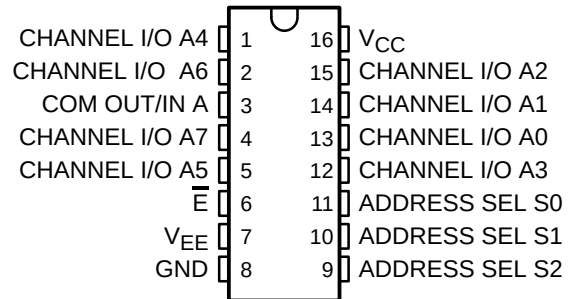


- **Controlled Baseline**
 - One Assembly/Test Site, One Fabrication Site
- **Extended Temperature Performance of –55°C to 125°C**
- **Enhanced Diminishing Manufacturing Sources (DMS) Support**
- **Enhanced Product Change Notification**
- **Qualification Pedigree[†]**
- **Wide Analog Input Voltage Range of ±5 V Max**
- **Low ON Resistance**
 - 70 Ω Typical ($V_{CC} - V_{EE} = 4.5 \text{ V}$)
 - 40 Ω Typical ($V_{CC} - V_{EE} = 9 \text{ V}$)
- **Low Crosstalk Between Switches**
- **Fast Switching and Propagation Speeds**
- **Break-Before-Make Switching**
- **Operation Control Voltage = 2 V to 6 V**
- **Switch Voltage = 0 V to 10 V**
- **High Noise Immunity $N_{IL} = 30\%$, $N_{IH} = 30\%$ of V_{CC} , $V_{CC} = 5 \text{ V}$**

[†] Component qualification in accordance with JEDEC and industry standards to ensure reliable operation over an extended temperature range. This includes, but is not limited to, Highly Accelerated Stress Test (HAST) or biased 85/85, temperature cycle, autoclave or unbiased HAST, electromigration, bond intermetallic life, and mold compound life. Such qualification testing should not be viewed as justifying use of this component beyond specified performance and environmental limits.

M PACKAGE
(TOP VIEW)



description

This device is a digitally controlled analog switch that utilizes silicon gate CMOS technology to achieve operating speeds similar to LSTTL, with the low power consumption of standard CMOS integrated circuits.

This analog multiplexer/demultiplexer controls analog voltages that may vary across the voltage supply range (i.e., V_{CC} to V_{EE}). These bidirectional switches allow any analog input to be used as an output and vice versa. The switches have low ON resistance and low OFF leakages. In addition, the device has an enable control ($\bar{E}$) that, when high, disables all switches to their OFF state.

ORDERING INFORMATION

T_A	PACKAGE [‡]		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–55°C to 125°C	SOIC – M	Tape and reel	CD74HC4051MM96EP	HC4051MEP

[‡] Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.



POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 2002, Texas Instruments Incorporated

