TEXAS INSTRUMENTS
Data sheet acquired from Harris Semiconductor
SCHS093C – Revised October 2003

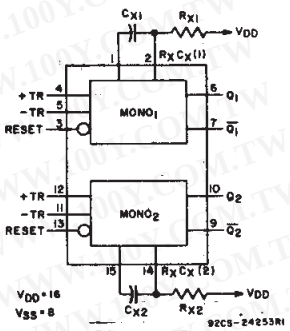
# CD14538B Types



## CMOS Dual Precision Monostable Multivibrator

### High-Voltage Types (20-Volt Rating)

**Features:**
- *Retriggerable/resettable capability*
- *Trigger and reset propagation delays independent of $R_x$, $C_x$*
- *Triggering from leading or trailing edge*
- *Q and $\overline{Q}$ buffered outputs available*
- *Separate resets*
- *Replaces CD4538B Type*




**CD14538B**
**FUNCTIONAL DIAGRAM**

■ CD14538B dual precision monostable multivibrator provides stable retriggerable/resettable one-shot operation for any fixed-voltage timing application.

An external resistor ($R_X$) and an 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 time delay from trigger input to output transition (trigger propagation delay) and the time delay from reset input to output transition (reset propagation delay) are independent of $R_X$ and $C_X$. Precision control of output pulse widths is achieved through linear CMOS techniques.

Leading-edge-triggering (+TR) and trailing-edge-triggering (–TR) inputs are provided for triggering from either edge of an input pulse. An unused +TR input should be tied to $V_{SS}$. An unused –TR input should be tied to $V_{DD}$. A RESET (on low level) is provided for immediate termination of the output pulse or to prevent output pulses when power is turned on. An unused RESET input should be tied to $V_{DD}$. However, if an entire section of the CD14538B is not used, its inputs must be tied to either $V_{DD}$ or $V_{SS}$. See Table I.

In normal operation the circuit retriggers (extends the output pulse one period) on the application of each new trigger pulse. For operation in the non-retriggerable mode, $\overline{Q}$ is connected to –TR when leading-edge triggering (+TR) is used or Q is connected to +TR when trailing-edge triggering (–TR) is used. The time period (T) for this multivibrator can be calculated by: $T = R_XC_X$.

The minimum value of external resistance, $R_X$, is 4 KΩ. The minimum and maximum values of external capacitance, $C_X$, are 0 pF and 100 μF, respectively.

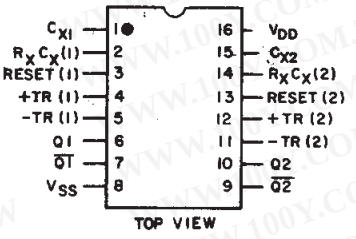
The CD14538B is interchangeable with type MC14538 and is similar to and pin-compatible with the CD4098B* and CD4538B. It can replace the CD4538B which type is not recommended for new designs.

The CD14538B types are supplied in 16-lead hermetic dual-in-line ceramic packages (F3A suffix), 16-lead dual-in-line plastic packages (E suffix), 16-lead small-outline packages (M, M96, MT, and NSR suffixes), and 16-lead thin shrink small-outline packages (PW and PWR suffixes).

*T = 0.5 $R_XC_X$ for $C_X \geq 1000$ pF  #T = $R_XC_X$; $C_X$min = 5000 pF

- *Wide range of output-pulse widths*
- *Schmitt-trigger input allows unlimited rise and fall times on +TR and –TR inputs*
- *100% tested for maximum quiescent current at 20 V*
- *Maximum input current of 1 μA at 18 V over full package-temperature range; 100 nA at 18 V and 25°C*
- *Noise margin (full package-temperature range):*
  - *1 V at $V_{DD} = 5$ V*
  - *2 V at $V_{DD} = 10$ V*
  - *2.5 V at $V_{DD} = 15$ V*
- *5-V, 10-V, and 15-V parametric ratings*
- *Standardized, symmetrical output characteristics*
- *Meets all requirements of JEDEC Tentative Standard No. 13B, "Standard Specifications for Description of 'B' Series CMOS Devices."*

**Applications:**
- *Pulse delay and timing*
- *Pulse shaping*




TERMINALS 1, 8, 15 ARE ELECTRICALLY CONNECTED INTERNALLY

92CS-24848RI

**Terminal Assignment**

**MAXIMUM RATINGS,** *Absolute-Maximum Values:*

DC SUPPLY-VOLTAGE RANGE, ($V_{DD}$)
Voltages referenced to $V_{SS}$ Terminal) ..... -0.5V to +20V
INPUT VOLTAGE RANGE, ALL INPUTS ..... -0.5V to $V_{DD}$ +0.5V
DC INPUT CURRENT, ANY ONE INPUT ..... ±10mA
POWER DISSIPATION PER PACKAGE ($P_D$):
For $T_A$ = -55°C to +100°C ..... 500mW
For $T_A$ = +100°C to +125°C ..... Derate Linearity at 12mW/°C to 200mW
DEVICE DISSIPATION PER OUTPUT TRANSISTOR
FOR $T_A$ = FULL PACKAGE-TEMPERATURE RANGE (All Package Types) ..... 100mW
OPERATING-TEMPERATURE RANGE ($T_A$) ..... -55°C to +125°C
STORAGE TEMPERATURE RANGE ($T_{stg}$) ..... -65°C to +150°C
LEAD TEMPERATURE (DURING SOLDERING):
At distance 1/16 ± 1/32 inch (1.59 ± 0.79mm) from case for 10s max ..... +265°C

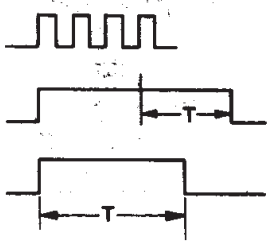
**RECOMMENDED OPERATING CONDITIONS**
**For maximum reliability, nominal operating conditions should be selected so that operating is always within the following ranges:**

| CHARACTERISTIC | | $V_{DD}$ (V) | LIMITS | | UNITS |
|---|---|---|---|---|---|
| | | | Min. | Max. | |
| Supply-Voltage Range (For $T_A$=Full Package-Temperature Range) | | — | 3 | 18 | V |
| Input Pulse Width +TR, -TR, or RESET | $t_{WH}$, $t_{WL}$ | 5 | 140 | — | ns |
| | | 10 | 80 | — | |
| | | 15 | 60 | — | |

