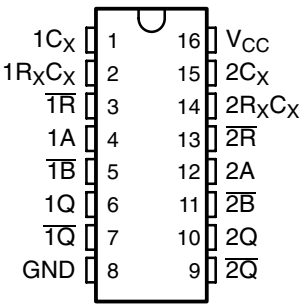
- **Qualified for Automotive Applications**
- **Retriggerable/Resettable Capability**
- **Trigger and Reset Propagation Delays Independent of R_X, C_X**
- **Triggering From the Leading or Trailing Edge**
- **Q and $\overline{Q}$ Buffered Outputs Available**
- **Separate Resets**
- **Wide Range of Output 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**

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

† 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.

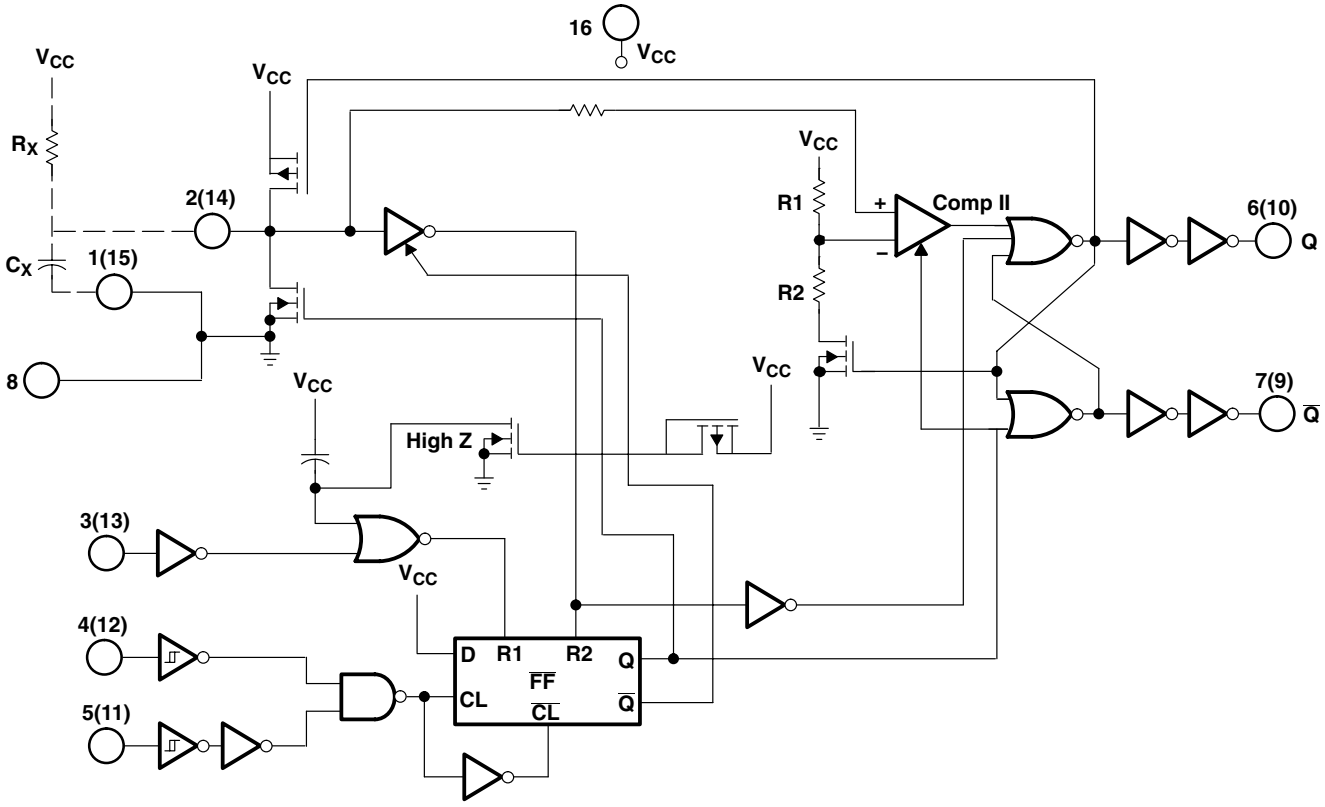
‡ Package drawings, thermal data, and symbolization are available at http://www.ti.com/packaging.