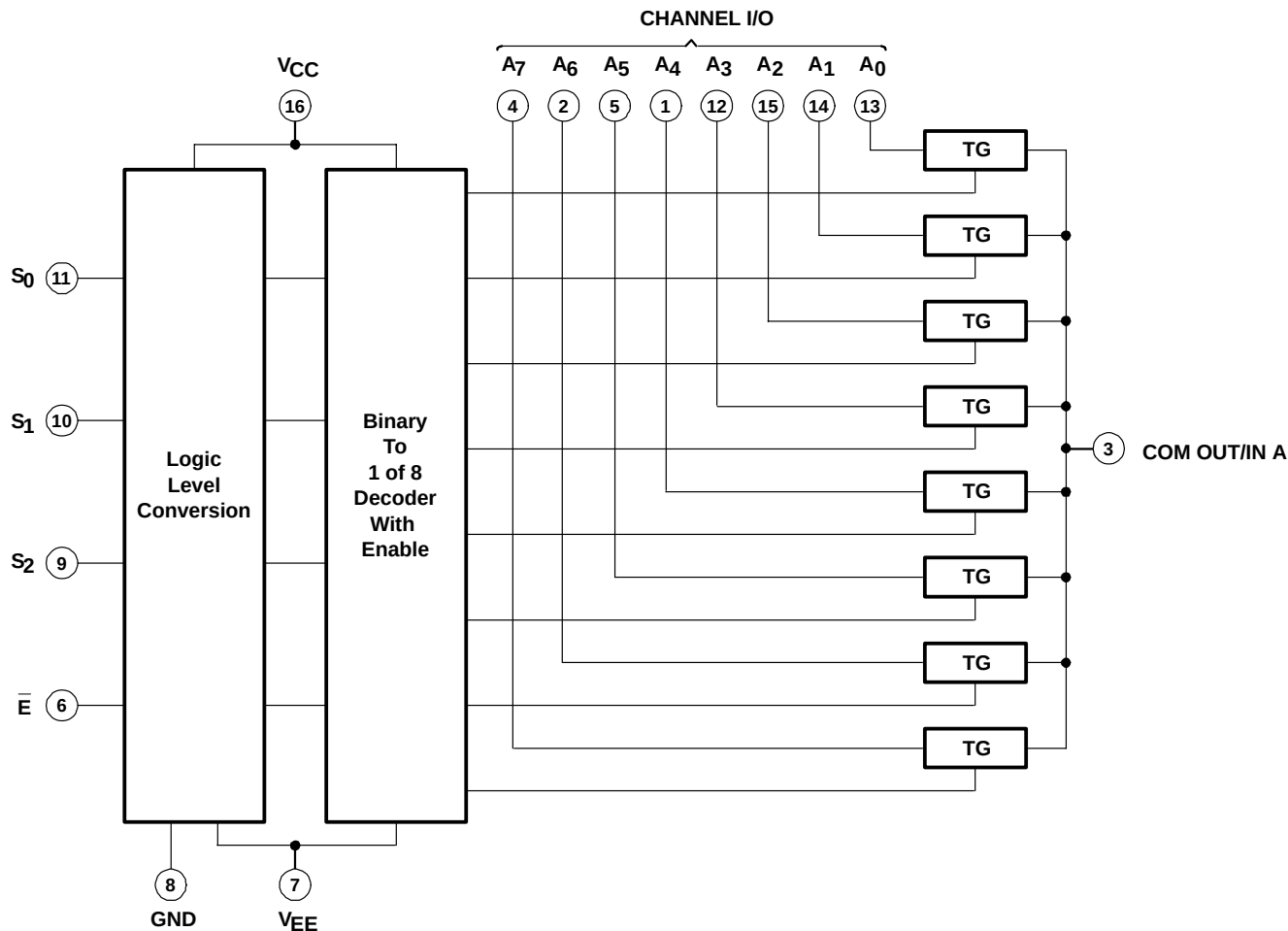
CD74HC4051-EP
ANALOG MULTIPLEXER/DEMULTIPLEXER

SCLS464 – SEPTEMBER 2002

INPUTS				ON CHANNEL(S)
$\overline{E}$	S ₂	S ₁	S ₀	
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

X = Don't care

logic diagram (positive logic)



absolute maximum ratings over operating free-air temperature range (unless otherwise noted)[†]

Supply voltage range, $V_{CC} - V_{EE}$ (see Note 1)	–0.5 V to 10.5 V
Supply voltage range, V_{CC}	–0.5 V to 7 V
Supply voltage range, V_{EE}	+0.5 V to –7 V
Input clamp current, I_{IK} ($V_I < -0.5$ V or $V_I > V_{CC} + 0.5$ V)	±20 mA
Output clamp current, I_{OK} ($V_O < V_{EE} - 0.5$ V or $V_O > V_{CC} + 0.5$ V)	±20 mA
Switch current ($V_I > V_{EE} - 0.5$ V or $V_I < V_{CC} + 0.5$ V)	±25 mA
Continuous current through V_{CC} or GND	±50 mA
V_{EE} current, I_{EE}	–20 mA
Package thermal impedance, θ_{JA} (see Note 2): M package	73°C/W
Maximum junction temperature, T_J	150°C
Lead temperature (during soldering):	
At distance $1/16 \pm 1/32$ inch (1.59 ± 0.79 mm) from case for 10 s max	300°C
Storage temperature range, T_{Stg}	–65°C to 150°C

[†] Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES: 1. All voltages referenced to GND unless otherwise specified.
2. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions (see Note 3)

		MIN	MAX	UNIT
V_{CC}	Supply voltage (see Note 4)	2	6	V
	Supply voltage, $V_{CC} - V_{EE}$ (see Figure 1)	2	10	V
V_{EE}	Supply voltage, (see Note 4 and Figure 2)	0	–6	V
V_{IH}	High-level input voltage	$V_{CC} = 2$ V	1.5	V
		$V_{CC} = 4.5$ V	3.15	
		$V_{CC} = 6$ V	4.2	
V_{IL}	Low-level input voltage	$V_{CC} = 2$ V	0.5	V
		$V_{CC} = 4.5$ V	1.35	
		$V_{CC} = 6$ V	1.8	
V_I	Input control voltage	0	V_{CC}	V
V_{IS}	Analog switch I/O voltage	V_{EE}	V_{CC}	V
t_t	Input transition (rise and fall) time	$V_{CC} = 2$ V	0	ns
		$V_{CC} = 4.5$ V	0	
		$V_{CC} = 6$ V	0	
T_A	Operating free-air temperature	–55	125	°C

- NOTES: 3. 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.
4. 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 0.6 V (calculated from r_{ON} values shown in electrical characteristics table). No V_{CC} current flows through R_L if the switch current flows into the COM OUT/IN A terminal.

