

74VHC4051AFT, 74VHC4052AFT, 74VHC4053AFT

1. Functional Description

74VHC4051AFT: 8-Channel Analog Multiplexer/Demultiplexer

74VHC4052AFT: Dual 4-Channel Analog Multiplexer/Demultiplexer

74VHC4053AFT: Triple 2-Channel Analog Multiplexer/Demultiplexer

2. General

The 74VHC4051AFT, 74VHC4052AFT and 74VHC4053AFT are high-speed, low-voltage drive analog multiplexer/demultiplexers using silicon gate CMOS technology. In 3 V and 5 V systems these can achieve high-speed operation with the low power dissipation that is a feature of CMOS.

The 74VHC4051AFT, 74VHC4052AFT and 74VHC4053AFT offer analog/digital signal selection as well as mixed signals. The 74VHC4051AFT has an 8-channel configuration, the 74VHC4052AFT has an 4-channel $\times 2$ configuration, and the 74VHC4053AFT has a 2-channel $\times 3$ configuration.

The switches for each channel are turned ON by the control pin digital signals.

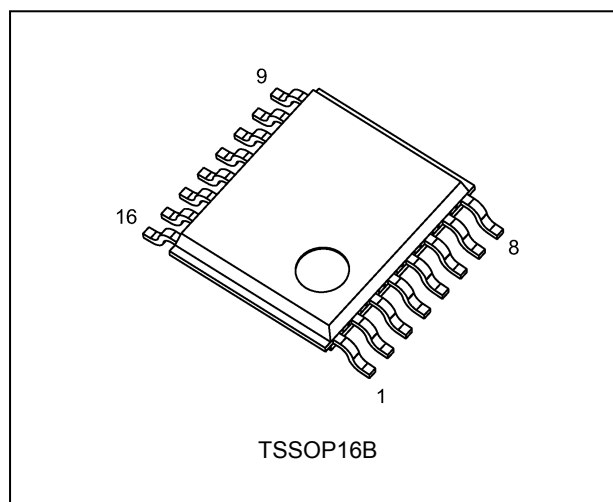
All control inputs are equipped with a newly developed input protection circuit that avoids the need for a diode on the plus side (forward side from the input to the V_{CC}). As a result, for example, 5.5 V signals can be permitted on the inputs even when the power supply voltage to the circuits is off. As a result of this input power protection, the 74VHC4051AFT, 74VHC4052AFT and 74VHC4053AFT can be used in a variety of applications, including in the system which has two power supplies, and in battery backup circuits.

3. Features

- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating temperature range: $T_{opr} = -40$ to 125 °C
- (3) Low ON-resistance: $R_{ON} = 45$ Ω (typ.) ($V_{CC} = 3.0$ V)
 $R_{ON} = 24$ Ω (typ.) ($V_{CC} = 4.5$ V)
- (4) Low power dissipation: $I_{CC} = 2.0$ μ A (max) ($T_a = 25$ °C)
- (5) High noise immunity: $V_{IL} = 0.8$ V (max) $V_{CC} = 3.0$ V
 $V_{IH} = 2.0$ V (min) $V_{CC} = 3.0$ V
- (6) Power down protection is provided on all control inputs.

Note 1: This device is compliant with the reliability requirements of AEC-Q100. For details, contact your Toshiba sales representative.

4. Packaging

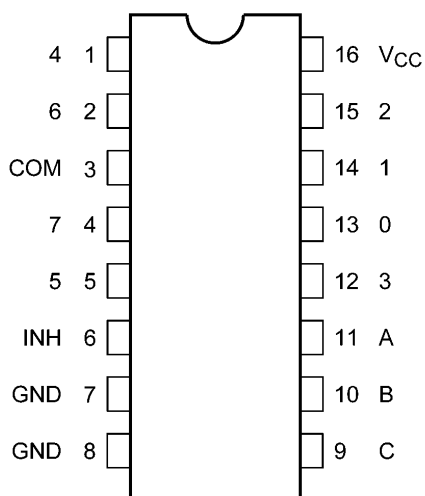


Start of commercial production

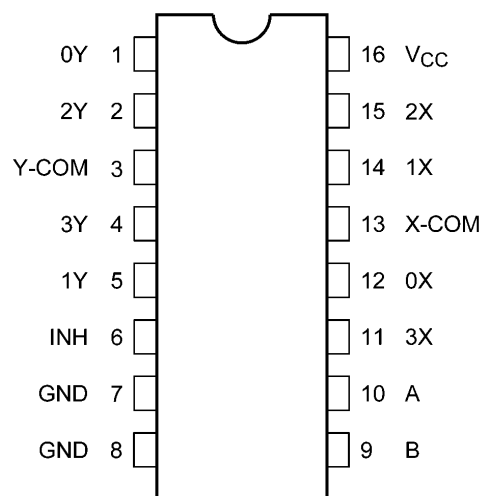
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5. Pin Assignment

