

# CD74HC4538-Q1

## HIGH-SPEED CMOS LOGIC DUAL RETRIGGERABLE PRECISION MONOSTABLE MULTIVIBRATOR

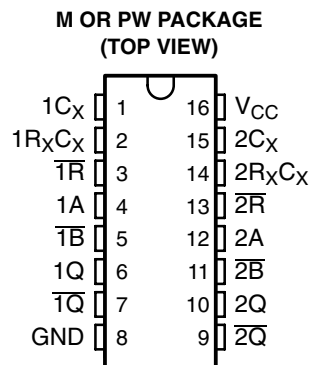
SCLS595A – NOVEMBER 2004 – REVISED APRIL 2008

- Qualified for Automotive Applications
- Retriggerable/Resettable Capability
- Trigger and Reset Propagation Delays Independent of  $R_X$ ,  $C_X$
- Triggering From the Leading or Trailing Edge
- Q and  $\bar{Q}$  Buffered Outputs Available
- Separate Resets
- Wide Range of Output Pulse Widths
- Schmitt-Trigger Input on A and  $\bar{B}$  Inputs
- Retrigger Time Is Independent of  $C_X$
- Fanout (Over Temperature Range)
  - Standard Outputs . . . 10 LSTTL Loads
  - Bus Driver Outputs . . . 15 LSTTL Loads
- Balanced Propagation Delay and Transition Times
- Significant Power Reduction Compared to LSTTL Logic ICs
- $V_{CC}$  Voltage = 2 V to 6 V
- High Noise Immunity  $N_{IL}$  or  $N_{IH}$  = 30% of  $V_{CC}$ ,  $V_{CC} = 5$  V

### description/ordering information

The CD74HC4538 is a dual retriggerable/resettable precision monostable multivibrator for fixed-voltage timing applications. An external resistor ( $R_X$ ) and external capacitor ( $C_X$ ) control the timing and accuracy for the circuit. Adjustment of  $R_X$  and  $C_X$  provides a wide range of output pulse widths from the Q and  $\bar{Q}$  terminals. The propagation delay from trigger input-to-output transition and the propagation delay from reset input-to-output transition are independent of  $R_X$  and  $C_X$ .

Leading-edge triggering (A) and trailing-edge triggering ( $\bar{B}$ ) inputs are provided for triggering from either edge of the input pulse. An unused A input should be tied to GND and an unused  $\bar{B}$  input should be tied to  $V_{CC}$ . On power up, the IC is reset. Unused resets and sections must be terminated. In normal operation, the circuit retriggers on the application of each new trigger pulse. To operate in the nontriggerable mode,  $\bar{Q}$  is connected to  $\bar{B}$  when leading-edge triggering (A) is used, or Q is connected to A when trailing-edge triggering ( $\bar{B}$ ) is used. The period ( $\tau$ ) can be calculated from  $\tau = (0.7) R_X C_X$ ;  $R_{MIN}$  is 5 k $\Omega$ .  $C_{MIN}$  is 0 pF.



### ORDERING INFORMATION†

T <sub>A</sub>	PACKAGE‡		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 125°C	SOIC – M	Tape and reel	CD74HC4538QM96Q1	HC4538M
	TSSOP – PW	Tape and reel	CD74HC4538QPWRQ1	HC4538M

† For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at <http://www.ti.com>.

‡ Package drawings, thermal data, and symbolization are available at <http://www.ti.com/packaging>.



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.

**TEXAS  
INSTRUMENTS**

POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 2008, Texas Instruments Incorporated

