CMOS Digital Integrated Circuits Silicon Monolithic

74HCT4053D

1. Functional Description

· Triple 2-Channel Analog Multiplexer/Demultiplexer

2. General

The 74HCT4053D are high speed CMOS ANALOG MULTIPLEXER/DEMULTIPLEXER fabricated with silicon gate C2MOS technology. They achieve the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation.

This device may be used as a level converter for interfacing TTL or NMOS to High Speed CMOS. This inputs are compatible with TTL, NMOS and CMOS output voltage levels.

The 74HCT4053D has a 2 channel \times 3 configuration.

The digital signal to the control terminal turns "ON" the corresponding switch of each channel a large amplitude signal (V_{CC} - V_{EE}) can then be switched by the small logical amplitude (V_{CC} - GND) control signal.

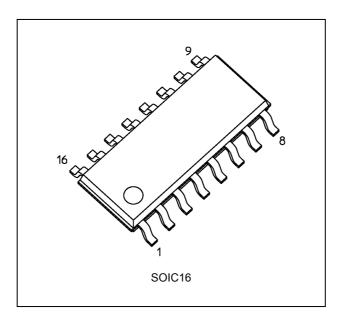
For example, in the case of $V_{\rm CC}$ = 5 V, GND = 0 V, $V_{\rm EE}$ = -5 V, signals between -5 V and +5 V can be switched from the logical circuit with a single power supply of 5 V. As the ON-resistance of each switch is low, they can be connected to circuits with low input impedance.

All inputs are equipped with protection circuits against static discharge or transient excess voltage.

3. Features

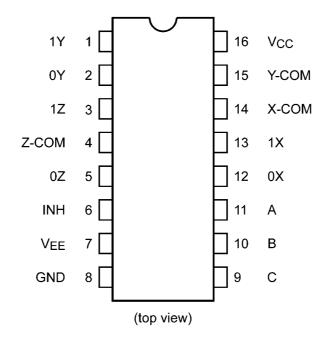
- (1) Low power dissipation: $I_{CC} = 4.0 \mu A \text{ (max)} \text{ (V}_{CC} = 5.5 \text{ V}, V_{EE} = \text{GND}, T_a = 25 ^{\circ}\text{C})$
- (2) Compatible with TTL output: $V_{IH} = 2.0 \text{ V (min)}$, $V_{IL} = 0.8 \text{ V (max)}$
- (3) Wide interfacing ability: LSTTL, NMOS, CMOS
- (4) Low ON-resistance: $R_{ON} = 50 \Omega$ (typ.) at V_{CC} $V_{EE} = 9 V$
- (5) High noise immunity: THD = 0.020 % (typ.) at V_{CC} V_{EE} = 9 V
- (6) Pin and function compatible with 4053B

4. Packaging

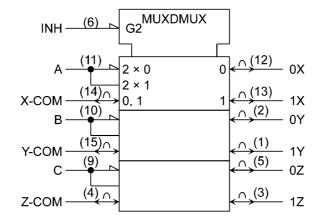




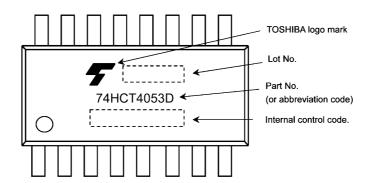
5. Pin Assignment



6. IEC Logic Symbol

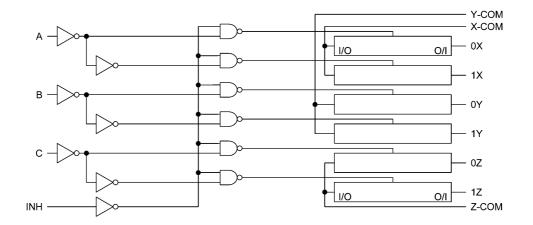


7. Marking





8. System Diagram





9. Truth Table

Input Inhibit	Input C	Input B	Input A	ON Channel
L	L	L	L	0X, 0Y, 0Z
L	L	L	Н	1X, 0Y, 0Z
L	L	Н	L	0X, 1Y, 0Z
L	L	Н	Н	1X, 1Y, 0Z
L	Н	L	L	0X, 0Y, 1Z
L	Н	L	Н	1X, 0Y, 1Z
L	Н	Н	L	0X, 1Y, 1Z
L	Н	Н	Н	1X, 1Y, 1Z
Н	X	X	X	None

X: Don't care

10. Absolute Maximum Ratings (Note)

Characteristics	Symbol	Rating	Unit
Supply voltage	V _{CC}	-0.5 to 13.0	V
	V _{CC} -V _{EE}	-0.5 to 13.0	
Input voltage	V _{IN}	-0.5 to V _{CC} + 0.5	V
Switch I/O voltage	V _{I/O}	V_{EE} - 0.5 to V_{CC} + 0.5	V
Input diode current	I _{IK}	±20	mA
I/O diode current	I _{I/OK}	±20	mA
Switch through current	I _T	±25	mA
V _{CC} /ground current	I _{CC}	±50	mA
Power dissipation	P _D	500	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).

