# TSC700A
# Four Digit LED Display Decoder and Driver High Segment Drive Current

## General Description

The TSC700A drives common anode LED displays with 28 high current, open-drain N channel output transistors. Four seven segment LED displays may be driven. Drive current is guaranteed to be 11 mA minimum. This is twice the minimum drive current available from comparable devices and will provide high LED luminance. High luminous intensity is an important factor when a dark contrasting background is unavailable or the LED is viewed at a distance. The TSC700A current capability makes it an ideal large character LED driver.

Four data bit inputs and four digit select signals permit interfacing to multiplexed BCD or binary output devices. The four bit data input is decoded into the seven segment alphanumeric code known as "Code B". A 0 to 9, —, E, H, L, P or "blank" reading may be displayed.

An added feature includes a brightness control input that adjusts segment drive current. The control pin may also be used as a digital display enable. The TSC700A is an improved pin compatible and functional equivalent to the ICM7212A and TSC7212A.

## Ordering Information

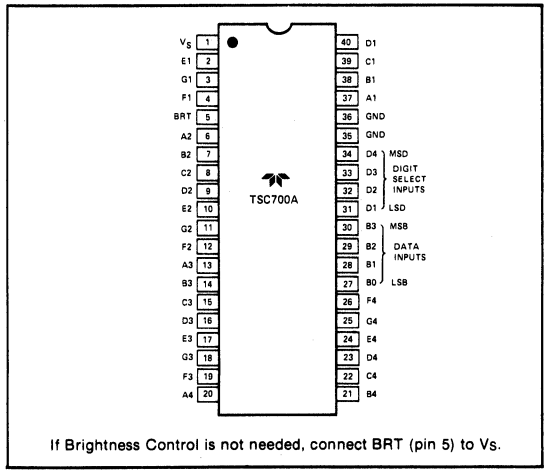
| Part No. | Package | Temp. Range | LED Segment Current | Output Code |
|---|---|---|---|---|
| TES700AMJL* | 40-Pin CerDIP | -55°C to +125°C | 14 mA | Code B |
| TSC700AIJL* | 40-Pin CerDIP | -25°C to +85°C | 14 mA | Code B |
| TSC700A/Y | CHIP | 25°C | 14 mA | Code B |

* Add /BI to part number suffix for 160 hour, +125°C burn-in.

## Features

- High Drive Current for High Luminance LED Display
- Guaranteed High LED Segment Current 11 mA Minimum
- 28 Common Anode LED Drivers (4 Digits)
- Code B Output Format ... 0 to 9, —, E, H, L, P, "blank"
- BCD/Binary Input to Seven Segment LED Code
- Four Separate Digit Selects for Multiplexed Input
- Digital or Analog Brightness Control
- Digital Display Enable
- Low Thermal Resistance Package
- Military Temperature Range Devices Available
- Pin Compatible With TSC7212A, ICM7212A

## Pin Configuration




If Brightness Control is not needed, connect BRT (pin 5) to Vs.

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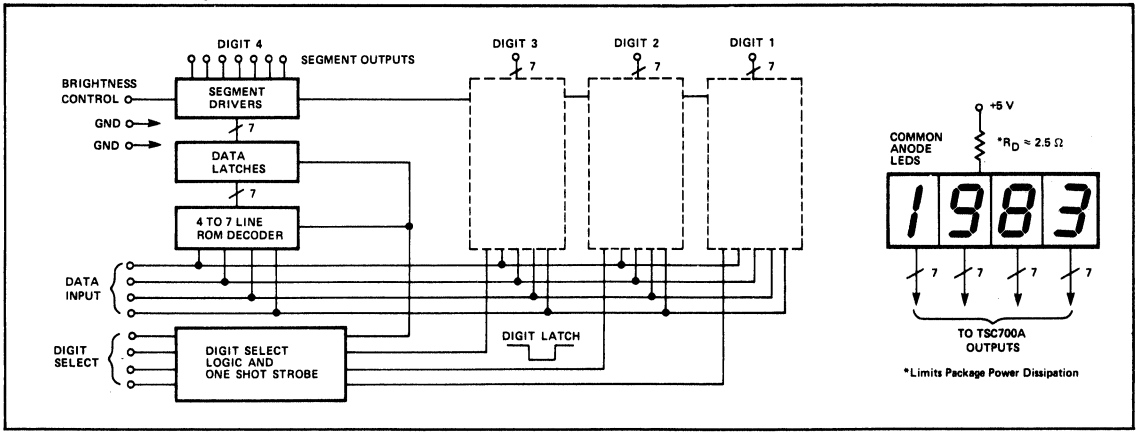
## Functional Diagram