**TABLE I**
**CD4538B FUNCTIONAL TERMINAL CONNECTIONS**

| FUNCTIION | $V_{DD}$ TO TERM. NO. | | $V_{SS}$ TO TERM. NO. | | INPUT PULSE TO TERM. NO. | | 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/ Non-Retriggerable | 3 | 13 | | | 4 | 12 | 5-7 | 11-9 |
| Trailing-Edge Trigger/ Retriggerable | 3 | 13 | 4 | 12 | 5 | 11 | | |
| Trailing-Edge Trigger/ Non-Retriggerable | 3 | 13 | | | 5 | 11 | 4-6 | 12-10 |

NOTES:
1. A RETRIGGERABLE ONE-SHOT MULTIVIBRATOR HAS AN OUTPUT PULSE WIDTH WHICH IS EXTENDED ONE FULL TIME PERIOD (T) AFTER APPLICATION OF THE LAST TRIGGER PULSE.
2. A NON—RETRIGGERABLE ONE-SHOT MULTIVIBRATOR HAS A TIME PERIOD (T) REFERENCED FROM THE APPLICATION OF THE FIRST TRIGGER PULSE.



## STATIC ELECTRICAL CHARACTERISTICS

| CHARACTERISTIC | CONDITIONS | | | LIMITS AT INDICATED TEMPERATURES (°C) | | | | | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | $V_O$ (V) | $V_{IN}$ (V) | $V_{DD}$ (V) | -55 | -40 | +85 | +125 | Min. | +25 Typ. | Max. | |
| Quiescent Device Current, $I_{DD}$ Max. | — | 0,5 | 5 | 5 | 5 | 150 | 150 | — | 0.04 | 5 | μA |
| | — | 0,10 | 10 | 10 | 10 | 300 | 300 | — | 0.04 | 10 | |
| | — | 0,15 | 15 | 20 | 20 | 600 | 600 | — | 0.04 | 20 | |
| | — | 0,20 | 20 | 100 | 100 | 3000 | 3000 | — | 0.08 | 100 | |
| Output Low (Sink) Current, $I_{OL}$ Min. | 0.4 | 0,5 | 5 | 0.64 | 0.61 | 0.42 | 0.36 | 0.51 | 1 | — | mA |
| | 0.5 | 0,10 | 10 | 1.6 | 1.5 | 1.1 | 0.9 | 1.3 | 2.6 | — | |
| | 1.5 | 0,15 | 15 | 4.2 | 4 | 2.8 | 2.4 | 3.4 | 6.8 | — | |
| Output High (Source) Current, $I_{OH}$ Min. | 4.6 | 0,5 | 5 | -0.64 | -0.61 | -0.42 | -0.36 | -0.51 | -1 | — | |
| | 2.5 | 0,5 | 5 | -2 | -1.8 | -1.3 | -1.15 | -1.6 | -3.2 | — | |
| | 9.5 | 0,10 | 10 | -1.6 | -1.5 | -1.1 | -0.9 | -1.3 | -2.6 | — | |
| | 13.5 | 0,15 | 15 | -4.2 | -4 | -2.8 | -2.4 | -3.4 | -6.8 | — | |
| Output Voltage: Low-Level, $V_{OL}$ Max. | — | 0,5 | 5 | 0.05 | | | | — | 0 | 0.05 | V |
| | — | 0,10 | 10 | 0.05 | | | | — | 0 | 0.05 | |
| | — | 0,15 | 15 | 0.05 | | | | — | 0 | 0.05 | |
| Output Voltage: High-Level, $V_{OH}$ Min. | — | 0,5 | 5 | 4.95 | | | | 4.95 | 5 | — | |
| | — | 0,10 | 10 | 9.95 | | | | 9.95 | 10 | — | |
| | — | 0,15 | 15 | 14.95 | | | | 14.95 | 15 | — | |
| Input Low Voltage, $V_{IL}$ Max. | 0.5,4.5 | — | 5 | 1.5 | | | | — | — | 1.5 | V |
| | 1,9 | — | 10 | 3 | | | | — | — | 3 | |
| | 1.5,13.5 | — | 15 | 4 | | | | — | — | 4 | |
| Input High Voltage, $V_{IH}$ Min. | 0.5,4.5 | — | 5 | 3.5 | | | | 3.5 | — | — | |
| | 1,9 | — | 10 | 7 | | | | 7 | — | — | |
| | 1.5,13.5 | — | 15 | 11 | | | | 11 | — | — | |
| Input Current, $I_{IN}$ Max. | — | 0,18 | 18 | ±0.1 | ±0.1 | ±1 | ±1 | — | $±10^{-5}$ | ±0.1 | μA |

