

MC74HC393A

Dual 4-Stage Binary Ripple Counter

High-Performance Silicon-Gate CMOS

The MC74HC393A is identical in pinout to the LS393. The device inputs are compatible with standard CMOS outputs; with pullup resistors, they are compatible with LSTTL outputs.

This device consists of two independent 4-bit binary ripple counters with parallel outputs from each counter stage. A ÷ 256 counter can be obtained by cascading the two binary counters.

Internal flip-flops are triggered by high-to-low transitions of the clock input. Reset for the counters is asynchronous and active-high. State changes of the Q outputs do not occur simultaneously because of internal ripple delays. Therefore, decoded output signals are subject to decoding spikes and should not be used as clocks or as strobes except when gated with the Clock of the HC393A.

Features

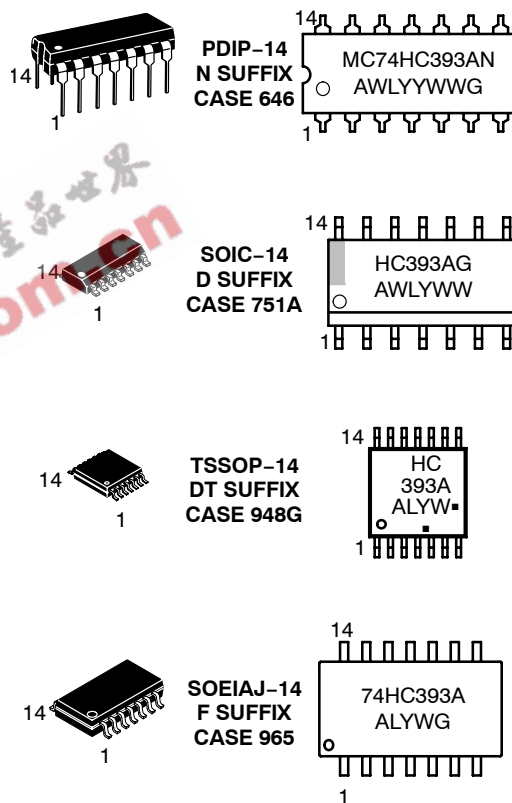
- Output Drive Capability: 10 LSTTL Loads
- Outputs Directly Interface to CMOS, NMOS, and TTL
- Operating Voltage Range: 2.0 to 6.0 V
- Low Input Current: 1 μ A
- High Noise Immunity Characteristic of CMOS Devices
- In Compliance with the JEDEC Standard No. 7A Requirements
- Chip Complexity: 236 FETs or 59 Equivalent Gates
- Pb-Free Packages are Available



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MARKING DIAGRAMS



A = Assembly Location
L, WL = Wafer Lot
Y, YY = Year
W, WW = Work Week
G or ■ = Pb-Free Package

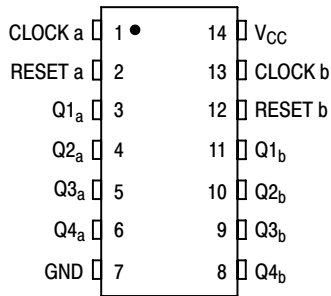
(Note: Microdot may be in either location)

ORDERING INFORMATION

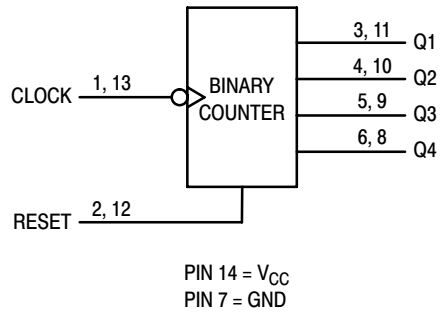
See detailed ordering and shipping information in the package dimensions section on page 2 of this data sheet.

MC74HC393A

PIN ASSIGNMENT



LOGIC DIAGRAM



FUNCTION TABLE

| Inputs | | Outputs |
|--------|-------|-----------------------|
| Clock | Reset | |
| X | H | L |
| H | L | No Change |
| L | L | No Change |
| | L | No Change |
| | L | Advance to Next State |

ORDERING INFORMATION

| Device | Package | Shipping [†] |
|-----------------|---------------------|-----------------------|
| MC74HC393AN | PDIP-14 | 25 Units / Rail |
| MC74HC393ANG | PDIP-14 (Pb-Free) | |
| MC74HC393AD | SOIC-14 | 55 Units / Rail |
| MC74HC393ADG | SOIC-14 (Pb-Free) | |
| MC74HC393ADR2 | SOIC-14 | 2500 / Tape & Reel |
| MC74HC393ADR2G | SOIC-14 (Pb-Free) | |
| MC74HC393ADTR2 | TSSOP-14* | |
| MC74HC393ADTR2G | TSSOP-14* | |
| MC74HC393AFEL | SOEIAJ-14 | 2000 / Tape & Reel |
| MC74HC393AFELG | SOEIAJ-14 (Pb-Free) | |

[†]For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

*This package is inherently Pb-Free.

