

Product Preview
**Dual 4-Stage
Binary Ripple Counter**
High-Performance Silicon-Gate CMOS

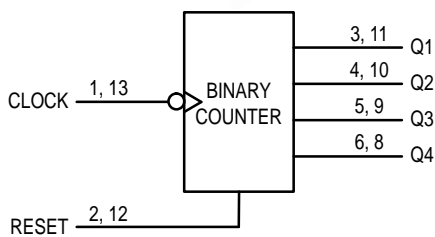
The MC54/74HC393A is identical in pinout to the LS393. The device inputs are compatible with standard CMOS outputs; with pullup resistors, they are compatible with LSTTL outputs.

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.

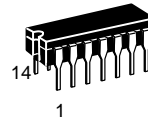
- Output Drive Capability: 10 LSTTL Loads
- Outputs Directly Interface to CMOS, NMOS, and TTL
- Operating Voltage Range: 2 to 6 V
- Low Input Current: 1 µA
- High Noise Immunity Characteristic of CMOS Devices
- In Compliance with the Requirements Defined by JEDEC Standard No. 7A
- Chip Complexity: 236 FETs or 59 Equivalent Gates

LOGIC DIAGRAM

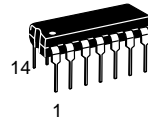


PIN 14 = V_{CC}
PIN 7 = GND

MC54/74HC393A



J SUFFIX
CERAMIC PACKAGE
CASE 632-08



N SUFFIX
PLASTIC PACKAGE
CASE 646-06



D SUFFIX
SOIC PACKAGE
CASE 751A-03



DT SUFFIX
TSSOP PACKAGE
CASE 948G-01

ORDERING INFORMATION

| | |
|--------------|---------|
| MC54HCXXXAJ | Ceramic |
| MC74HCXXXAN | Plastic |
| MC74HCXXXAD | SOIC |
| MC74HCXXXADT | TSSOP |

PIN ASSIGNMENT

| | | | |
|-----------------|---|----|-----------------|
| CLOCK a | 1 | 14 | V _{CC} |
| RESET a | 2 | 13 | CLOCK b |
| Q1 _a | 3 | 12 | RESET b |
| Q2 _a | 4 | 11 | Q1 _b |
| Q3 _a | 5 | 10 | Q2 _b |
| Q4 _a | 6 | 9 | Q3 _b |
| GND | 7 | 8 | Q4 _b |

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 |

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MC54/74HC393A

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) | - 1.5 to V _{CC} + 1.5 | 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 or Ceramic 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 (Ceramic DIP) | 260 300 | °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 ≤ (V_{in} or V_{out}) ≤ 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.

* Maximum Ratings are those values beyond which damage to the device may occur.

Functional operation should be restricted to the Recommended Operating Conditions.

† Derating — Plastic DIP: - 10 mW/°C from 65° to 125°C
Ceramic DIP: - 10 mW/°C from 100° 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 Motorola 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 V V _{CC} = 3.0 V V _{CC} = 4.5 V V _{CC} = 6.0 V | 0 0 0 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 V or V _{CC} - 0.1 V I _{out} ≤ 20 μA | 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 V or V _{CC} - 0.1 V I _{out} ≤ 20 μA | 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} or V _{IL} I _{out} ≤ 20 μA | 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} or V _{IL} I _{out} ≤ 2.4 mA I _{out} ≤ 4.0 mA I _{out} ≤ 5.2 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 | |

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 Motorola 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 | |
| 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 | 20 | 25 | 30 | |
| | | 6.0 | 16 | 21 | 27 | |
| t _{PLH} , t _{PHL} | Maximum Propagation Delay, Clock to Q2 (Figures 1 and 3) | 2.0 | 90 | 105 | 180 | ns |
| | | 3.0 | 56 | 70 | 100 | |
| | | 4.5 | 32 | 38 | 45 | |
| | | 6.0 | 25 | 31 | 40 | |
| t _{PLH} , t _{PHL} | Maximum Propagation Delay, Clock to Q3 (Figures 1 and 3) | 2.0 | 60 | 75 | 90 | ns |
| | | 3.0 | 40 | 55 | 65 | |
| | | 4.5 | 30 | 40 | 50 | |
| | | 6.0 | 25 | 35 | 42 | |
| t _{PLH} , t _{PHL} | Maximum Propagation Delay, Clock to Q4 (Figures 1 and 3) | 2.0 | 200 | 250 | 300 | ns |
| | | 3.0 | 160 | 185 | 210 | |
| | | 4.5 | 35 | 45 | 60 | |
| | | 6.0 | 30 | 40 | 50 | |
| 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 | 28 | 32 | 40 | |
| | | 6.0 | 21 | 25 | 30 | |
| 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 Motorola High-Speed CMOS Data Book (DL129/D).
- Information on typical parametric values can be found in Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).