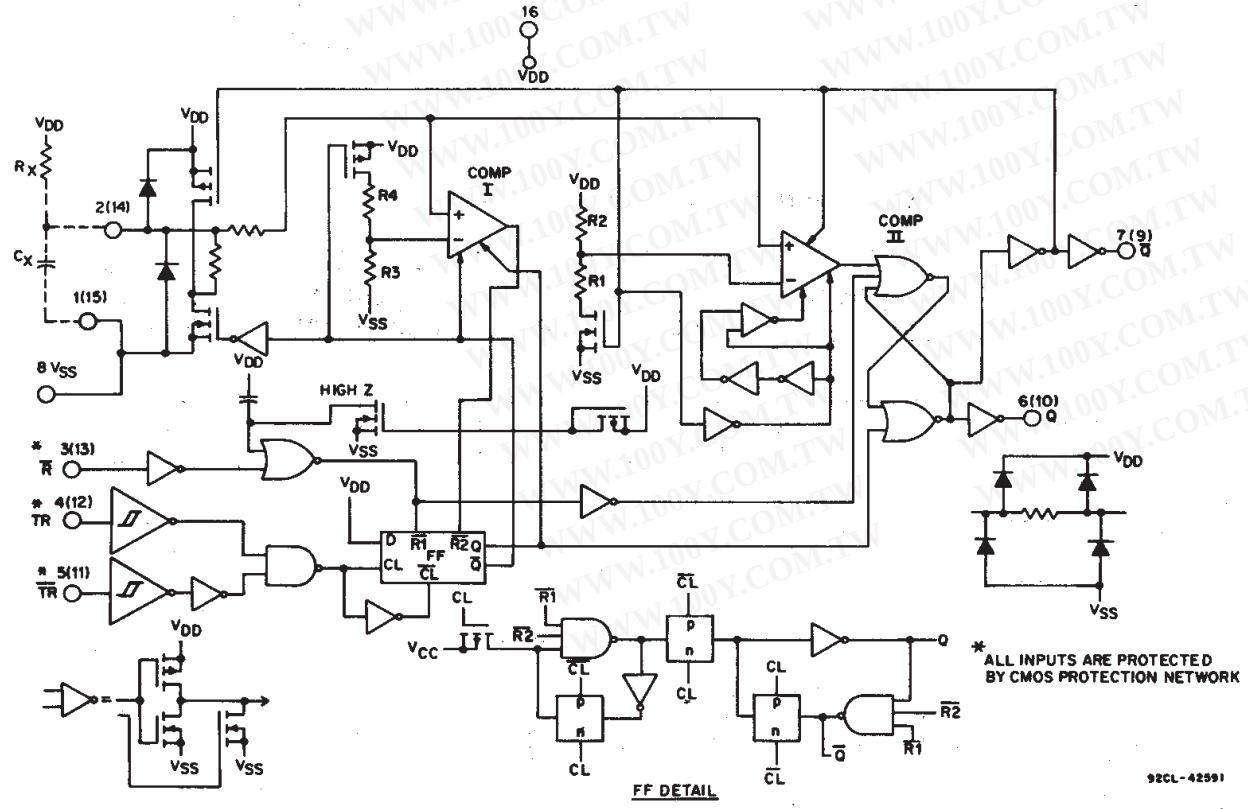



*Fig. 1 - Logic diagram (½ of device shown).*

**DYNAMIC ELECTRICAL CHARACTERISTICS, At $T_A$=25°C; Input $t_r$,$t_f$=20 ns, $C_L$=50 pF**

| CHARACTERISTIC | | TEST CONDITIONS $V_{DD}$ (V) | LIMITS Min. | LIMITS Typ. | LIMITS Max. | UNITS |
|---|---|---|---|---|---|---|
| Transition Time | $t_{TLH}$, $t_{THL}$ | 5 | — | 100 | 200 | ns |
| | | 10 | — | 50 | 100 | |
| | | 15 | — | 40 | 80 | |
| Propagation Delay Time: +TR or -TR to Q or $\overline{Q}$ | $t_{PLH}$, $t_{PHL}$ | 5 | — | 300 | 600 | |
| | | 10 | — | 150 | 300 | |
| | | 15 | — | 100 | 220 | |
| Reset to Q or $\overline{Q}$ | | 5 | — | 250 | 500 | |
| | | 10 | — | 125 | 250 | |
| | | 15 | — | 95 | 190 | |
| Minimum Input Pulse Width: +TR, -TR or Reset | $t_{WH}$, $t_{WL}$ | 5 | — | 80 | 140 | |
| | | 10 | — | 40 | 80 | |
| | | 15 | — | 30 | 60 | |
| Output Pulse Width - Q or $\overline{Q}$: $C_X$ = 0.002 μF, $R_X$ = 100 KΩ | T | 5 | 198 | 210 | 230 | μs |
| | | 10 | 200 | 212 | 232 | |
| | | 15 | 202 | 214 | 234 | |
| $C_X$=0.1 μF, $R_X$=100 KΩ | | 5 | 9.4 | 9.97 | 10.5 | ms |
| | | 10 | 9.4 | 9.95 | 10.6 | |
| | | 15 | 9.5 | 10 | 10.6 | |
| $C_X$=10 μF, $R_X$=100 KΩ | | 5 | 0.95 | 1 | 1.06 | s |
| | | 10 | 0.95 | 1 | 1.06 | |
| | | 15 | 0.96 | 1.01 | 1.07 | |
| Pulse Width Match between circuits in same package: $C_X$=0.1 μF, $R_X$=100 KΩ | $\frac{100\,(T_1-T_2)}{T_1}$ | 5 | — | ±1 | — | % |
| | | 10 | — | ±1 | — | |
| | | 15 | — | ±1 | — | |
| Minimum Retrigger Time | $t_{rr}$ | 5 | 0 | — | — | ns |
| | | 10 | 0 | — | — | |
| | | 15 | 0 | — | — | |
| Input Capacitance | $C_{IN}$ | Any Input | — | 5 | 7.5 | pF |

*Note: Minimum $R_X$ value=4 KΩ, minimum $C_X$ value=5000 pF.

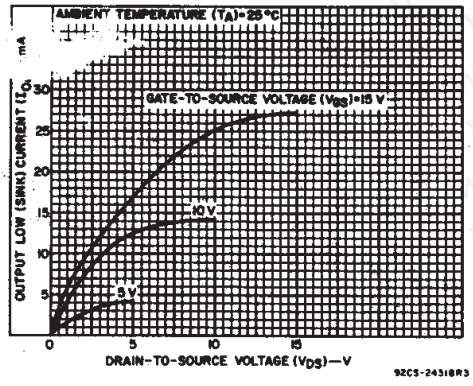



Fig. 2 - Typical output low (sink) current characteristics.

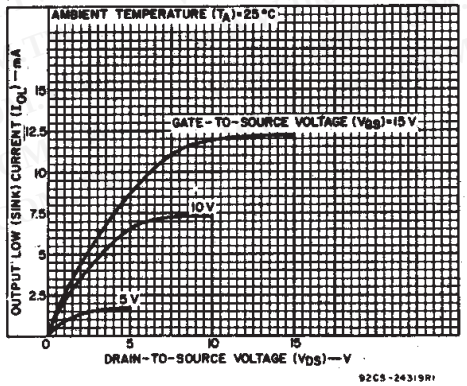



Fig. 3 - Minimum output low (sink) current characteristics.