CD74HC4051-EP

ANALOG MULTIPLEXER/DEMULTIPLEXER

SCLS464 – SEPTEMBER 2002

recommended operating area as a function of supply voltages

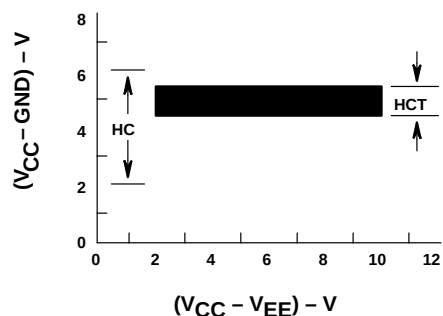


Figure 1

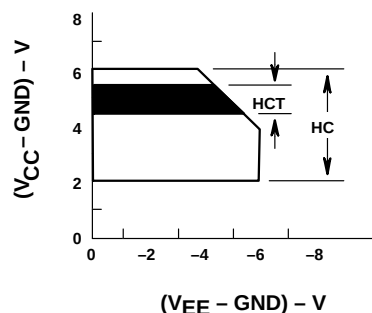


Figure 2

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

PARAMETER	TEST CONDITIONS		V _{EE}	V _{CC}	T _A = 25°C			T _A = -55°C TO 125°C		UNIT
					MIN	TYP	MAX	MIN	MAX	
r _{on}	I _O = 1 mA, V _I = V _{IH} or V _{IL} , See Figure 8	V _{IS} = V _{CC} or V _{EE}	0 V	4.5 V		70	160		240	Ω
			0 V	6 V		60	140		210	
			-4.5 V	4.5 V		40	120		180	
		V _{IS} = V _{CC} to V _{EE}	0 V	4.5 V		90	180		270	
			0 V	6 V		80	160		240	
			-4.5 V	4.5 V		45	130		195	
Δr _{on}	Between any two channels	0 V	4.5 V		10				Ω	
		0 V	6 V		8.5					
		-4.5 V	4.5 V		5					
I _{Iz}	For switch OFF: When V _{IS} = V _{CC} , V _{OS} = V _{EE} ; When V _{IS} = V _{EE} , V _{OS} = V _{CC} For switch ON: All applicable combinations of V _{IS} and V _{OS} voltage levels, V _I = V _{IH} or V _{IL}	0 V	6 V			±0.2		±2	μA	
		-5 V	5 V			±0.4		±4		
I _{IL}	V _I = V _{CC} or GND		0 V	6 V			±0.1		±1	μA
I _{CC}	I _O = 0, V _I = V _{CC} or GND	When V _{IS} = V _{EE} , V _{OS} = V _{CC}	0 V	6 V			8		160	μA
		When V _{IS} = V _{CC} , V _{OS} = V _{EE}	-5 V	5 V			16		320	

switching characteristics over recommended operating free-air temperature range (unless otherwise noted) (see Figure 7)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	V _{EE}	V _{CC}	T _A = 25°C		T _A = –55°C TO 125°C		UNIT
						MIN	MAX	MIN	MAX	
t _{pd}	IN	OUT	C _L = 15 pF		5 V		4			ns
			C _L = 50 pF	0 V	2 V		60		90	ns
					4.5 V		12		18	
					6 V		10		15	
					–4.5 V	4.5 V	8		12	
t _{en}	ADDRESS SEL or $\overline{E}$	OUT	C _L = 15 pF		5 V		19			ns
			C _L = 50 pF	0 V	2 V		225		340	
					4.5 V		45		68	
					6 V		38		57	
					–4.5 V	4.5 V	32		48	
t _{dis}	ADDRESS SEL or $\overline{E}$	OUT	C _L = 15 pF		5 V		19			ns
			C _L = 50 pF	0 V	2 V		225		340	
					4.5 V		45		68	
					6 V		38		57	
					–4.5 V	4.5 V	32		48	
C _I	Control		C _L = 50 pF				10		10	pF

operating characteristics, V_{CC} = 5 V, T_A = 25°C, Input t_r, t_f = 6 ns

PARAMETER		TYP	UNIT
C _{pd}	Power dissipation capacitance (see Note 5)	50	pF

NOTE 5: C_{pd} is used to determine the dynamic power consumption, per package.