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)

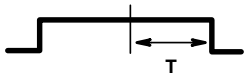


FUNCTIONAL TERMINAL CONNECTIONS

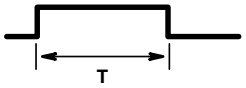
FUNCTION	V_{CC} TO TERMINAL NUMBER		GND TO TERMINAL NUMBER		INPUT PULSE TO TERMINAL NUMBER		OTHER CONNECTIONS	
	$MONO_1$	$MONO_2$	$MONO_1$	$MONO_2$	$MONO_1$	$MONO_2$	$MONO_1$	$MONO_2$
Leading-edge trigger/retriggerable	3, 5	11, 13			4	12		
Leading-edge trigger/nonretriggerable	3	13			4	12	5–7	11–9
Trailing-edge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

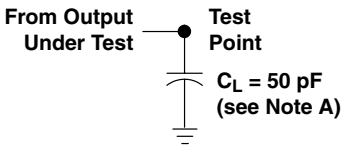
† Output pulse width with R_X = 10 kΩ and C_X = 0.1 μF

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

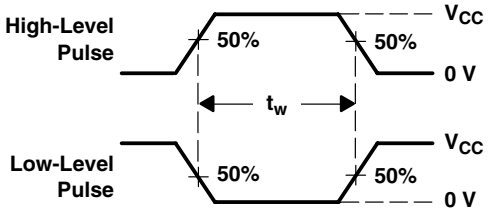
PARAMETER		TYP	UNIT
C_{pd}	Power dissipation capacitance (see Note 6)	136	pF

