CMOS Digital Integrated Circuits Silicon Monolithic

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 ×2 configuration, and the 74VHC4053AFT has a 2-channel ×3 configuration.

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

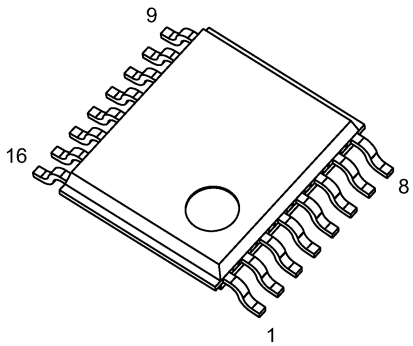
All control inputs are equipped with a newly developed input protection circuit that avoids the need for a diode on the plus side (forward side from the input to the V_{CC}). As a result, for example, 5.5 V signals can be permitted on the inputs even when the power supply voltage to the circuits is off. 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 μA (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

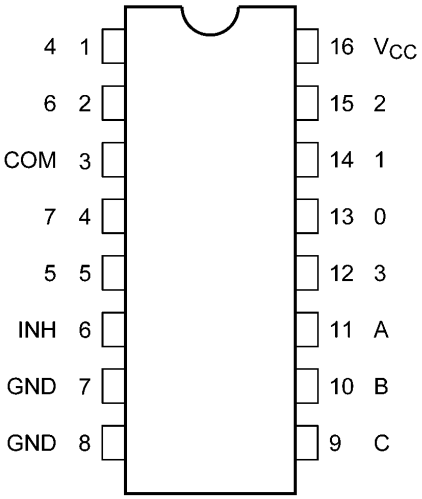


TSSOP16B

Start of commercial production
2013-06

5. Pin Assignment

74VHC4051AFT



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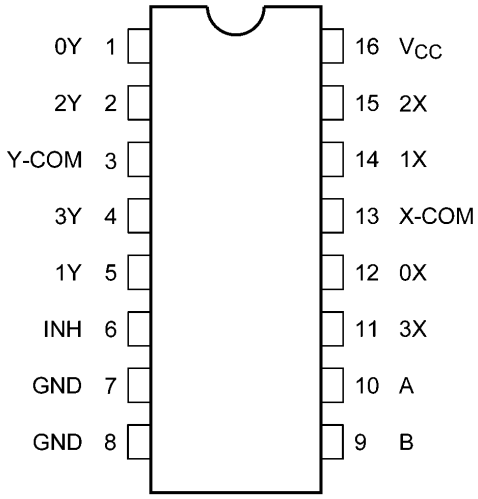

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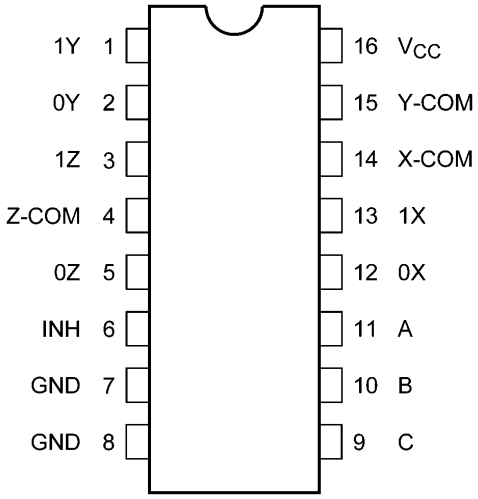
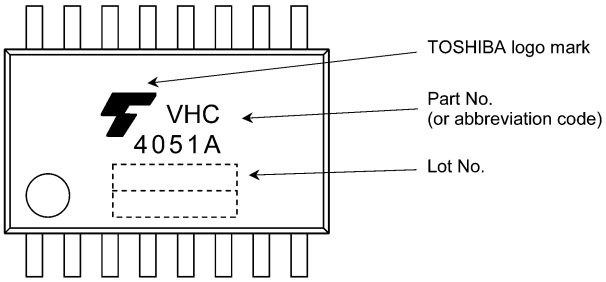


