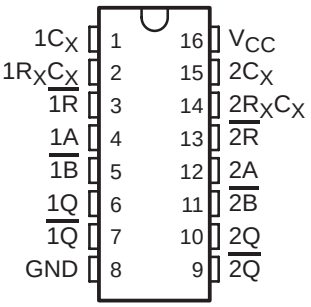
CD74HC4538-Q1
HIGH-SPEED CMOS LOGIC DUAL RETRIGGERABLE PRECISION MONOSTABLE MULTIVIBRATOR

SCLS595 − NOVEMBER 2004

- **Qualification in Accordance With AEC-Q100†**
- **Qualified for Automotive Applications**
- **Customer-Specific Configuration Control Can Be Supported Along With Major-Change Approval**
- **Retriggerable/Resettable Capability**
- **Trigger and Reset Propagation Delays Independent of R_X, C_X**
- **Triggering From the Leading or Trailing Edge**
- **Q and $\overline{Q}$ Buffered Outputs Available**
- **Separate Resets**
- **Wide Range of Output Pulse Widths**
- **Schmitt-Trigger Input on A and $\overline{B}$ 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**

† Contact factory for details. Q100 qualification data available on request.

M OR PW PACKAGE
(TOP VIEW)



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 $\overline{Q}$ 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 ($\overline{B}$) inputs are provided for triggering from either edge of the input pulse. An unused A input should be tied to GND and an unused $\overline{B}$ 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, $\overline{Q}$ is connected to $\overline{B}$ when leading-edge triggering (A) is used, or Q is connected to A when trailing-edge triggering ($\overline{B}$) is used. The period (τ) can be calculated from $\tau = (0.7)\ R_X, C_X$; R_{MIN} is 5 kΩ. C_{MIN} is 0 pF.

ORDERING INFORMATION

T_A	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

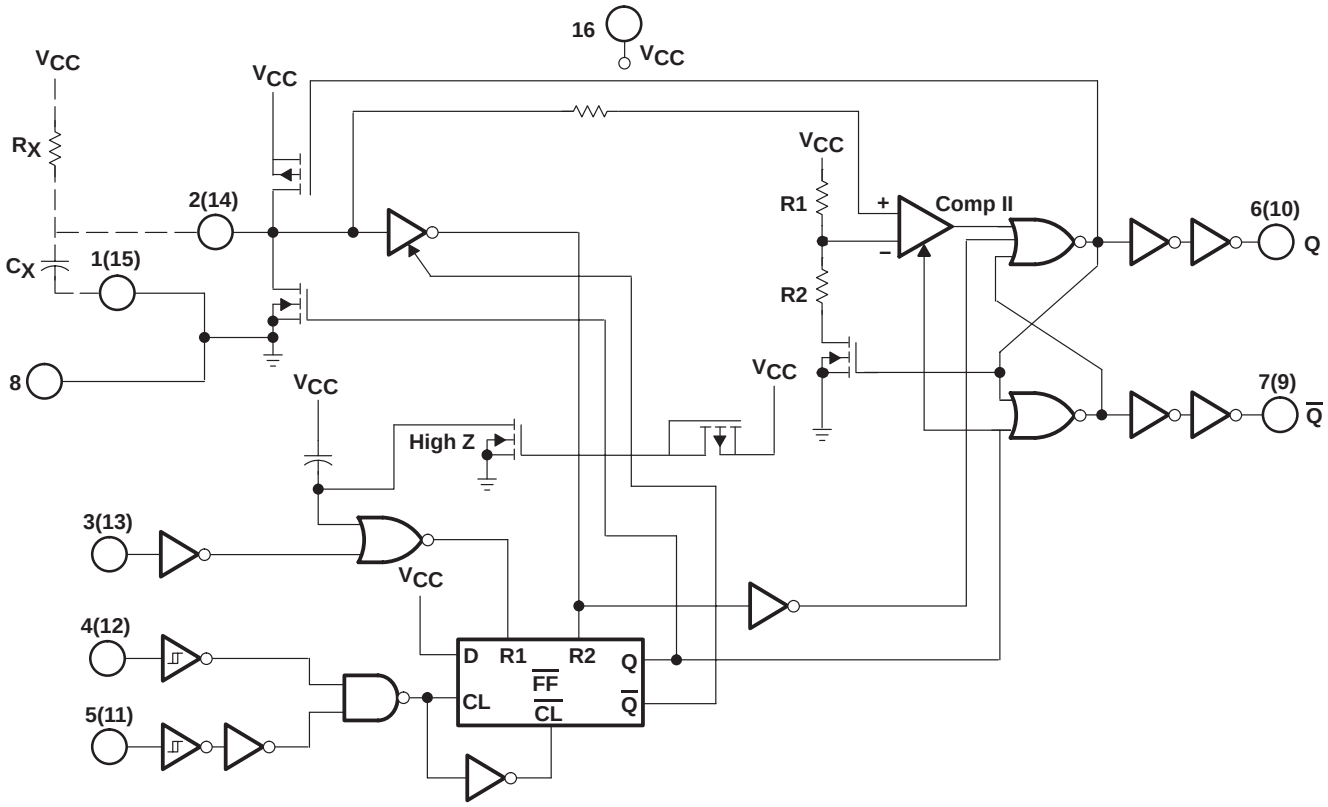
‡ Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