# CD74HC4538-Q1 HIGH-SPEED CMOS LOGIC DUAL RETRIGGERABLE PRECISION MONOSTABLE MULTIVIBRATOR

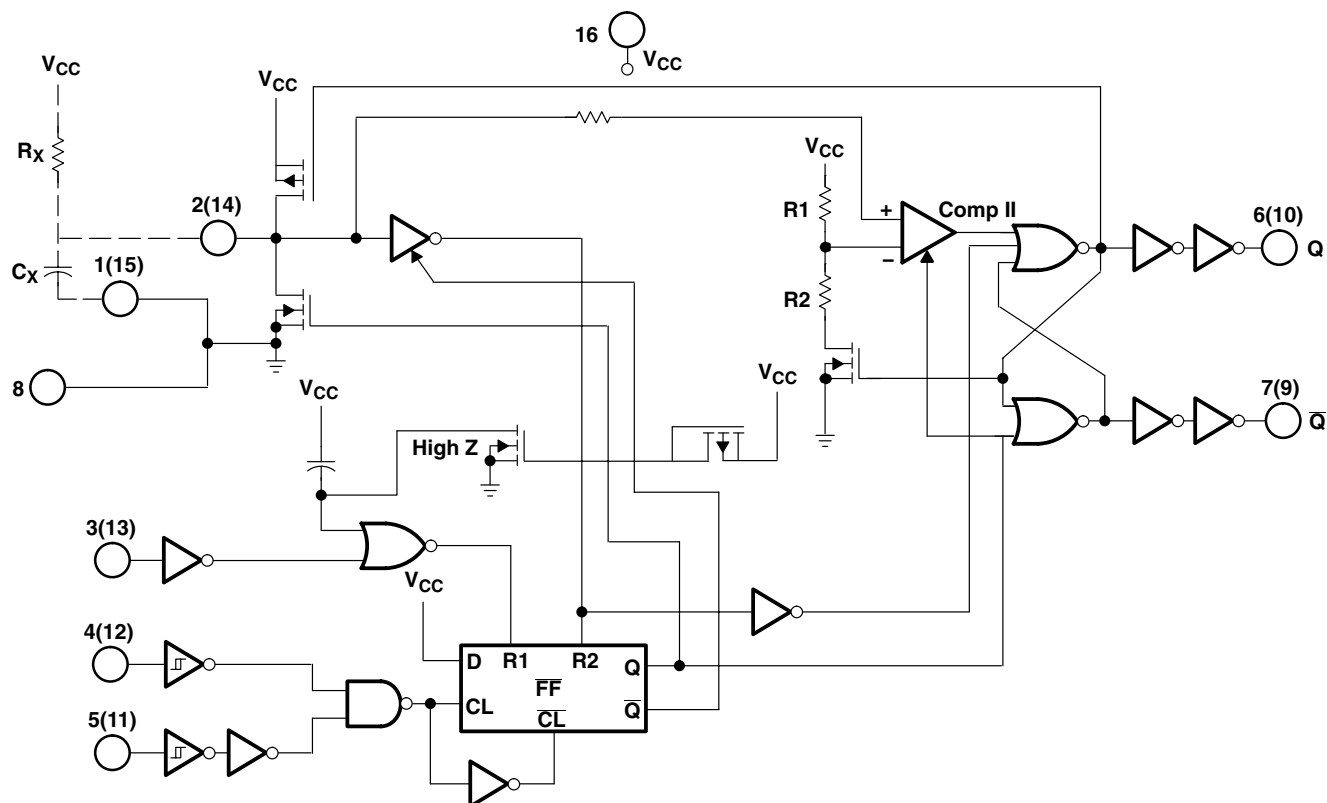
SCLS595A – NOVEMBER 2004 – REVISED APRIL 2008

FUNCTION TABLE

INPUTS			OUTPUTS	
R	A	B	Q	Q̄
L	X	X	L	H
X	H	X	L	H
X	X	L	L	H
H	L	↓	⌋	⌋
H	↑	H	⌋	⌋

NOTE: H = High voltage level  
 L = Low voltage level  
 ↑ = Transition from low to high level  
 ↓ = Transition from high to low level  
 ⌋ = one high-level pulse  
 ⌋ = one low-level pulse  
 X = Irrelevant