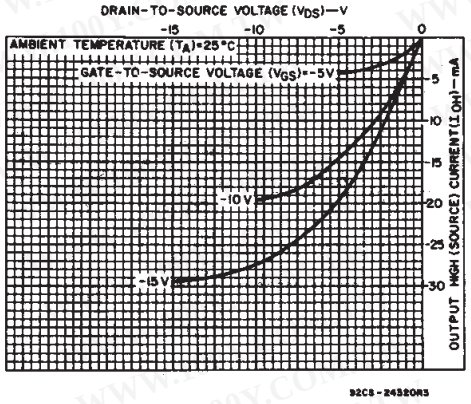



Fig. 4 - Typical output high (source) current characteristics.

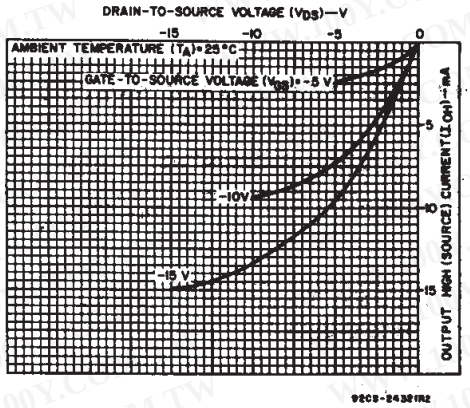



Fig. 5 - Minimum output high (source) current characteristics.

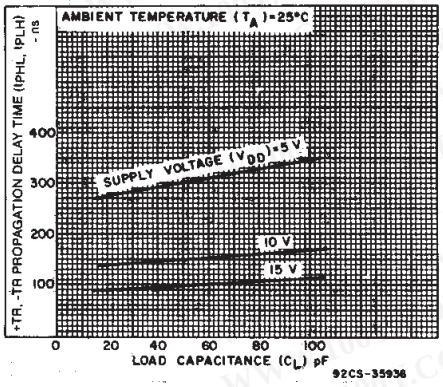



Fig. 6 - Typical propagation delay time as a function of load capacitance (+TR or −TR to Q or $\overline{Q}$).

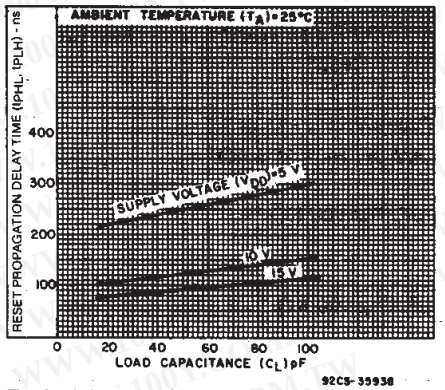



Fig. 7 - Typical propagation delay time as a function of load capacitance (RESET to Q or $\overline{Q}$).

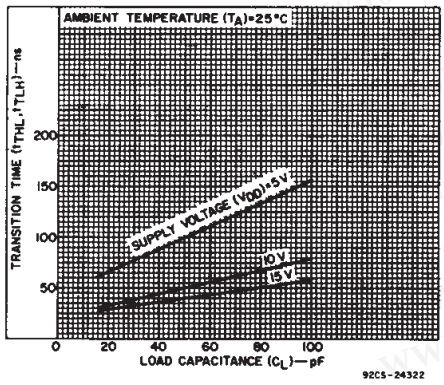



Fig. 8 - Typical transition time as a function of load capacitance.

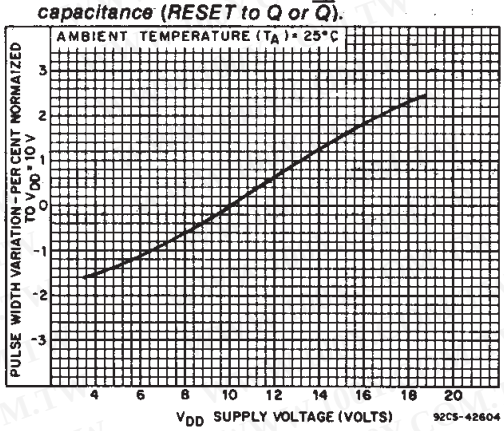



Fig. 9 - Typical pulse-width variation as a function of supply voltage.

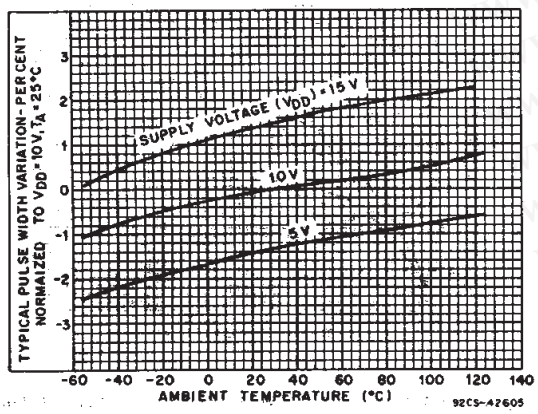



Fig. 10 - Typical pulse-width variation as a function of temperature ($R_X$=100 KΩ, $C_X$=0.1 μF).

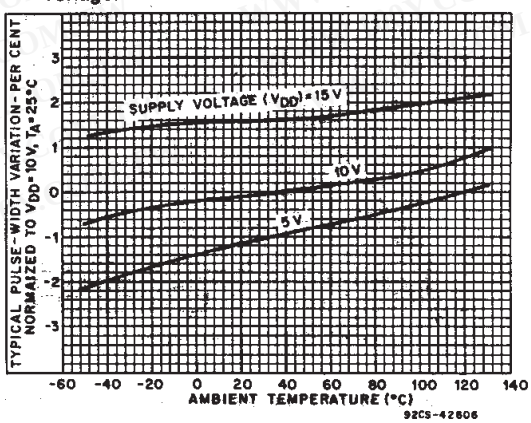



Fig. 11 - Typical pulse-width variation as a function of temperature ($R_X$=100 KΩ, $C_X$=2000 pF).

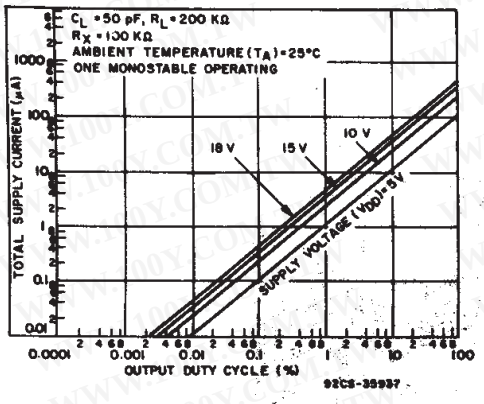



Fig. 12 - Typical total supply current as a function of output duty cycle.