FUNCTION TABLE

INPUTS			OUTPUTS	
$\overline{R}$	A	$\overline{B}$	Q	$\overline{Q}$
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)

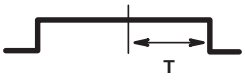


FUNCTIONAL TERMINAL CONNECTIONS

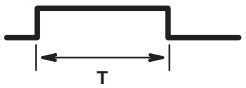
FUNCTION	V_{CC} TO TERMINAL NUMBER		GND TO TERMINAL NUMBER		INPUT PULSE TO TERMINAL NUMBER		OTHER CONNECTIONS	
	$MONO_1$	$MONO_2$	$MONO_1$	$MONO_2$	$MONO_1$	$MONO_2$	$MONO_1$	$MONO_2$
Leading-edge trigger/retriggerable	3, 5	11, 13			4	12		
Leading-edge trigger/nonretriggerable	3	13			4	12	5−7	11−9
Trailing-edge 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 nontriggerable 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)†

Supply voltage range, V_{CC} (see Note 1) . . . . . −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} ($V_O < -0.5$ V or $V_O > V_{CC} + 0.5$ V) . . . . . ±20 mA
Switch current per output pin, I_O ($V_O > -0.5$ V or $V_O < V_{CC} + 0.5$ V) . . . . . ±25 mA
Continuous current through V_{CC} or GND . . . . . ±50 mA
Package thermal impedance, θ_{JA} (see Note 2): M package . . . . . 73°C/W
PW package . . . . . 108°C/W
Maximum junction temperature, T_J . . . . . 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_{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 are 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			2	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 voltage			0	V_{CC}	V
V_O	Output voltage			0	V_{CC}	V
t_t	Input transition (rise and fall) time	Reset input	V_{CC} = 2 V	0	1000	ns
			V_{CC} = 4.5 V	0	500	
			V_{CC} = 6 V	0	400	
		Trigger inputs A or $\overline{B}$	V_{CC} = 2 V	0	Unlimited	
			V_{CC} = 4.5 V	0	Unlimited	
			V_{CC} = 6 V	0	Unlimited	
R_X	External timing resistor (see Note 4)			5		kΩ
C_X	External timing capacitor (see Note 4)			0		F
T_A	Operating free-air temperature			−40	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. 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 MΩ.