MC74HC393A

MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|-----------|---|-------------------------|------|
| V_{CC} | DC Supply Voltage (Referenced to GND) | - 0.5 to + 7.0 | V |
| V_{in} | DC Input Voltage (Referenced to GND) | - 0.5 to $V_{CC} + 0.5$ | V |
| V_{out} | DC Output Voltage (Referenced to GND) | - 0.5 to $V_{CC} + 0.5$ | V |
| I_{in} | DC Input Current, per Pin | ± 20 | mA |
| I_{out} | DC Output Current, per Pin | ± 25 | mA |
| I_{CC} | DC Supply Current, V_{CC} and GND Pins | ± 50 | mA |
| P_D | Power Dissipation in Still Air, Plastic DIP† SOIC Package† TSSOP Package† | 750 500 450 | mW |
| T_{stg} | Storage Temperature | - 65 to + 150 | °C |
| T_L | Lead Temperature, 1 mm from Case for 10 Seconds Plastic DIP, SOIC or TSSOP Package | 260 | °C |

This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation, V_{in} and V_{out} should be constrained to the range $GND \leq (V_{in} \text{ or } V_{out}) \leq V_{CC}$. Unused inputs must always be tied to an appropriate logic voltage level (e.g., either GND or V_{CC}). Unused outputs must be left open.

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

†Derating — Plastic DIP: - 10 mW/°C from 65° to 125°C
SOIC Package: - 7 mW/°C from 65° to 125°C
TSSOP Package: - 6.1 mW/°C from 65° to 125°C

For high frequency or heavy load considerations, see Chapter 2 of the ON Semiconductor High-Speed CMOS Data Book (DL129/D).

RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | Min | Max | Unit |
|-------------------|--|--|--------------------------------|------|
| V_{CC} | DC Supply Voltage (Referenced to GND) | 2.0 | 6.0 | V |
| V_{in}, V_{out} | DC Input Voltage, Output Voltage (Referenced to GND) | 0 | V_{CC} | V |
| T_A | Operating Temperature, All Package Types | - 55 | + 125 | °C |
| t_r, t_f | Input Rise and Fall Time (Figure 1) | $V_{CC} = 2.0 \text{ V}$ $V_{CC} = 3.0 \text{ V}$ $V_{CC} = 4.5 \text{ V}$ $V_{CC} = 6.0 \text{ V}$ | 0 1000 600 500 400 | ns |

DC ELECTRICAL CHARACTERISTICS (Voltages Referenced to GND)

| Symbol | Parameter | Test Conditions | V_{CC} V | Guaranteed Limit | | | Unit |
|----------|-----------------------------------|---|---------------|------------------|---------|----------|------|
| | | | | - 55 to 25° C | ≤ 85° C | ≤ 125° C | |
| V_{IH} | Minimum High-Level Input Voltage | $V_{out} = 0.1 \text{ V or } V_{CC} - 0.1 \text{ V}$ $ I_{out} \leq 20 \mu\text{A}$ | 2.0 | 1.5 | 1.5 | 1.5 | V |
| | | | 3.0 | 2.1 | 2.1 | 2.1 | |
| | | | 4.5 | 3.15 | 3.15 | 3.15 | |
| | | | 6.0 | 4.2 | 4.2 | 4.2 | |
| V_{IL} | Maximum Low-Level Input Voltage | $V_{out} = 0.1 \text{ V or } V_{CC} - 0.1 \text{ V}$ $ I_{out} \leq 20 \mu\text{A}$ | 2.0 | 0.5 | 0.5 | 0.5 | V |
| | | | 3.0 | 0.9 | 0.9 | 0.9 | |
| | | | 4.5 | 1.35 | 1.35 | 1.35 | |
| | | | 6.0 | 1.80 | 1.80 | 1.80 | |
| V_{OH} | Minimum High-Level Output Voltage | $V_{in} = V_{IH} \text{ or } V_{IL}$ $ I_{out} \leq 20 \mu\text{A}$ | 2.0 | 1.9 | 1.9 | 1.9 | V |
| | | | 4.5 | 4.4 | 4.4 | 4.4 | |
| | | | 6.0 | 5.9 | 5.9 | 5.9 | |
| | | $V_{in} = V_{IH} \text{ or } V_{IL}$ $ I_{out} \leq 2.4 \text{ mA}$ $ I_{out} \leq 4.0 \text{ mA}$ $ I_{out} \leq 5.2 \text{ mA}$ | 3.0 | 2.48 | 2.34 | 2.20 | |
| | | | 4.5 | 3.98 | 3.84 | 3.70 | |
| | | | 6.0 | 5.48 | 5.34 | 5.20 | |

