

# CD74HCT4051-Q1 Automotive High-Speed CMOS Logic

## Analog Multiplexers and Demultiplexers

### 1 Features

- Wide analog input voltage range:  $\pm 5V$  maximum
- Low ON-resistance:
  - $70\Omega$  typical ( $V_{CC} - V_{EE} = 4.5V$ )
  - $40\Omega$  typical ( $V_{CC} - V_{EE} = 9V$ )
- Low crosstalk between switches
- Fast switching and propagation speeds
- Break-before-make switching
- Wide operating temperature range:  
 $-40^{\circ}C$  to  $+125^{\circ}C$
- Operation control voltage:  $4.5V$  to  $5.5V$
- Switch voltage:  $0V$  to  $10V$
- Direct LSTTL input logic compatibility  
 $V_{IL} = 0.8V$  maximum,  $V_{IH} = 2V$  minimum
- CMOS input compatibility  
 $I_I \leq 1\mu A$  at  $V_{OL}$ ,  $V_{OH}$

### 2 Applications

- [Digital radio](#)
- Signal gating
- [Factory automation](#)
- [Televisions](#)
- [Appliances](#)
- Programmable logic circuits
- [Sensors](#)

### 3 Description

The CD74HCT4051-Q1 device is a digitally controlled analog switch that uses silicon gate CMOS technology to achieve operating speeds similar to LSTTL with the low-power consumption of standard CMOS integrated circuits.

This analog multiplexer and demultiplexer controls analog voltages that may vary across the voltage supply range (for example,  $V_{CC}$  to  $V_{EE}$ ). It is a bidirectional switch that allows any analog input to be used as an output and vice versa. The switch has low ON resistance and low OFF leakages. In addition, this device has an enable control that, when high, disables all switches to their OFF state.