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 $f_I \ll 1/\tau$

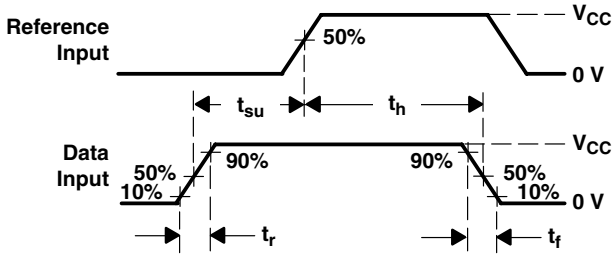
PARAMETER MEASUREMENT INFORMATION



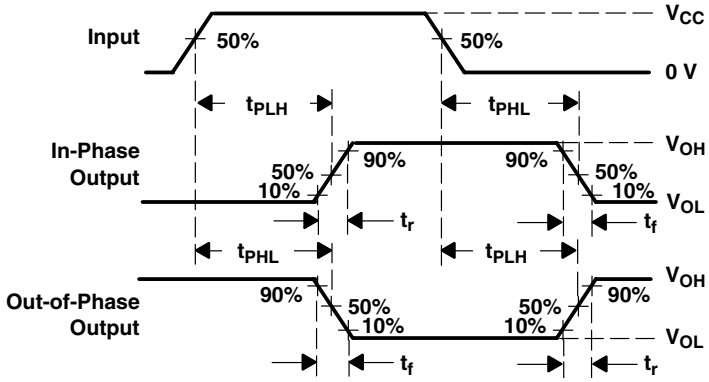
LOAD CIRCUIT



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

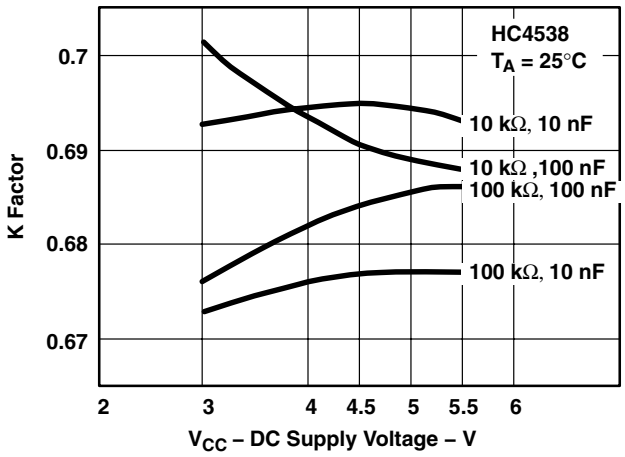


Figure 2. K Factor vs DC Supply Voltage

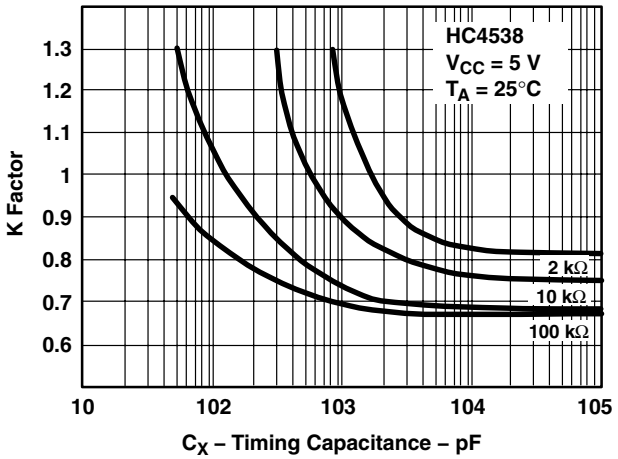


Figure 3. K Factor vs C_X

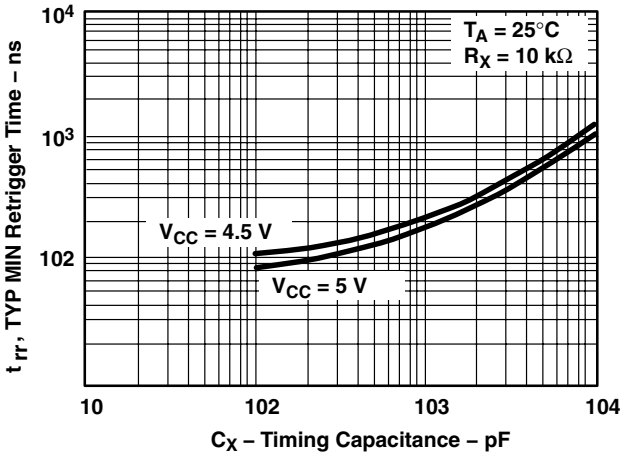


Figure 4. Minimum Retrigger Time vs Timing Capacitance

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.

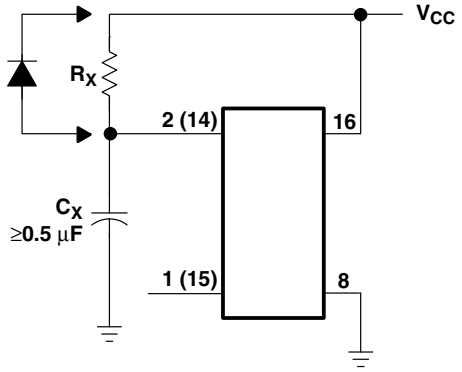


Figure 5. Rapid-Power-Down Protection Circuit

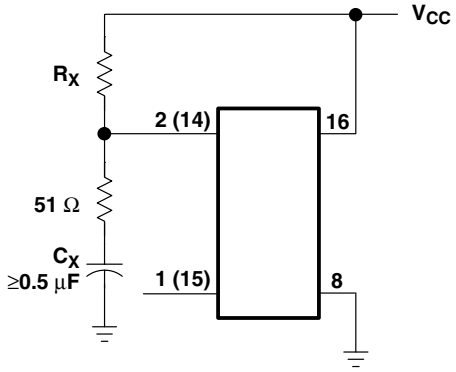


Figure 6. Alternative Rapid-Power-Down Protection Circuit

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
CD74HC4538QM96G4Q1	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	HC4538M	Samples
CD74HC4538QPWRG4Q1	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	HC4538M	Samples
CD74HC4538QPWRQ1	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	HC4538M	Samples

(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.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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 :

