

SN54HC393, SN74HC393 DUAL 4-BIT BINARY COUNTERS

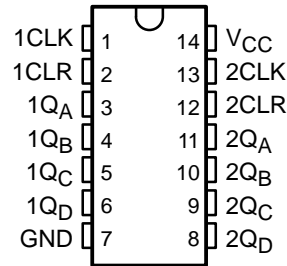
SCLS143C – DECEMBER 1982 – REVISED JANUARY 2003

- Wide Operating Voltage Range of 2 V to 6 V
- Outputs Can Drive Up To 10 LSTTL Loads
- Low Power Consumption, 80- μ A Max I_{CC}
- Typical $t_{pd} = 13$ ns
- ± 4 -mA Output Drive at 5 V
- Low Input Current of 1 μ A Max
- Dual 4-Bit Binary Counters With Individual Clocks
- Direct Clear for Each 4-Bit Counter
- Can Significantly Improve System Densities by Reducing Counter Package Count by 50 Percent

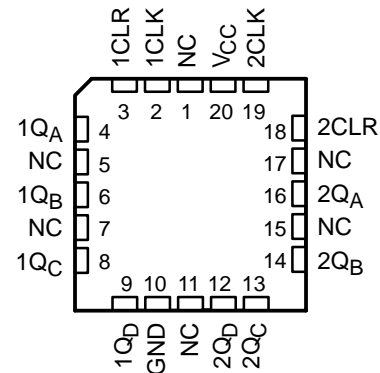
description/ordering information

The 'HC393 devices contain eight flip-flops and additional gating to implement two individual 4-bit counters in a single package. These devices comprise two independent 4-bit binary counters, each having a clear (CLR) and a clock (CLK) input. N-bit binary counters can be implemented with each package, providing the capability of divide by 256. The 'HC393 devices have parallel outputs from each counter stage so that any submultiple of the input count frequency is available for system timing signals.

SN54HC393 . . . J OR W PACKAGE
SN74HC393 . . . D, DB, N, NS, OR PW PACKAGE
(TOP VIEW)



SN54HC393 . . . FK PACKAGE
(TOP VIEW)



NC – No internal connection

ORDERING INFORMATION

| T _A | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|----------------|---------------|---------------|-----------------------|------------------|
| -40°C to 85°C | PDIP – N | Tube | SN74HC393N | SN74HC393N |
| | SOIC – D | Tube | SN74HC393D | HC393 |
| | | Tape and reel | SN74HC393DR | |
| | SOP – NS | Tape and reel | SN74HC393NSR | HC393 |
| | SSOP – DB | Tape and reel | SN74HC393DBR | HC393 |
| TSSOP – PW | Tape and reel | SN74HC393PWR | HC393 | |
| -55°C to 125°C | CDIP – J | Tube | SNJ54HC393J | SNJ54HC393J |
| | CFP – W | Tube | SNJ54HC393W | SNJ54HC393W |
| | LCCC – FK | Tube | SNJ54HC393FK | SNJ54HC393FK |

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



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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

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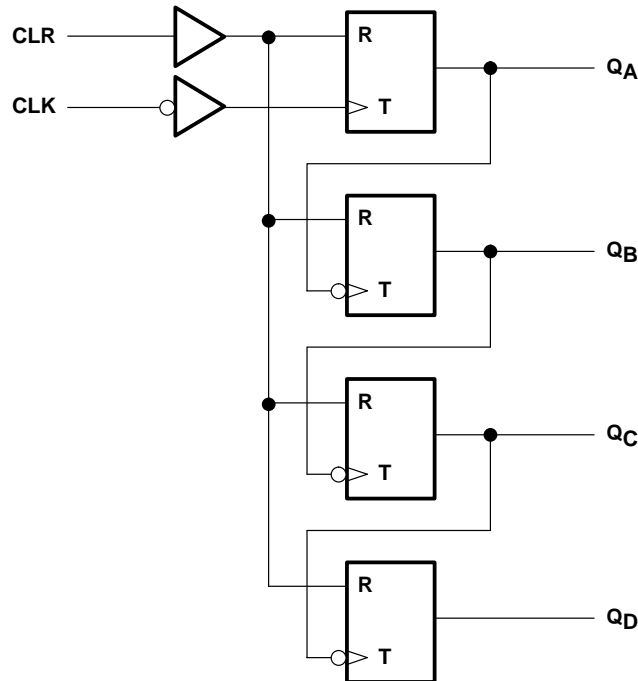
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FUNCTION TABLE COUNT SEQUENCE
(each counter)