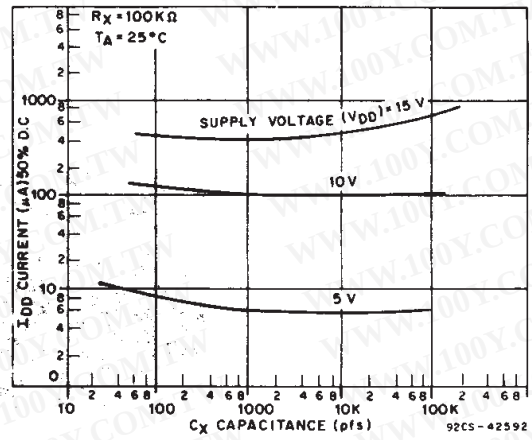
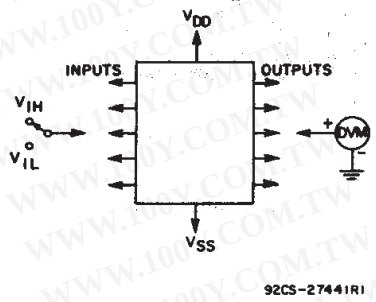



Fig. 13 - Typical total supply current as a function of load capacitance.




NOTE:
1. Test any combination of inputs.
2. When measuring $V_{IH}$ or $V_{IL}$ for Schmitt trigger inputs (+TR, -TR), the input must first be brought to $V_{DD}$ or $V_{SS}$, respectively, then reduced to the specified limit.

Fig. 14 - Input voltage test circuit.

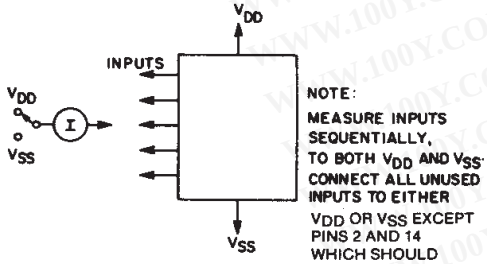



Fig. 15 - Input leakage-current test circuit.

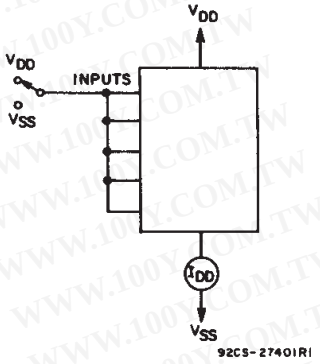



Fig. 16 - Quiescent device current test circuit.

## Power-Down Mode

During a rapid power-down condition, as would occur with a power-supply short circuit or with a poorly filtered power supply, the energy stored in $C_X$ could discharge into Pin 2 or 14. To avoid possible device damage in this mode, when $C_X$ is ≥ 0.5 microfarad, a protection diode with a 1-ampere or higher rating (1N5395 or equivalent) and a separate ground return for $C_X$ should be provided as shown in Fig. 17.

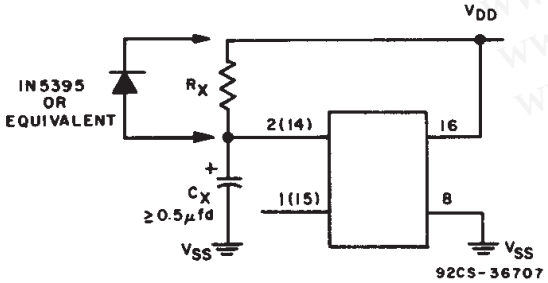



Fig. 17 - Rapid power-down protection circuit.

An alternate protection method is shown in Fig. 18, where a 51-ohm current-limiting resistor is inserted in series with $C_X$. Note that a small pulse width decrease will occur however, and $R_X$ must be appropriately increased to obtain the originally desired pulse width.

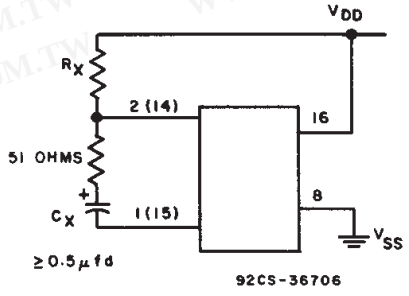
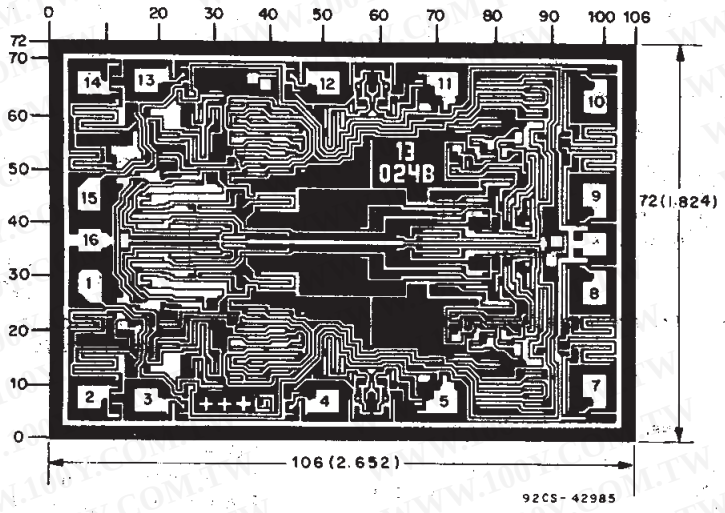



Fig. 18 - Alternate rapid power-down protection circuit.




*Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated. Grid graduations are in mils ($10^{-3}$ inch).*

*Dimensions and pad layout for CD14538BH.*

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) |
|---|---|---|---|---|---|---|---|---|
| 5962-9055701EA | ACTIVE | CDIP | J | 16 | 1 | None | Call TI | Level-NC-NC-NC |
| CD14538BE | ACTIVE | PDIP | N | 16 | 25 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| CD14538BF | ACTIVE | CDIP | J | 16 | 1 | None | Call TI | Level-NC-NC-NC |
| CD14538BF3A | ACTIVE | CDIP | J | 16 | 1 | None | Call TI | Level-NC-NC-NC |
| CD14538BM | ACTIVE | SOIC | D | 16 | 40 | Pb-Free (RoHS) | CU NIPDAU | Level-2-260C-1 YEAR/ Level-1-235C-UNLIM |
| CD14538BM96 | ACTIVE | SOIC | D | 16 | 2500 | Pb-Free (RoHS) | CU NIPDAU | Level-2-260C-1 YEAR/ Level-1-235C-UNLIM |
| CD14538BMT | ACTIVE | SOIC | D | 16 | 250 | Pb-Free (RoHS) | CU NIPDAU | Level-2-260C-1 YEAR/ Level-1-235C-UNLIM |
| CD14538BNSR | ACTIVE | SO | NS | 16 | 2000 | Pb-Free (RoHS) | CU NIPDAU | Level-2-260C-1 YEAR/ Level-1-235C-UNLIM |
| CD14538BPW | ACTIVE | TSSOP | PW | 16 | 90 | Pb-Free (RoHS) | CU NIPDAU | Level-1-250C-UNLIM |
| CD14538BPWR | ACTIVE | TSSOP | PW | 16 | 2000 | Pb-Free (RoHS) | CU NIPDAU | Level-1-250C-UNLIM |

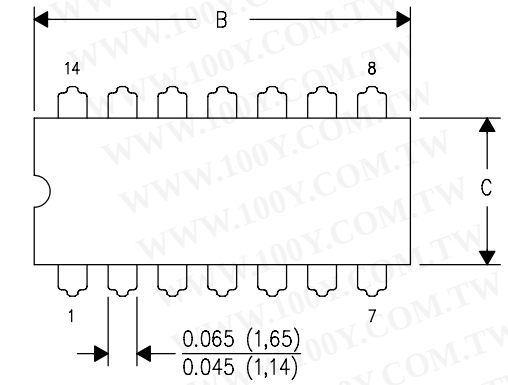
(1) The marketing status values are defined as follows:
**ACTIVE:** Product device recommended for new designs.
**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
**NRND:** Not recommended for new designs. Device is in production to support existing 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 - May not be currently available - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
**None:** Not yet available Lead (Pb-Free).
**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.
**Green (RoHS & no Sb/Br):** TI defines "Green" to mean "Pb-Free" and in addition, uses package materials that do not contain halogens, including bromine (Br) or antimony (Sb) above 0.1% of total product weight.

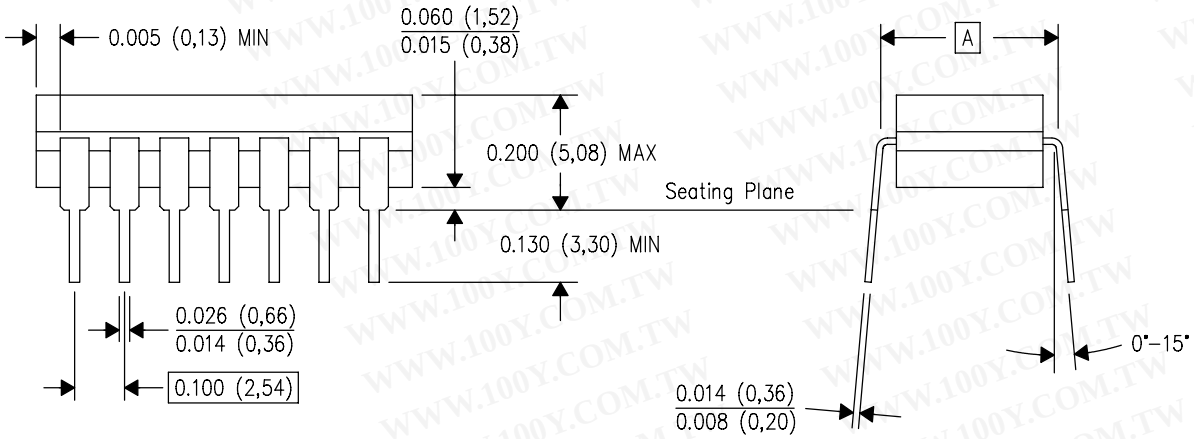
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDECindustry standard classifications, and peak solder temperature.

# J (R–GDIP–T**) CERAMIC DUAL IN–LINE PACKAGE

14 LEADS SHOWN




| DIM \ PINS ** | 14 | 16 | 18 | 20 |
|---|---|---|---|---|
| A | 0.300 (7,62) BSC | 0.300 (7,62) BSC | 0.300 (7,62) BSC | 0.300 (7,62) BSC |
| B MAX | 0.785 (19,94) | .840 (21,34) | 0.960 (24,38) | 1.060 (26,92) |
| B MIN | — | — | — | — |
| C MAX | 0.300 (7,62) | 0.300 (7,62) | 0.310 (7,87) | 0.300 (7,62) |
| C MIN | 0.245 (6,22) | 0.245 (6,22) | 0.220 (5,59) | 0.245 (6,22) |



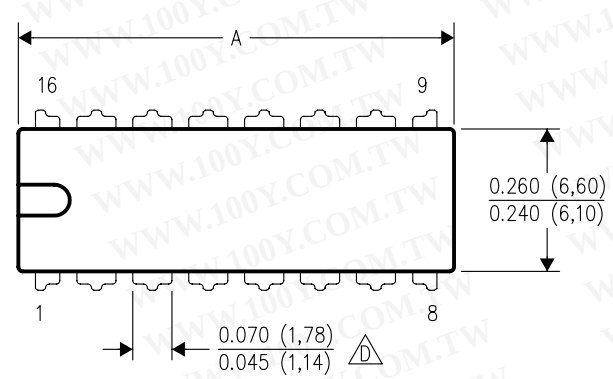

4040083/F 03/03

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package is hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
E. Falls within MIL STD 1835 GDIP1–T14, GDIP1–T16, GDIP1–T18 and GDIP1–T20.