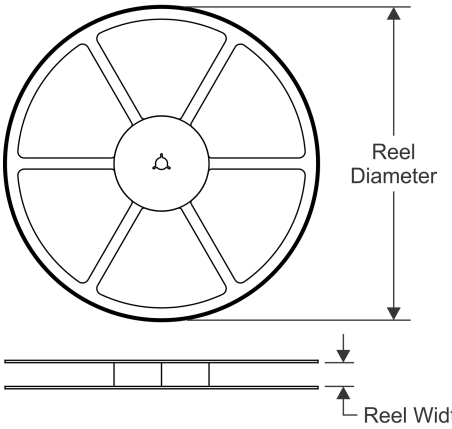
- Catalog: CD74HC4538
- Military: CD54HC4538

NOTE: Qualified Version Definitions:

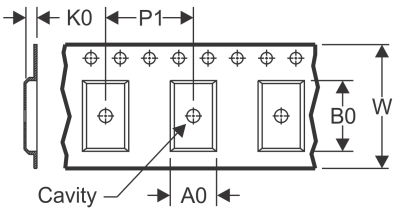
- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications

TAPE AND REEL INFORMATION

REEL DIMENSIONS

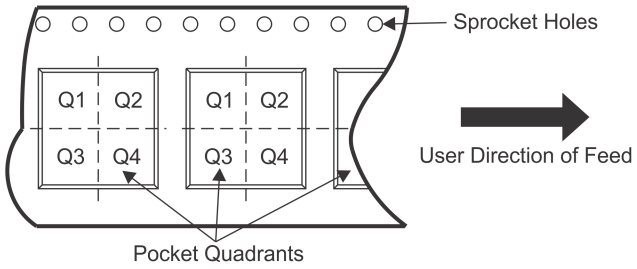


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

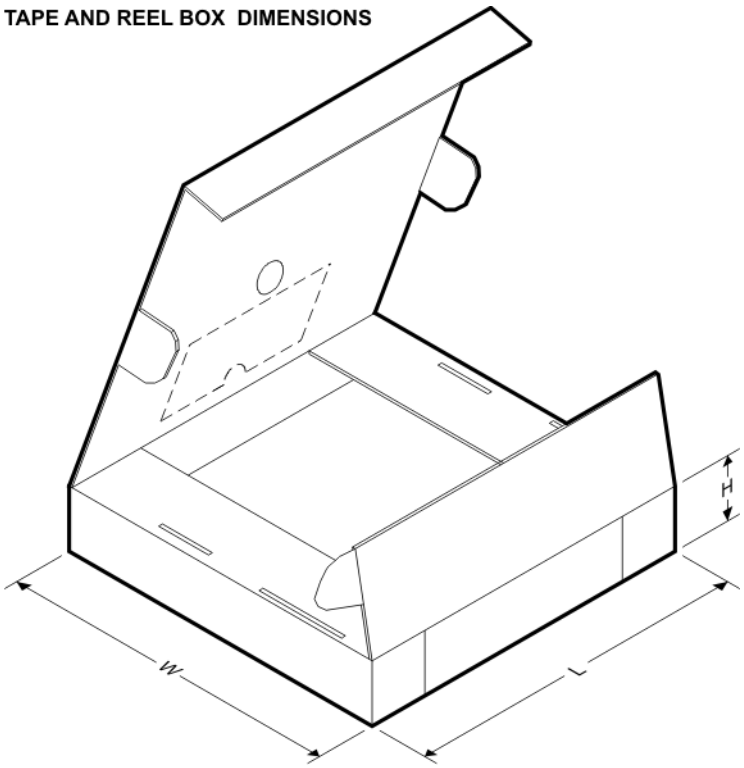
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
CD74HC4538QPWRG4Q1	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
CD74HC4538QPWRQ1	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1