| COUNT | OUTPUTS | | | |
|-------|----------------|----------------|----------------|----------------|
| | Q _D | Q _C | Q _B | Q _A |
| 0 | L | L | L | L |
| 1 | L | L | L | H |
| 2 | L | L | H | L |
| 3 | L | L | H | H |
| 4 | L | H | L | L |
| 5 | L | H | L | H |
| 6 | L | H | H | L |
| 7 | L | H | H | H |
| 8 | H | L | L | L |
| 9 | H | L | L | H |
| 10 | H | L | H | L |
| 11 | H | L | H | H |
| 12 | H | H | L | L |
| 13 | H | H | L | H |
| 14 | H | H | H | L |
| 15 | H | H | H | H |

logic diagram, each counter (positive logic)



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

| | |
|---|----------------|
| Supply voltage range, V_{CC} | –0.5 V to 7 V |
| Input clamp current, I_{IK} ($V_I < 0$ or $V_I > V_{CC}$) (see Note 1) | ±20 mA |
| Output clamp current, I_{OK} ($V_O < 0$ or $V_O > V_{CC}$) (see Note 1) | ±20 mA |
| Continuous output current, I_O ($V_O = 0$ to V_{CC}) | ±25 mA |
| Continuous current through V_{CC} or GND | ±50 mA |
| Package thermal impedance, θ_{JA} (see Note 2): D package | 86°C/W |
| DB package | 96°C/W |
| N package | 80°C/W |
| NS package | 76°C/W |
| PW package | 113°C/W |
| 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. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
2. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions (see Note 3)

| | | SN54HC393 | | | SN74HC393 | | | UNIT |
|-----------------------|---------------------------------|------------------|-----|----------|------------------|-----|----------|------|
| | | MIN | NOM | MAX | MIN | NOM | MAX | |
| V_{CC} | Supply voltage | 2 | 5 | 6 | 2 | 5 | 6 | V |
| V_{IH} | High-level input voltage | $V_{CC} = 2$ V | | 1.5 | $V_{CC} = 2$ V | | 1.5 | V |
| | | $V_{CC} = 4.5$ V | | 3.15 | $V_{CC} = 4.5$ V | | 3.15 | |
| | | $V_{CC} = 6$ V | | 4.2 | $V_{CC} = 6$ V | | 4.2 | |
| V_{IL} | Low-level input voltage | $V_{CC} = 2$ V | | | 0.5 | | 0.5 | V |
| | | $V_{CC} = 4.5$ V | | | 1.35 | | 1.35 | |
| | | $V_{CC} = 6$ V | | | 1.8 | | 1.8 | |
| V_I | Input voltage | 0 | | V_{CC} | 0 | | V_{CC} | V |
| V_O | Output voltage | 0 | | V_{CC} | 0 | | V_{CC} | V |
| $\Delta t/\Delta v$ † | Input transition rise/fall time | $V_{CC} = 2$ V | | | 1000 | | 1000 | ns |
| | | $V_{CC} = 4.5$ V | | | 500 | | 500 | |
| | | $V_{CC} = 6$ V | | | 400 | | 400 | |
| T_A | Operating free-air temperature | –55 | | 125 | –40 | | 85 | °C |

NOTE 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.

† If this device is used in the threshold region (from $V_{ILmax} = 0.5$ V to $V_{IHmin} = 1.5$ V), there is a potential to go into the wrong state from induced grounding, causing double clocking. Operating with the inputs at $t_f = 1000$ ns and $V_{CC} = 2$ V does not damage the device; however, functionally, the CLK inputs are not ensured while in the shift, count, or toggle operating modes.