MC74HC393A

DC ELECTRICAL CHARACTERISTICS (Voltages Referenced to GND)

| Symbol | Parameter | Test Conditions | V _{CC} V | Guaranteed Limit | | | Unit |
|-----------------|--|--|----------------------|------------------|--------|---------|------|
| | | | | - 55 to 25°C | ≤ 85°C | ≤ 125°C | |
| V _{OL} | Maximum Low-Level Output Voltage | V _{in} = V _{IH} or V _{IL} I _{out} ≤ 20 μA | 2.0 | 0.1 | 0.1 | 0.1 | V |
| | | | 4.5 | 0.1 | 0.1 | 0.1 | |
| | | | 6.0 | 0.1 | 0.1 | 0.1 | |
| | | V _{in} = V _{IH} or V _{IL} I _{out} ≤ 2.4 mA I _{out} ≤ 4.0 mA I _{out} ≤ 5.2 mA | 3.0 | 0.26 | 0.33 | 0.40 | |
| | | | 4.5 | 0.26 | 0.33 | 0.40 | |
| | | | 6.0 | 0.26 | 0.33 | 0.40 | |
| I _{in} | Maximum Input Leakage Current | V _{in} = V _{CC} or GND | 6.0 | ±0.1 | ±1.0 | ±1.0 | μA |
| I _{CC} | Maximum Quiescent Supply Current (per Package) | V _{in} = V _{CC} or GND I _{out} = 0 μA | 6.0 | 4 | 40 | 160 | μA |

NOTE: Information on typical parametric values can be found in Chapter 2 of the ON Semiconductor High-Speed CMOS Data Book (DL129/D).

AC ELECTRICAL CHARACTERISTICS (C_L = 50 pF, Input t_r = t_f = 6 ns)

| Symbol | Parameter | V _{CC} V | Guaranteed Limit | | | Unit |
|--|---|----------------------|------------------|--------|---------|------|
| | | | - 55 to 25°C | ≤ 85°C | ≤ 125°C | |
| f _{max} | Maximum Clock Frequency (50% Duty Cycle) (Figures 1 and 3) | 2.0 | 10 | 9 | 8 | MHz |
| | | 3.0 | 15 | 14 | 12 | |
| | | 4.5 | 30 | 28 | 25 | |
| | | 6.0 | 50 | 45 | 40 | |
| | | 6.0 | 50 | 45 | 40 | |
| t _{PLH} , t _{PHL} | Maximum Propagation Delay, Clock to Q1 (Figures 1 and 3) | 2.0 | 70 | 80 | 90 | ns |
| | | 3.0 | 40 | 45 | 50 | |
| | | 4.5 | 24 | 30 | 36 | |
| | | 6.0 | 20 | 26 | 31 | |
| t _{PLH} , t _{PHL} | Maximum Propagation Delay, Clock to Q2 (Figures 1 and 3) | 2.0 | 100 | 105 | 180 | ns |
| | | 3.0 | 56 | 70 | 100 | |
| | | 4.5 | 34 | 45 | 55 | |
| | | 6.0 | 20 | 38 | 48 | |
| t _{PLH} , t _{PHL} | Maximum Propagation Delay, Clock to Q3 (Figures 1 and 3) | 2.0 | 130 | 150 | 180 | ns |
| | | 3.0 | 80 | 105 | 130 | |
| | | 4.5 | 44 | 55 | 70 | |
| | | 6.0 | 37 | 47 | 58 | |
| t _{PLH} , t _{PHL} | Maximum Propagation Delay, Clock to Q4 (Figures 1 and 3) | 2.0 | 160 | 250 | 300 | ns |
| | | 3.0 | 110 | 185 | 210 | |
| | | 4.5 | 52 | 65 | 82 | |
| | | 6.0 | 44 | 55 | 65 | |
| t _{PHL} | Maximum Propagation Delay, Reset to any Q (Figures 2 and 3) | 2.0 | 80 | 95 | 110 | ns |
| | | 3.0 | 48 | 65 | 75 | |
| | | 4.5 | 30 | 38 | 50 | |
| | | 6.0 | 26 | 33 | 43 | |
| t _{TLH} , t _{THL} | Maximum Output Transition Time, Any Output (Figures 1 and 3) | 2.0 | 75 | 95 | 110 | ns |
| | | 3.0 | 27 | 32 | 36 | |
| | | 4.5 | 15 | 19 | 22 | |
| | | 6.0 | 13 | 16 | 19 | |
| C _{in} | Maximum Input Capacitance | — | 10 | 10 | 10 | pF |