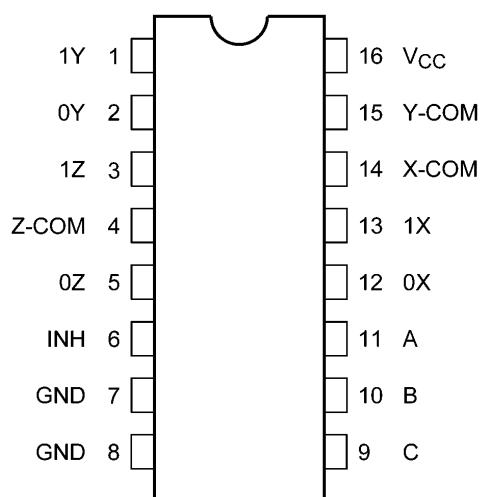
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74VHC4052AFT



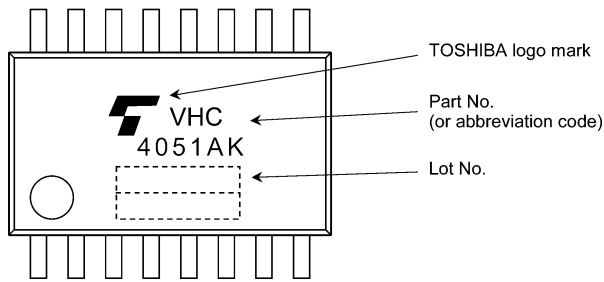
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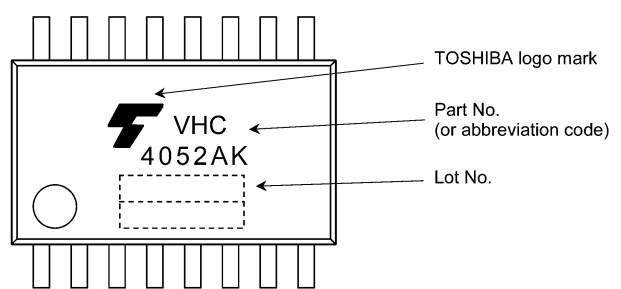
6. Markin

6.1. Marking (Note)

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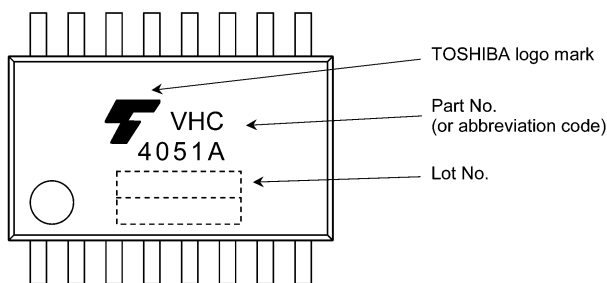
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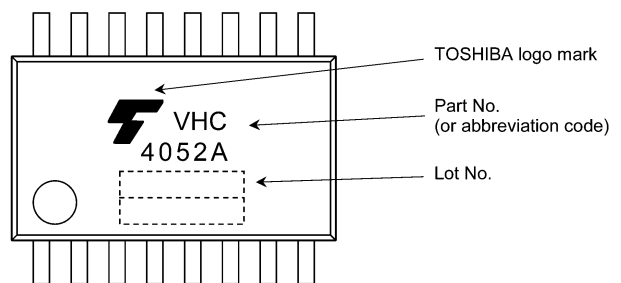
Note: For devices with the ordering part number ending in K.