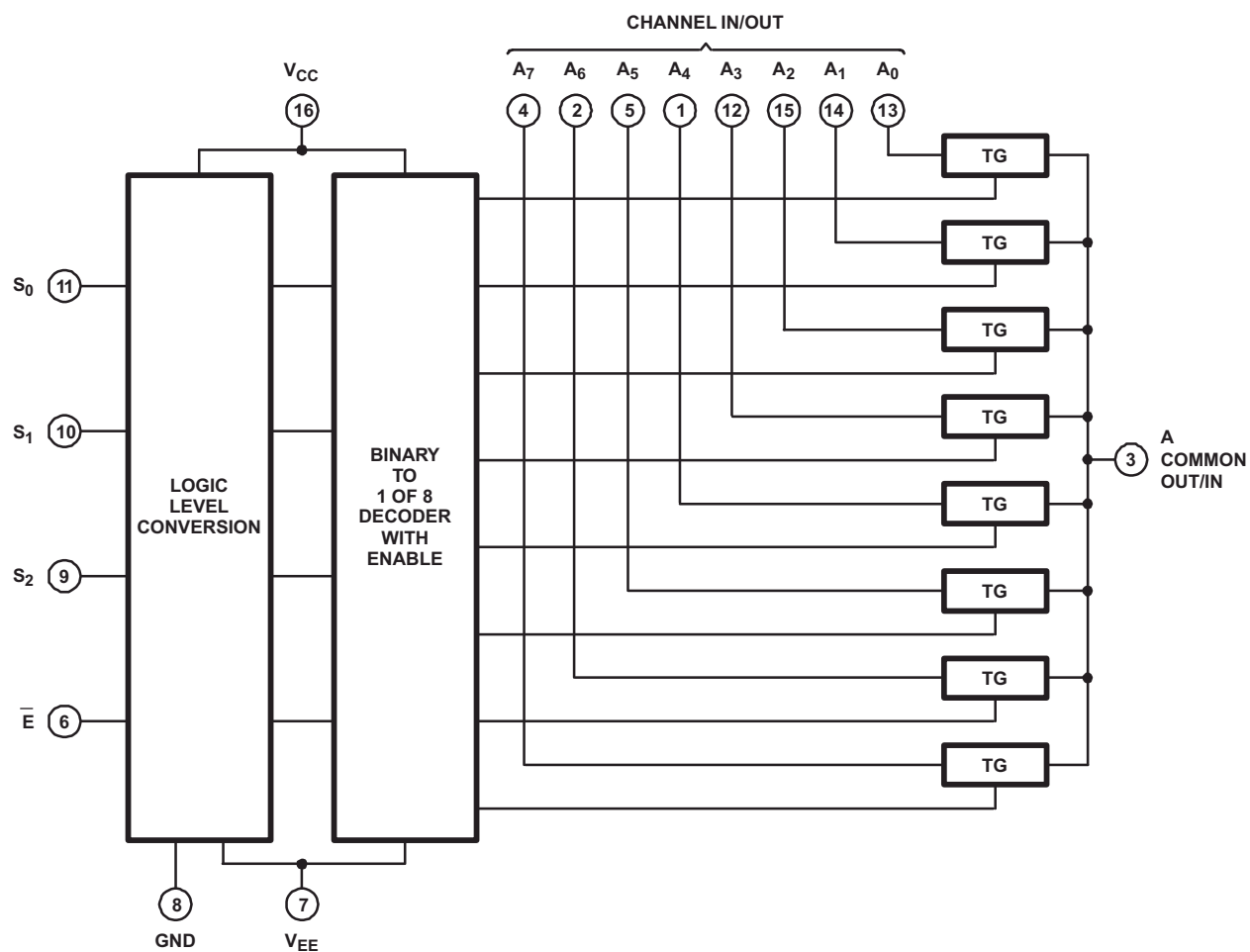
#### Package Information

PART NUMBER	PACKAGE <sup>(1)</sup>	PACKAGE SIZE <sup>(2)</sup>
CD74HCT4051-Q1	D (SOIC, 16)	9.9mm × 3.9mm

(1) For more information, see [Section 9](#).

(2) The package size (length × width) is a nominal value and includes pins, where applicable.





Functional Diagram of HCT4051

## Table of Contents

<b>1 Features</b> .....	<b>1</b>	<b>6 Parameter Measurement Information</b> .....	<b>8</b>
<b>2 Applications</b> .....	<b>1</b>	<b>7 Device and Documentation Support</b> .....	<b>11</b>
<b>3 Description</b> .....	<b>1</b>	7.1 Documentation Support.....	11
<b>4 Pin Configuration and Functions</b> .....	<b>3</b>	7.2 Receiving Notification of Documentation Updates....	11
<b>5 Specifications</b> .....	<b>4</b>	7.3 Support Resources.....	11
5.1 Absolute Maximum Ratings.....	4	7.4 Trademarks.....	11
5.2 Recommended Operating Conditions.....	4	7.5 Electrostatic Discharge Caution.....	11
5.3 Electrical Characteristics: HCT Devices.....	5	7.6 Glossary.....	11
5.4 Switching Characteristics.....	5	<b>8 Revision History</b> .....	<b>11</b>
5.5 Analog Channel Specifications.....	6	<b>9 Mechanical, Packaging, and Orderable Information..</b>	<b>11</b>
5.6 Typical Characteristics.....	7		

## 4 Pin Configuration and Functions

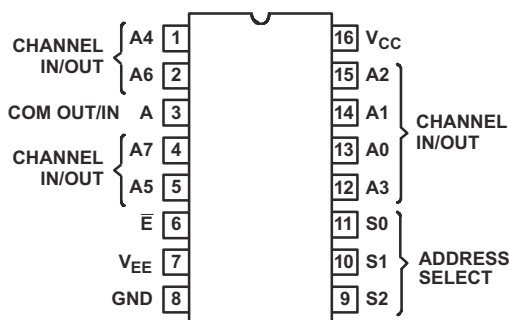


Figure 4-1. D Package, 16-Pin SOIC (Top View)