NOTES:

- For propagation delays with loads other than 50 pF, see Chapter 2 of the ON Semiconductor High-Speed CMOS Data Book (DL129/D).
- Information on typical parametric values can be found in Chapter 2 of the ON Semiconductor High-Speed CMOS Data Book (DL129/D).

| C _{PD} | Power Dissipation Capacitance (Per Counter)* | Typical @ 25°C, V _{CC} = 5.0 V | |
|-----------------|--|---|--|
| | | 35 | |

* Used to determine the no-load dynamic power consumption: P_D = C_{PD} V_{CC}²f + I_{CC} V_{CC}. For load considerations, see Chapter 2 of the ON Semiconductor High-Speed CMOS Data Book (DL129/D).

MC74HC393A

TIMING REQUIREMENTS (Input $t_r = t_f = 6$ ns)

| Symbol | Parameter | V _{CC} V | Guaranteed Limit | | | Unit |
|------------|--|----------------------|------------------|--------|---------|------|
| | | | - 55 to 25°C | ≤ 85°C | ≤ 125°C | |
| t_{rec} | Minimum Recovery Time, Reset Inactive to Clock (Figure 2) | 2.0 | 25 | 30 | 40 | ns |
| | | 3.0 | 15 | 20 | 30 | |
| | | 4.5 | 10 | 13 | 15 | |
| | | 6.0 | 9 | 11 | 13 | |
| t_w | Minimum Pulse Width, Clock (Figure 1) | 2.0 | 75 | 95 | 110 | ns |
| | | 3.0 | 27 | 32 | 36 | |
| | | 4.5 | 15 | 19 | 22 | |
| | | 6.0 | 13 | 15 | 19 | |
| t_w | Minimum Pulse Width, Reset (Figure 2) | 2.0 | 75 | 95 | 110 | ns |
| | | 3.0 | 27 | 32 | 36 | |
| | | 4.5 | 15 | 19 | 22 | |
| | | 6.0 | 13 | 15 | 19 | |
| t_r, t_f | Maximum Input Rise and Fall Times (Figure 1) | 2.0 | 1000 | 1000 | 1000 | ns |
| | | 3.0 | 800 | 800 | 800 | |
| | | 4.5 | 500 | 500 | 500 | |
| | | 6.0 | 400 | 400 | 400 | |

NOTE: Information on typical parametric values can be found in Chapter 2 of the ON Semiconductor High-Speed CMOS Data Book (DL129/D).

PIN DESCRIPTIONS

INPUTS

Clock (Pins 1, 13)

Clock input. The internal flip-flops are toggled and the counter state advances on high-to-low transitions of the clock input.

OUTPUTS

Q1, Q2, Q3, Q4 (Pins 3, 4, 5, 6, 8, 9, 10, 11)

Parallel binary outputs Q4 is the most significant bit.

CONTROL INPUTS

Reset (Pins 2, 12)

Active-high, asynchronous reset. A separate reset is provided for each counter. A high at the Reset input prevents counting and forces all four outputs low.

MC74HC393A

SWITCHING WAVEFORMS

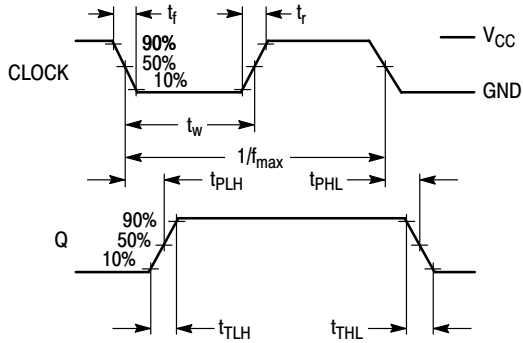


Figure 1.