11. Operating Ranges (Note)

Characteristics	Symbol	Rating	Unit
Supply voltage	V _{CC}	4.5 to 5.5	V
	V_{EE}	-7.5 to 0	
	V _{CC} -V _{EE}	4.5 to 12.0	
Input voltage	V_{IN}	0 to V _{CC}	V
Switch I/O voltage	V _{I/O}	V _{EE} to V _{CC}	V
Operating temperature	T_{opr}	-40 to 85	ပ္
Input rise and fall times	t_r, t_f	0 to 50	μS

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.



12. Electrical Characteristics

12.1. DC Characteristics (Unless otherwise specified, T_a = 25 °C)

Characteristics	Symbol	Test Condition	V _{EE} (V)	V _{CC} (V)	Min	Тур.	Max	Unit
High-level input voltage	V _{IH}	_		4.5 to 5.5	2.0	_	_	V
Low-level input voltage	V _{IL}	_		4.5 to 5.5	_	_	0.8	V
ON-resistance	R _{ON}	V _{IN} = V _{IH} or V _{IL}	GND	4.5	_	85	180	Ω
		$V_{I/O} = V_{CC}$ to V_{EE} $I_{I/O} \le 2 \text{ mA}$	-4.5	4.5	_	55	120	
		/0 ≥ 2 A	-5.5	5.5	_	50	110	
		V _{IN} = V _{IH} or V _{IL}	GND	4.5	_	70	150	
		$V_{I/O} = V_{CC}$ or V_{EE} $I_{I/O} \le 2 \text{ mA}$	-4.5	4.5	_	50	100	
		/0 ≥ 2 A	-5.5	5.5	_	45	90	
Difference of ON-resistance	ΔR_{ON}	$V_{IN} = V_{IH} \text{ or } V_{IL}$ $V_{I/O} = V_{CC} \text{ to } V_{EE}$ $I_{I/O} \le 2 \text{ mA}$	GND	4.5	_	10	30	Ω
between switches			-4.5	4.5	_	5	12	
		/0 ≥ 2 A	-5.5	5.5	_	5	11	
Input/Output leakage current (Switch OFF)	I _{OFF}	V _{OS} = V _{CC} or GND	GND	5.5		_	±0.06	μΑ
(SWILCH OFF)		V_{IS} = GND or V_{CC} V_{IN} = V_{IH} or V_{IL}	-5.5	5.5	1	_	±0.1	
Input/Output leakage current	I _{I/O}	V _{OS} = V _{CC} or GND	GND	5.5		_	±0.06	μΑ
(Switch ON)		$V_{IN} = V_{IH}$ or V_{IL}	-5.5	5.5	_	_	±0.1	
Control input leakage current	I _{IN}	V _{IN} = V _{CC} or GND	GND	5.5	_	_	±0.1	μА
Quiescent supply current	I _{CC}	V _{IN} = V _{CC} or GND	GND	5.5	_	_	4.0	μА
			-5.5	5.5	_	_	8.0	
	I _{CC}	Per input: V_{IN} = 0.5 V or 2.4 V Other input: V_{CC} or GND	GND	5.5	_	_	2.0	mA

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

Characteristics	Symbol	Test Condition	V _{EE} (V)	V _{CC} (V)	Min	Max	Unit
High-level input voltage	V_{IH}	_		4.5 to 5.5	2.0	_	V
Low-level input voltage	V _{IL}	_		4.5 to 5.5	_	0.8	V
ON-resistance	R _{ON}	V _{IN} = V _{IH} or V _{IL}	GND	4.5	_	225	Ω
		$V_{I/O} = V_{CC}$ to V_{EE} $I_{I/O} \le 2 \text{ mA}$	-4.5	4.5	_	150	
		11/0 = 2 111A	-5.5	5.5	_	140	
		V _{IN} = V _{IH} or V _{IL}	GND	4.5	_	190	
		$V_{I/O} = V_{CC}$ or V_{EE} $I_{I/O} \le 2 \text{ mA}$	-4.5	4.5	_	125	
		11/0 ≥ 2 111A	-5.5	5.5	_	115	
Difference of ON-resistance	ΔR_{ON}	V _{IN} = V _{IH} or V _{IL}	GND	4.5	_	35	Ω
between switches		$V_{I/O}$ = V_{CC} to V_{EE} $I_{I/O} \le 2 \text{ mA}$	-4.5	4.5	_	15	
			-5.5	5.5	_	14	
Input/Output leakage current (Switch OFF)	I _{OFF}	$V_{OS} = V_{CC}$ or GND	GND	5.5	_	±0.6	μА
(SWILCH OFF)		V_{IS} = GND or V_{CC} V_{IN} = V_{IH} or V_{IL}	-5.5	5.5	_	±1.0	
Input/Output leakage current	I _{I/O}	V _{OS} = V _{CC} or GND	GND	5.5	_	±0.6	μА
(Switch ON)		$V_{IN} = V_{IH} \text{ or } V_{IL}$	-5.5	5.5	_	±1.0	
Control input leakage current	I _{IN}	V _{IN} = V _{CC} or GND	GND	5.5	_	±1.0	μА
Quiescent supply current	I _{CC}	V _{IN} = V _{CC} or GND	GND	5.5	_	40.0	μА
			-5.5	5.5		80.0	
	Icc	Per input: V _{IN} = 0.5 V or 2.4 V Other input: V _{CC} or GND	GND	5.5	_	2.9	mA