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

| PARAMETER | TEST CONDITIONS | | V _{CC} | T _A = 25°C | | | SN54HC393 | | SN74HC393 | | UNIT |
|-----------------|---|---------------------------|-----------------|-----------------------|-------|------|-----------|-------|-----------|-------|------|
| | | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| V _{OH} | V _I = V _{IH} or V _{IL} | I _{OH} = -20 μA | 2 V | 1.9 | 1.998 | | 1.9 | | 1.9 | V | |
| | | | 4.5 V | 4.4 | 4.499 | | 4.4 | | 4.4 | | |
| | | | 6 V | 5.9 | 5.999 | | 5.9 | | 5.9 | | |
| | | I _{OH} = -4 mA | 4.5 V | 3.98 | 4.3 | | 3.7 | | 3.84 | | |
| | | I _{OH} = -5.2 mA | 6 V | 5.48 | 5.8 | | 5.2 | | 5.34 | | |
| V _{OL} | V _I = V _{IH} or V _{IL} | I _{OL} = 20 μA | 2 V | | 0.002 | 0.1 | | 0.1 | | 0.1 | V |
| | | | 4.5 V | | 0.001 | 0.1 | | 0.1 | | 0.1 | |
| | | | 6 V | | 0.001 | 0.1 | | 0.1 | | 0.1 | |
| | | I _{OL} = 4 mA | 4.5 V | | 0.17 | 0.26 | | 0.4 | | 0.33 | |
| | | I _{OL} = 5.2 mA | 6 V | | 0.15 | 0.26 | | 0.4 | | 0.33 | |
| I _I | V _I = V _{CC} or 0 | | 6 V | | ±0.1 | ±100 | | ±1000 | | ±1000 | nA |
| I _{CC} | V _I = V _{CC} or 0, I _O = 0 | | 6 V | | | 8 | | 160 | | 80 | μA |
| C _i | | | 2 V to 6 V | | 3 | 10 | | 10 | | 10 | pF |

timing requirements over recommended operating free-air temperature range (unless otherwise noted)

| | | V _{CC} | T _A = 25°C | | SN54HC393 | | SN74HC393 | | UNIT |
|--------------------|--------------------------|-----------------|-----------------------|-----|-----------|-----|-----------|-----|------|
| | | | MIN | MAX | MIN | MAX | MIN | MAX | |
| f _{clock} | Clock frequency | 2 V | | 6 | | 4.2 | | 5 | MHz |
| | | 4.5 V | | 31 | | 21 | | 25 | |
| | | 6 V | | 36 | | 25 | | 28 | |
| t _w | Pulse duration | CLK high or low | 2 V | 80 | | 120 | | 100 | ns |
| | | | 4.5 V | 16 | | 24 | | 20 | |
| | | | 6 V | 14 | | 20 | | 18 | |
| | | CLR high | 2 V | 80 | | 120 | | 100 | |
| | | | 4.5 V | 16 | | 24 | | 20 | |
| | | | 6 V | 14 | | 20 | | 18 | |
| t _{su} | Setup time, CLR inactive | 2 V | | 25 | | 25 | | 25 | ns |
| | | 4.5 V | | 5 | | 5 | | 5 | |
| | | 6 V | | 5 | | 5 | | 5 | |



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switching characteristics over recommended operating free-air temperature range, $C_L = 50$ pF (unless otherwise noted) (see Figure 1)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | V _{CC} | T _A = 25°C | | | SN54HC393 | | SN74HC393 | | UNIT |
|------------------|--------------|----------------|-----------------|-----------------------|-----|-----|-----------|-----|-----------|-----|------|
| | | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| f _{max} | CLK | Q _A | 2 V | 6 | 10 | | 4.2 | | 5 | MHz | |
| | | | 4.5 V | 31 | 50 | | 21 | | 25 | | |
| | | | 6 V | 36 | 60 | | 25 | | 28 | | |
| t _{pd} | CLK | Q _A | 2 V | | 50 | 120 | | 180 | | 150 | ns |
| | | | 4.5 V | | 15 | 24 | | 36 | | 30 | |
| | | | 6 V | | 13 | 20 | | 31 | | 26 | |
| | | Q _B | 2 V | | 72 | 190 | | 285 | | 240 | |
| | | | 4.5 V | | 22 | 38 | | 57 | | 47 | |
| | | | 6 V | | 18 | 32 | | 48 | | 40 | |
| | | Q _C | 2 V | | 91 | 240 | | 360 | | 300 | |
| | | | 4.5 V | | 28 | 48 | | 72 | | 60 | |
| | | | 6 V | | 22 | 41 | | 61 | | 51 | |
| | | Q _D | 2 V | | 100 | 290 | | 430 | | 360 | |
| | | | 4.5 V | | 32 | 58 | | 87 | | 72 | |
| | | | 6 V | | 24 | 50 | | 74 | | 62 | |
| t _{PHL} | CLR | Any | 2 V | | 45 | 165 | | 250 | | 205 | ns |
| | | | 4.5 V | | 17 | 33 | | 49 | | 41 | |
| | | | 6 V | | 14 | 28 | | 42 | | 35 | |
| t _t | | Any | 2 V | | 28 | 75 | | 110 | | 95 | ns |
| | | | 4.5 V | | 8 | 15 | | 22 | | 19 | |
| | | | 6 V | | 6 | 13 | | 19 | | 16 | |