$$P_D = C_{pd} V_{CC}^2 f_I + \Sigma (C_L + C_S) V_{CC}^2 f_O$$

f_O = output frequency

f_I = input frequency

C_L = output load capacitance

C_S = switch capacitance

V_{CC} = supply voltage

CD74HC4051-EP

ANALOG MULTIPLEXER/DEMULTIPLEXER

SCLS464 – SEPTEMBER 2002

analog channel characteristics, $T_A = 25^{\circ}\text{C}$

PARAMETER	TEST CONDITIONS	V_{EE}	V_{CC}	MIN	TYP	MAX	UNIT
C_I	Switch input capacitance				5		pF
C_{COM}	Common output capacitance				25		pF
f_{max}	Minimum switch frequency response at -3 dB	-2.25 V	2.25 V		145		MHz
		-4.5 V	4.5 V		180		
Sine-wave distortion	See Figure 4	-2.25 V	2.25 V		0.035		%
		-4.5 V	4.5 V		0.018		
$\overline{E}$ or ADDRESS SEL to switch feed-through noise	See Figure 5, and Notes 7 and 8	-2.25 V	2.25 V		(TBD)		mV
		-4.5 V	4.5 V		(TBD)		
Switch OFF signal feed through	See Figure 6 and Figure 10, and Notes 7 and 8	-2.25 V	2.25 V		-73		dB
		-4.5 V	4.5 V		-75		

NOTES: 6. Adjust input voltage to obtain 0 dBm at V_{OS} for $f_{IN} = 1\text{ MHz}$.
7. V_{IS} is centered at $(V_{CC} - V_{EE})/2$.
8. Adjust input for 0 dBm.

PARAMETER MEASUREMENT INFORMATION

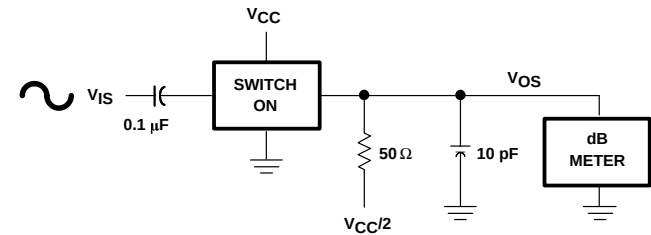


Figure 3. Frequency-Response Test Circuit

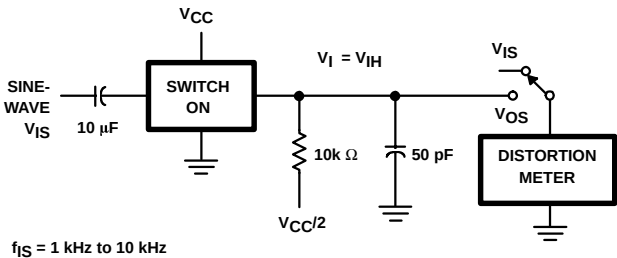


Figure 4. Sine-Wave Distortion Test Circuit

PARAMETER MEASUREMENT INFORMATION

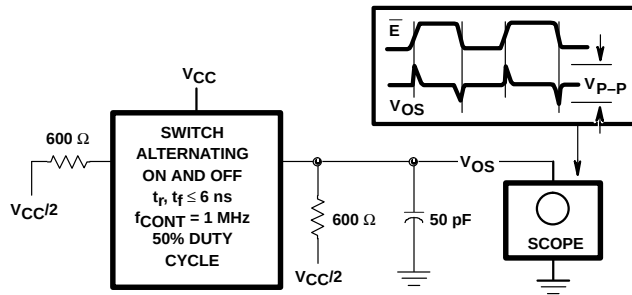


Figure 5. Control to Switch Feed-Through Noise Test Circuit

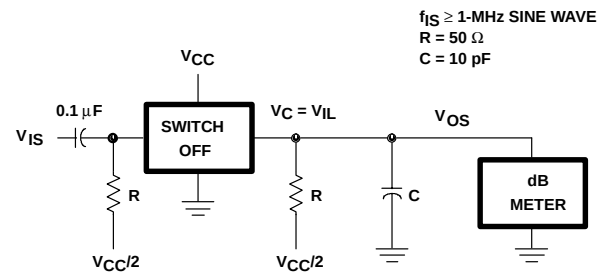
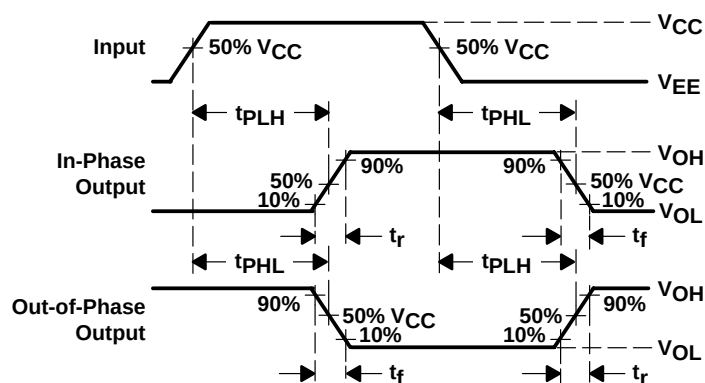