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

PARAMETER	TEST CONDITIONS		I_O (mA)	V_{CC}	T_A = 25°C		T_A = −40°C TO 85°C		T_A = −40°C TO 125°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		0.1	V
				4.5 V		0.1		0.1		0.1	
				6 V		0.1		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, $\overline{B}$, R		6 V		±0.1		±1		±1	µA
		R_XC_X (see Note 5)		6 V		±0.05		±0.5		±0.5	
I_{CC}	V_I = V_{CC} or GND	Quiescent	0	6 V		8		80		160	µA
		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°C			T_A = −40°C TO 85°C		T_A = −40°C TO 125°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			±1						%

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	V_{CC}	T_A = 25°C			T_A = −40°C TO 85°C		T_A = −40°C TO 125°C		UNIT
					MIN	TYP	MAX	MIN	MAX	MIN	MAX	
t_{pd}	A, $\overline{B}$	Q or $\overline{Q}$	C_L = 50 pF	2 V			250		315		375	ns
				4.5 V			50		63		75	
				6 V			43		54		64	
			C_L = 15 pF	5 V		21						
	$\overline{R}$	Q or $\overline{Q}$	C_L = 50 pF	2 V			250		315		375	
				4.5 V			50		63		75	
				6 V			43		54		64	
			C_L = 15 pF	5 V		21						
t_t			C_L = 50 pF	2 V			75		95		110	ns
				4.5 V			15		19		22	
				6 V			13		16		19	
τ†			C_L = 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	

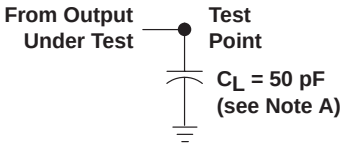
† Output pulse width with R_X = 10 kΩ and C_X = 0.1 μF

operating characteristics, V_{CC} = 5 V, T_A = 25°C, input t_r, t_f = 6 ns, C_L = 15 pF

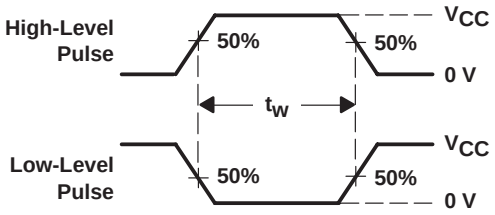
PARAMETER		TYP	UNIT
C_{pd}	Power dissipation capacitance (see Note 6)	136	pF

NOTE 6: C_{pd} 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_I = input frequency
f_O = output frequency
C_L = output load capacitance
C_X = external capacitance
V_{CC} = supply voltage, assuming $f_I \ll l/\tau$

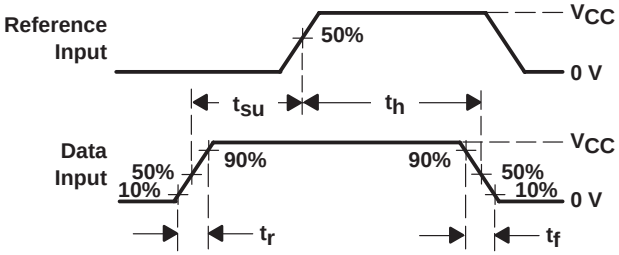
PARAMETER MEASUREMENT INFORMATION



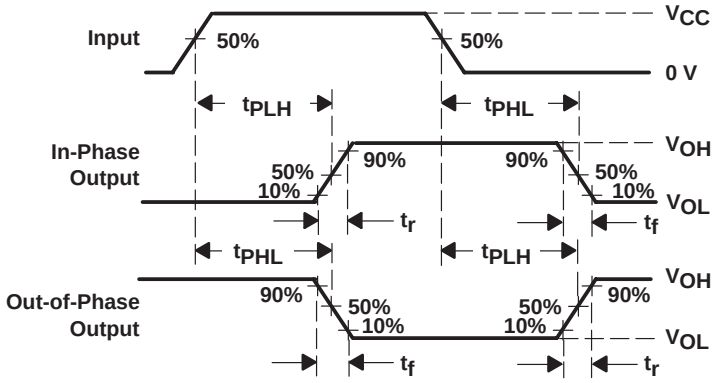
LOAD CIRCUIT



VOLTAGE WAVEFORMS
PULSE DURATIONS



VOLTAGE WAVEFORMS
SETUP AND HOLD AND INPUT RISE AND FALL TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY AND OUTPUT TRANSITION TIMES