## logic diagram (positive logic)



# CD74HC4538-Q1

## HIGH-SPEED CMOS LOGIC DUAL RETRIGGERABLE PRECISION MONOSTABLE MULTIVIBRATOR

SCLS595A – NOVEMBER 2004 – REVISED APRIL 2008

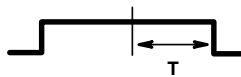
### FUNCTIONAL TERMINAL CONNECTIONS

FUNCTION	V <sub>CC</sub> TO TERMINAL NUMBER		GND TO TERMINAL NUMBER		INPUT PULSE TO TERMINAL NUMBER		OTHER CONNECTIONS	
	MONO <sub>1</sub>	MONO <sub>2</sub>	MONO <sub>1</sub>	MONO <sub>2</sub>	MONO <sub>1</sub>	MONO <sub>2</sub>	MONO <sub>1</sub>	MONO <sub>2</sub>
Leading-edge trigger/retriggerable	3, 5	11, 13			4	12		
Leading-edge trigger/nonretriggerable	3	13			4	12	5–7	11–9
Trailing-edge trigger/retriggerable	3	13	4	12	5	11		
Trailing-edge trigger/nonretriggerable	3	13			5	11	4–6	12–10

- NOTES: 1. A retriggerable one-shot multivibrator has an output pulse width that is extended one full time period (T) after application of the last trigger pulse.  
 2. A nonretriggerable one-shot multivibrator has a time period (T) referenced from the application of the first trigger pulse.



Input Pulse Train



Retriggerable Mode  
Pulse Width (A Mode)



Nonretriggerable Mode  
Pulse Width (A Mode)

### absolute maximum ratings over operating free-air temperature range (unless otherwise noted)<sup>†</sup>

Supply voltage range, V <sub>CC</sub> (see Note 1)	–0.5 V to 7 V
Input clamp current, I <sub>IK</sub> (V <sub>I</sub> < –0.5 V or V <sub>I</sub> > V <sub>CC</sub> + 0.5 V)	±20 mA
Output clamp current, I <sub>OK</sub> (V <sub>O</sub> < –0.5 V or V <sub>O</sub> > V <sub>CC</sub> + 0.5 V)	±20 mA
Switch current per output pin, I <sub>O</sub> (V <sub>O</sub> > –0.5 V or V <sub>O</sub> < V <sub>CC</sub> + 0.5 V)	±25 mA
Continuous current through V <sub>CC</sub> or GND	±50 mA
Package thermal impedance, θ <sub>JA</sub> (see Note 2): M package	73°C/W
PW package	108°C/W
Maximum junction temperature, T <sub>J</sub>	150°C
Lead temperature (during soldering):	
At distance 1/16 ± 1/32 inch (1,59 ± 0,79 mm) from case for 10 s max	300°C
Storage temperature range, T <sub>stg</sub>	–65°C to 150°C

<sup>†</sup> 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 are referenced to GND, unless otherwise specified.  
 2. The package thermal impedance is calculated in accordance with JESD 51-7.

# CD74HC4538-Q1

## HIGH-SPEED CMOS LOGIC DUAL RETRIGGERABLE PRECISION MONOSTABLE MULTIVIBRATOR

SCLS595A – NOVEMBER 2004 – REVISED APRIL 2008

### recommended operating conditions (see Note 3)

		MIN	MAX	UNIT	
$V_{CC}$	Supply voltage	2	6	V	
$V_{IH}$	High-level input voltage	$V_{CC} = 2\text{ V}$	1.5	V	
		$V_{CC} = 4.5\text{ V}$	3.15		
		$V_{CC} = 6\text{ V}$	4.2		
$V_{IL}$	Low-level input voltage	$V_{CC} = 2\text{ V}$	0.5	V	
		$V_{CC} = 4.5\text{ V}$	1.35		
		$V_{CC} = 6\text{ V}$	1.8		
$V_I$	Input voltage	0	$V_{CC}$	V	
$V_O$	Output voltage	0	$V_{CC}$	V	
$t_t$	Reset input	$V_{CC} = 2\text{ V}$	0	1000	ns
		$V_{CC} = 4.5\text{ V}$	0	500	
		$V_{CC} = 6\text{ V}$	0	400	
	Trigger inputs A or $\bar{B}$	$V_{CC} = 2\text{ V}$	0	Unlimited	
		$V_{CC} = 4.5\text{ V}$	0	Unlimited	
		$V_{CC} = 6\text{ V}$	0	Unlimited	
$R_X$	External timing resistor (see Note 4)	5		k $\Omega$	
$C_X$	External timing capacitor (see Note 4)	0		F	
$T_A$	Operating free-air temperature	-40	125	$^{\circ}\text{C}$	

