOn Leakage Current[6]	$I_{COM(ON)}$	V_{CC} = 5.5V, V_{COM} = +4.5V, V_{NO} or V_{NC} = +4.5V	25		0.016		
			Full	-80		80	

Electrical Characteristics-Single 5.0V Supply(continued)

(VCC=5V±10%, GND=0V, VINH=2.4V, VINL=0.8V)

Parameter	Symbol	Conditions	Temp(°C)	Min[1]	Typ[2]	Max[1]	Unit
Logic Input							
Input High Voltage	V_{INH}	Guaranteed logic High Level	Full	2			V
Input Low Voltage	V_{INL}	Guaranteed logic Low Level				0.8	
Input Current with Input Voltage High	I_{INH}	V_{IN} = 2.4V, all others = 0.8V		-1	0.005	1	µA
Input Current with Input Voltage Low	I_{INL}	V_{IN} = 0.8V, all others = 2.4V		-1	0.005	1	
Dynamic							
Turn-On Time	t_{ON}	V_{CC} = 5V, Figure 1	25		8	15	ns
			Full			20	
Turn-Off Time	t_{OFF}		25		3.5	7	
			Full			10	
Charge Injection[3]	Q	C_L = 1nF, V_{GEN} = 2.5V, Figure 2	25		6	10	pC
Off Isolation	OIRR	R_L = 50Ω, C_L = 5pF f = 10MHz, Figure 3			-55		dB
Crosstalk[8]	$I_{COM(OFF)}$	R_L = 50Ω, C_L = 5pF f = 10MHz, Figure 4			-93		
NC or NO Capacitance	$C_{(OFF)}$	f = 1kHz, Figure 5			8		pF
COM Off Capacitance	$C_{COM(OFF)}$				8		
COM On Capacitance	$C_{COM(ON)}$	f = 1kHz, Figure 6			14		
-3dB Bandwidth	BW	R_L = 50Ω, Figure 7	Full		250		MHz
Distorton[9]	D	R_L = 10kΩ			0.02		%
Supply							
Power-Supply Range	V_{CC}		Full	2		6	V
Positive Supply Current	I_{CC}	V_{CC} = 5.5V, V_{IN}= 0V or V_{CC}, all channels on or off				1	µA

Notes:

1. The algebraic convention, where the most negative value is a minimum and the most positive is a maximum, is used in this data sheet.
2. Typical values are for DESIGN AID ONLY, not guaranteed or subject to production testing.
3. Guaranteed by design
4. $\Delta R_{ON} = R_{ON}$ max - R_{ON} min
5. Flatness is defined as the difference between the maximum and minimum value of on-resistance measured.
6. Leakage parameters are 100% tested at maximum rated hot temperature and guaranteed by correlation at +25°C.
7. Off Isolation = $20\log_{10}[V_{COM}/(V_{NO}$ or $V_{NC})]$. See figure 3.
8. Between any two stitches. See figure 4.
9. $D = R_{FLAT(ON)}/R_L$.

Electrical Specifications-Single 3.3V Supply

(Vcc = 3.3V±10%, GND = 0V, VINH = 2.4V, VINL = 0.8V)

Parameter	Symbol	Test Conditions	Temp(°C)	Min[1]	Typ[2]	Max[1]	Unit
Analog Switch							
Analog Signal Range[3]	V_{ANALOG}		Full	0		V_{CC}	V
ON-Resistance	R_{ON}	V_{CC} = 3V, I_{COM} = -30mA, V_{NO} or V_{NC} = 1.5V	25		11	18	Ω
			Full			22	
On-Resistance Match Between Channels[4]	ΔR_{ON}		25		0.3	1	
			Full			2	
On-ResistanceFlatness[3,5]	$R_{FLAT(ON)}$	V_{CC} = 3.3V, I_{COM} = 30mA, V_{NO} or V_{NC} = 0.8V, 2.5V	25		2	4	
			Full			12	
Dynamic							
Turn-On Time	t_{ON}	V_{CC} = 3.3V, V_{NO} or V_{NC} = 1.5V, Figure 1	25		14	25	ns
			Full			40	
Turn-Off Time	t_{OFF}		25		5	12	
			Full			20	
Charge Injection[3]	Q	C_L = 1nF, V_{GEN} = 1.5V, Figure 2	25		5	10	pC
Supply							
Positive Supply Current	I_{CC}	V_{CC} = 3.6V, V_{IN} = 0V or V_{CC}, all channels on or off	Full			1	µA

Notes:

1. The algebraic convention, where the most negative value is a minimum and the most positive is a maximum, is used in this data sheet.
2. Typical values are for DESIGN AID ONLY, not guaranteed or subject to production testing.
3. Guaranteed by design
4. $\Delta R_{ON} = R_{ON}$ max - R_{ON} min
5. Flatness is defined as the difference between the maximum and minimum value of on-resistance measured.