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 ≤ 1 MHz, Z_O = 50 Ω, 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

TYPICAL CHARACTERISTICS

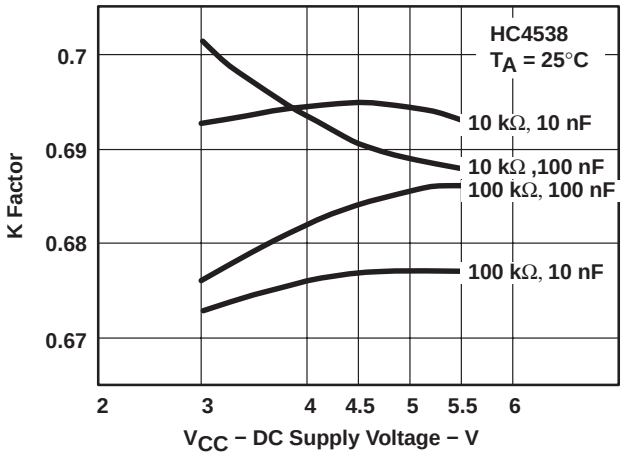


Figure 2. K Factor vs DC Supply Voltage

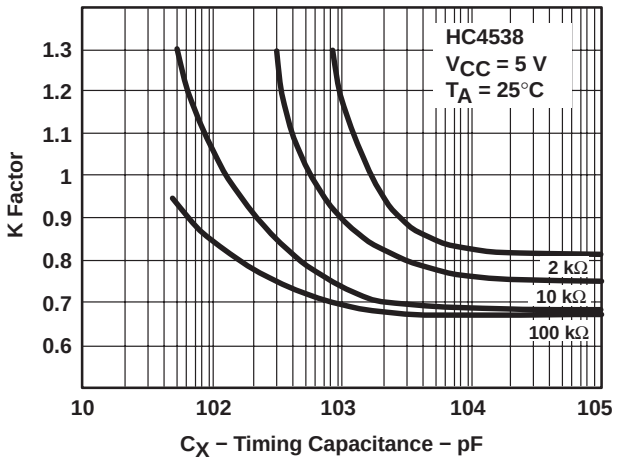


Figure 3. K Factor vs C_X

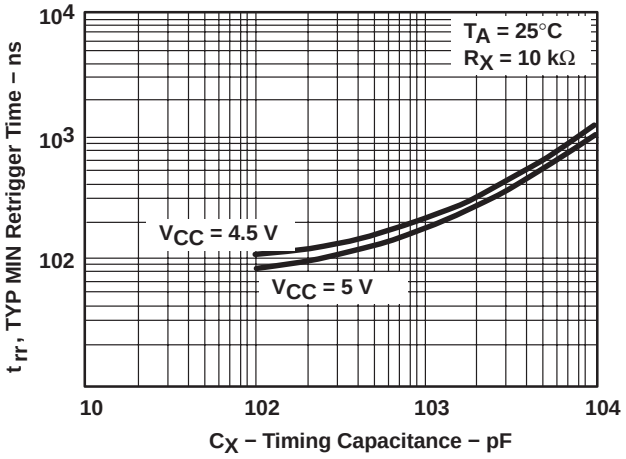


Figure 4. Minimum Retrigger Time vs Timing Capacitance

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 ≥ 0.5 μF, 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-Ω 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.