operating characteristics, T_A = 25°C

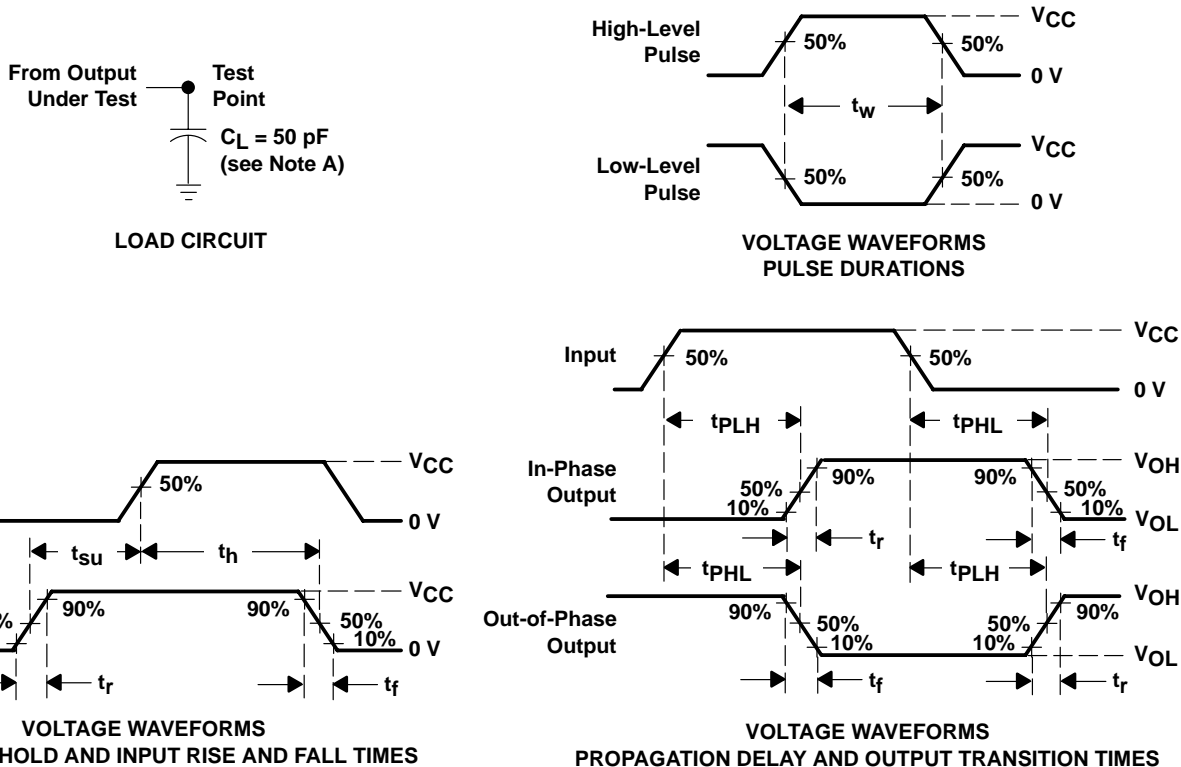
| PARAMETER | TEST CONDITIONS | TYP | UNIT |
|---|-----------------|-----|------|
| C _{pd} Power dissipation capacitance per counter | No load | 40 | pF |



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

J (R-GDIP-T**)