## Absolute Maximum Ratings (Notes 1, 2)

Power Dissipation ..... *1.0 W
Supply Voltage ..... 6.5 V
Input Voltage (Any Terminal) $V_S$ + 0.3 V to Ground -0.3 V
Operating Temperature
M Version ..... -55°C to +125°C
I Version ..... -25°C to +85°C

Maximum Chip Temperature ..... +150°C
Storage Temperature ..... -55°C to +150°C
Lead Temperature (10 Sec) ..... 300°C

* To 85°C, See Derating Curve on Page 4 for operation above 85°C.

## Electrical Characteristics: Specifications measured with $V_S$ = 5.0 V at $T_A$ = 25°C.

| TYPE | NO. | SYMBOL | PARAMETER | TEST CONDITIONS | TSC700A MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| LED DRIVER | 1 | $I_{SEG}$ | Segment ON Current | Test Circuit | 11 | 14 | 18 | mA |
| | 2 | $I_{SLK}$ | Segment Leakage | | — | ±0.01 | ±1.0 | μA |
| INPUT | 3 | $V_{IH}$ | Logic "1" Input Voltage | | 3.0 | — | — | V |
| | 4 | $V_{IL}$ | Logic "0" Input Voltage | | — | — | 1.0 | V |
| | 5 | $I_{IN}$ | Input Current | Pins 27-34 | — | ±0.01 | ±1.0 | μA |
| | 6 | $C_{IN}$ | Digital Input Capacitance | Pins 27-34 | — | 5 | — | pF |
| | 7 | $C_{BR}$ | Brightness Input Capacitance | | — | 200 | — | pF |
| TIMING | 8 | $t_{pw}$ | Digit Select Pulse Width | See Timing Diagram | 1.0 | — | — | μs |
| | 9 | $t_{DS}$ | Data Setup Time | See Timing Diagram | — | — | 100 | ns |
| | 10 | $t_{DH}$ | Data Hold Time | See Timing Diagram | — | 0 | — | ns |
| | 11 | $t_{IDS}$ | Inter-Digit Select Time | See Timing Diagram | 2.0 | — | — | μs |
| POWER | 12 | $V_S$ | Operating Supply Voltage Range | | 4 | 5 | 6 | V |
| | 13 | $I_S$ | Supply Current | Display OFF | — | — | 50 | μA |
| | 14 | $I_{op}$ | Operating Current | Pin 5, 27-34 at GND, Display all "8's" | — | 440 | — | mA |

**Notes:**
1. Functional operation above the absolute maximum stress ratings is not implied.
2. Static Sensitive device. Unused devices must be stored in conductive material to protect devices from static discharge and static fields.

## Output Pin Description and Function

| OUTPUT | TERMINAL | | FUNCTION | OUTPUT | TERMINAL | | FUNCTION |
|---|---|---|---|---|---|---|---|
| A1 | 37 | A | Segment Dr. Digit 1 (LSD) | A3 | 13 | A | Segment Dr. Digit 3 |
| B1 | 38 | B | ↓ ↓ ↓ | B3 | 14 | B | ↓ ↓ |
| C1 | 39 | C | | C3 | 15 | C | |
| D1 | 40 | D | | D3 | 16 | D | |
| E1 | 2 | E | | E3 | 17 | E | |
| F1 | 4 | F | | F3 | 19 | F | |
| G1 | 3 | G | | G3 | 18 | G | |
| A2 | 6 | A | Segment Dr. Digit 2 | A4 | 20 | A | Segment Dr. Digit 4 (MSD) |
| B2 | 7 | B | ↓ ↓ | B4 | 21 | B | ↓ ↓ ↓ |
| C2 | 8 | C | | C4 | 22 | C | |
| D2 | 9 | D | | D4 | 23 | D | |
| E2 | 10 | E | | E4 | 24 | E | |
| F2 | 12 | F | | F4 | 26 | F | |
| G2 | 11 | G | | G4 | 25 | G | |