Figure 6. Switch OFF Signal Feed-Through Test Circuit

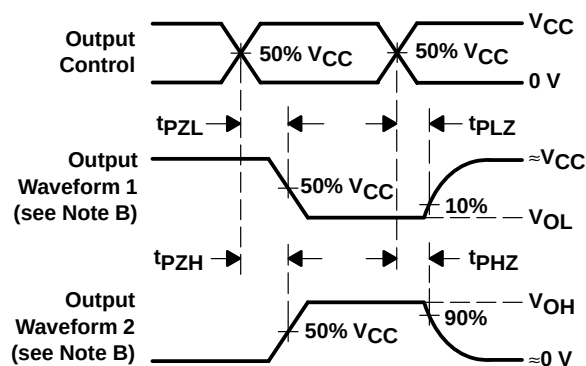
LOAD CIRCUIT

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



VOLTAGE WAVEFORMS

PROPAGATION DELAY AND OUTPUT TRANSITION TIMES



VOLTAGE WAVEFORMS

OUTPUT ENABLE AND DISABLE TIMES

- NOTES:
- 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: $PRR \leq 1$ MHz, $Z_O = 50 \Omega$, $t_r = 6$ ns, $t_f = 6$ 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_{pg} .

Figure 7. Load Circuit and Voltage Waveforms

TYPICAL CHARACTERISTICS

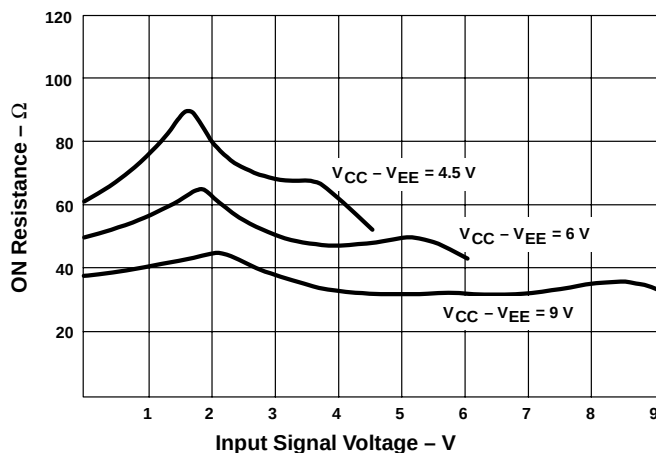


Figure 8. Typical ON Resistance vs Input Signal Voltage

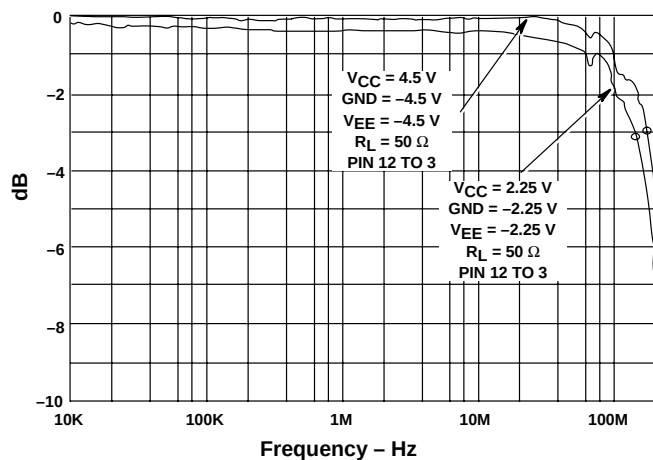


Figure 9. Channel ON Bandwidth

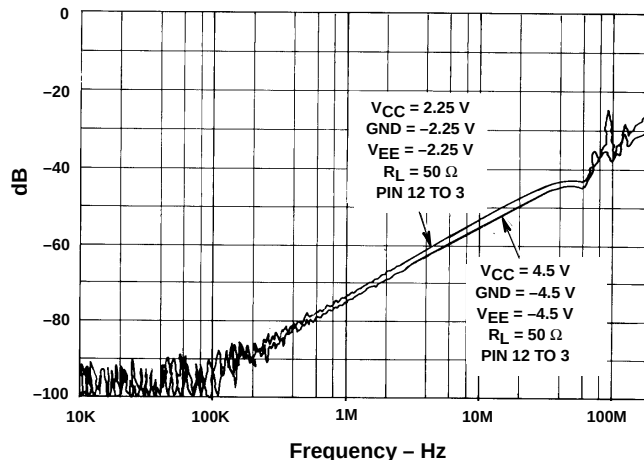


Figure 10. Channel OFF Feed Through

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
CD74HC4051MM96EP	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
V62/03606-01XE	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBsolete: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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.