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

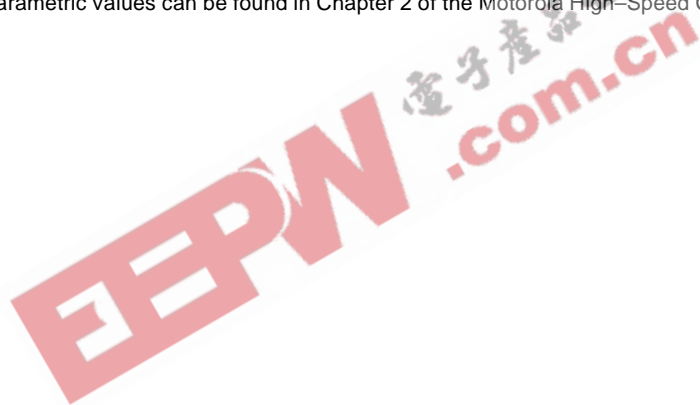
* Used to determine the no-load dynamic power consumption: P_D = C_{PD} V_{CC}²f + I_{CC} V_{CC}. For load considerations, see Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).

MC54/74HC393A

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

| Symbol | Parameter | VCC 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 | 5 | 6 | 10 | |
| | | 6.0 | 5 | 5 | 7 | |
| 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 Motorola 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.

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.

vided for each counter. A high at the Reset input prevents counting and forces all four outputs low.

OUTPUTS

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

Parallel binary outputs Q4 is the most significant bit.

SWITCHING WAVEFORMS

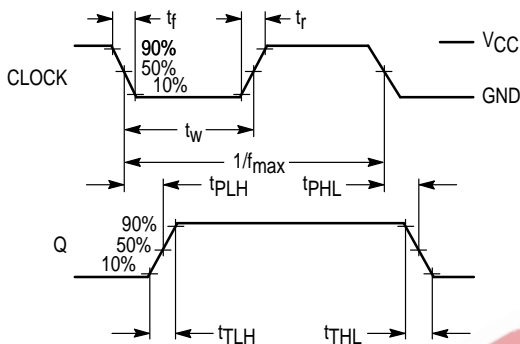


Figure 1.

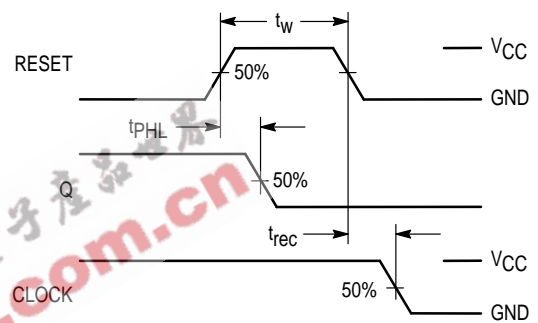
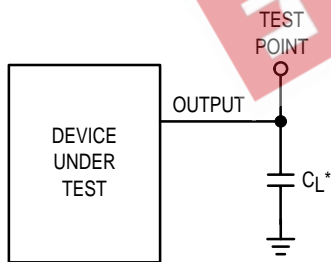