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. The maximum allowable values of  $R_X$  and  $C_X$  are a function of leakage of capacitor  $C_X$ , leakage of the CD74HC4538, and leakage due to board layout and surface resistance. Values of  $R_X$  and  $C_X$  should be chosen so that the maximum current into pin 2 or pin 14 is 30 mA. Susceptibility to externally induced noise signals may occur for  $R_X > 1\text{ M}\Omega$ .



**CD74HC4538-Q1**  
**HIGH-SPEED CMOS LOGIC DUAL RETRIGGERABLE**  
**PRECISION MONOSTABLE MULTIVIBRATOR**

SCLS595A – NOVEMBER 2004 – REVISED APRIL 2008

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

PARAMETER	TEST CONDITIONS		$I_O$ (mA)	$V_{CC}$	$T_A = 25^\circ\text{C}$		$T_A = -40^\circ\text{C}$ TO $85^\circ\text{C}$		$T_A = -40^\circ\text{C}$ TO $125^\circ\text{C}$		UNIT
					MIN	MAX	MIN	MAX	MIN	MAX	
$V_{OH}$	$V_I = V_{IH}$ or $V_{IL}$	CMOS loads	-0.02	2 V	1.9		1.9		1.9	V	
				4.5 V	4.4		4.4		4.4		
				6 V	5.9		5.9		5.9		
		TTL loads		-4	4.5 V	3.98		3.84			3.7
				-5.2	6 V	5.48		5.34			5.2
$V_{OL}$	$V_I = V_{IH}$ or $V_{IL}$	CMOS loads	0.02	2 V		0.1		0.1	V		
				4.5 V		0.1		0.1			
				6 V		0.1		0.1			
		TTL loads		4	4.5 V	0.26		0.33			0.4
				5.2	6 V	0.26		0.33			0.4
$I_I$	$V_I = V_{CC}$ or GND	A, $\bar{B}$ , R		6 V		$\pm 0.1$		$\pm 1$	$\mu\text{A}$		
		$R_X C_X$ (see Note 5)		6 V		$\pm 0.05$		$\pm 0.5$			
$I_{CC}$	$V_I = V_{CC}$ or GND	Quiescent	0	6 V		8		80	$\mu\text{A}$		
		Active, Q = high, Pins 2 and 14 at $V_{CC}/4$	0	6 V		0.6		0.8	1	mA	
$C_{IN}$	$C_L = 50$ pF					10		10	10	pF	

NOTE 5: When testing  $I_{IL}$ , the Q output must be high. If Q is low (device not triggered), the pullup P device is ON and the low-resistance path from  $V_{DD}$  to the test pin causes a current far exceeding the specification.

**timing requirements over recommended operating free-air temperature range (unless otherwise noted) (see Figure 1)**

PARAMETER		$V_{CC}$	$T_A = 25^\circ\text{C}$			$T_A = -40^\circ\text{C}$ TO $85^\circ\text{C}$		$T_A = -40^\circ\text{C}$ TO $125^\circ\text{C}$		UNIT
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
$t_w$	Input pulse width	2 V		80		100		120	ns	
		4.5 V		16		20		24		
		6 V		14		17		20		
$t_{su}$	Reset setup time	2 V		5		5		5	ns	
		4.5 V		5		5		5		
		6 V		5		5		5		
$t_{rr}$	Retrigger time (see Figure 4)	5 V		175					ns	
	Output pulse-width match, same package			$\pm 1$					%	