6.2. Marking

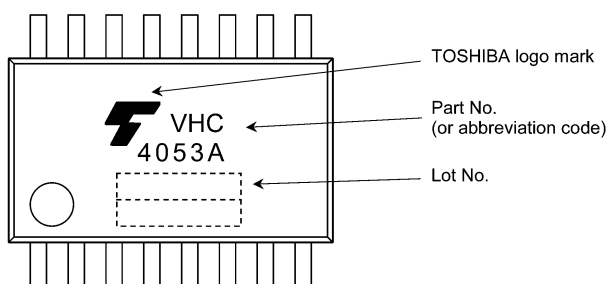
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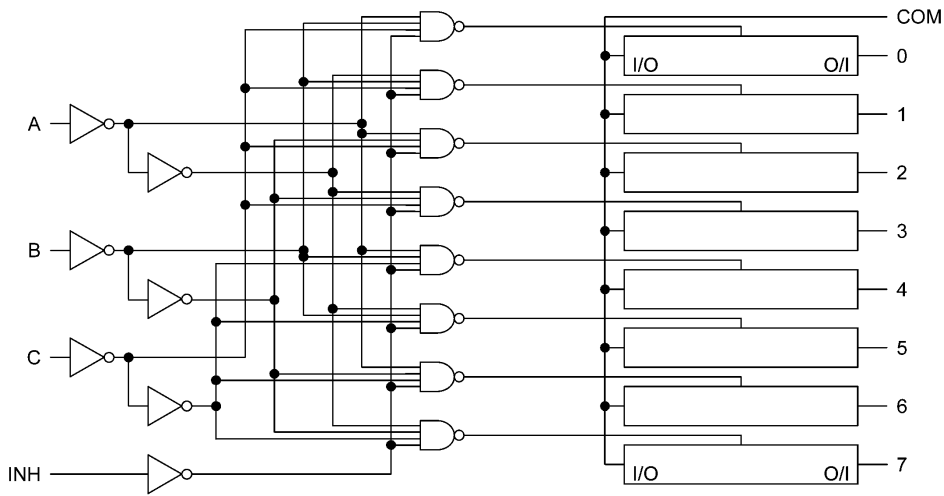


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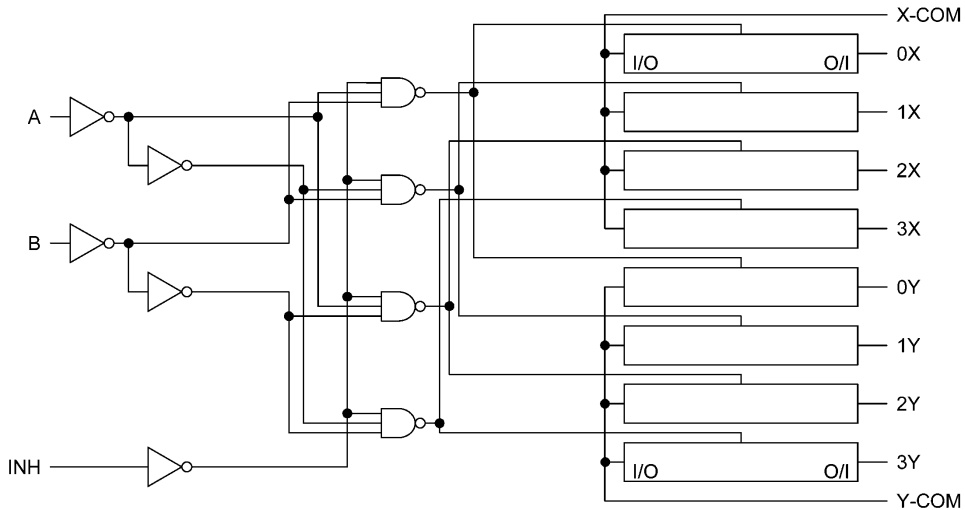


7. System Diagram

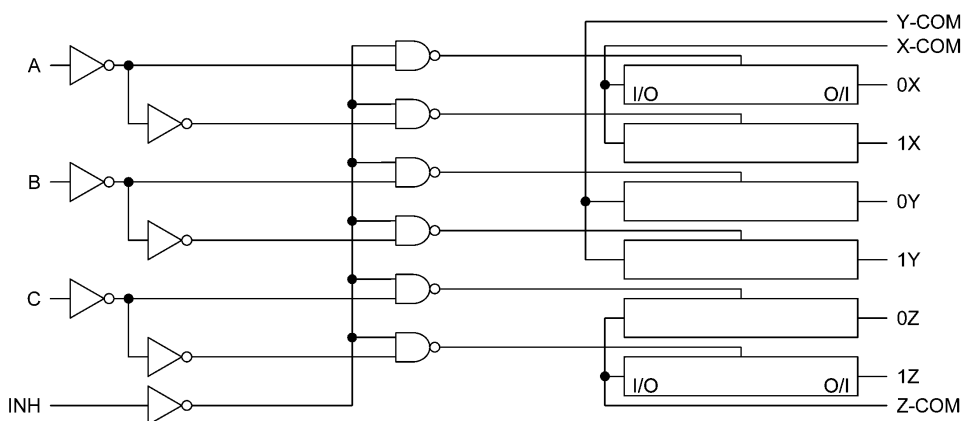
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74VHC4052AFT