INPUTS				ON CHANNELS
ENABLE	S2	S1	S0	
L	L	L	L	A0
L	L	L	H	A1
L	L	H	L	A2
L	L	H	H	A3
L	H	L	L	A4
L	H	L	H	A5
L	H	H	L	A6
L	H	H	H	A7
H	X	X	X	None

## 5 Specifications

### 5.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)<sup>(1) (2)</sup>

			MIN	MAX	UNIT
$V_{CC} - V_{EE}$ <sup>(2)</sup>	DC Supply voltage		-0.5	10.5	V
$V_{CC}$			-0.5	7	V
$V_{EE}$			0.5	-7	V
$I_{IK}$	DC input diode current	$V_I < -0.5V$ or $V_I > V_{CC} + 0.5V$	-20	20	mA
$I_{OK}$	DC switch diode current	$V_I < V_{EE} - 0.5V$ or $V_I > V_{CC} + 0.5V$	-20	20	mA
	DC switch current	$V_I < V_{EE} - 0.5V$ or $V_I > V_{CC} + 0.5V$	-25	25	mA
$I_{CC}$	DC $V_{CC}$ or ground current		-50	50	mA
$I_{EE}$	DC $V_{EE}$ current		-20		mA
$R_{\theta JA}$	Package thermal impedance <sup>(3)</sup>			91.6	°C/W
$T_{JMAX}$	Maximum junction temperature			150	°C
$T_{LMAX}$	Maximum lead temperature	Soldering 10 s		300	°C
$T_{stg}$	Storage temperature		-65	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Rating* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Condition*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltages are with respect to ground, unless otherwise specified.
- (3) The package thermal impedance is calculated in accordance with JESD 51-7

### 5.2 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

			MIN	NOM	MAX	UNIT
$V_{CC}$	Supply voltage range ( $T_A$ = full package temperature range) <sup>(2)</sup>		4.5		5.5	V
$V_{CC} - V_{EE}$	Supply voltage range ( $T_A$ = full package temperature range) <sup>(2)</sup>		2		10	V
$V_{EE}$ <sup>(2)</sup>	Supply voltage range ( $T_A$ = full package temperature range) <sup>(3)</sup>		0		-6	V
$V_{IH}$	High-level input voltage		2			V
$V_{IL}$	Low-level input voltage				0.8	V
$V_I$	DC input control voltage		0		$V_{CC}$	V
$V_{IS}$	Analog switch I/O voltage		$V_{EE}$		$V_{CC}$	V
$t_r, t_f$	Input rise and fall times	$V_{CC} = 4.5V$	0		500	ns
$T_A$	Ambient temperature		-40		125	°C

- (1) All unused inputs of the device must be held at  $V_{CC}$  or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, Literature number SCBA004.
- (2) In certain applications, the external load resistor current may include both  $V_{CC}$  and signal-line components. To avoid drawing  $V_{CC}$  current when switch current flows into the transmission gate inputs, the voltage drop across the bidirectional switch must not exceed 0.6V (calculated from  $r_{on}$  values shown in electrical characteristics tables). No  $V_{CC}$  current flows through  $R_L$  if the switch current flows into the COM OUT/IN A terminal.

### 5.3 Electrical Characteristics: HCT Devices

Over operating free-air temperature range,  $V_{SUPPLY} = \pm 5V$ , and  $R_L = 100\Omega$ , (unless otherwise noted)<sup>(1)</sup>