6. Marking

74VHC4051AFT



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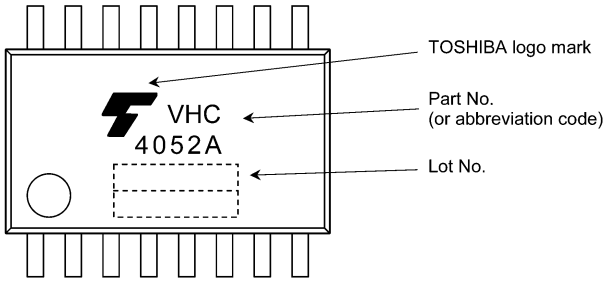

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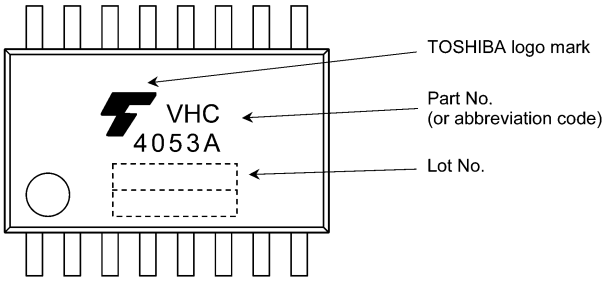
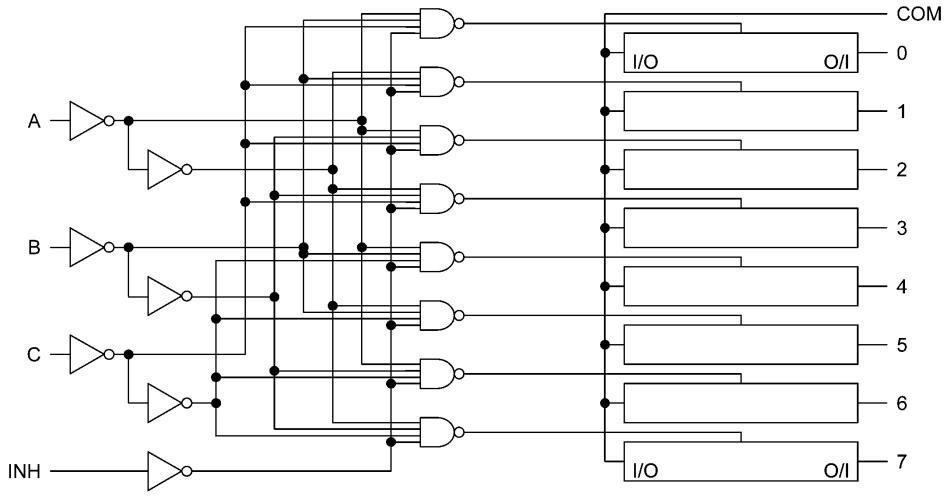


7. System Diagram

74VHC4051AFT



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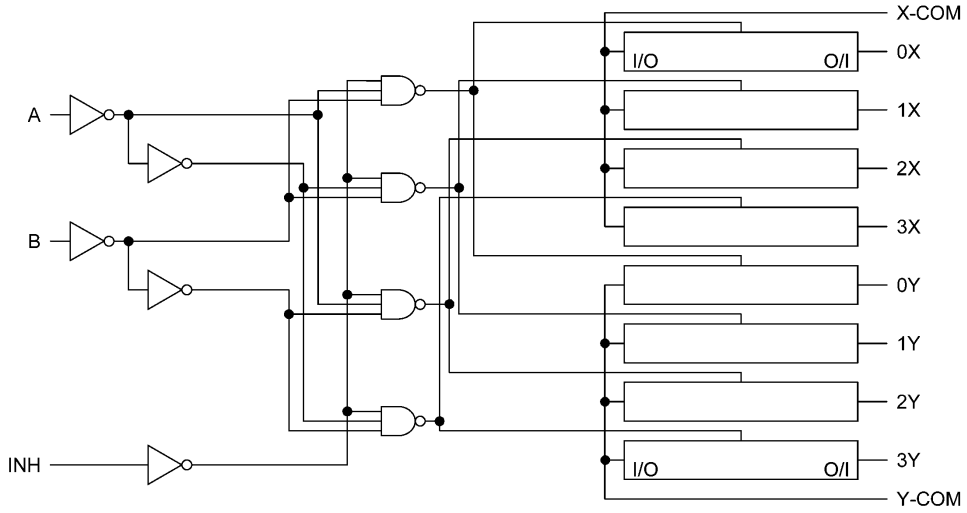