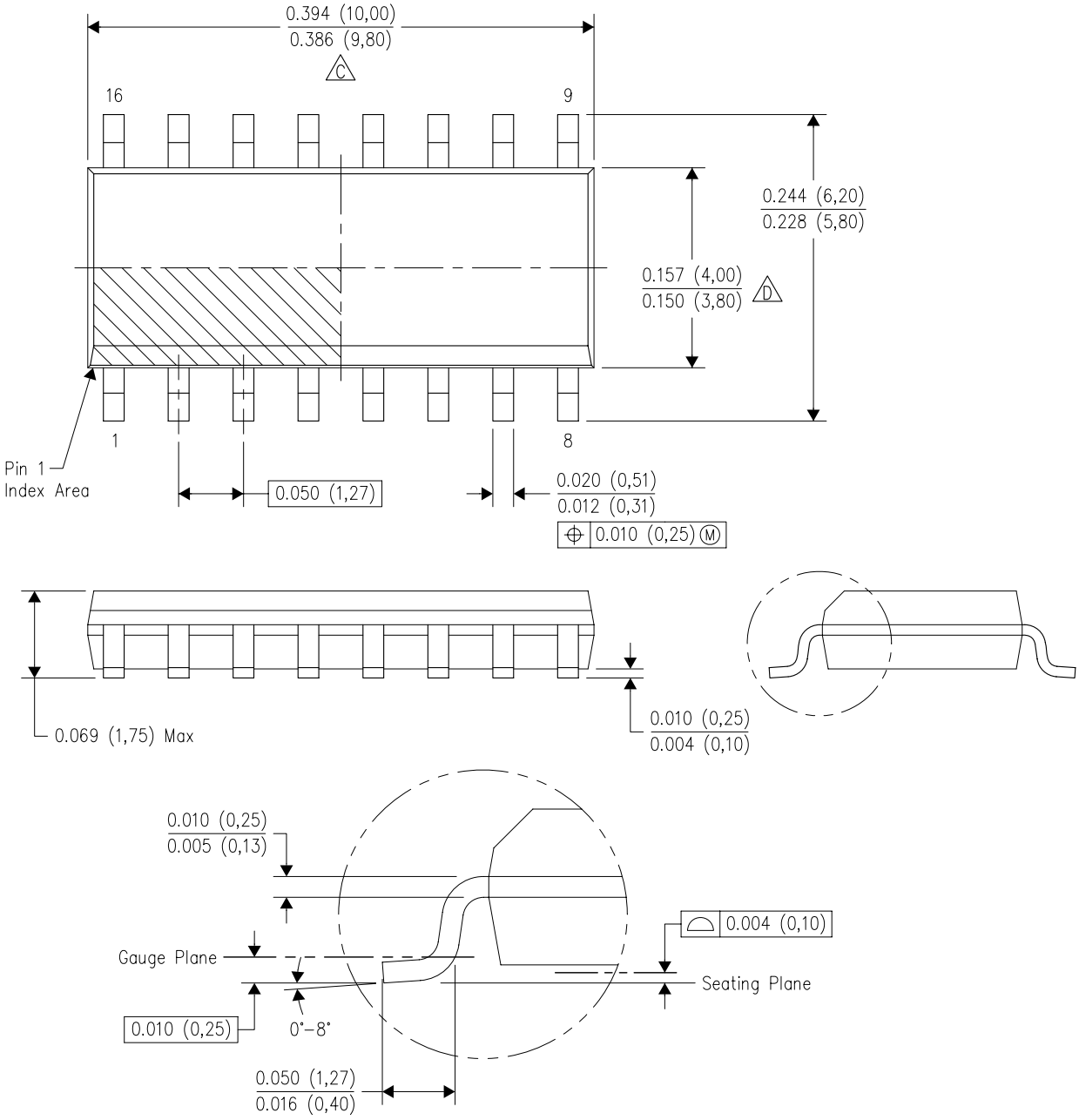
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