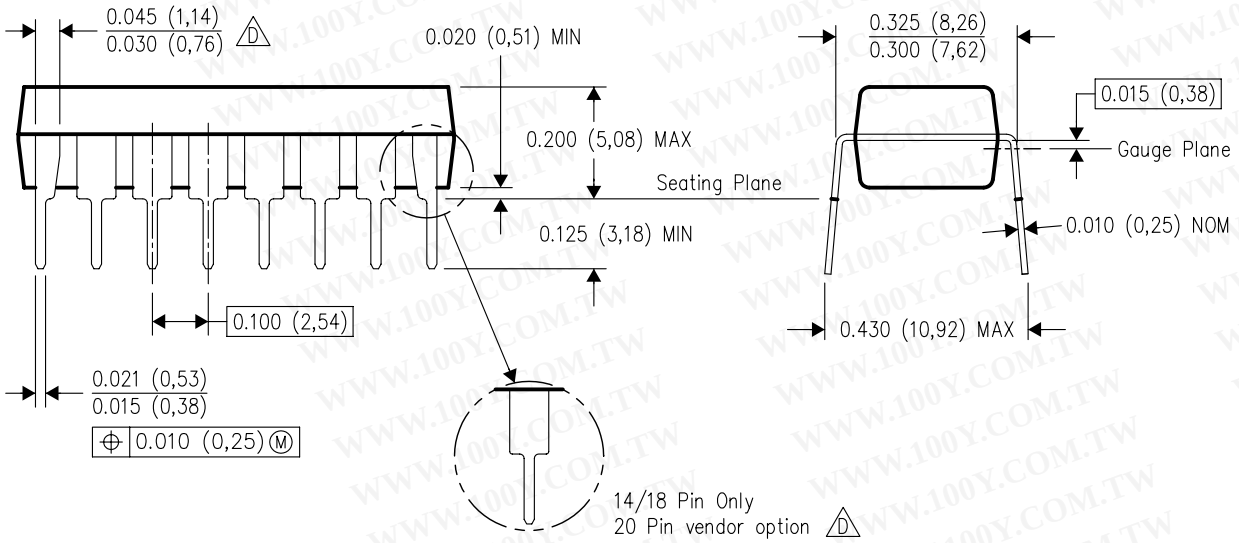
## N (R–PDIP–T**)

## PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN



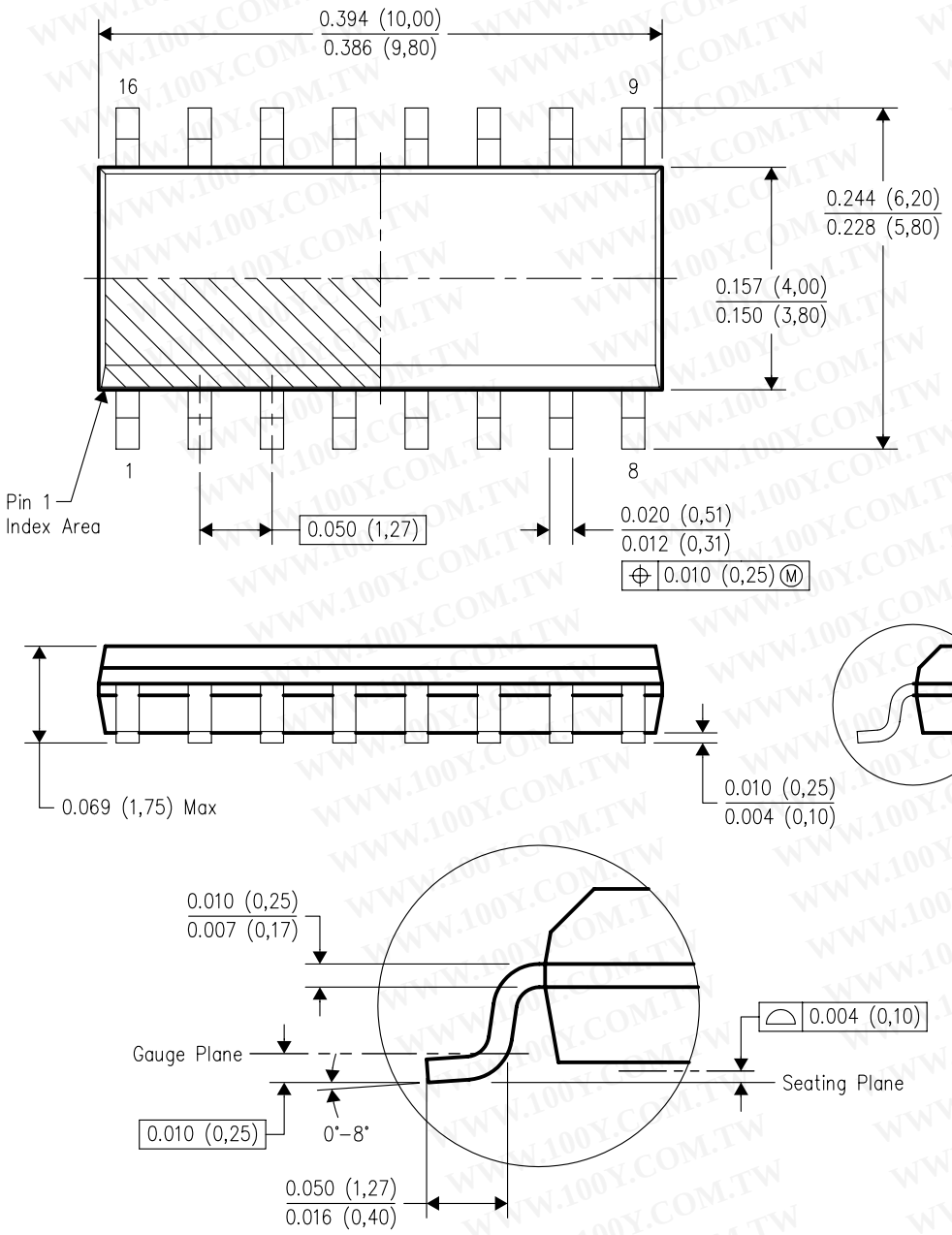

| DIM \ PINS ** | 14 | 16 | 18 | 20 |
|---|---|---|---|---|
| A MAX | 0.775 (19,69) | 0.775 (19,69) | 0.920 (23,37) | 1.060 (26,92) |
| A MIN | 0.745 (18,92) | 0.745 (18,92) | 0.850 (21,59) | 0.940 (23,88) |
| C MS–001 VARIATION | AA | BB | AC | AD |