## Input Pin Description and Function

| INPUT | TERMINAL | FUNCTION | |
|---|---|---|---|
| B0 | 27 | Ones (Least Significant) | |
| B1 | 28 | Twos | DATA INPUTS BITS |
| B2 | 29 | Fours | |
| B3 | 30 | Eights (Most Significant) | |
| D1 | 31 | D1 (Least Significant) Digit Select | |
| D2 | 32 | D2 Digit Select | |
| D3 | 33 | D3 Digit Select | |
| D4 | 34 | D4 (Most Significant) Digit Select | |
| BRT | 5 | Brightness Control: Logic 1 = ON<br>Logic 0 = OFF<br>See Typical Characteristic Curve for $I_{SEG}$ Vs Brightness Control Voltage | |

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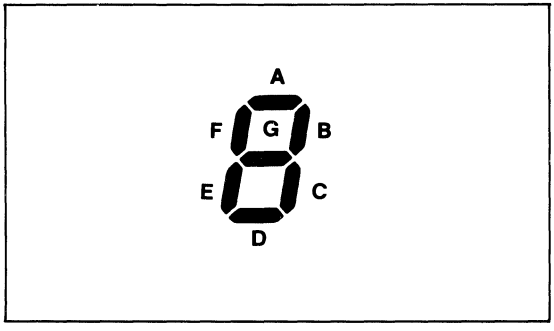
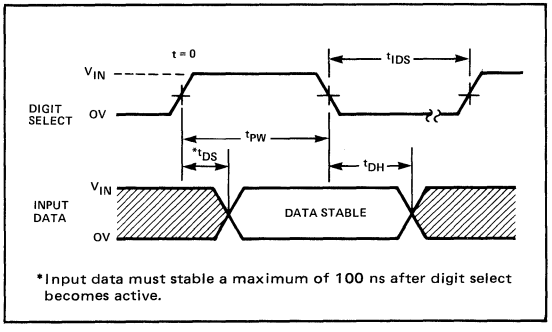
## Segment Assignment



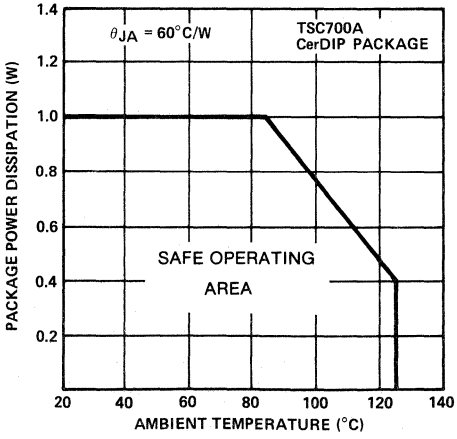

## Timing Diagram



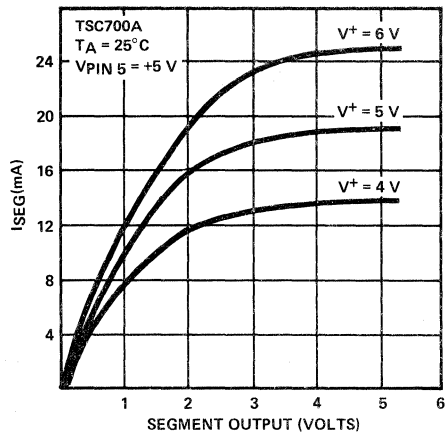

*Input data must stable a maximum of 100 ns after digit select becomes active.

## Electrical Operating Characteristics

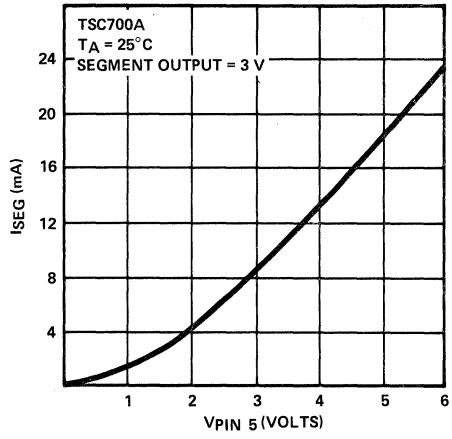
### Maximum Power Dissipation




### LED Segment Current vs Output Voltage




### LED Segment Current vs Brightness Control Voltage



## Operation Description

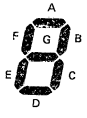
### Output Format

The TSC700A accepts four bit binary information at pins 27 (LSB) through 30 (MSB). The binary input is decoded to the seven segment output in a format known as "Code B". The display format is 0 to 9, —, E, H, L, P and "blank".