Test Circuits/Timing Diagrams

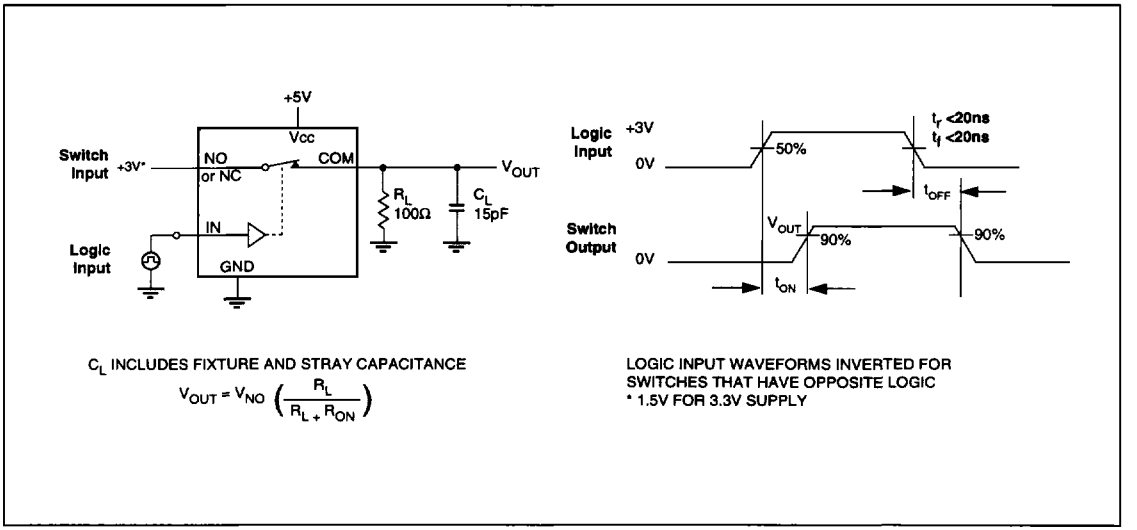


Figure 1. Switching Time

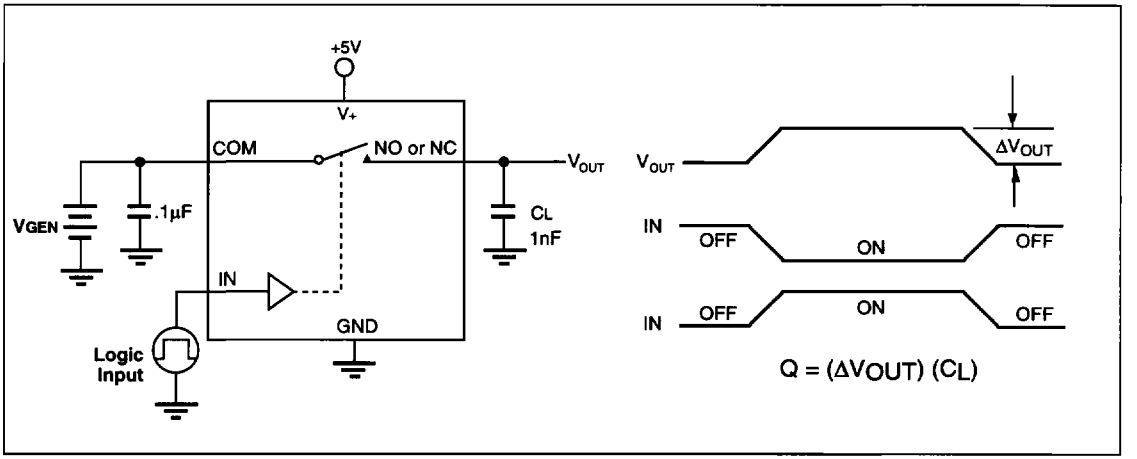


Figure 2. Charge Injection

Test Circuits/Timing Diagrams (continued)