PARAMETER	TEST CONDITIONS					MIN	TYP	MAX	UNIT
CD74HCT4051-Q1									
r <sub>ON</sub> ON resistance	I <sub>O</sub> = 1mA V <sub>I</sub> =V <sub>IH</sub> or V <sub>IL</sub>	V <sub>IS</sub> = V <sub>CC</sub> or V <sub>EE</sub>	0	4.5	25°C	70	160	Ω	
					–40°C to +125°C	240			
			–4.5	4.5	25°C	40	120		
					–40°C to +125°C	180			
		V <sub>IS</sub> = V <sub>CC</sub> to V <sub>EE</sub>	0	4.5	25°C	90	180	Ω	
					–40°C to +125°C	270			
			–4.5	4.5	25°C	45	130		
					–40°C to +125°C	195			
Δr <sub>ON</sub> Maximum ON resistance between any two channels	Between any two channels		0	4.5	25°C	10	Ω		
			–4.5	4.5	25°C	5			
I <sub>IZ</sub> Switch ON/OFF leakage current	For switch OFF: When V <sub>IS</sub> = V <sub>CC</sub> , V <sub>OS</sub> = V <sub>EE</sub> ; When V <sub>IS</sub> = V <sub>EE</sub> , V <sub>OS</sub> = V <sub>CC</sub> , For switch ON: All applicable combinations of V <sub>IS</sub> and V <sub>OS</sub> voltage levels V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>		0	6	25°C	±0.2	μA		
					–40°C to 125°C	±2			
			–5	5	25°C	±0.4			
					–40°C to 125°C	±4			
I <sub>IL</sub> Control input leakage current	V <sub>I</sub> = V <sub>CC</sub> or GND			5.5	25°C	±0.1	μA		
					–40°C to 125°C	±1			
Quiescent Device Current, I <sub>CC</sub> Max	I <sub>O</sub> = 0 V <sub>IS</sub> = V <sub>CC</sub> or GND	When V <sub>IS</sub> = V <sub>EE</sub> , V <sub>OS</sub> = V <sub>CC</sub>	0	6	25°C	12	μA		
					–40°C to 125°C	160			
		When V <sub>IS</sub> = V <sub>CC</sub> , V <sub>OS</sub> = V <sub>EE</sub>	–5	5	25°C	32			
					–40°C to 125°C	320			
Quiescent Device Current, ΔI <sub>CC</sub> Max <sup>(1)</sup>	Per input pin: 1 unit load, V <sub>IN</sub> = V <sub>CC</sub> - 2.1V			4.5V to 5.5V	25°C	100	360	μA	
					–40°C to 125°C	490			

(1) For dual-supply systems, theoretical worst case ( $V_I = 2.4V$ ,  $V_{CC} = 5.5V$ ) specification is 1.8mA.

### 5.4 Switching Characteristics

over operating free-air temperature range (unless otherwise noted)

Parameter	Test Conditions			MIN	NOM	MAX	UNIT
$t_{PD}$	Switch IN to OUT	$C_L = 15pF$	$V_{CC} = 5V$	25°C	4		ns
		$C_L = 50pF$	$V_{CC} = 4.5V$	25°C		12	ns
				–40°C to +125°C		18	ns
			$V_{CC} = 4.5V$ , $V_{EE} = -4.5V$	25°C		8	ns
				–40°C to +125°C		12	ns

## 5.4 Switching Characteristics (continued)

over operating free-air temperature range (unless otherwise noted)

Parameter		Test Conditions			MIN	NOM	MAX	UNIT
$t_{en}$	ADDRESS SEL or $\bar{E}$ to OUT	$C_L = 15\text{pF}$	$V_{CC} = 5\text{V}$	25°C		23		ns
		$C_L = 50\text{pF}$	$V_{CC} = 4.5\text{V}$	25°C			55	ns
				–40°C to +125°C			83	ns
			$V_{CC} = 4.5\text{V}, V_{EE} = -4.5\text{V}$	25°C			48	ns
				–40°C to +125°C			60	ns
$t_{dis}$	ADDRESS SEL or $\bar{E}$ to OUT	$C_L = 15\text{pF}$	$V_{CC} = 5\text{V}$	25°C		35		ns
		$C_L = 50\text{pF}$	$V_{CC} = 4.5\text{V}$	25°C			50	ns
				–40°C to +125°C			68	ns
			$V_{CC} = 4.5\text{V}, V_{EE} = -4.5\text{V}$	25°C			44	ns
				–40°C to +125°C			55	ns
$C_i$	Control			–40°C to +125°C			10	pF
$C_{PD}$	Power dissipation capacitance <sup>(1)</sup>					52		pF

(1) Cpd is used to determine the dynamic power consumption, per package.