### Output Code

| BINARY INPUT | | | | TSC700A Output |
|---|---|---|---|---|
| B3 | B2 | B1 | B0 | "Code B" |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 2 |
| 0 | 0 | 1 | 1 | 3 |
| 0 | 1 | 0 | 0 | 4 |
| 0 | 1 | 0 | 1 | 5 |
| 0 | 1 | 1 | 0 | 6 |
| 0 | 1 | 1 | 1 | 7 |
| 1 | 0 | 0 | 0 | 8 |
| 1 | 0 | 0 | 1 | 9 |
| 1 | 0 | 1 | 0 | - |
| 1 | 0 | 1 | 1 | E |
| 1 | 1 | 0 | 0 | H |
| 1 | 1 | 0 | 1 | L |
| 1 | 1 | 1 | 0 | P |
| 1 | 1 | 1 | 1 | (Blank) |

### Segment Assignment



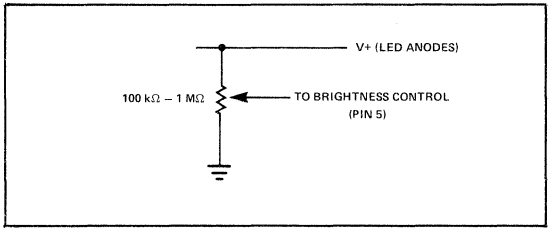

### Special Order Output Format

The TSC700A is mask programmed to give 16 combinations of seven segment output codes. For large volume orders (50 K minimum pieces) custom decoder options are available. Contact factory for details.

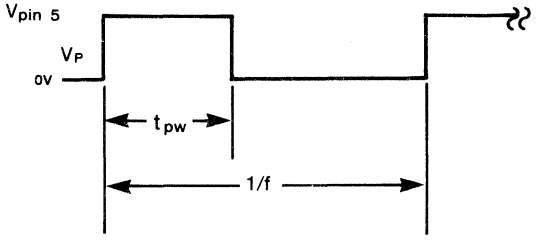
### Brightness Control Operation

The voltage at the brightness control input is transferred to the output transistor gate for "ON" segments. The brightness voltage directly modulates the segment driver "ON" resistance. A brightness input (pin 5) can be used in two ways to control output transistor drain current. A variable brightness control may be implemented with a single potentiometer. A high value potentiometer (100 KΩ to 1 MΩ) will minimize power consumption.

### Brightness Control




A logic signal of varying duty cycle will also control display brightness.

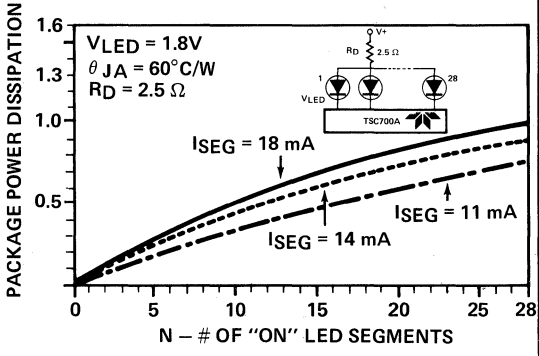



$$V_{pin\ 5} = \left(\frac{1}{(1/f)}\right) \int_{o}^{(1/f)} (V_{pin\ 5})\, dt = f\, V_p\, t_{pw} = V_p\ [\text{Duty Cycle}]$$

The display may be blanked (all segments OFF) by applying the input code 1111 or by driving the brightness pin with a logic 0. If brightness control is not needed, pin 5 should be tied to 5.0 V.

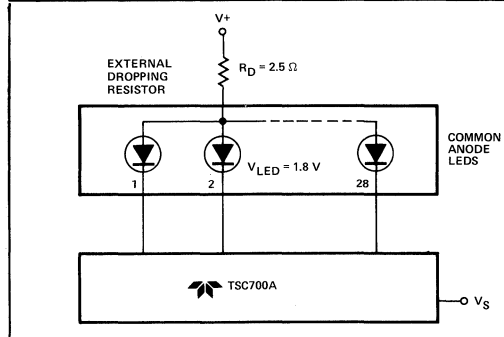
## Package Power Dissipation Minimization