14 LEADS SHOWN

CERAMIC DUAL IN-LINE PACKAGE



| 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) |

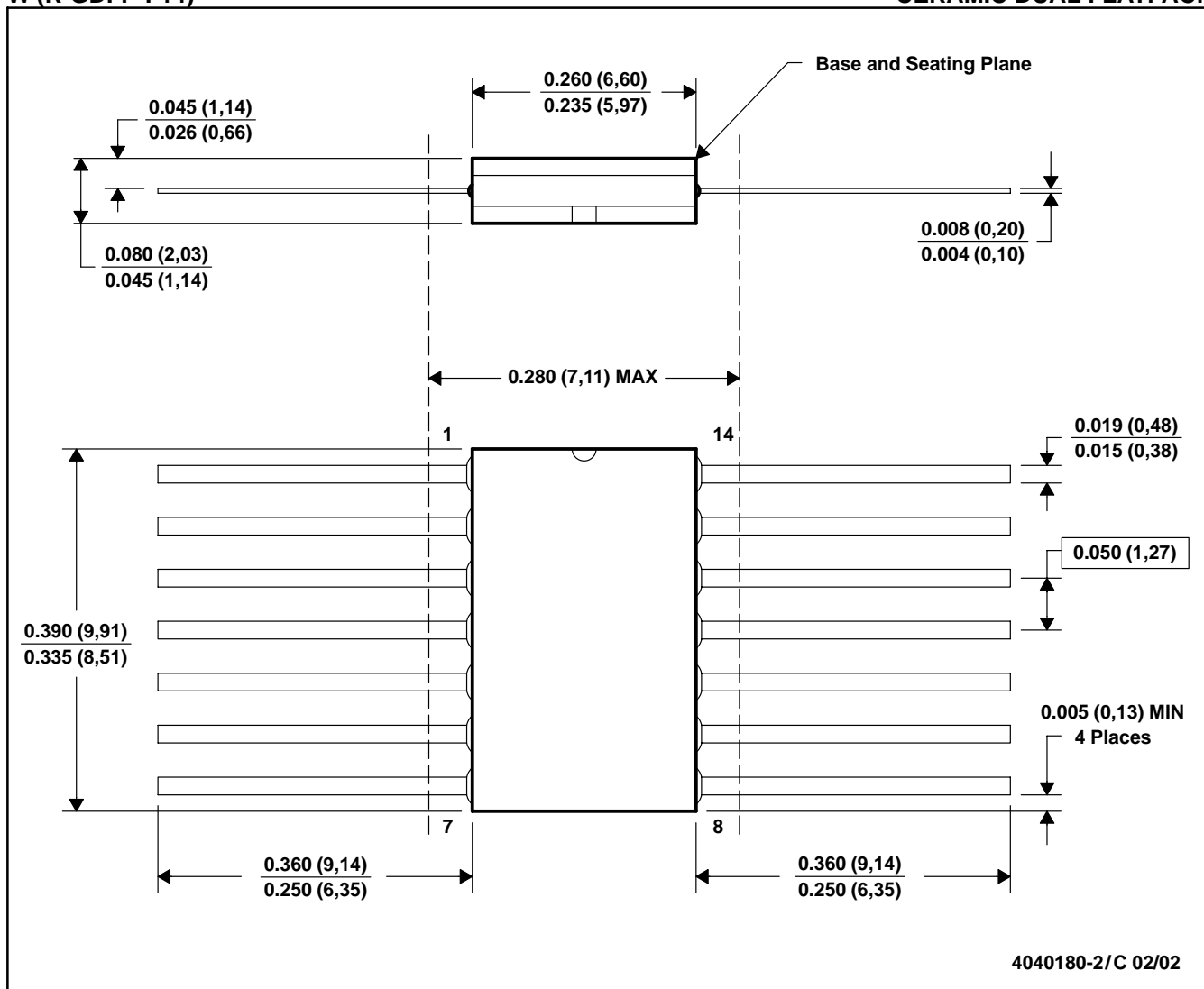


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- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. This package is hermetically sealed with a ceramic lid using glass frit.
 - D. Index point is provided on cap for terminal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

W (R-GDFP-F14)

CERAMIC DUAL FLATPACK



- NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.
 C. This package can be hermetically sealed with a ceramic lid using glass frit.
 D. Index point is provided on cap for terminal identification only.
 E. Falls within MIL STD 1835 GDFP1-F14 and JEDEC MO-092AB