4040049/E 12/2002

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

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

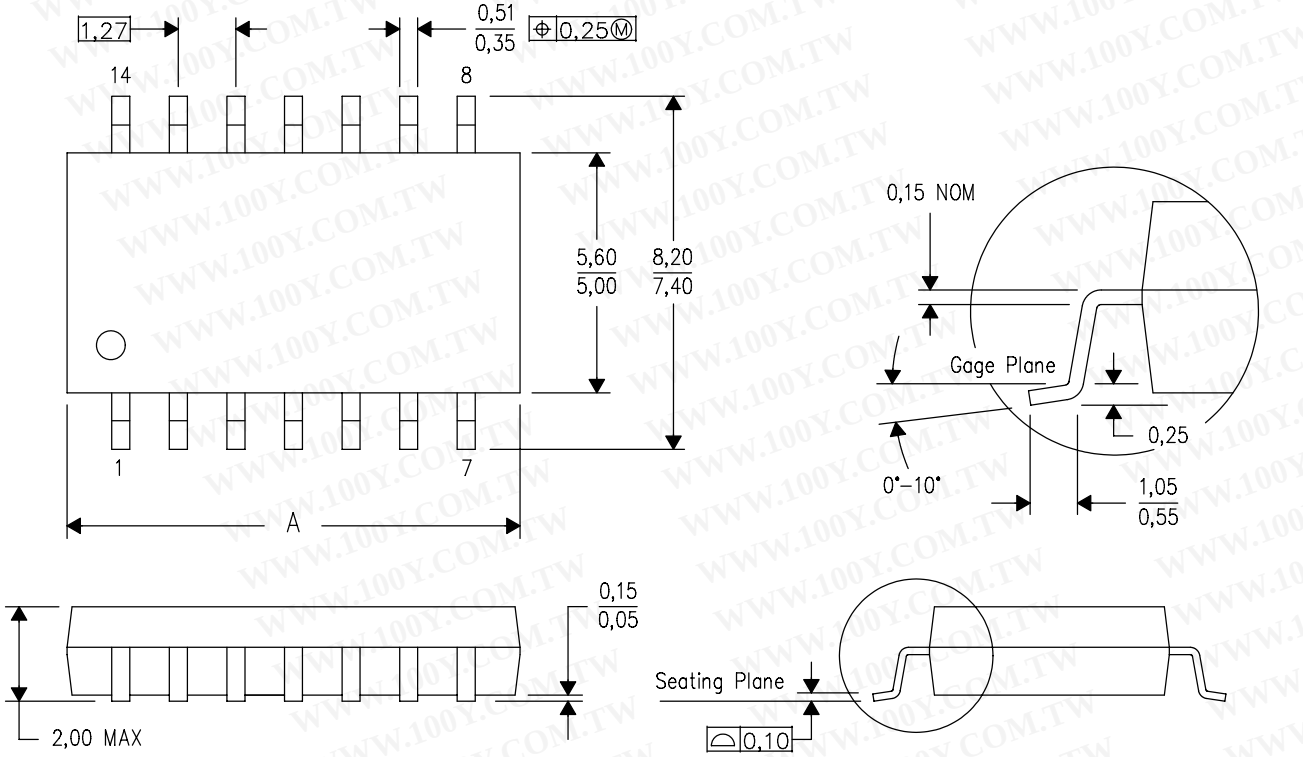



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
D. Falls within JEDEC MS–012 variation AC.

## MECHANICAL DATA

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

**14-PINS SHOWN**




| DIM \ PINS ** | 14 | 16 | 20 | 24 |
|---|---|---|---|---|
| A MAX | 10,50 | 10,50 | 12,90 | 15,30 |
| A MIN | 9,90 | 9,90 | 12,30 | 14,70 |

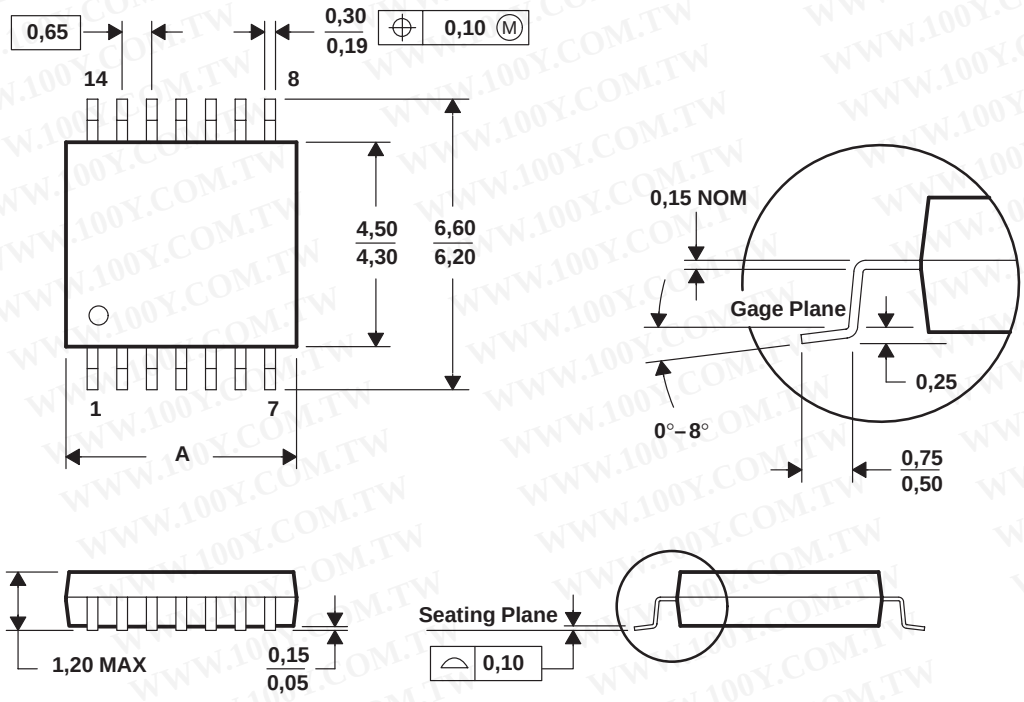


4040062/C 03/03

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.

**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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