The TSC700A high LED current drive capability requires package power dissipation be limited and that a low thermal resistance packaae be used. The cerDIP package thermal resistance ($\theta$jc = 30° C/W, $\theta$ja = 60° C/W) permits operation over the full −25° C to +85° C industrial operating temperature range. Power dissipation is easily controlled by reducing the applied voltage at the segment driver outputs. A 2.5 Ω voltage dropping resistor placed in series with the common anode LED display voltage will maintain dissipation under 1 watt with a worst case continuous 8888 display. Figure 1 gives the package power dissipation vs the number of "ON" LED segments for the operating circuit in Figure 2. Driver outputs should be maintained above 1.85 V for constant current operation.




| Character Displayed | No of "ON" Segments |
|---|---|
| 0 | 6 |
| 1 | 2 |
| 2 | 5 |
| 3 | 5 |
| 4 | 4 |
| 5 | 5 |
| 6 | 6 |
| 7 | 3 |
| 8 | 7 |
| 9 | 6 |
| — | 1 |
| E | 5 |
| H | 5 |
| L | 3 |
| P | 5 |

**Figure 1: Package Power Dissipation**




$$P_D = V_S I_S + I_{SEG} (N) [V^+ - V_{LED} - N(I_{SEG}) R_D]$$

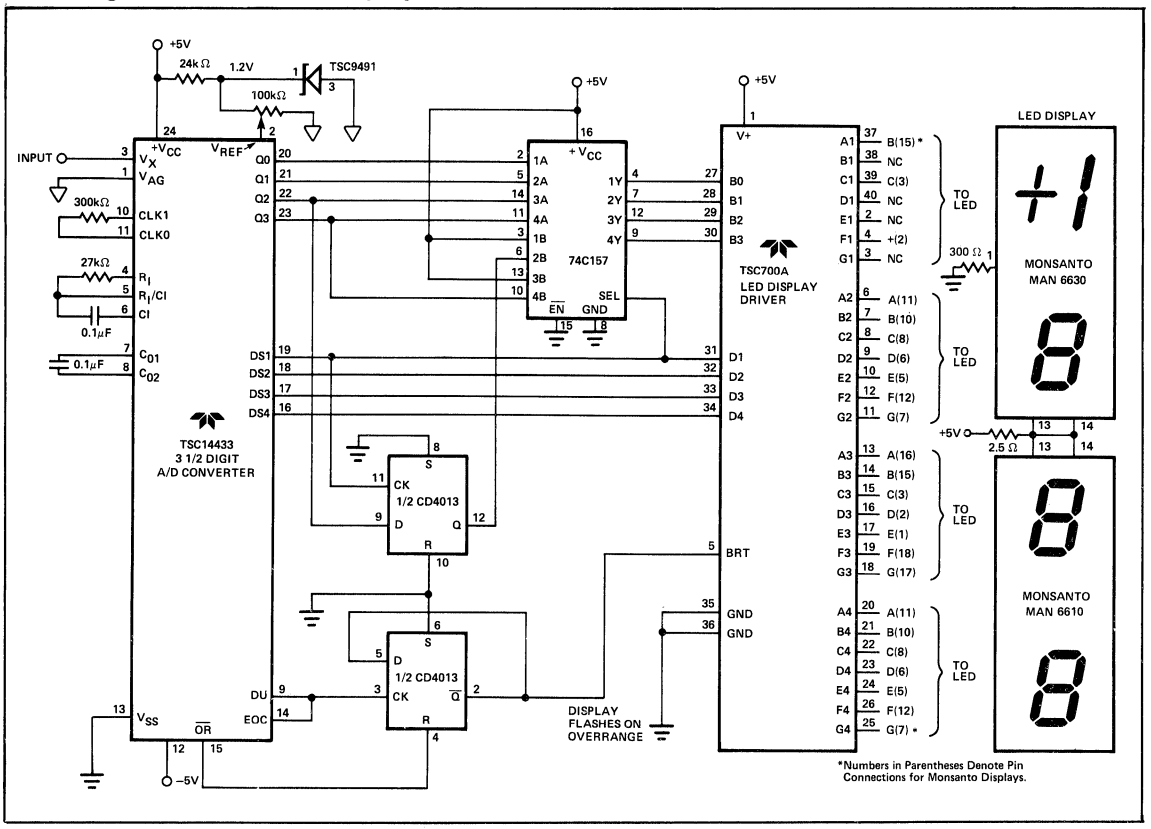
$$\approx I_{SEG} (N) [V^+ - V_{LED} - N(I_{SEG}) R_D]$$

Where:
$I_{SEG}$ = LED Segment Current
N = Number of ON Segments
$V_{LED}$ = Voltage Across on LED
$P_D$ = Max. Package Power Dissipation
$V_S$ = TSC700A Power Supply Voltage (5 V)
$I_S$ = TSC700A Quiescent Current (≈ 50 μA)