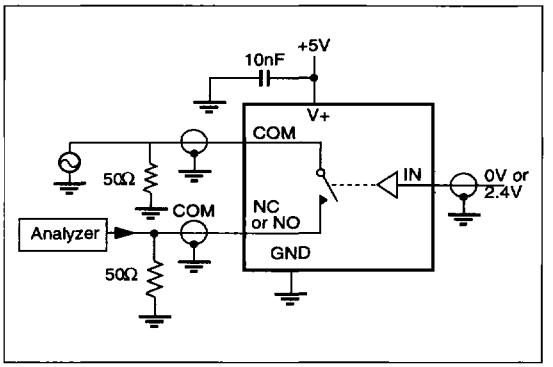


Figure 3. Off Isolation

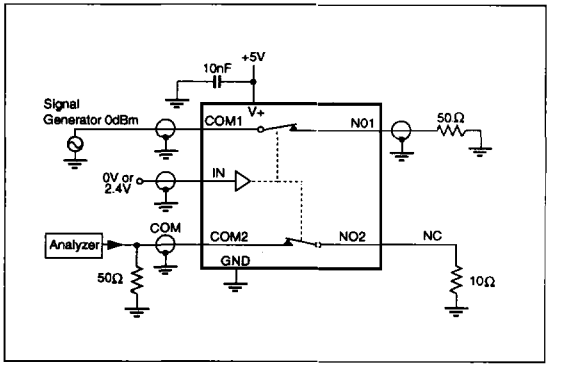


Figure 4. Crosstalk

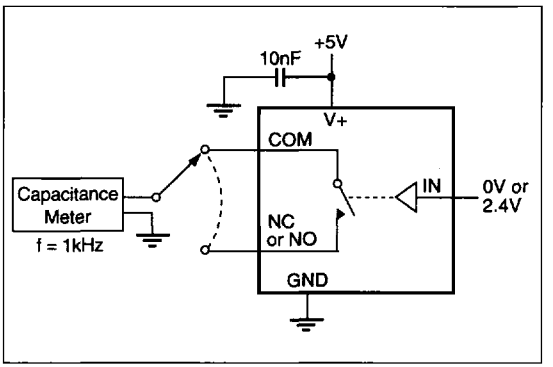


Figure 5. Channel-Off Capacitance

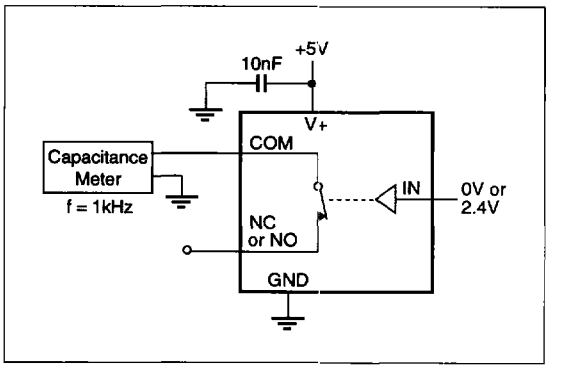


Figure 6. Channel-On Capacitance

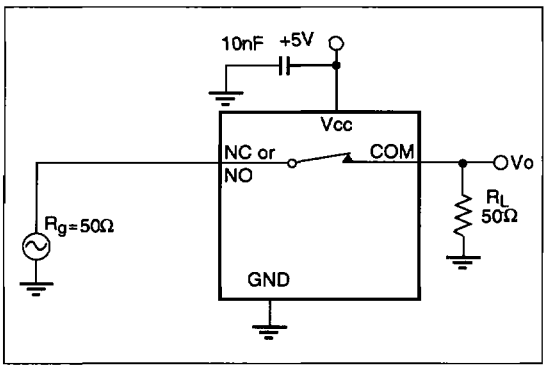
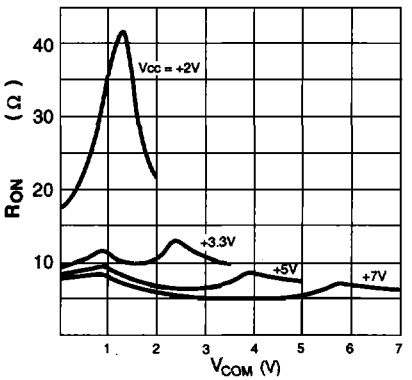


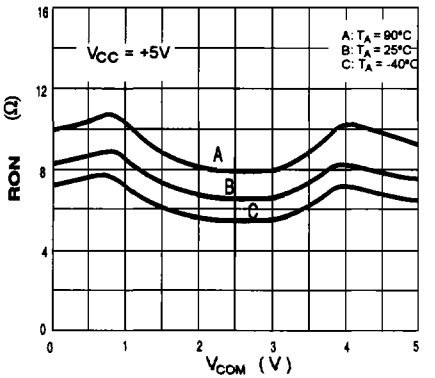
Figure 7. Bandwidth

Typical Operating Characteristics (T_A=+25°C, unless otherwise noted)