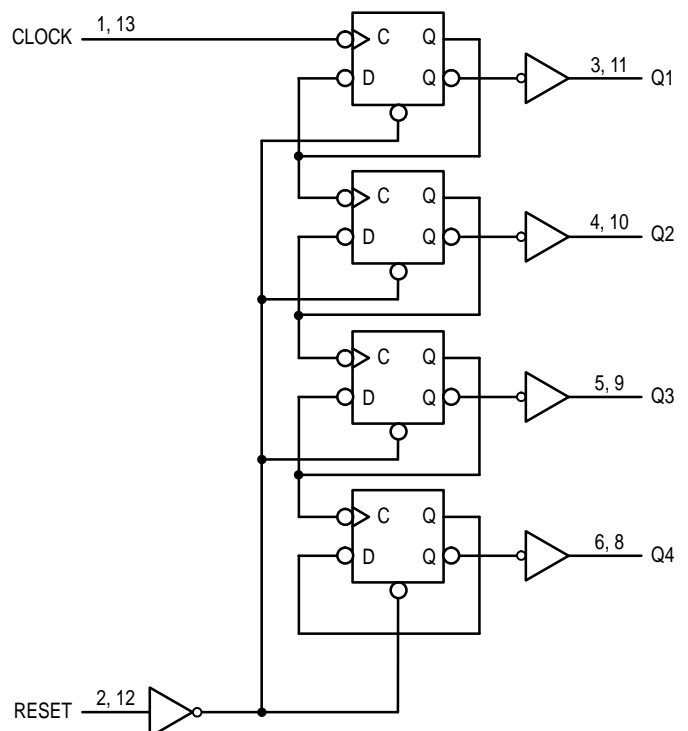
Figure 2.