**Figure 2: Operating Circuit**

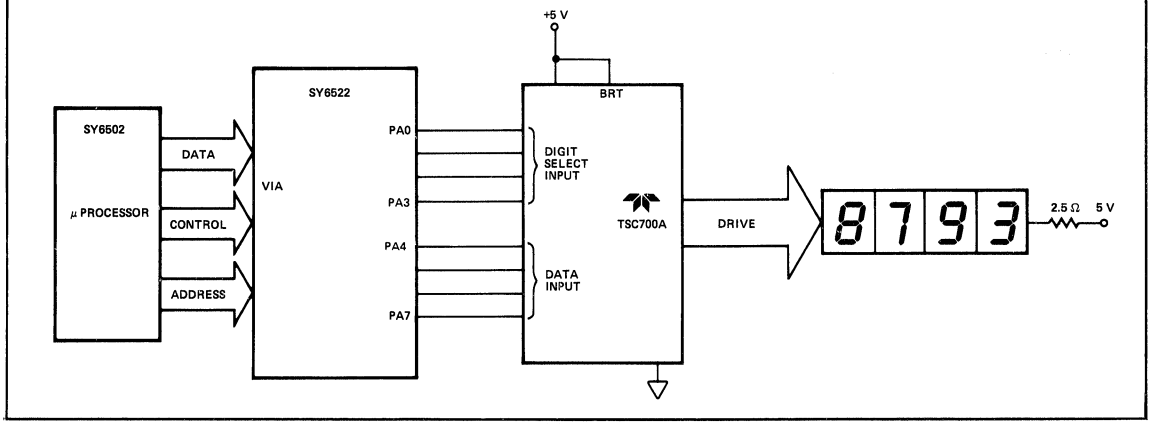
## Applications Information:

### 3 1/2 Digit ADC with LED Display



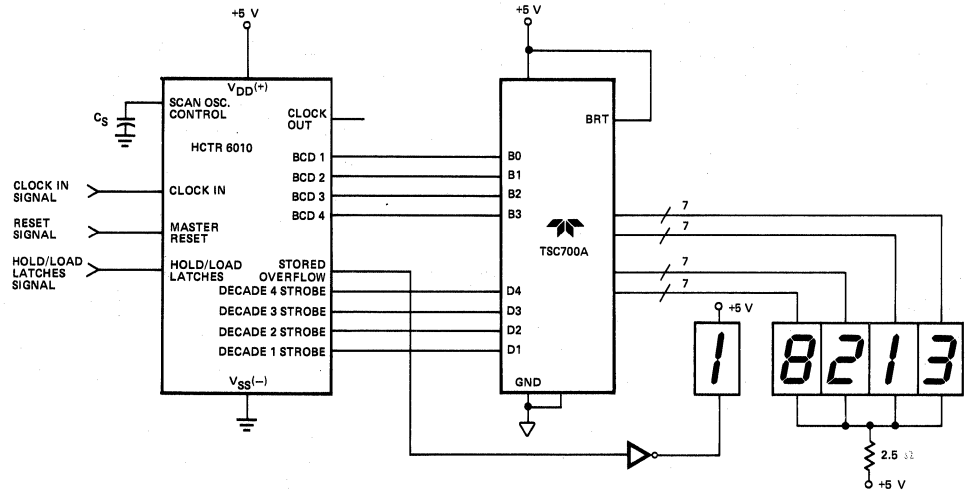

*Numbers in Parentheses Denote Pin Connections for Monsanto Displays.

### μ - Processor Controlled Display



## Applications Information (continued)

### 4 1/2 Digit Counter




| INPUTS | | | INTERNAL COUNTER RESPONSE | BCD & STORED OVERFLOW OUTPUT RESPONSE |
|---|---|---|---|---|
| MASTER RET | CLOCK IN | HOLD/LOAD LATCHES | | |
| 0 | ↓ | 0 | Advances 1 Count | Indicates New Count |
| 0 | ↑ | 0 | No Change | No Change |
| 0 | ↓ | 1 | Advances 1 Count | Retains Prior Count |
| 1 | x | 0 | Resets entire Counter | Outputs go to Zero |
| 1 | x | 1 | Resets entire Counter | Retains Prior Count |

## Package Information

**40-Pin CerDIP**
**J Package**
**(Package #20)**