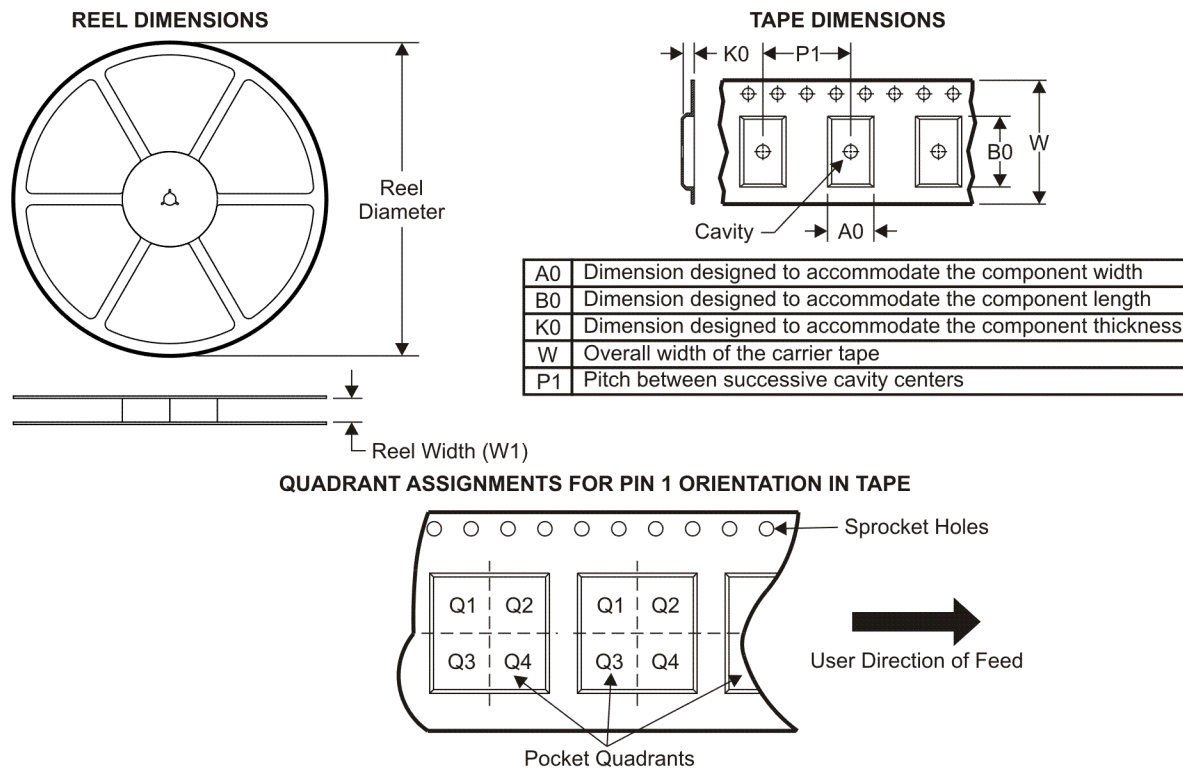
OTHER QUALIFIED VERSIONS OF CD74HC4051-EP :

- Catalog: [CD74HC4051](#)
- Automotive: [CD74HC4051-Q1](#)
- Military: [CD54HC4051](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects
- Military - QML certified for Military and Defense Applications

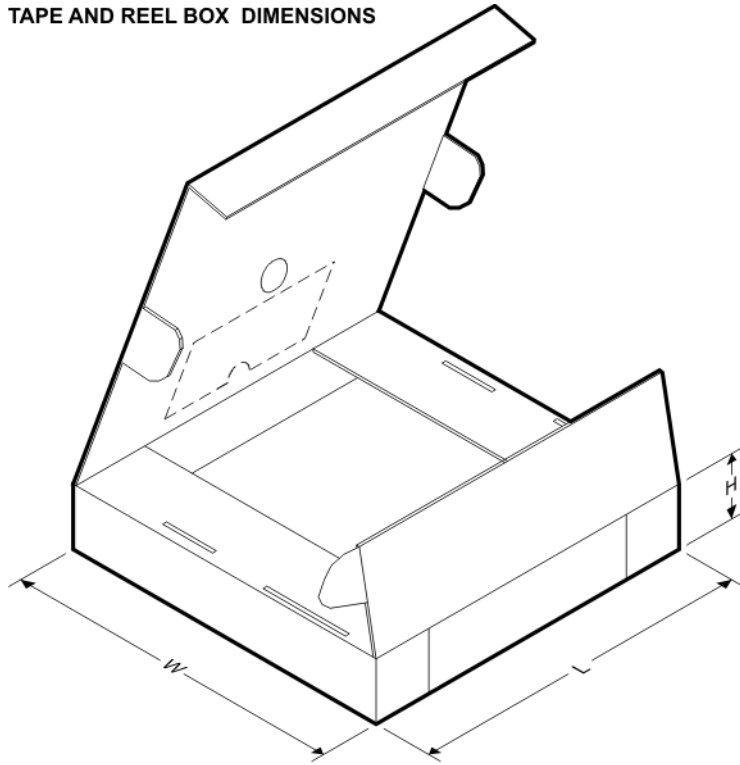
TAPE AND REEL INFORMATION



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
CD74HC4051MM96EP	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS

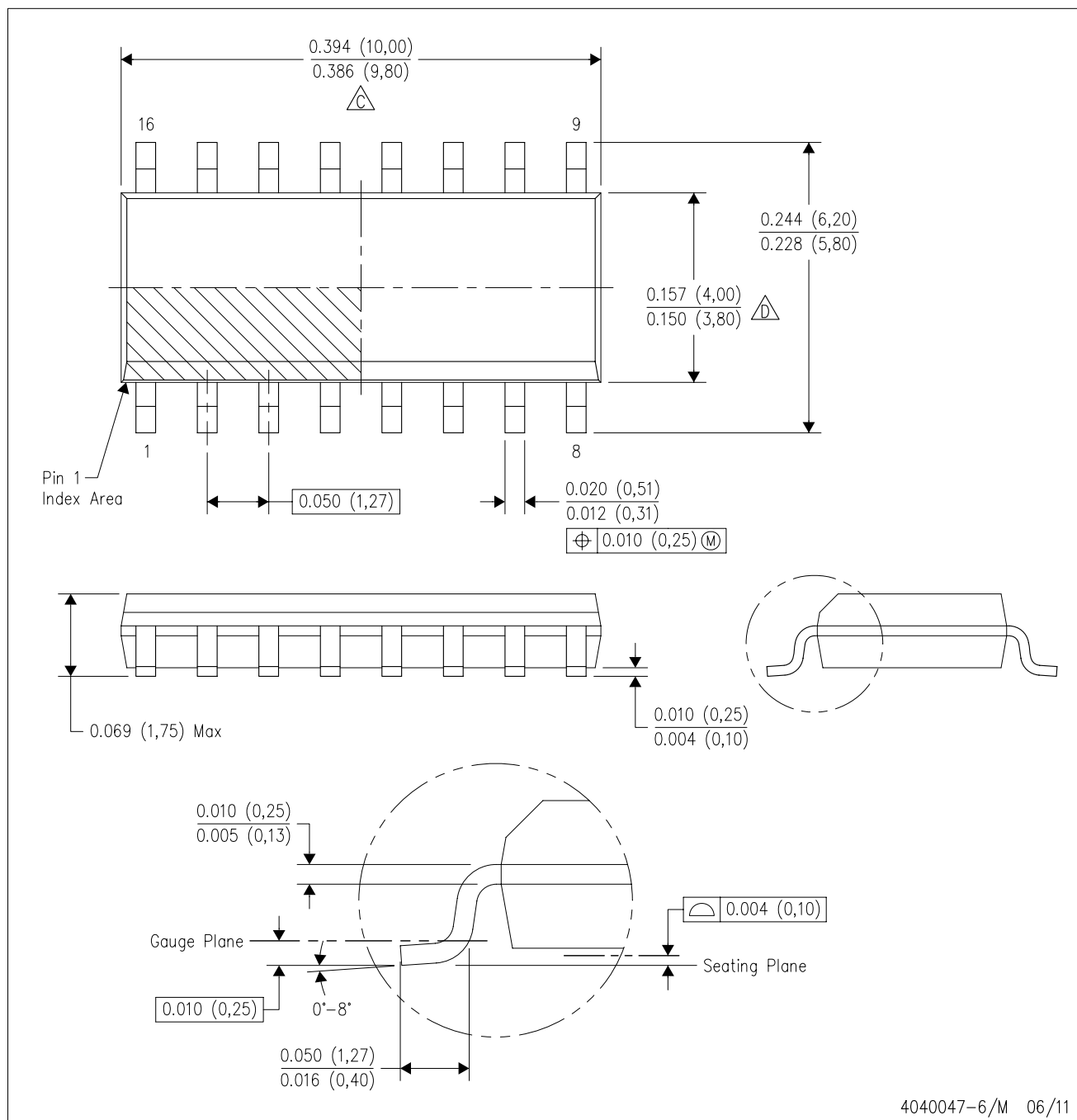


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CD74HC4051MM96EP	SOIC	D	16	2500	333.2	345.9	28.6

D (R-PDSO-G16)