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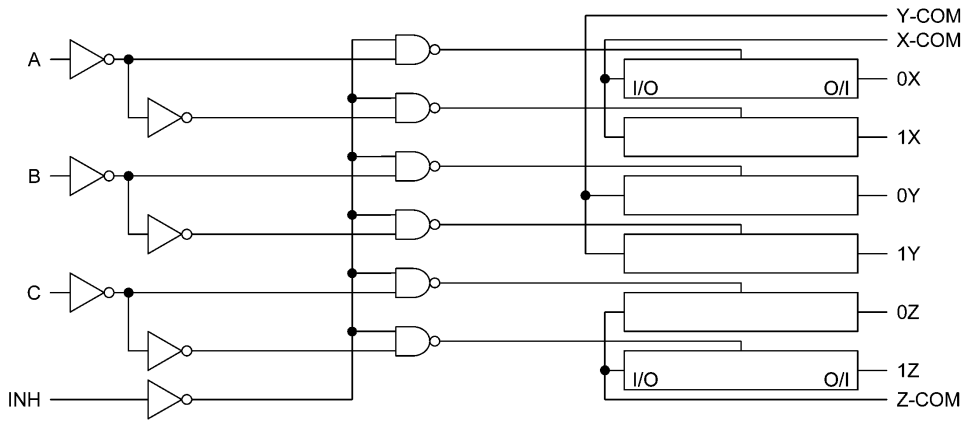


8. Truth Table

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 ± 0.2 V	0 to 200	ns/V
		V_{CC} = 3.3 ± 0.3 V	0 to 100	
		V_{CC} = 5 ± 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 °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 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 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 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} = 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 °C, Input: $t_r = t_f$ = 3 ns)

Characteristics	Part Number	Symbol	Test Condition	V_{CC} (V)	C_L (pF)	Min	Typ.	Max	Unit
Phase difference between input to output		$\varphi_{I/O}$		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 kΩ 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 kΩ 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	$\varphi_{I/O}$		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 kΩ 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 kΩ 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)