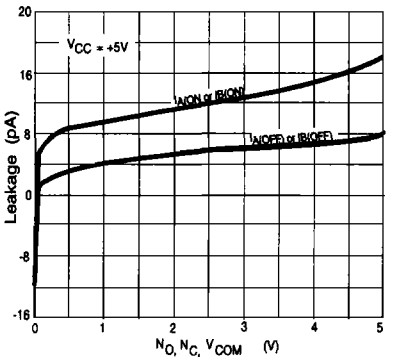
R_{ON} vs. V_{COM}



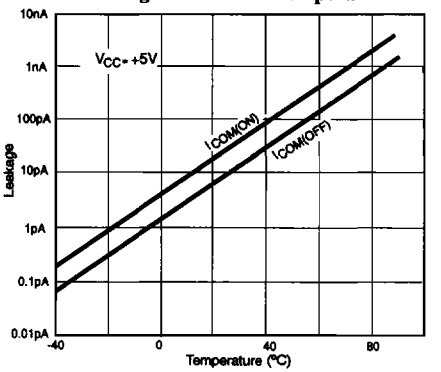
R_{ON} vs. V_{COM} and Temperature



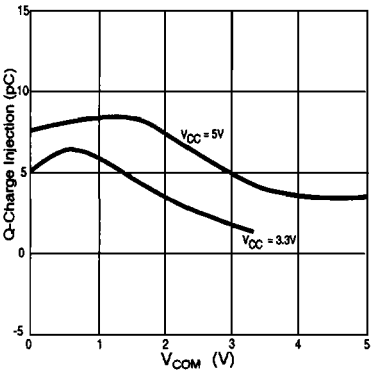
Leakage Currents vs. Analog Voltage



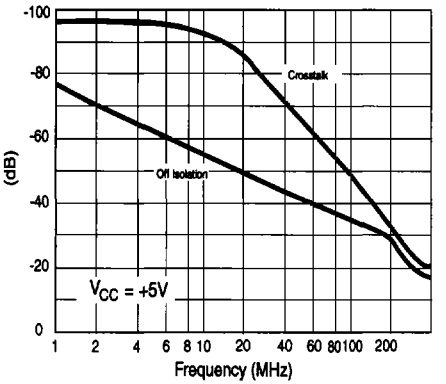
Leakage Current vs. Temperature



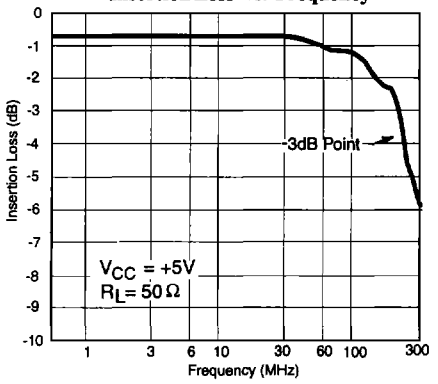
Charge Injection vs. Analog Voltage



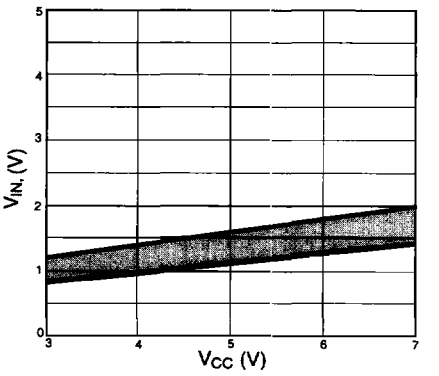
Crosstalk and Off-Isolation vs. Frequency



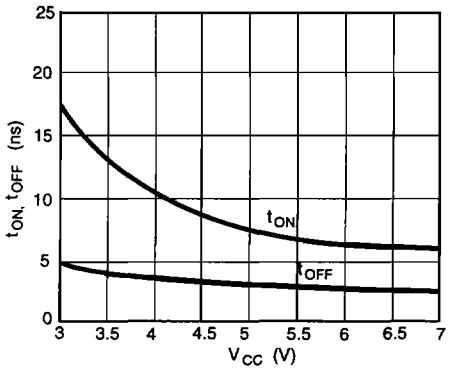
Insertion Loss vs. Frequency



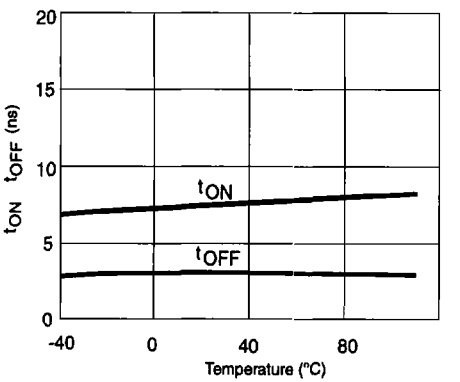
Input Switching Threshold vs. Supply Voltage



R_{ON} vs. V_{COM} and Single Supply



Switching Times vs. Temperature



Ordering Information

P/N	Package
PI5A391AP	16 Pin PDIP
PI5A391AW	Narrow Body SOIC-16
PI5A391AQ	16 Pin QSOP
PI5A392AP	16 Pin PDIP
PI5A392AW	Narrow Body SOIC-16

P/N	Package
PI5A392AQ	16 Pin QSOP
PI5A393AP	16 Pin PDIP
PI5A393AW	Narrow Body SOIC-16
PI5A393AQ	16 Pin QSOP