# CD74HC4538-Q1

## HIGH-SPEED CMOS LOGIC DUAL RETRIGGERABLE PRECISION MONOSTABLE MULTIVIBRATOR

SCLS595A – NOVEMBER 2004 – REVISED APRIL 2008

switching characteristics over recommended operating free-air temperature range (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	V <sub>CC</sub>	T <sub>A</sub> = 25°C			T <sub>A</sub> = -40°C TO 85°C		T <sub>A</sub> = -40°C TO 125°C		UNIT
					MIN	TYP	MAX	MIN	MAX	MIN	MAX	
t <sub>pd</sub>	A, $\bar{B}$	Q or $\bar{Q}$	C <sub>L</sub> = 50 pF	2 V		250		315		375	ns	
				4.5 V		50		63		75		
				6 V		43		54		64		
	R	Q or $\bar{Q}$	C <sub>L</sub> = 15 pF	5 V		21						
				2 V		250		315		375		
				4.5 V		50		63		75		
C <sub>L</sub> = 50 pF	C <sub>L</sub> = 15 pF	5 V		21								
		2 V		75		95		110	ns			
		4.5 V		15		19		22				
6 V		13		16		19						
τ <sup>†</sup>			C <sub>L</sub> = 50 pF	3 V	0.64	0.78	0.612	0.812	0.605	0.819	ms	
				5 V	0.63	0.77	0.602	0.798	0.595	0.805		

† Output pulse width with R<sub>X</sub> = 10 kΩ and C<sub>X</sub> = 0.1 μF

operating characteristics, V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C, input t<sub>r</sub>, t<sub>f</sub> = 6 ns, C<sub>L</sub> = 15 pF

PARAMETER	TYP	UNIT
C <sub>pd</sub> Power dissipation capacitance (see Note 6)	136	pF

NOTE 6: C<sub>pd</sub> is used to determine the dynamic power consumption, per one shot.