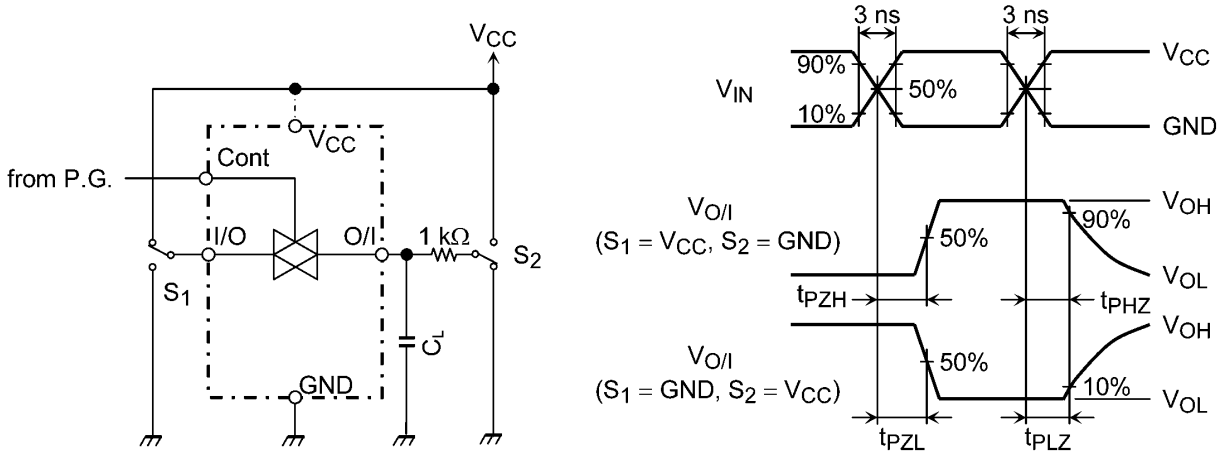
Characteristics	Symbol	Test Condition	V_{CC} (V)	C_L (pF)	Min	Max	Unit
Phase difference between input to output	$\varphi_{I/O}$		2.5 ± 0.2	15	—	20	ns
				50	—	22	
			3.3 ± 0.3	15	—	13	
				50	—	14	
			5.0 ± 0.5	15	—	9	
				50	—	9.5	
Output enable time	t_{PZL},t_{PZH}	R_L = 1 kΩ Figure 1	2.5 ± 0.2	15	—	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 kΩ 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	
			V_{IN} is centered at (V_{CC}/2). Adjust input for 0 dBm. R_L = 50 Ω, C_L = 10 pF, f_{IN} = 1 MHz, sine wave Figure 4		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}

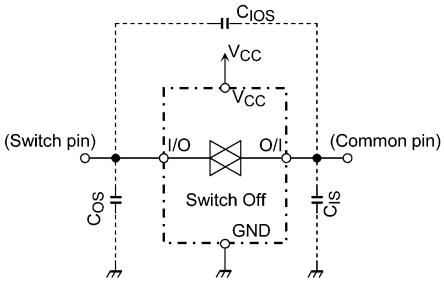


Figure 2 C_{IOS}, C_{IS}, C_{OS}

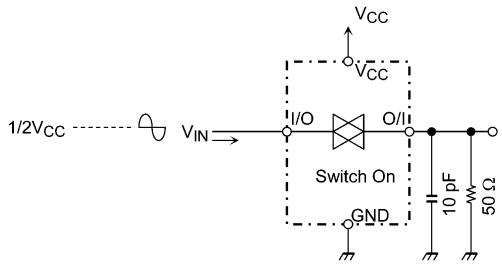


Figure 3 Frequency Response

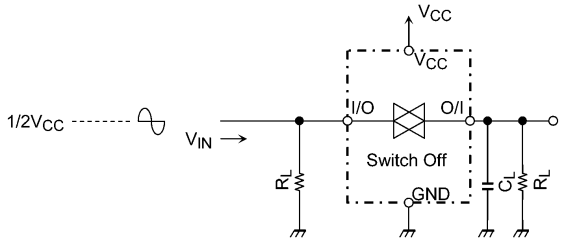
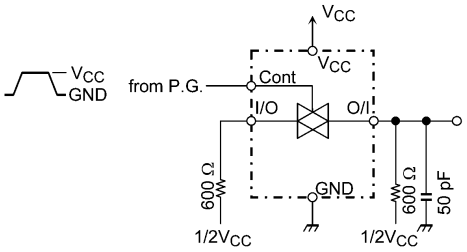


Figure 4 Feedthrough Attenuation



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)