FK (S-CQCC-N**)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN

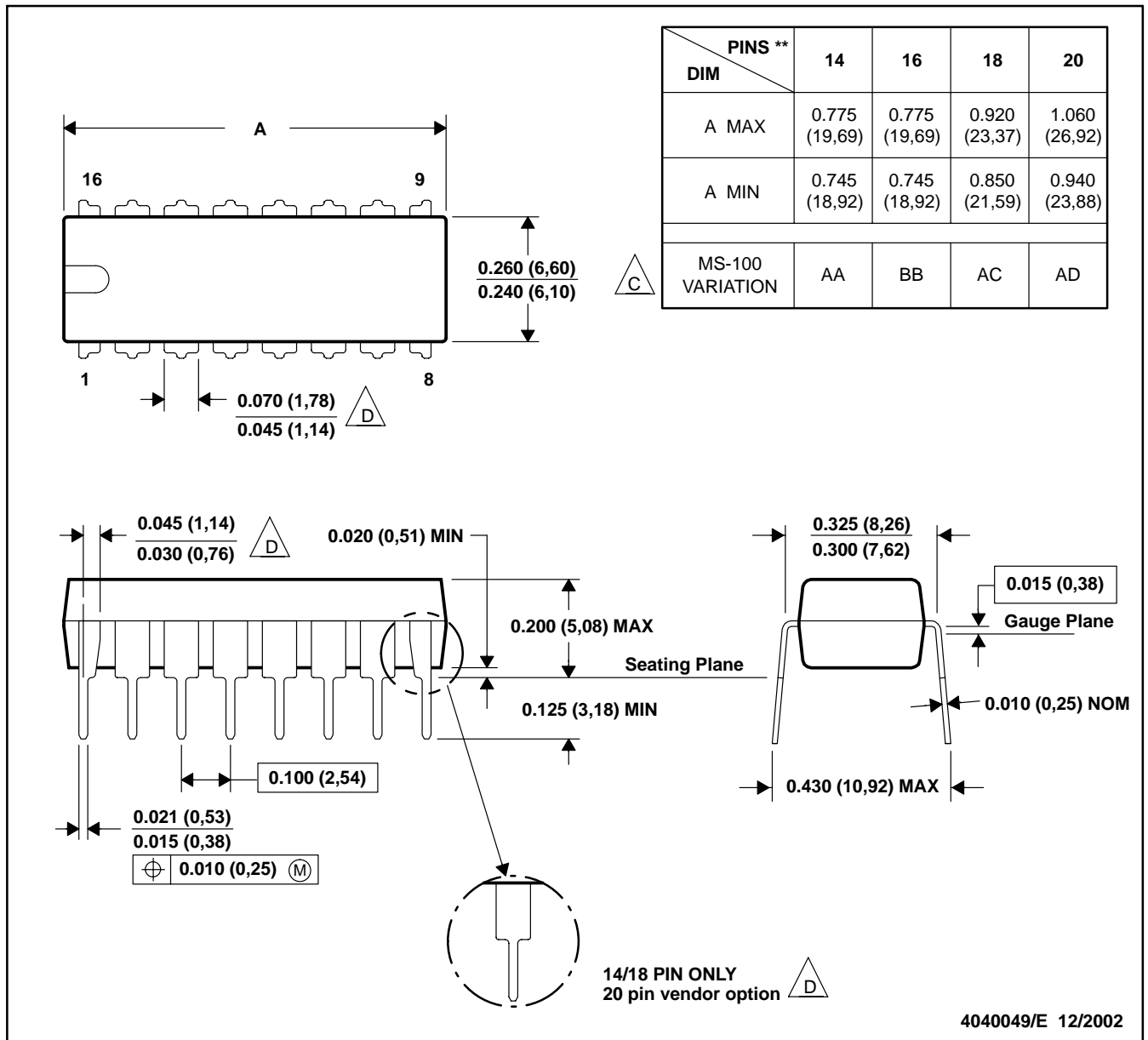


- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. This package can be hermetically sealed with a metal lid.
 - D. The terminals are gold plated.
 - E. Falls within JEDEC MS-004

N (R-PDIP-T**)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN



- 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-G**)

PLASTIC SMALL-OUTLINE PACKAGE

8 PINS SHOWN



- 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

MECHANICAL DATA

NS (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



- 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.

DB (R-PDSO-G**)

PLASTIC SMALL-OUTLINE

28 PINS SHOWN



- 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-150

PW (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



- 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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