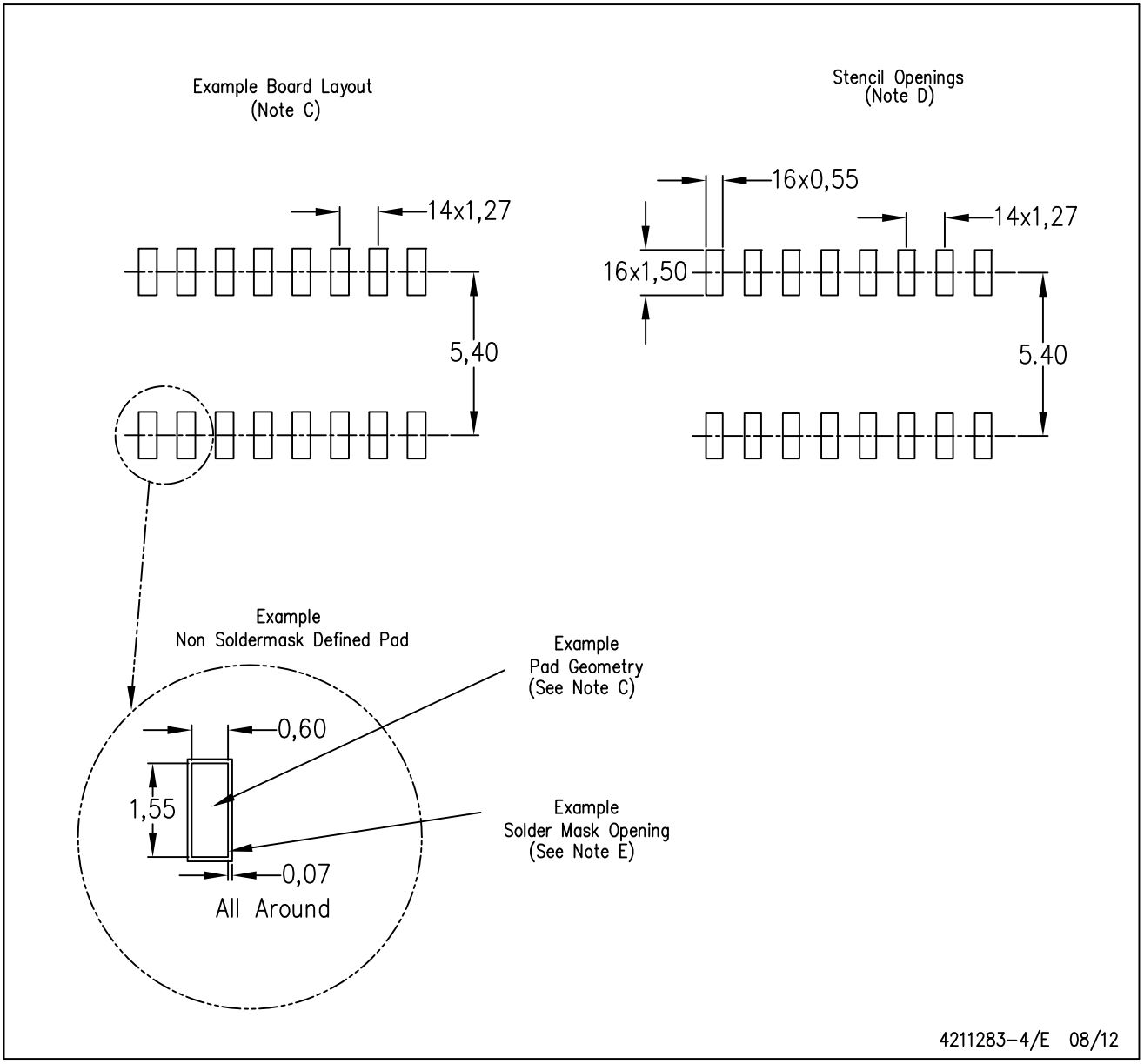
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CD74HC4538QPWRG4Q1	TSSOP	PW	16	2000	367.0	367.0	35.0
CD74HC4538QPWRQ1	TSSOP	PW	16	2000	367.0	367.0	35.0