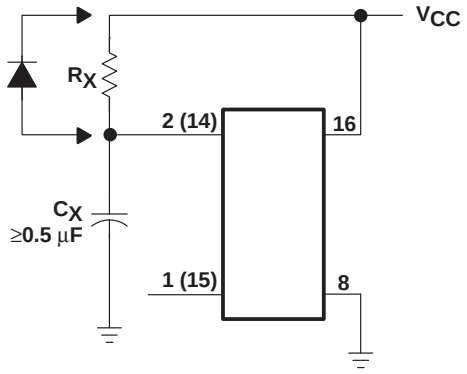


Figure 5. Rapid-Power-Down Protection Circuit

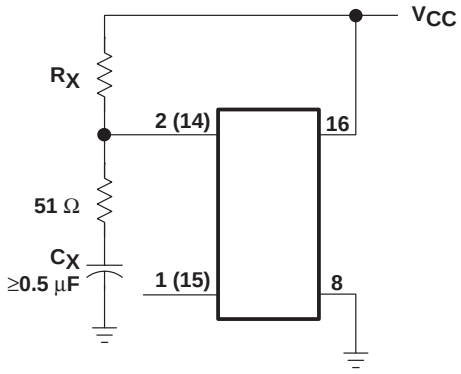
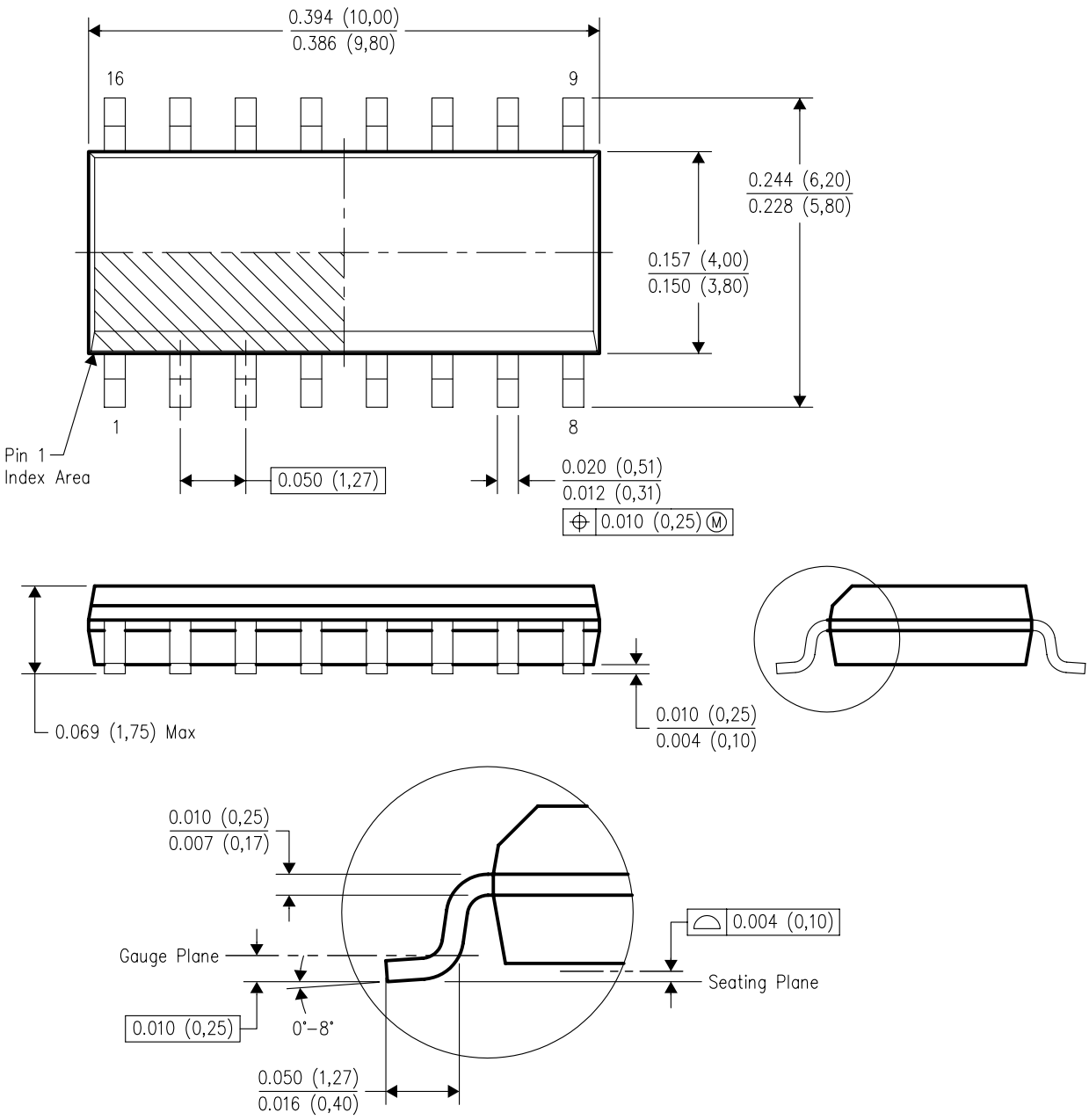