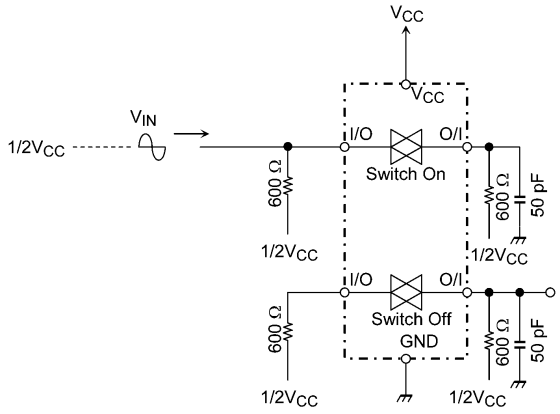
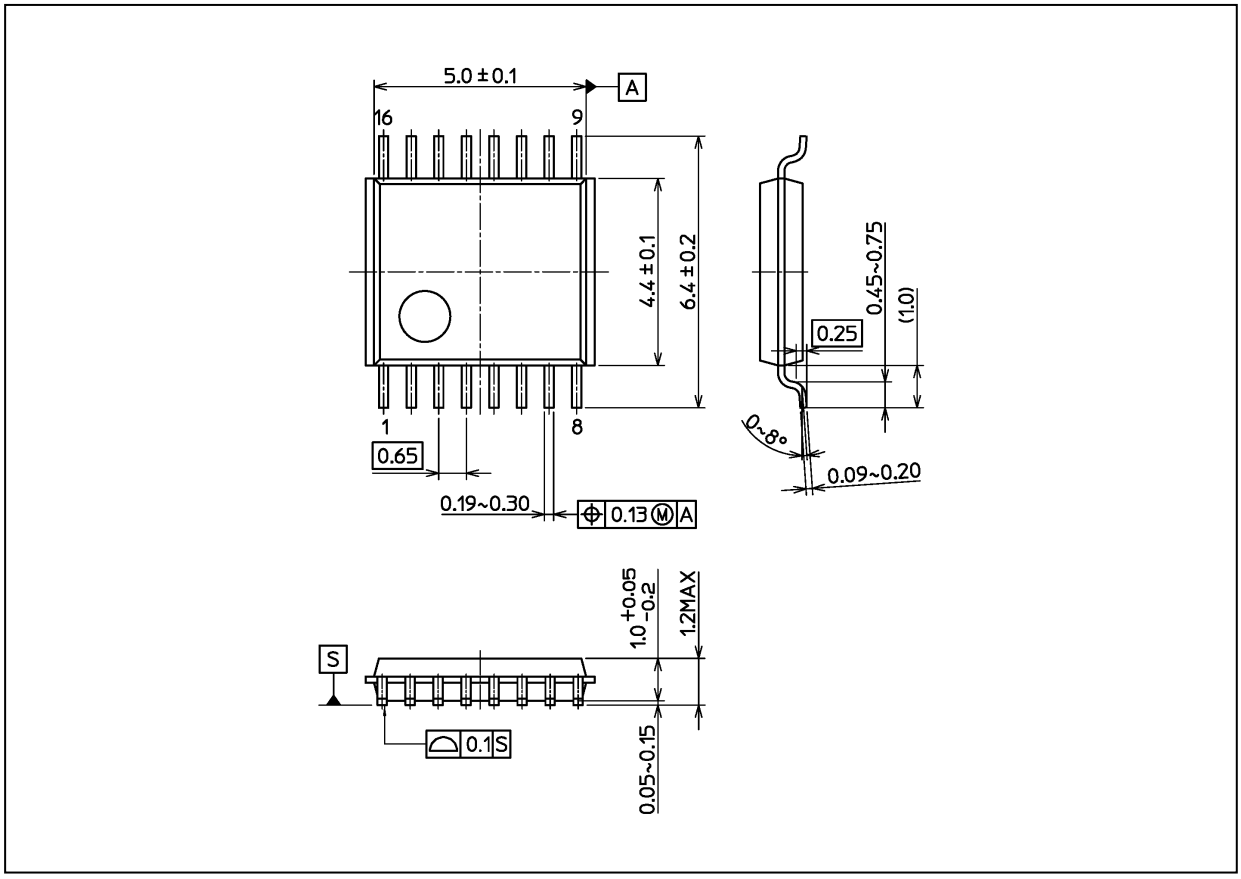


Figure 6 Cross Talk (between any two switches)

Package Dimensions

Unit: mm



Weight: 0.055 g (typ.)

Package Name(s)
Nickname: TSSOP16B

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