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



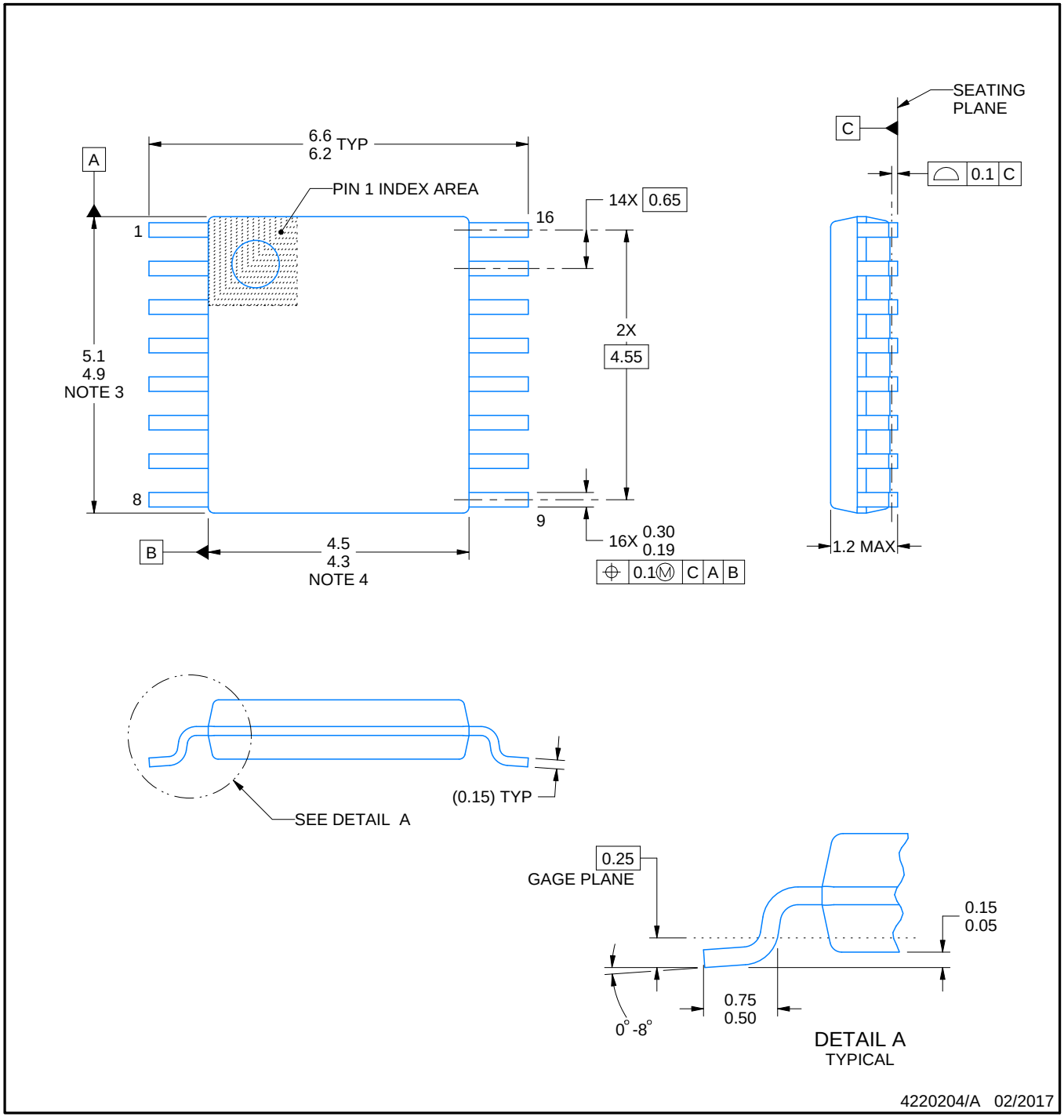
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact 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.