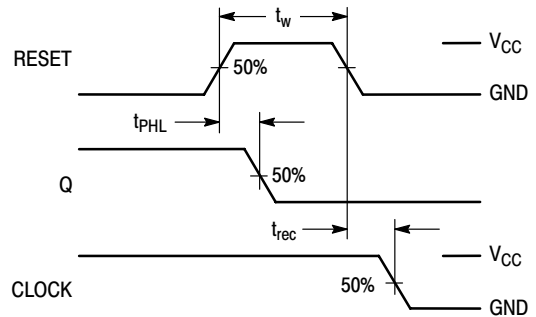
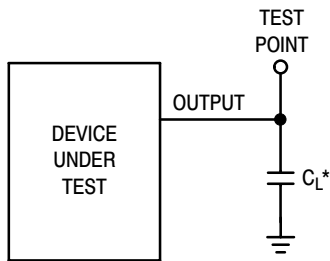


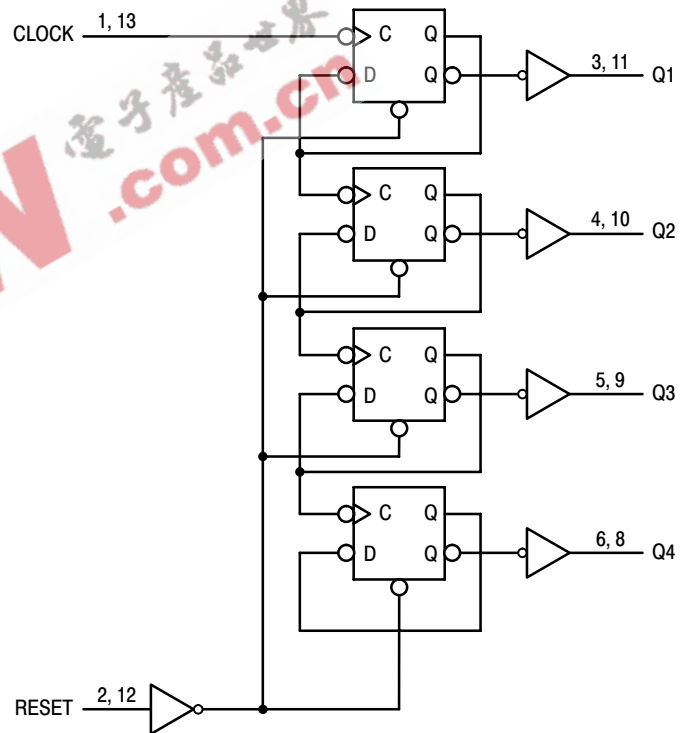
Figure 2.