$$PD = C_{pd} V_{CC2} f_i + \sum (C_L + C_S) V_{CC2} f_O$$

$f_O$  = output frequency

$f_i$  = input frequency

$C_L$  = output load capacitance

$C_S$  = switch capacitance

$V_{CC}$  = supply voltage

## 5.5 Analog Channel Specifications

over operating free-air temperature range (unless otherwise noted)

Parameter	Test Conditions	$V_{EE}$ (V)	$V_{CC}$ (V)	MIN	NOM	MAX	UNIT
$C_i$ Switch input capacitance					5		pF
$C_{COM}$ Common output capacitance					25		pF
$f_{MAX}$ <sup>(2)</sup> Minimum switch frequency response at –3 dB <sup>(1)</sup>		–2.25	2.25		145		MHz
		–4.5	4.5		180		
THD Sine-wave distortion		–2.25	2.25		0.035		%
		–4.5	4.5		0.018		
Switch OFF signal <sup>(2)</sup> feedthrough <sup>(3)</sup>		–2.25	2.25		–73		dB
		–4.5	4.5		–75		

(1) Adjust input voltage to obtain 0 dBm at VOS for  $f_{IN} = 1\text{ MHz}$ .

(2) VIS is centered at  $(V_{CC} - V_{EE})/2$ .

(3) Adjust input for 0 dBm.

## 5.6 Typical Characteristics

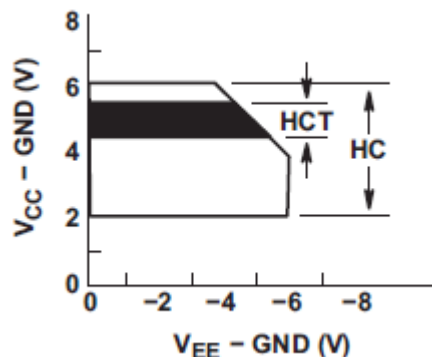


Figure 5-1. Recommended Operating Area as a Function of ( $V_{CC} - V_{EE}$ )

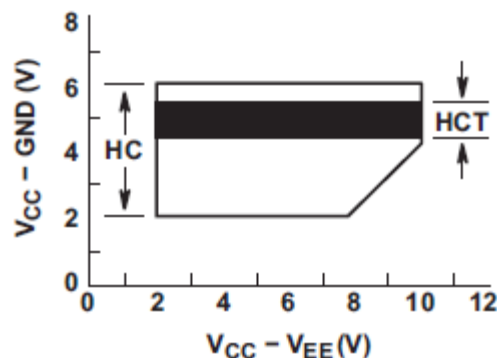


Figure 5-2. Recommended Operating Area as a Function of ( $V_{CC} - V_{EE}$ )