Figure 6. Alternative Rapid-Power-Down Protection Circuit

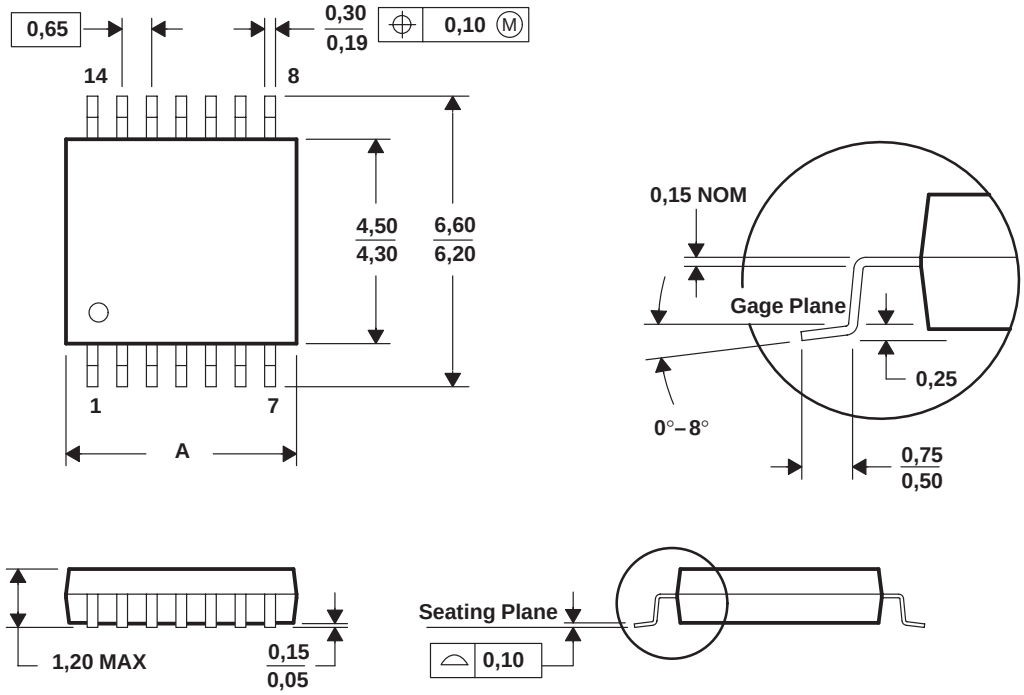
D (R–PDSO–G16) PLASTIC SMALL–OUTLINE PACKAGE



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
D. Falls within JEDEC MS–012 variation AC.

PW (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PINS SHOWN



DIM \ PINS **	8	14	16	20	24	28
A MAX	3,10	5,10	5,10	6,60	7,90	9,80
A MIN	2,90	4,90	4,90	6,40	7,70	9,60

4040064/F 01/97

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
D. Falls within JEDEC MO-153

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