PACKAGE OUTLINE

PW0016A

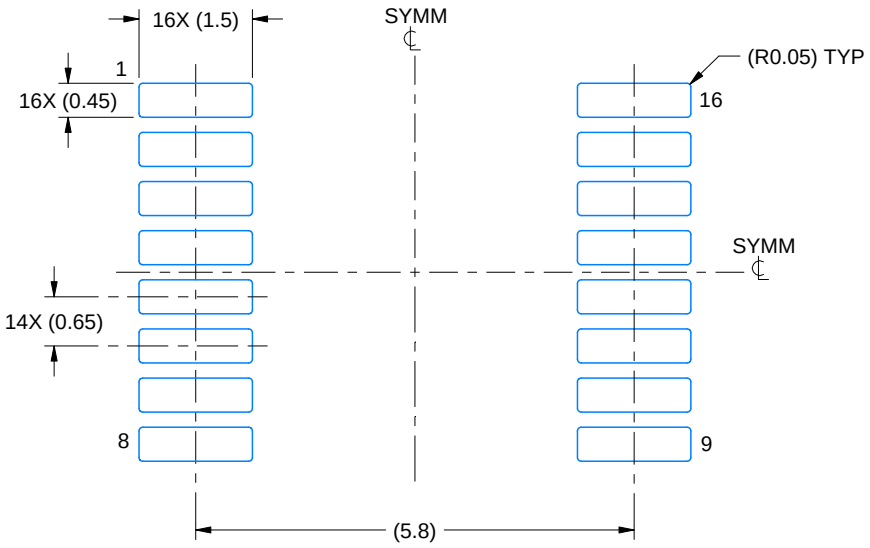
TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE

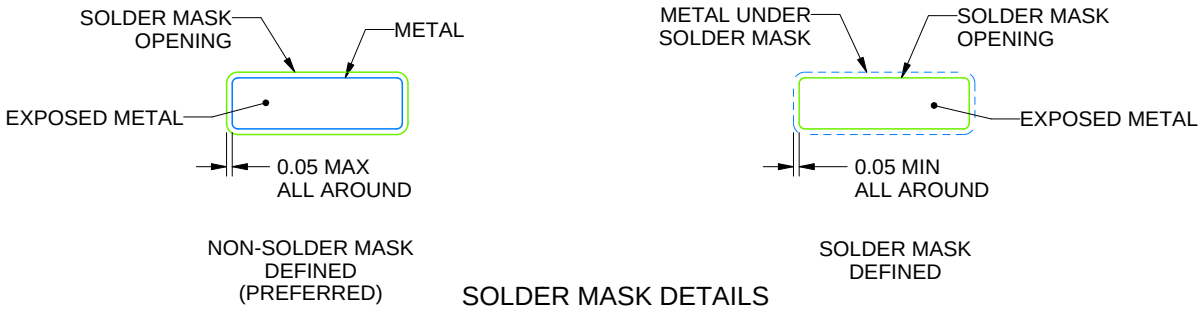


NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X

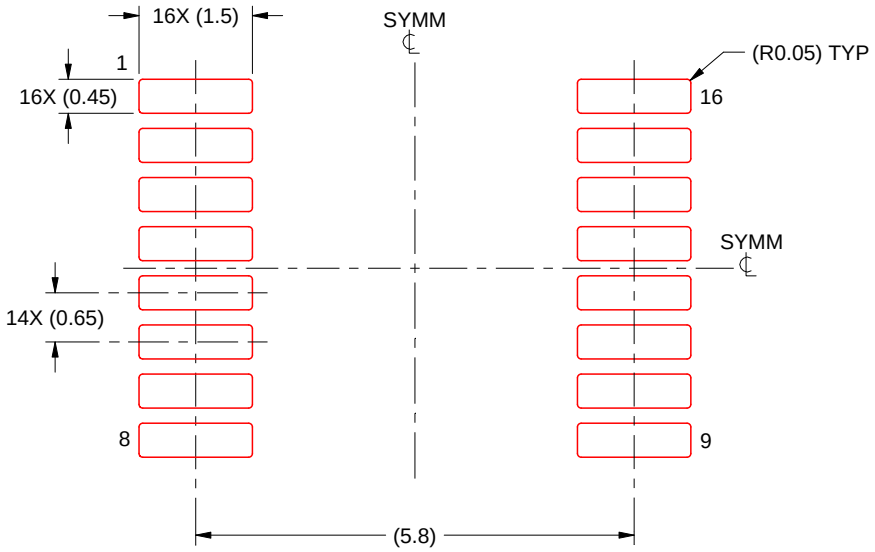


SOLDER MASK DETAILS

4220204/A 02/2017

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 10X

4220204/A 02/2017

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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