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

f<sub>I</sub> = input frequency

f<sub>O</sub> = output frequency

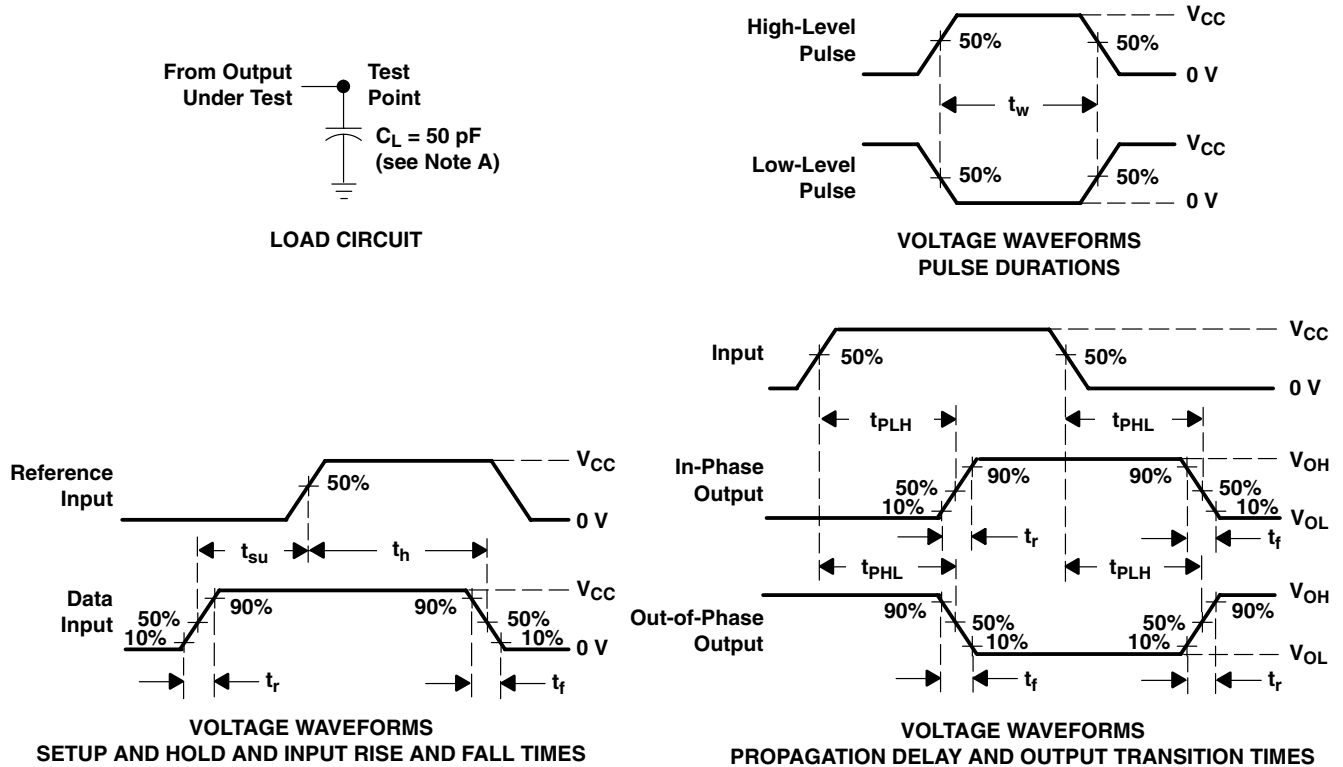
C<sub>L</sub> = output load capacitance

C<sub>X</sub> = external capacitance

V<sub>CC</sub> = supply voltage, assuming f<sub>I</sub> ≪ 1/τ



**PARAMETER MEASUREMENT INFORMATION**



- NOTES:
- A.  $C_L$  includes probe and test-fixture capacitance.
  - B. 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.
  - C. For clock inputs,  $f_{max}$  is measured when the input duty cycle is 50%.
  - D. The outputs are measured one at a time, with one input transition per measurement.
  - E.  $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .

**Figure 1. Load Circuit and Voltage Waveforms**

**CD74HC4538-Q1**  
**HIGH-SPEED CMOS LOGIC DUAL RETRIGGERABLE**  
**PRECISION MONOSTABLE MULTIVIBRATOR**

SCLS595A – NOVEMBER 2004 – REVISED APRIL 2008

**TYPICAL CHARACTERISTICS**

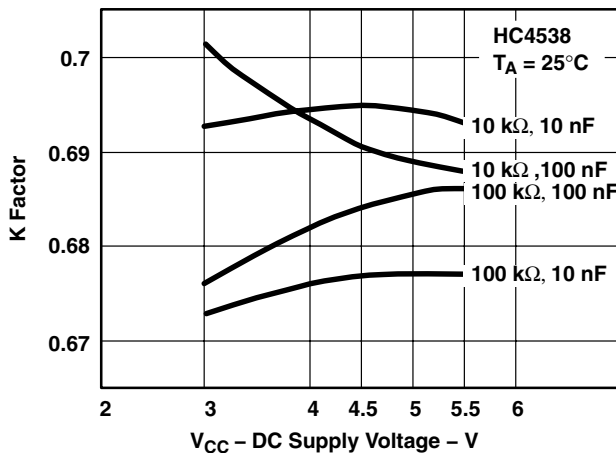


Figure 2. K Factor vs DC Supply Voltage

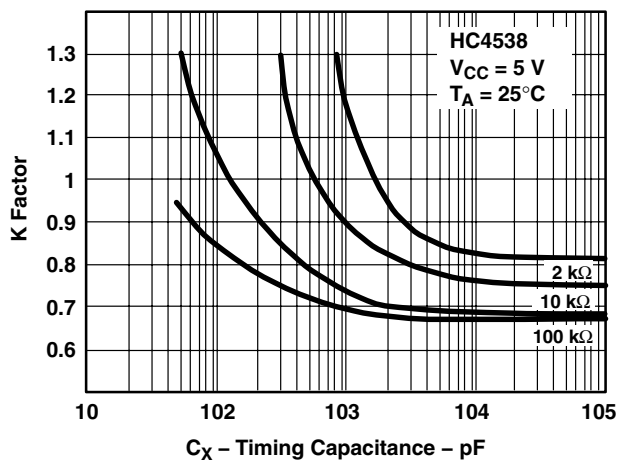


Figure 3. K Factor vs  $C_X$

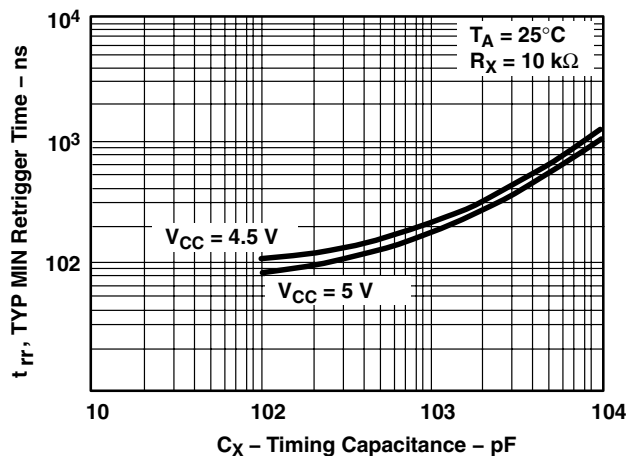


Figure 4. Minimum Retrigger Time vs Timing Capacitance

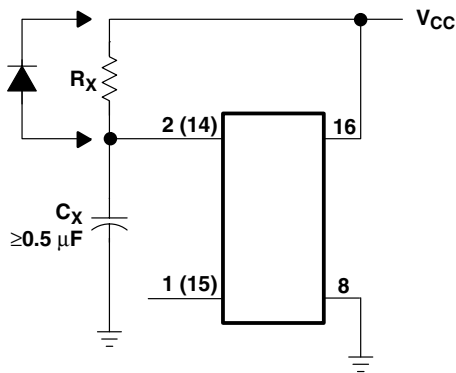


### TYPICAL APPLICATION DATA

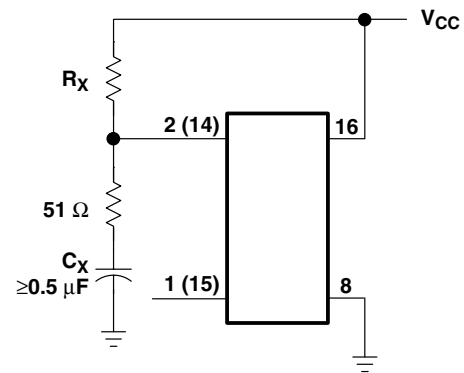
#### power-down mode

During a rapid power-down condition (as would occur with a power-supply short circuit with a poorly filtered power supply), the energy stored in  $C_X$  could discharge into pin 2 or pin 14. To avoid possible device damage in this mode when  $C_X$  is  $\geq 0.5 \mu\text{F}$ , a protection diode with a 1-A rating or higher (1N5395 or equivalent) and a separate ground return for  $C_X$  should be provided (see Figure 5).

An alternate protection method is shown in Figure 6, where a  $51\text{-}\Omega$  current-limiting resistor is inserted in series with  $C_X$ . Note that a small pulse-duration decrease occurs, however, and  $R_X$  must be increased appropriately to obtain the originally desired pulse duration.



**Figure 5. Rapid-Power-Down Protection Circuit**



**Figure 6. Alternative Rapid-Power-Down Protection Circuit**

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Samples (Requires Login)
CD74HC4538QM96G4Q1	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
CD74HC4538QM96Q1	OBSOLETE	SOIC	D	16		TBD	Call TI	Call TI	
CD74HC4538QPWRG4Q1	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
CD74HC4538QPWRQ1	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	

(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 CD74HC4538-Q1 :**

- Catalog: [CD74HC4538](#)
- Military: [CD54HC4538](#)

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.
  - 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.
  - 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