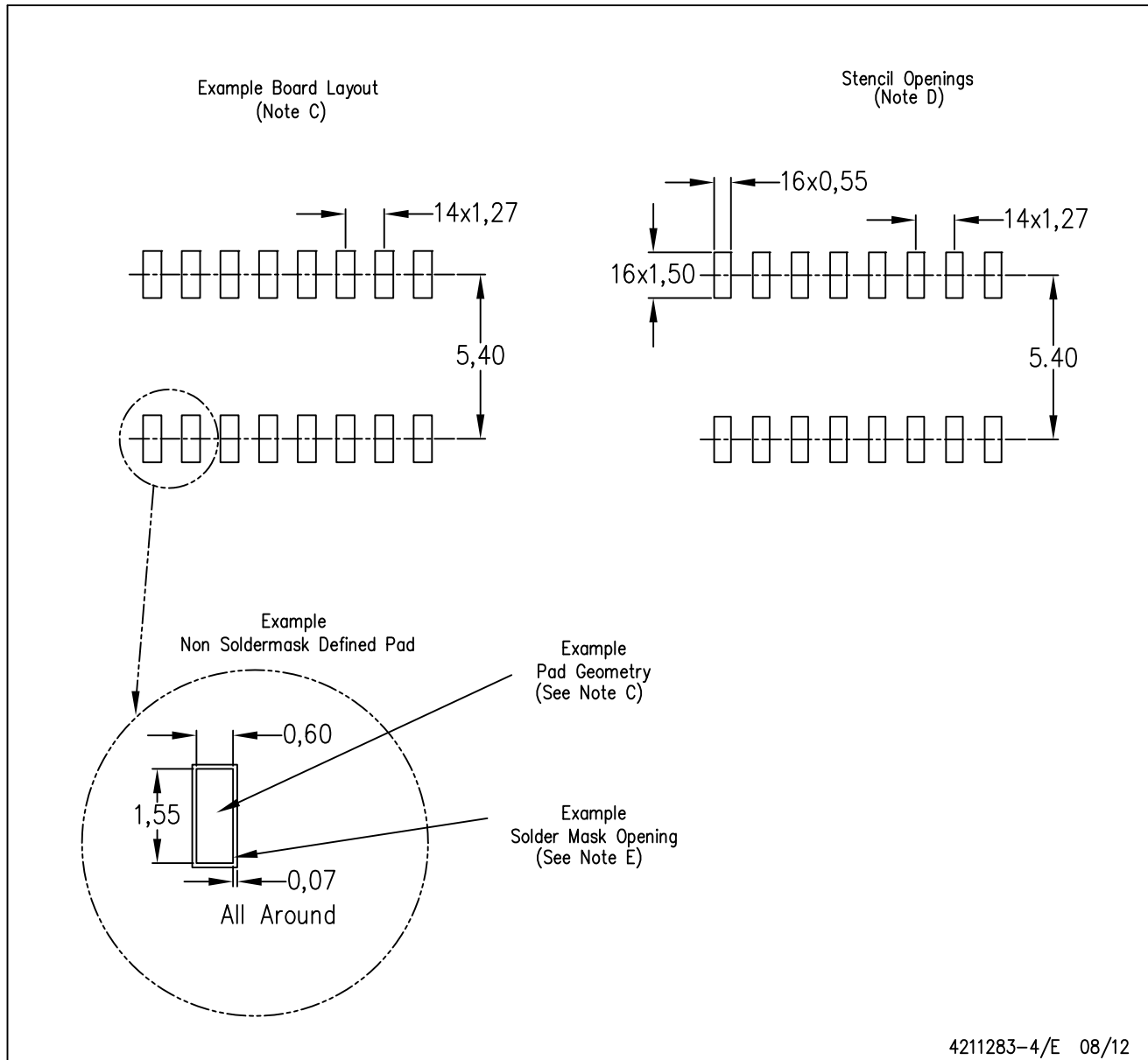
PLASTIC SMALL OUTLINE



- 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.

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Publication IPC-7351 is recommended for alternate designs.
 - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
 - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46C and to discontinue any product or service per JESD48B. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components which meet ISO/TS16949 requirements, mainly for automotive use. Components which have not been so designated are neither designed nor intended for automotive use; and TI will not be responsible for any failure of such components to meet such requirements.

Products

Audio	www.ti.com/audio
Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
OMAP Mobile Processors	www.ti.com/omap
Wireless Connectivity	www.ti.com/wirelessconnectivity

Applications

Automotive and Transportation	www.ti.com/automotive
Communications and Telecom	www.ti.com/communications
Computers and Peripherals	www.ti.com/computers
Consumer Electronics	www.ti.com/consumer-apps
Energy and Lighting	www.ti.com/energy
Industrial	www.ti.com/industrial
Medical	www.ti.com/medical
Security	www.ti.com/security
Space, Avionics and Defense	www.ti.com/space-avionics-defense
Video and Imaging	www.ti.com/video

TI E2E Community e2e.ti.com