74VHC4053AFT



8. Truth Table

Input Inhibit	Input C*	Input B	Input A	ON Channel 74VHC4051AFT	ON Channel 74VHC4052AFT	ON Channel 74VHC4053AFT
L	L	L	L	0	0X, 0Y	0X, 0Y, 0Z
L	L	L	H	1	1X, 1Y	1X, 0Y, 0Z
L	L	H	L	2	2X, 2Y	0X, 1Y, 0Z
L	L	H	H	3	3X, 3Y	1X, 1Y, 0Z
L	H	L	L	4	—	0X, 0Y, 1Z
L	H	L	H	5	—	1X, 0Y, 1Z
L	H	H	L	6	—	0X, 1Y, 1Z
L	H	H	H	7	—	1X, 1Y, 1Z
H	X	X	X	None	None	None

X: Don't care

*: Except 74VHC4052AFT

9. Absolute Maximum Ratings (Note)

Characteristics	Symbol	Note	Rating	Unit
Supply voltage	V_{CC}		-0.5 to 7.0	V
Input voltage	V_{IN}		-0.5 to 7.0	V
Switch I/O voltage	$V_{I/O}$		-0.5 to $V_{CC} + 0.5$	V
Input diode current	I_{IK}		-20	mA
I/O diode current	$I_{I/OK}$		± 25	mA
Switch through current	I_T		± 25	mA
V_{CC} /ground current	I_{CC}		± 50	mA
Power dissipation	P_D	(Note 1)	180	mW
Storage temperature	T_{stg}		-65 to 150	°C

Note: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.

Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Note 1: 180 mW in the range of $T_a = -40$ to 85 °C. From $T_a = 85$ to 125 °C a derating factor of -3.25 mW/°C shall be applied until 50 mW.

10. Operating Ranges (Note)

Characteristics	Symbol	Test Condition	Rating	Unit
Supply voltage	V_{CC}		2.0 to 5.5	V
Input voltage	V_{IN}		0 to 5.5	V
Switch I/O voltage	V_S		0 to V_{CC}	V
Operating temperature	T_{opr}		-40 to 125	°C
Input rise and fall times	dt/dv	$V_{CC} = 2.5 \pm 0.2$ V	0 to 200	ns/V
		$V_{CC} = 3.3 \pm 0.3$ V	0 to 100	
		$V_{CC} = 5 \pm 0.5$ V	0 to 20	

Note: The operating ranges must be maintained to ensure the normal operation of the device.

Unused inputs must be tied to either V_{CC} or GND.

11. Electrical Characteristics

11.1. DC Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Min	Typ.	Max	Unit
High-level input voltage	V_{IH}	—	2.0	1.5	—	—	V
			3.0	2.0	—	—	
			4.5	3.15	—	—	
			5.5	3.85	—	—	
Low-level input voltage	V_{IL}	—	2.0	—	—	0.5	V
			3.0	—	—	0.8	
			4.5	—	—	1.35	
			5.5	—	—	1.65	
ON-resistance	R_{ON}	$V_{IN} = V_{IH}$ or V_{IL} $V_{I/O} = V_{CC}$ to GND $I_{I/O} = 2\text{ mA}$	2.3	—	200	—	Ω
			3.0	—	45	86	
			4.5	—	24	37	
		$V_{IN} = V_{IH}$ or V_{IL} $V_{I/O} = V_{CC}$ or GND $I_{I/O} = 2\text{ mA}$	2.3	—	28	73	
			3.0	—	22	38	
			4.5	—	17	27	
Difference of ON-resistance between switches	ΔR_{ON}	$V_{IN} = V_{IH}$ or V_{IL} $V_{I/O} = V_{CC}$ to GND $I_{I/O} = 2\text{ mA}$	2.3	—	10	25	Ω
			3.0	—	5	15	
			4.5	—	5	13	
Input/Output leakage current (Switch OFF)	I_{OFF}	$V_{OS} = V_{CC}$ or GND $V_{IS} = \text{GND}$ to V_{CC} $V_{IN} = V_{IH}$ or V_{IL}	5.5	—	—	± 0.1	μA
Input/Output leakage current (Switch ON, Output OPEN)	$I_{I/O}$	$V_{OS} = V_{CC}$ or GND $V_{IN} = V_{IH}$ or V_{IL}	5.5	—	—	± 0.1	μA
Control input leakage current	I_{IN}	$V_{IN} = V_{CC}$ or GND	5.5	—	—	± 0.1	μA
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ or GND	5.5	—	—	2.0	μA