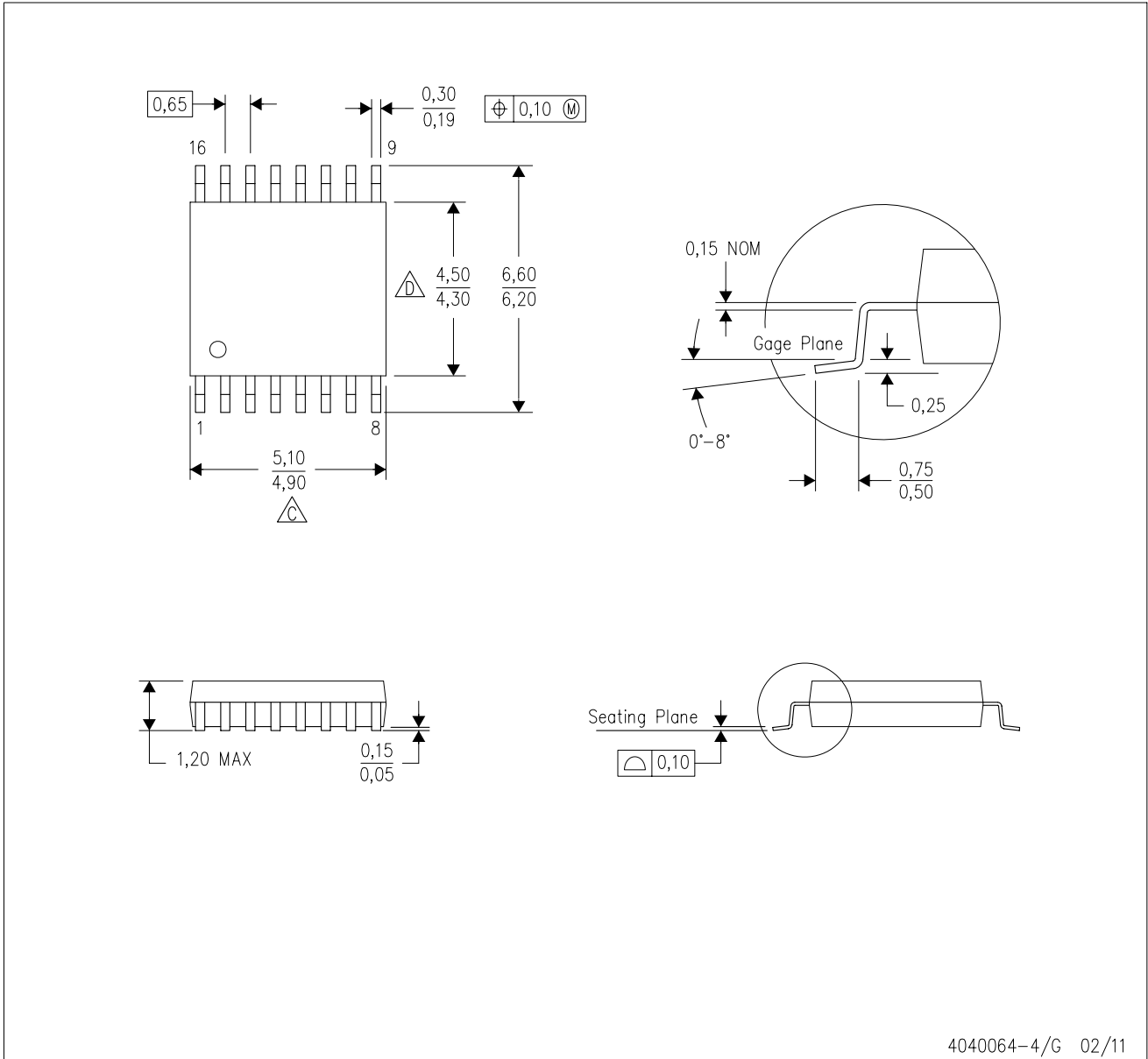


- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-7351 is recommended for alternate designs.
  - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact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



# MECHANICAL DATA

PW (R-PDSO-G16)

PLASTIC SMALL OUTLINE



4040064-4/G 02/11

- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  -  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
  -  Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
  - E. Falls within JEDEC MO-153

PW (R-PDSO-G16)

PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-7351 is recommended for alternate designs.
  - 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.
  - 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 JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. 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 as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

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

### Applications

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

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)