*Includes all probe and jig capacitance

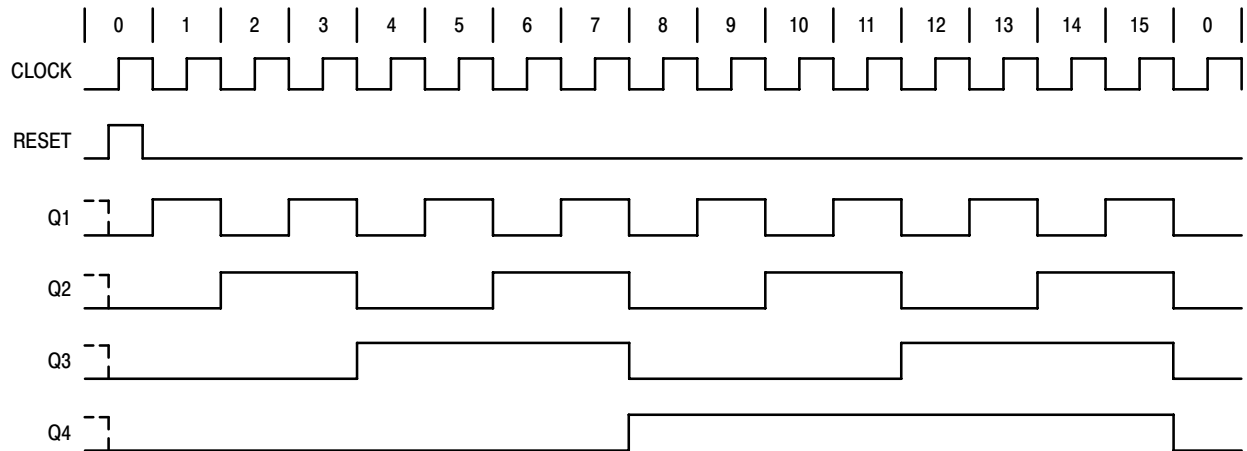
Figure 3. Test Circuit

EXPANDED LOGIC DIAGRAM



MC74HC393A

TIMING DIAGRAM



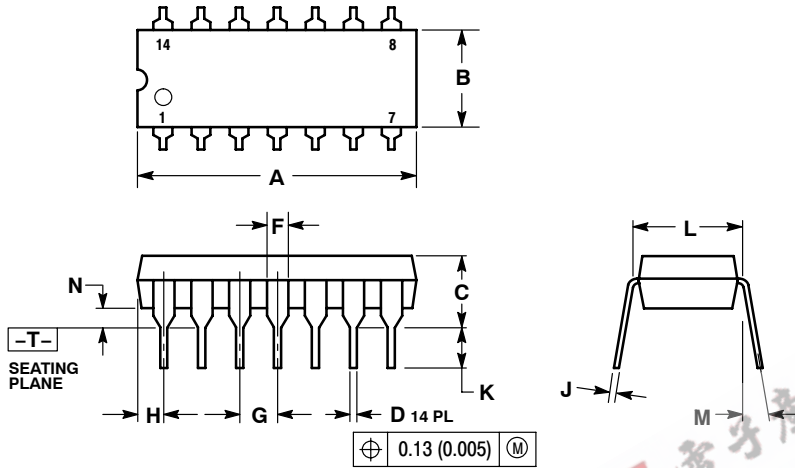
COUNT SEQUENCE

| Count | Outputs | | | |
|-------|---------|----|----|----|
| | Q4 | Q3 | Q2 | Q1 |
| 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 |

MC74HC393A

PACKAGE DIMENSIONS

PDIP-14
CASE 646-06
ISSUE P



NOTES:

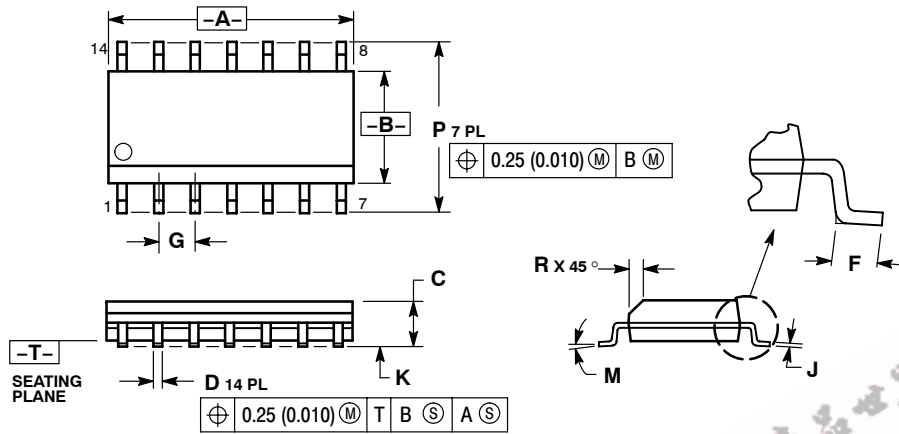
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
4. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
5. ROUNDED CORNERS OPTIONAL.

| DIM | INCHES | | MILLIMETERS | |
|-----|-----------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.715 | 0.770 | 18.16 | 19.56 |
| B | 0.240 | 0.260 | 6.10 | 6.60 |
| C | 0.145 | 0.185 | 3.69 | 4.69 |
| D | 0.015 | 0.021 | 0.38 | 0.53 |
| F | 0.040 | 0.070 | 1.02 | 1.78 |
| G | 0.100 BSC | | 2.54 BSC | |
| H | 0.052 | 0.095 | 1.32 | 2.41 |
| J | 0.008 | 0.015 | 0.20 | 0.38 |
| K | 0.115 | 0.135 | 2.92 | 3.43 |
| L | 0.290 | 0.310 | 7.37 | 7.87 |
| M | 10° | | 10° | |
| N | 0.015 | 0.039 | 0.38 | 1.01 |