* Includes all probe and jig capacitance

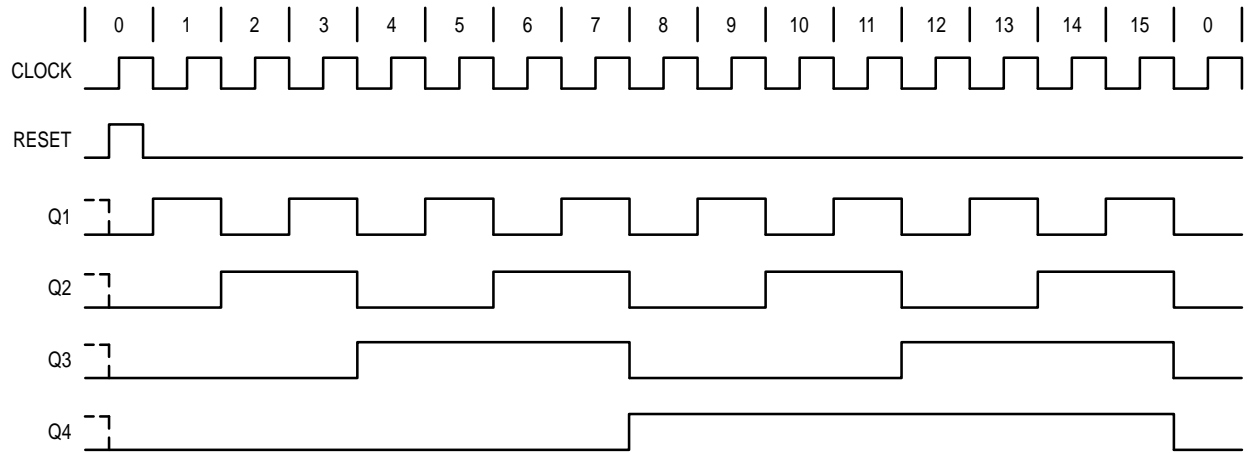
Figure 3. Test Circuit

EXPANDED LOGIC DIAGRAM



MC54/74HC393A

TIMING DIAGRAM

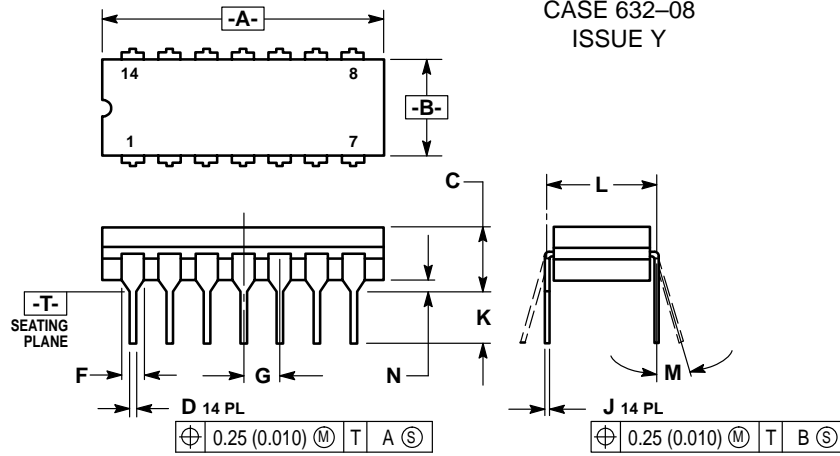


COUNT SEQUENCE

| 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 |

OUTLINE DIMENSIONS

J SUFFIX
CERAMIC DIP PACKAGE
 CASE 632-08
 ISSUE Y

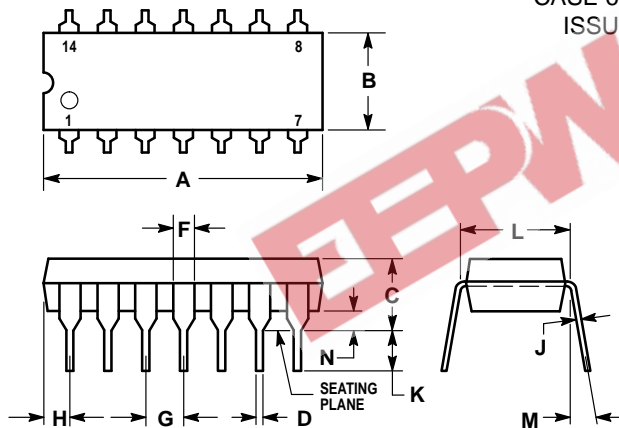


NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
4. DIMENSION F MAY NARROW TO 0.76 (0.030) WHERE THE LEAD ENTERS THE CERAMIC BODY.

| DIM | INCHES | | MILLIMETERS | |
|-----|-----------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.750 | 0.785 | 19.05 | 19.94 |
| B | 0.245 | 0.280 | 6.23 | 7.11 |
| C | 0.155 | 0.200 | 3.94 | 5.08 |
| D | 0.015 | 0.020 | 0.39 | 0.50 |
| F | 0.055 | 0.065 | 1.40 | 1.65 |
| G | 0.100 BSC | | 2.54 BSC | |
| J | 0.008 | 0.015 | 0.21 | 0.38 |
| K | 0.125 | 0.170 | 3.18 | 4.31 |
| L | 0.300 BSC | | 7.62 BSC | |
| M | 0° | 15° | 0° | 15° |
| N | 0.020 | 0.040 | 0.51 | 1.01 |

N SUFFIX
PLASTIC DIP PACKAGE
 CASE 646-06
 ISSUE L

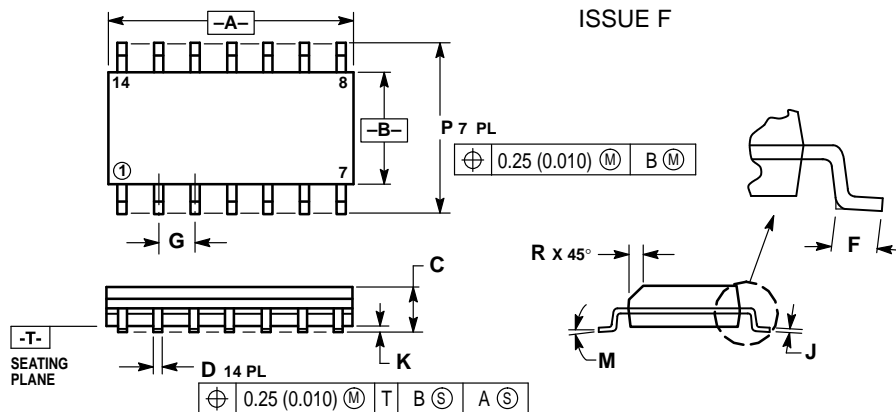


NOTES:

1. LEADS WITHIN 0.13 (0.005) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
2. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
4. 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 | 0.300 BSC | | 7.62 BSC | |
| M | 0° | 10° | 0° | 10° |
| N | 0.015 | 0.039 | 0.39 | 1.01 |