12.3. AC Characteristics (Unless otherwise specified, C_L = 50 pF, T_a = 25 °C, Input: t_r = t_f = 6 ns)

Characteristics	Symbol	Test Condition	V _{EE} (V)	V _{CC} (V)	Min	Тур.	Max	Unit
Phase difference between input	Φι/Ο	_	GND	4.5		6	12	ns
to output			GND	5.5	_	5	11	
Output enable time	t_{PZL}, t_{PZH}	$R_L = 1 k\Omega$	GND	4.5	_	33	60	ns
		Figure 1	GND	5.5	_	26	45	
Output disable time	t_{PLZ}, t_{PHZ}	$R_L = 1 k\Omega$	GND	4.5	_	45	65	ns
		Figure 1	GND	5.5	_	37	59	
Control input capacitance	C _{IN}	_	_	_		5	10	pF
Common terminal capacitance	C _{IS}	Figure 2	-5.0	5.0		11	20	pF
Switch terminal capacitance	Cos	Figure 2	-5.0	5.0	_	7	15	pF
Feedthrough capacitance	C _{IOS}	Figure 2	-5.0	5.0	_	0.75	2	pF
Power dissipation capacitance	C _{PD}	Figure 2 (Note 1)	GND	5.0	_	10	_	pF

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

12.4. AC Characteristics (Unless otherwise specified, C_L = 50 pF, T_a = -40 to 85 °C, Input: t_r = t_f = 6 ns)

Characteristics	Symbol	Test Condition	V _{EE} (V)	V _{CC} (V)	Min	Max	Unit
Phase difference between input to	Φι/Ο	_	GND	4.5		15	ns
output			GND	5.5		13	
Output enable time	t_{PZL},t_{PZH}	$R_L = 1 k\Omega$	GND	4.5		63	ns
		Figure 1	GND	5.5	_	57	
Output disable time	t_{PLZ},t_{PHZ}	$R_L = 1 k\Omega$	GND	4.5	_	81	ns
	Figure 1		GND	5.5	_	73	
Control input capacitance	C _{IN}	_	_	_	_	10	pF
Common terminal capacitance	C _{IS}	Figure 2	-5.0	5.0	_	20	pF
Switch terminal capacitance	Cos	Figure 2	-5.0	5.0	_	15	pF
Feedthrough capacitance	C _{IOS}	Figure 2	-5.0	5.0		2	pF



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

Characteristics	Symbol	Test Condition		V _{EE} (V)	V _{CC} (V)	Тур.	Unit
Sine Wave Distortion	THD	$R_L = 10 \text{ k}\Omega, C_L = 50 \text{ pF}$	$V_{IN} = 8.0 V_{p-p}$	-4.5	4.5	0.020	%
		f _{IN} = 1 kHz	V _{IN} = 11.0 V _{p-p}	-5.5	5.5	0.019	
Maximum frequency response	f _{MAX(I/O)}	Adjust f _{IN} voltage to obtain 0 dBm at V _{OS}	(Note 1)	-4.5	4.5	190	MHz
Тезропас		Increase f _{IN} frequency until dB meter reads -3 dB	(Note 2)			150	
		$R_L = 50 \Omega$, $C_L = 10 pF$	(Note 1)	-5.5	5.5	200	
		f _{IN} = 1 MHz, sine wave Figure 3	(Note 2)			180	
Feed through attenuation (switch OFF)	FTH	V_{IN} is centered at $(V_{CC} - V_{EE})/2$ Adjust input for 0 dBm. $R_1 = 600 \ \Omega, \ C_1 = 50 \ pF,$		-4.5	4.5	-50	dB
		f _{IN} = 1 MHz, sine wave Figure 4		-5.5	5.5	-50	
Crosstalk (control input to signal output)	X _{talk}	$R_L = 600 \Omega$, $C_L = 50 pF$, $f_{IN} = 1 MHz$,		-4.5	4.5	140	mV
		square wave ($t_r = t_f = 6 \text{ ns}$) Figure 5		-5.5	5.5	180	
Crosstalk (between any switches)	X _{talk}	Adjust V _{IN} to obtain 0 dBm at input.		-4.5	4.5	-50	dB
		R_L = 600 Ω , C_L = 50 pF, f_{IN} = 1 MHz, sine wave Figure 6		-5.5	5.5	-50	
	X _{talk}	$R_L = 50 \Omega$, $C_L = 15 pF$, $f_{IN} = 100 \text{ KHz}$, $V_{SWITCH} = 1 V_{RMS}$ Figure 6		-4.5	4.5	-90	dB