11.2. DC Characteristics (Unless otherwise specified, $T_a = -40$ to 85 °C)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Min	Max	Unit
High-level input voltage	V_{IH}	—	2.0	1.5	—	V
			3.0	2.0	—	
			4.5	3.15	—	
			5.5	3.85	—	
Low-level input voltage	V_{IL}	—	2.0	—	0.50	V
			3.0	—	0.8	
			4.5	—	1.35	
			5.5	—	1.65	
ON-resistance	R_{ON}	$V_{IN} = V_{IH}$ or V_{IL} $V_{I/O} = V_{CC}$ to GND $I_{I/O} = 2$ mA	2.3	—	—	Ω
			3.0	—	108	
			4.5	—	46	
		$V_{IN} = V_{IH}$ or V_{IL} $V_{I/O} = V_{CC}$ or GND $I_{I/O} = 2$ mA	2.3	—	84	
			3.0	—	44	
			4.5	—	31	
Difference of ON-resistance between switches	ΔR_{ON}	$V_{IN} = V_{IH}$ or V_{IL} $V_{I/O} = V_{CC}$ to GND $I_{I/O} = 2$ mA	2.3	—	35	Ω
			3.0	—	20	
			4.5	—	18	
Input/Output leakage current (Switch OFF)	I_{OFF}	$V_{OS} = V_{CC}$ or GND $V_{IS} =$ GND to V_{CC} $V_{IN} = V_{IH}$ or V_{IL}	5.5	—	± 1.0	μA
Input/Output leakage current (Switch ON, Output OPEN)	$I_{I/O}$	$V_{OS} = V_{CC}$ or GND $V_{IN} = V_{IH}$ or V_{IL}	5.5	—	± 1.0	μA
Control input leakage current	I_{IN}	$V_{IN} = V_{CC}$ or GND	5.5	—	± 1.0	μA
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ or GND	5.5	—	20.0	μA

11.3. DC Characteristics (Unless otherwise specified, $T_a = -40$ to 125 °C)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Min	Max	Unit
High-level input voltage	V_{IH}	—	2.0	1.5	—	V
			3.0	2.0	—	
			4.5	3.15	—	
			5.5	3.85	—	
Low-level input voltage	V_{IL}	—	2.0	—	0.5	V
			3.0	—	0.8	
			4.5	—	1.35	
			5.5	—	1.65	
ON-resistance	R_{ON}	$V_{IN} = V_{IH}$ or V_{IL} $V_{I/O} = V_{CC}$ to GND $I_{I/O} = 2$ mA	2.3	—	—	Ω
			3.0	—	125	
			4.5	—	54	
		$V_{IN} = V_{IH}$ or V_{IL} $V_{I/O} = V_{CC}$ or GND $I_{I/O} = 2$ mA	2.3	—	105	
			3.0	—	55	
			4.5	—	39	
Difference of ON-resistance between switches	ΔR_{ON}	$V_{IN} = V_{IH}$ or V_{IL} $V_{I/O} = V_{CC}$ to GND $I_{I/O} = 2$ mA	2.3	—	45	Ω
			3.0	—	25	
			4.5	—	23	
Input/Output leakage current (Switch OFF)	I_{OFF}	$V_{OS} = V_{CC}$ or GND $V_{IS} =$ GND to V_{CC} $V_{IN} = V_{IH}$ or V_{IL}	5.5	—	± 4.0	μA
Input/Output leakage current (Switch ON, Output OPEN)	$I_{I/O}$	$V_{OS} = V_{CC}$ or GND $V_{IN} = V_{IH}$ or V_{IL}	5.5	—	± 4.0	μA
Control input leakage current	I_{IN}	$V_{IN} = V_{CC}$ or GND	5.5	—	± 2.0	μA
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ or GND	5.5	—	40.0	μA

11.4. AC Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$, Input: $t_r = t_f = 3\text{ ns}$)

Characteristics	Part Number	Symbol	Test Condition	V_{CC} (V)	C_L (pF)	Min	Typ.	Max	Unit	
Phase difference between input to output		φ_{IO}		2.5 ± 0.2	15	—	1.2	10	ns	
					50	—	2.6	12		
				3.3 ± 0.3	15	—	0.8	6		
					50	—	1.5	9		
				5.0 ± 0.5	15	—	0.3	4		
					50	—	0.6	6		
Output enable time		t_{PZL}, t_{PZH}	$R_L = 1\text{ k}\Omega$ Figure 1	2.5 ± 0.2	15	—	3.3	15	ns	
					50	—	4.2	25		
				3.3 ± 0.3	15	—	2.3	11		
					50	—	3.0	18		
				5.0 ± 0.5	15	—	1.6	7		
					50	—	2.1	12		
Output disable time		t_{PLZ}, t_{PHZ}	$R_L = 1\text{ k}\Omega$ Figure 1	2.5 ± 0.2	15	—	6	15	ns	
					50	—	9.6	25		
				3.3 ± 0.3	15	—	4.5	11		
					50	—	7.2	18		
				5.0 ± 0.5	15	—	3.2	7		
					50	—	5.1	12		
Control input capacitance		C_{IN}	All types	—	—	—	2	—	pF	
Common terminal capacitance	74VHC4051AFT	C_{IS}	Figure 2	—	—	—	23.4	—	pF	
	74VHC4052AFT						—	13.1		—
	74VHC4053AFT						—	8.2		—
Switch terminal capacitance	74VHC4051AFT	C_{OS}	Figure 2	—	—	—	5.7	—	pF	
	74VHC4052AFT						—	5.6		—
	74VHC4053AFT						—	5.6		—
Feedthrough capacitance	74VHC4051AFT	C_{IOS}	Figure 2	—	—	—	0.5	—	pF	
	74VHC4052AFT						—	0.5		—
	74VHC4053AFT						—	0.5		—
Power dissipation capacitance	74VHC4051AFT	C_{PD}	Figure 2 (Note 1)	—	—	—	15	—	pF	
	74VHC4052AFT						—	24		—
	74VHC4053AFT						—	12		—