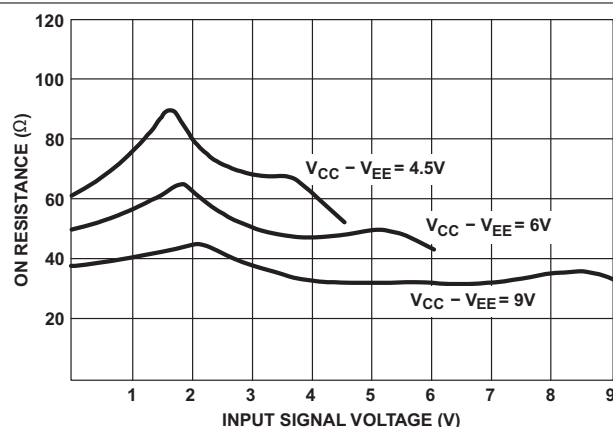


Figure 5-3. Typical ON Resistance vs Input Signal Voltage

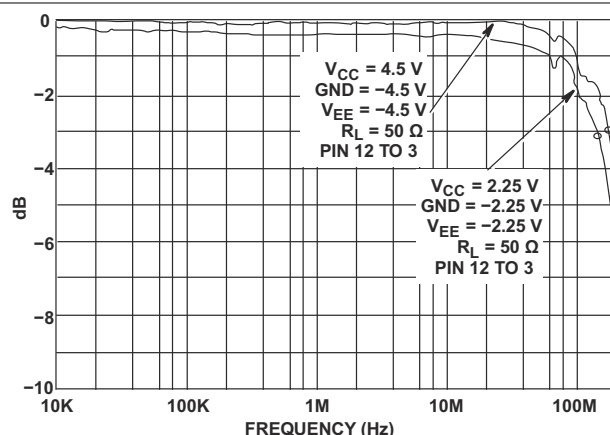


Figure 5-4. Channel ON Bandwidth (HC and HCT4051)

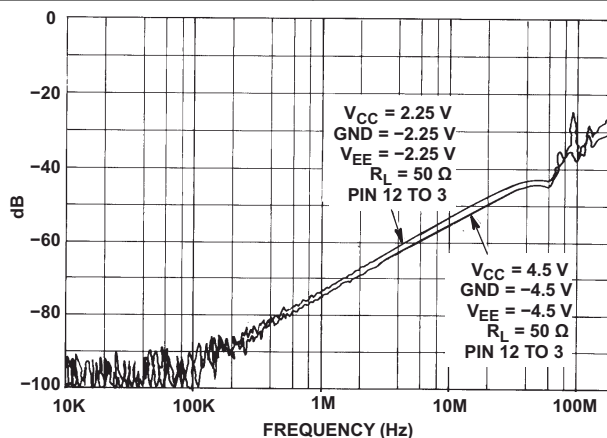
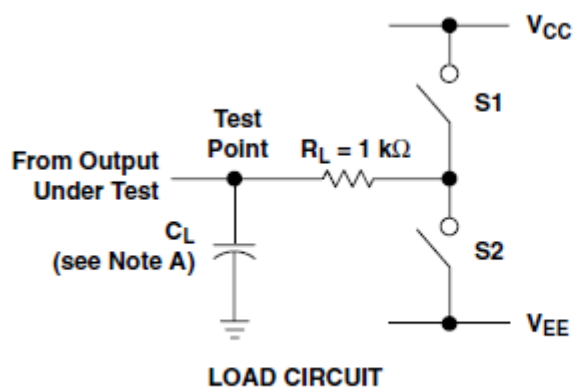


Figure 5-5. Channel OFF Feedthrough (HC and HCT4051)

## 6 Parameter Measurement Information



PARAMETER		S1	S2
$t_{en}$	$t_{PZH}$	Open	Closed
	$t_{PZL}$	Closed	Open
$t_{dis}$	$t_{PHZ}$	Open	Closed
	$t_{PLZ}$	Closed	Open
$t_{pd}$		Open	Open