MC74HC393A

PACKAGE DIMENSIONS

SOIC-14
CASE 751A-03
ISSUE H

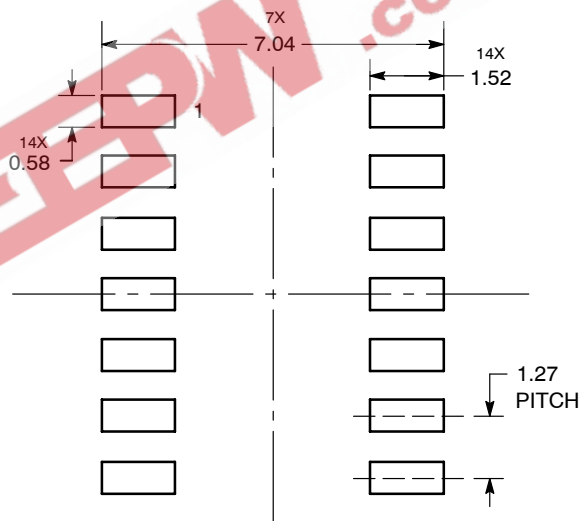


NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|------|-----------|-------|
| | MIN | MAX | MIN | MAX |
| A | 8.55 | 8.75 | 0.337 | 0.344 |
| B | 3.80 | 4.00 | 0.150 | 0.157 |
| C | 1.35 | 1.75 | 0.054 | 0.068 |
| D | 0.35 | 0.49 | 0.014 | 0.019 |
| F | 0.40 | 1.25 | 0.016 | 0.049 |
| G | 1.27 BSC | | 0.050 BSC | |
| J | 0.19 | 0.25 | 0.008 | 0.009 |
| K | 0.10 | 0.25 | 0.004 | 0.009 |
| M | 0° | 7° | 0° | 7° |
| P | 5.80 | 6.20 | 0.228 | 0.244 |
| R | 0.25 | 0.50 | 0.010 | 0.019 |