Note 1: C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation.

$$I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}$$

11.5. AC Characteristics

(Unless otherwise specified, $T_a = -40$ to 85 °C, Input: $t_r = t_f = 3$ ns)

Characteristics	Symbol	Test Condition	V_{CC} (V)	C_L (pF)	Min	Max	Unit
Phase difference between input to output	$\phi_{I/O}$		2.5 ± 0.2	15	—	16	ns
				50	—	18	
			3.3 ± 0.3	15	—	10	
				50	—	12	
			5.0 ± 0.5	15	—	7	
				50	—	8	
Output enable time	t_{PZL}, t_{PZH}	$R_L = 1$ k Ω Figure 1	2.5 ± 0.2	15	—	20	ns
				50	—	32	
			3.3 ± 0.3	15	—	15	
				50	—	22	
			5.0 ± 0.5	15	—	10	
				50	—	16	
Output disable time	t_{PLZ}, t_{PHZ}	$R_L = 1$ k Ω Figure 1	2.5 ± 0.2	15	—	23	ns
				50	—	32	
			3.3 ± 0.3	15	—	15	
				50	—	22	
			5.0 ± 0.5	15	—	10	
				50	—	16	
Control input capacitance	C_{IN}	—	—	—	—	10	pF

11.6. AC Characteristics

(Unless otherwise specified, $T_a = -40$ to 125 °C, Input: $t_r = t_f = 3$ ns)

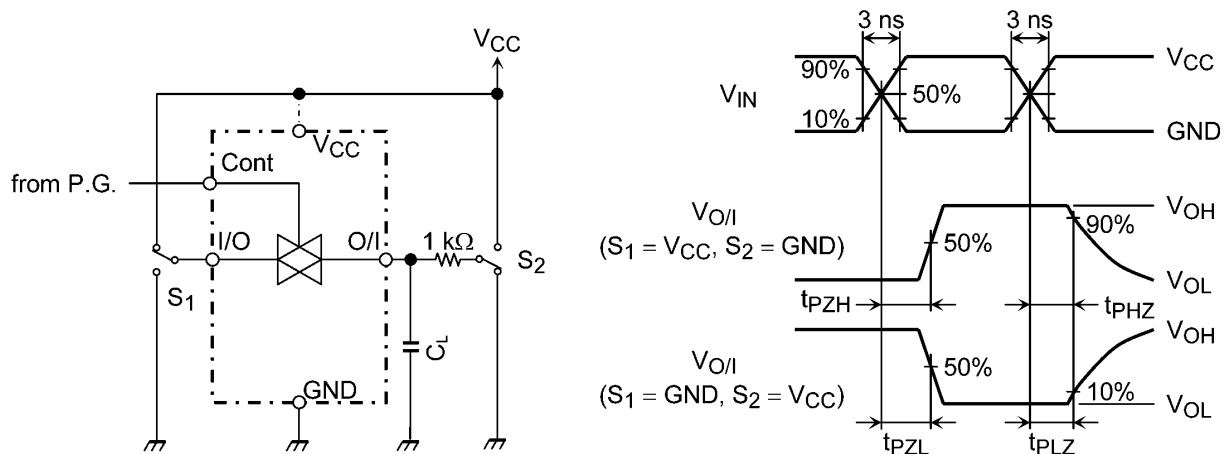
Characteristics	Symbol	Test Condition	V_{CC} (V)	C_L (pF)	Min	Max	Unit
Phase difference between input to output	$\phi_{I/O}$		2.5 ± 0.2	15	—	20	ns
				50	—	22	
			3.3 ± 0.3	15	—	13	
				50	—	14	
			5.0 ± 0.5	15	—	9	
				50	—	9.5	
Output enable time	t_{PZL}, t_{PZH}	$R_L = 1$ k Ω Figure 1	2.5 ± 0.2	15	—	23.5	ns
				50	—	37	
			3.3 ± 0.3	15	—	18	
				50	—	25	
			5.0 ± 0.5	15	—	12	
				50	—	19	
Output disable time	t_{PLZ}, t_{PHZ}	$R_L = 1$ k Ω Figure 1	2.5 ± 0.2	15	—	28.5	ns
				50	—	37	
			3.3 ± 0.3	15	—	18	
				50	—	25	
			5.0 ± 0.5	15	—	12	
				50	—	19	
Control input capacitance	C_{IN}	—	—	—	—	10	pF