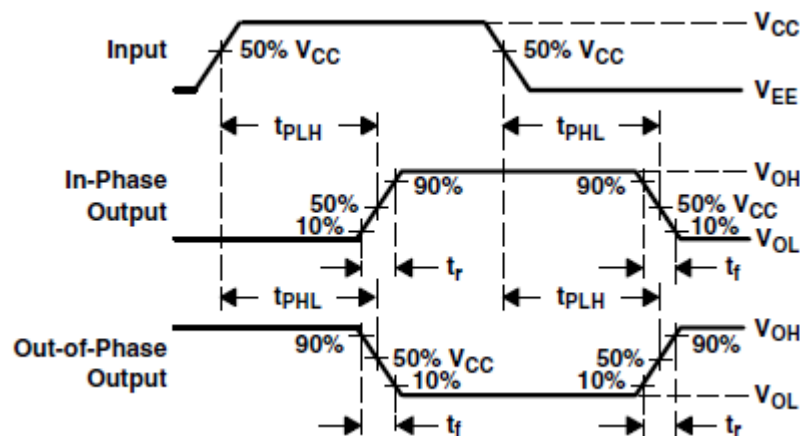


Figure 6-1. Propagation delay and output transition times. Waveform 1

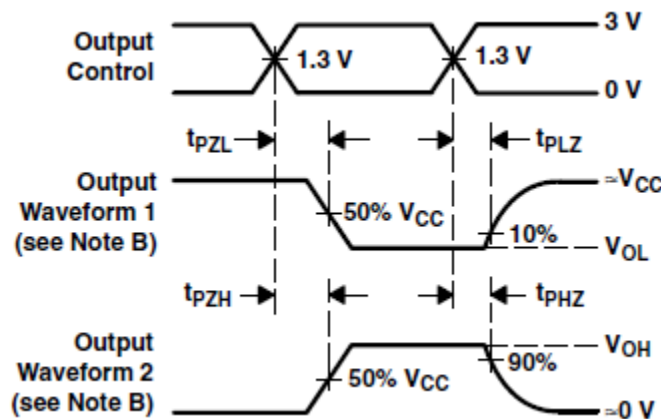


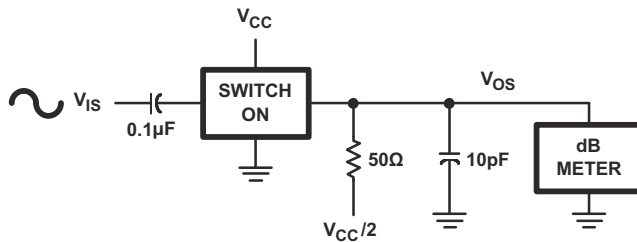
Figure 6-2. Output enable and disable times. Waveform 2

- A.  $C_L$  includes probe and test-fixture capacitance.
- B. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control.

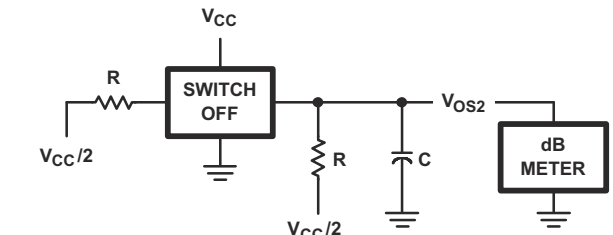
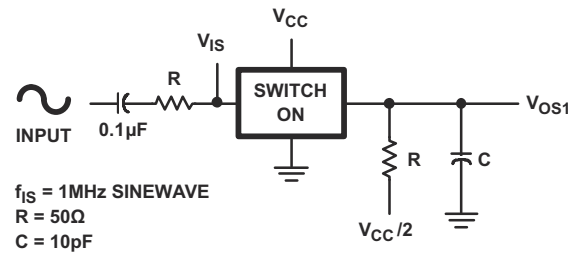


Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.

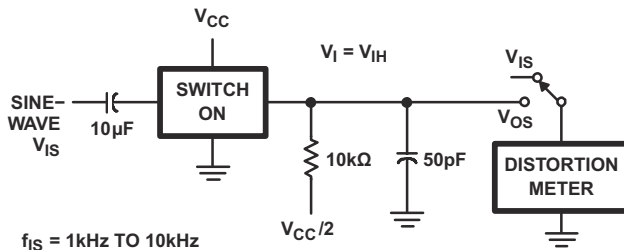
- C. Phase relationships between waveforms were chosen arbitrarily. All input pulses are supplied by generators having the following characteristics:  $PRR \leq 1\text{MHz}$ ,  $Z_O = 50\Omega$ ,  $t_r = 6\text{ns}$ ,  $t_f = 6\text{ns}$ .
- D. For clock inputs,  $f_{MAX}$  is measured with the input duty cycle at 50%.
- E. The outputs are measured one at a time, with one input transition per measurement.
- F.  $t_{PLZ}$  and  $t_{PHZ}$  are the same as  $t_{dis}$ .
- G.  $t_{PZL}$  AND  $t_{PZH}$  are the same as  $t_{en}$ .
- H.  $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .



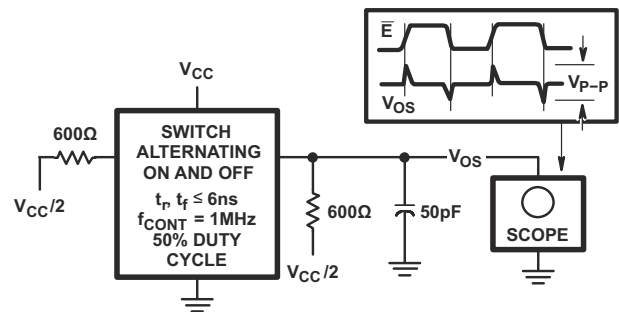
**Figure 6-3. Frequency Response Test Circuit**



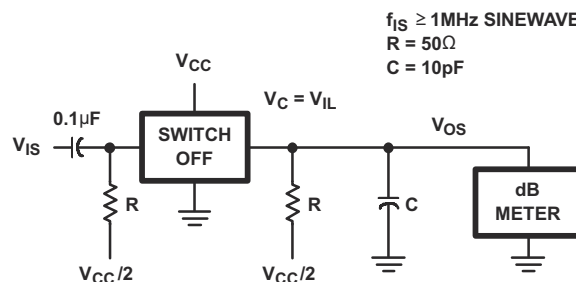
**Figure 6-4. Crosstalk Between Two Switches Test Circuit**



**Figure 6-5. 1/4 Sine-Wave Distortion Test Circuit**



**Figure 6-6. Control to Switch Feedthrough Noise Test Circuit**



**Figure 6-7. Switch OFF Signal Feedthrough**

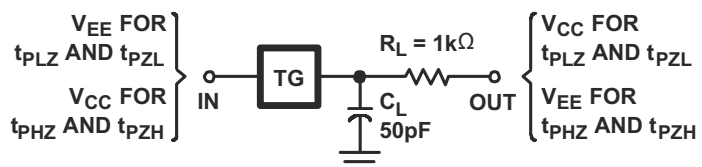


Figure 6-8. Switch ON/OFF Propagation Delay Test Circuit

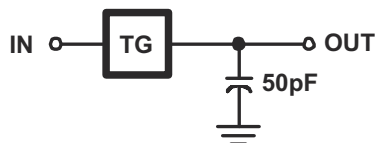


Figure 6-9. Switch In to Switch Out Propagation Delay Test Circuit

## 7 Device and Documentation Support

### 7.1 Documentation Support

#### 7.1.1 Related Documentation

For related documentation, see the following:

- Texas Instruments, [Implications of Slow or Floating CMOS Inputs](#)

### 7.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on [ti.com](#). Click on *Notifications* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

### 7.3 Support Resources

[TI E2E™ support forums](#) are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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### 7.4 Trademarks

TI E2E™ is a trademark of Texas Instruments.

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### 7.5 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

### 7.6 Glossary

#### [TI Glossary](#)

This glossary lists and explains terms, acronyms, and definitions.

## 8 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

<b>Changes from Revision B (April 2008) to Revision C (April 2024)</b>	<b>Page</b>
• Changed HCT ICC at 25°C single/dual supply.....	<a href="#">5</a>
• Changed $t_{en}$ ADDRESS SEL or $\bar{E}$ to OUT.....	<a href="#">5</a>
• Changed $t_{dis}$ ADDRESS SEL or $\bar{E}$ to OUT.....	<a href="#">5</a>

## 9 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

## PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package   Pins	Package qty   Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
<a href="#">CD74HCT4051QM96Q1</a>	Active	Production	SOIC (D)   16	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	HCT4051Q
CD74HCT4051QM96Q1.A	Active	Production	SOIC (D)   16	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	HCT4051Q
<a href="#">D24051QM96G4Q1</a>	Obsolete	Production	SOIC (D)   16	-	-	Call TI	Call TI	-40 to 125	HCT4051Q

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

<sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

### OTHER QUALIFIED VERSIONS OF CD74HCT4051-Q1 :

- Catalog : [CD74HCT4051](#)

- Military : [CD54HCT4051](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



## NOTES:

- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- $\triangle C$  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
- $\triangle D$  Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
- E. Reference JEDEC MS-012 variation AC.

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