SOLDERING FOOTPRINT*



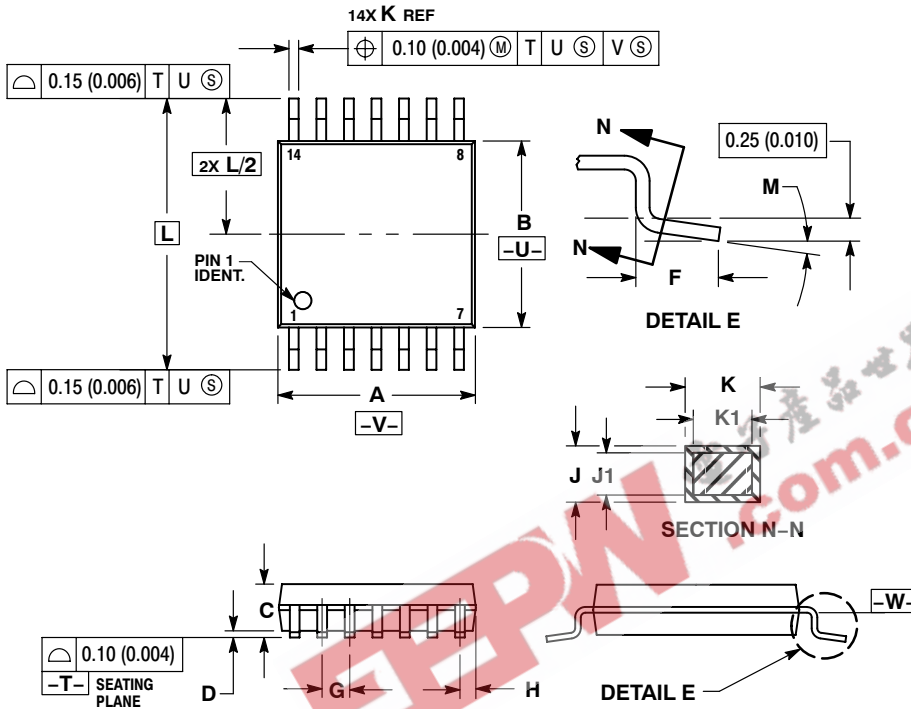
DIMENSIONS: MILLIMETERS

*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

MC74HC393A

PACKAGE DIMENSIONS

TSSOP-14
CASE 948G-01
ISSUE B

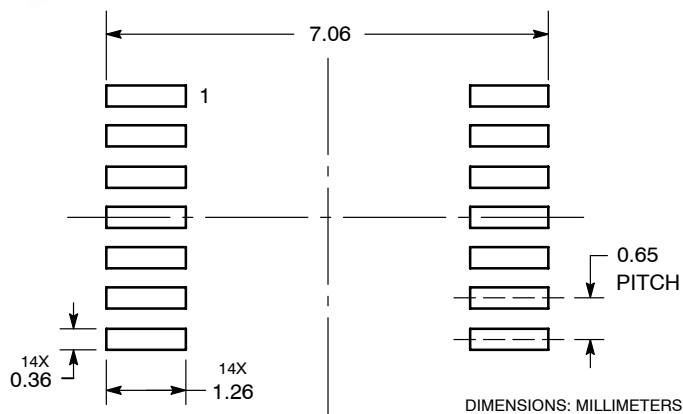


NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
7. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-

| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|------|-----------|-------|
| | MIN | MAX | MIN | MAX |
| A | 4.90 | 5.10 | 0.193 | 0.200 |
| B | 4.30 | 4.50 | 0.169 | 0.177 |
| C | --- | 1.20 | --- | 0.047 |
| D | 0.05 | 0.15 | 0.002 | 0.006 |
| F | 0.50 | 0.75 | 0.020 | 0.030 |
| G | 0.65 BSC | | 0.026 BSC | |
| H | 0.50 | 0.60 | 0.020 | 0.024 |
| J | 0.09 | 0.20 | 0.004 | 0.008 |
| J1 | 0.09 | 0.16 | 0.004 | 0.006 |
| K | 0.19 | 0.30 | 0.007 | 0.012 |
| K1 | 0.19 | 0.25 | 0.007 | 0.010 |
| L | 6.40 BSC | | 0.252 BSC | |
| M | 0° | 8° | 0° | 8° |

SOLDERING FOOTPRINT*

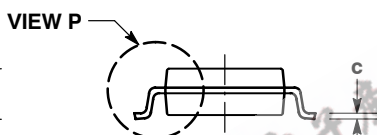
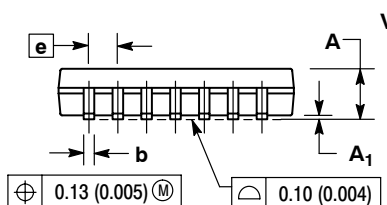
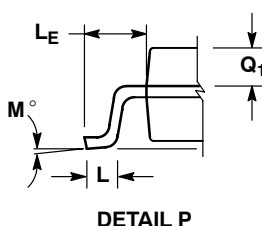
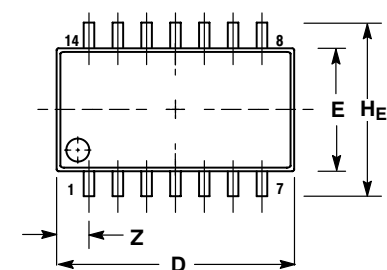


*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

MC74HC393A

PACKAGE DIMENSIONS


SOEIAJ-14
CASE 965-01
ISSUE A



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS AND ARE MEASURED AT THE PARTING LINE. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
5. THE LEAD WIDTH DIMENSION (b) DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE LEAD WIDTH DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSIONS AND ADJACENT LEAD TO BE 0.46 (0.018).

| DIM | MILLIMETERS | | INCHES | |
|----------------|-------------|-------|-----------|-------|
| | MIN | MAX | MIN | MAX |
| A | --- | 2.05 | --- | 0.081 |
| A ₁ | 0.05 | 0.20 | 0.002 | 0.008 |
| b | 0.35 | 0.50 | 0.014 | 0.020 |
| c | 0.10 | 0.20 | 0.004 | 0.008 |
| D | 9.90 | 10.50 | 0.390 | 0.413 |
| E | 5.10 | 5.45 | 0.201 | 0.215 |
| e | 1.27 BSC | | 0.050 BSC | |
| H _E | 7.40 | 8.20 | 0.291 | 0.323 |
| 0.50 | 0.50 | 0.85 | 0.020 | 0.033 |
| L _E | 1.10 | 1.50 | 0.043 | 0.059 |
| M | 0° | 10° | 0° | 10° |
| Q ₁ | 0.70 | 0.90 | 0.028 | 0.035 |
| Z | --- | 1.42 | --- | 0.056 |

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