D SUFFIX
PLASTIC SOIC PACKAGE
 CASE 751A-03
 ISSUE F



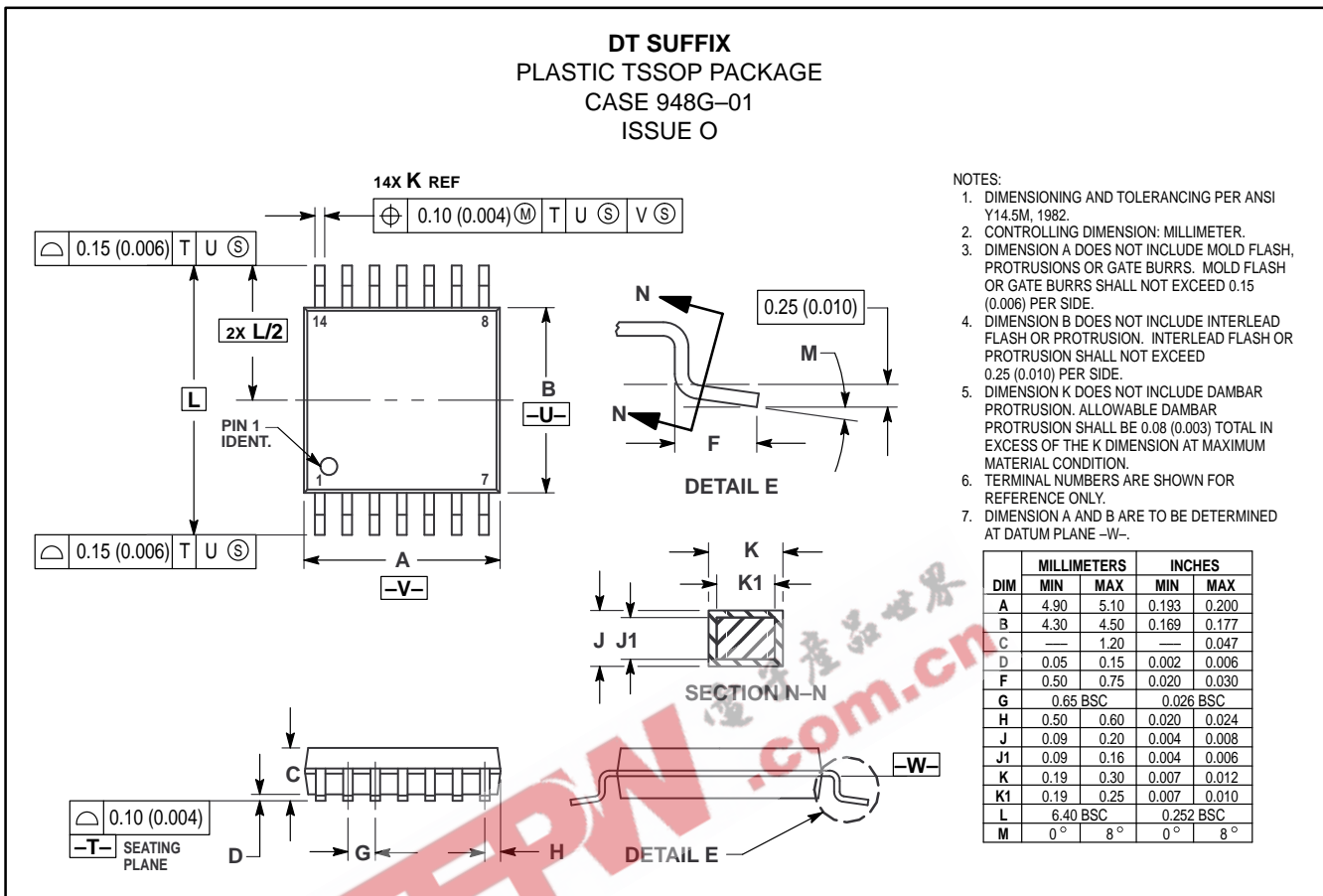
NOTES:

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 |

OUTLINE DIMENSIONS

DT SUFFIX
 PLASTIC TSSOP PACKAGE
 CASE 948G-01
 ISSUE O



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 P.O. Box 20912; Phoenix, Arizona 85036. 1-800-441-2447

JAPAN: Nippon Motorola Ltd.; Tatsumi-SPD-JLDC, Toshikatsu Otsuki,
 6F Seibu-Butsuryu-Center, 3-14-2 Tatsumi Koto-Ku, Tokyo 135, Japan. 03-3521-8315

MFAX: RMFAX0@email.sps.mot.com -TOUCHTONE (602) 244-6609
 INTERNET: http://Design-NET.com

HONG KONG: Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park,
 51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852-26629298