11.7. Analog Switch Characteristics (T_a = 25 °C) (Note)

Characteristics	Part Number	Symbol	Test Condition	V _{CC} (V)	Typ.	Unit	
Sine Wave Distortion		THD	R _L = 10 kΩ, C _L = 50 pF f _{IN} = 1 kHz	V _{IN} = 2.0 V _{p-p}	3.0	0.1	%
				V _{IN} = 4.0 V _{p-p}	4.5	0.03	
Maximum frequency response	74VHC4051AFT	f _{MAX(I/O)}	V _{IN} is centered at (V _{CC} /2). Adjust input for 0 dBm. Increase f _{IN} frequency until dB meter reads -3 dB. R _L = 50 Ω, C _L = 10 pF, sine wave Figure 3	3.0	150	MHz	
	74VHC4052AFT				200		
	74VHC4053AFT				240		
	74VHC4051AFT			4.5	180		
	74VHC4052AFT				230		
	74VHC4053AFT				280		
Feed through attenuation (switch OFF)		FTH	V _{IN} is centered at (V _{CC} /2). Adjust input for 0 dBm. R _L = 600 Ω, C _L = 50 pF, f _{IN} = 1 MHz, sine wave Figure 4	3.0	-45	dB	
				4.5	-45		
				3.0	-65		
				4.5	-65		
Crosstalk (control input to signal output)		X _{talk}	R _L = 600 Ω, C _L = 50 pF, f _{IN} = 1 MHz, square wave (t _r = t _f = 6 ns) Figure 5	3.0	60	mV	
				4.5	100		
Crosstalk (between any switches)		X _{talk}	V _{IN} is centered at (V _{CC} /2). Adjust input for 0 dBm. R _L = 600 Ω, C _L = 50 pF, f _{IN} = 1 MHz, sine wave Figure 6	3.0	-45	dB	
				4.5	-45		

Note: These characteristics are determined by design of devices.

12. AC Test Circuit



Cont : Control Inputs A or B or C or INH (C: Except VHC4052A)

P.G. : Pulse generator

Figure 1 t_{PLZ} , t_{PHZ} , t_{PZL} , t_{PZH}

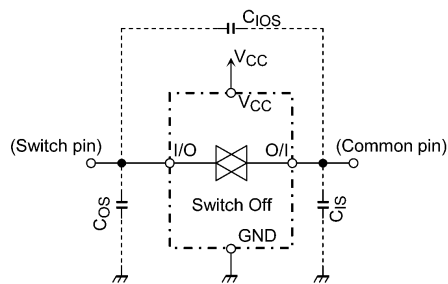


Figure 2 C_{10S} , C_{1S} , C_{0S}

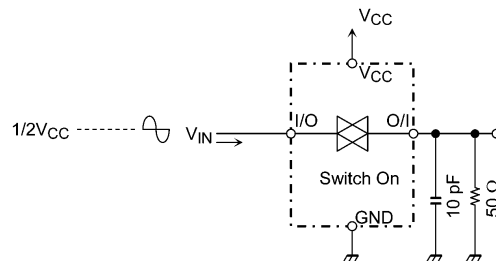


Figure 3 Frequency Response

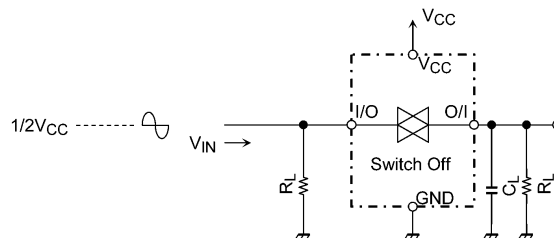
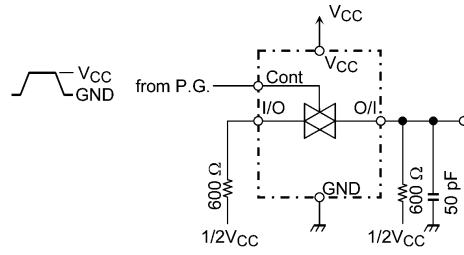


Figure 4 Feedthrough Attenuation



Cont : Control Inputs A or B or C or INH (C:Except VHC4052A)