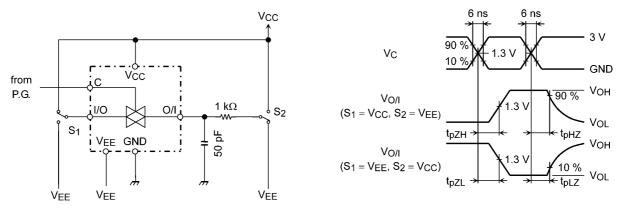
Note: These characteristics are determined by design of devices.

Note 1: Input COMMON terminal, and measured at SWITCH terminal.

Note 2: Input SWITCH terminal, and measured at COMMON terminal.



13. AC Test Circuit



P.G.: Pulse generator

Figure 1 tpLz, tpHz, tpZL, tpZH

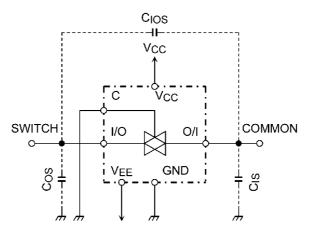


Figure 2 CIOS, CIS, COS

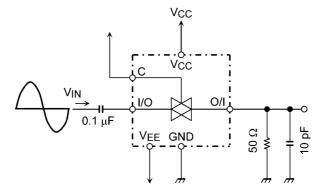


Figure 3 Frequency Response

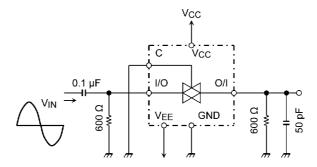
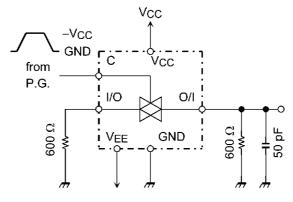


Figure 4 Feedthrough Attenuation



P.G.: Pulse generator

Figure 5 Cross Talk (control input to output signal)

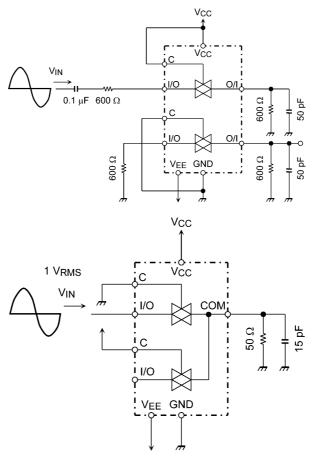
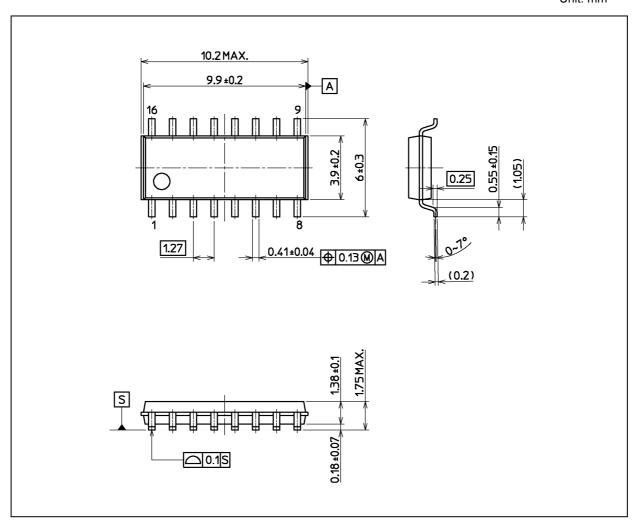


Figure 6 Cross Talk (between any two switches)



Package Dimensions

Unit: mm



Weight: 0.15 g (typ.)

	Package Name(s)
Nickname: SOIC16	



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