P.G. : Pulse generator

Figure 5 Cross Talk (control input to output signal)

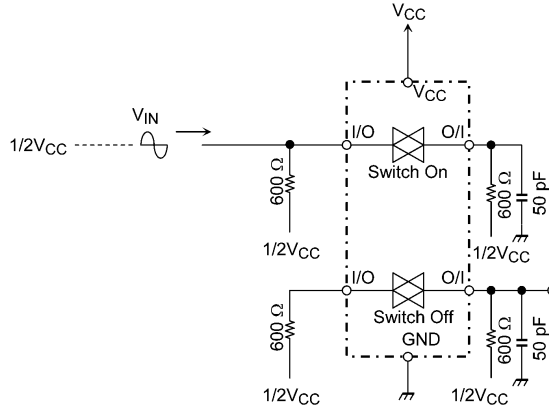
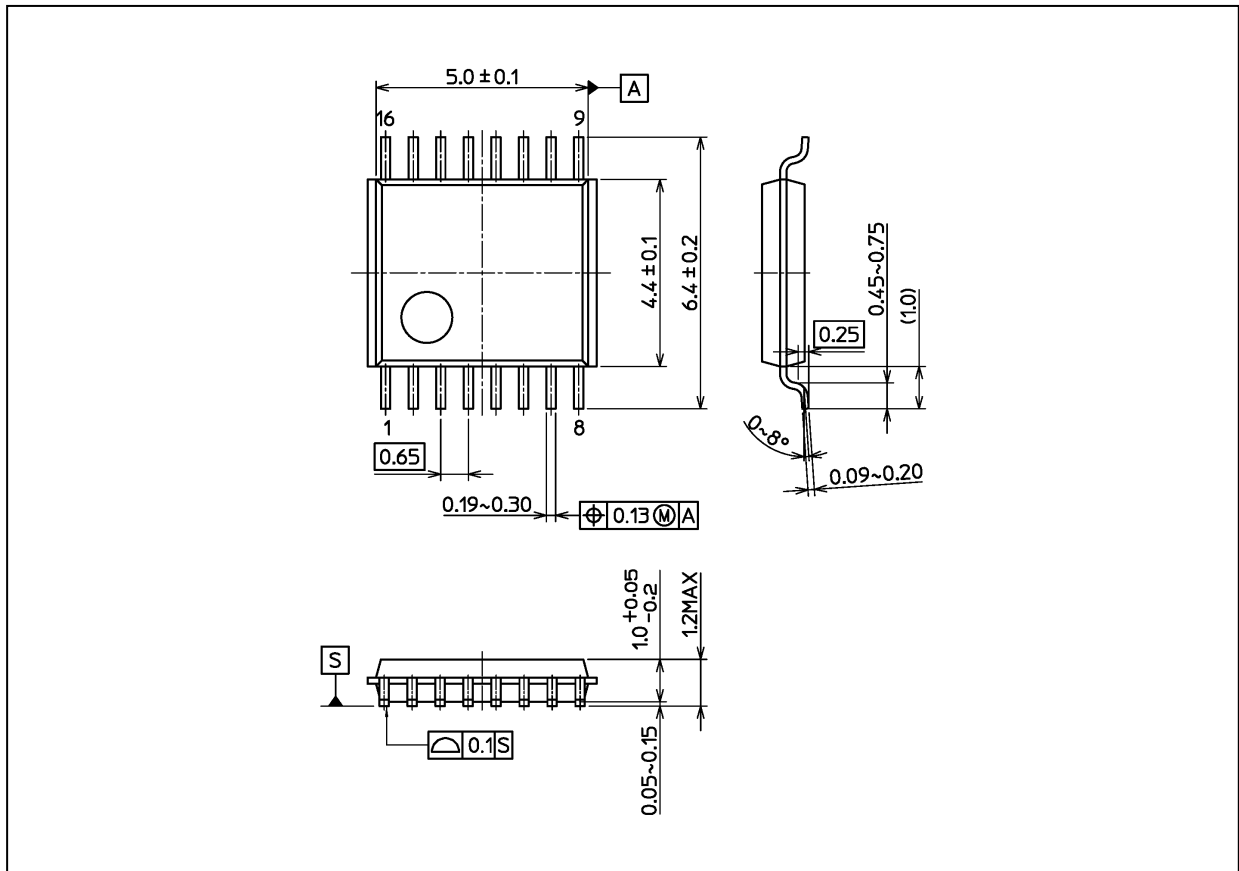


Figure 6 Cross Talk (between any two switches)

Package Dimensions

Unit: mm



Weight: 0.055 g (typ.)

Package Name(s)
Nickname: TSSOP16B

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