

CMOS BCD-to-7-Segment Latch Decoder Drivers

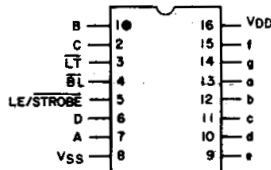
High-Voltage Types (20-Volt Rating)



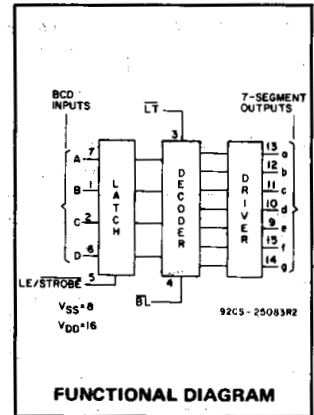
■ CD4511B types are BCD-to-7-segment latch decoder drivers constructed with CMOS logic and n-p-n bipolar transistor output devices on a single monolithic structure. These devices combine the low quiescent power dissipation and high noise immunity features of RCA CMOS with n-p-n bipolar output transistors capable of sourcing up to 25 mA. This capability allows the CD4511B types to drive LED's and other displays directly.

Lamp Test (LT), Blanking (BL), and Latch Enable or Strobe inputs are provided to test the display, shut off or intensity-modulate it, and store or strobe a BCD code, respectively. Several different signals may be multiplexed and displayed when external multiplexing circuitry is used. The CD4511B is supplied in 16-lead hermetic dual-in-line ceramic packages (D and F suffixes), 16-lead dual-in-line plastic packages (E suffix), 16-lead small-outline package (NSR suffix), and in chip form (H suffix).

These devices are similar to the type MC14511.



TOP VIEW
92CS-25084RI
CD4511B
TERMINAL ASSIGNMENT



Features:

- High-output-sourcing capability up to 25 mA
- Input latches for BCD Code storage
- Lamp Test and Blanking capability
- 7-segment outputs blanked for BCD input codes > 1001
- 100% tested for quiescent current at 20 V
- Max. input current of 1 μ A at 18 V, over full package-temperature range, 100 nA at 18 V and 25°C
- 5-V, 10-V, and 15-V parametric ratings

Applications:

- Driving common-cathode LED displays
- Multiplexing with common-cathode LED displays
- Driving incandescent displays
- Driving low-voltage fluorescent displays

MAXIMUM RATINGS, Absolute-Maximum Values:

| | |
|---|--------------------------------------|
| DC SUPPLY-VOLTAGE RANGE, (V _{DD}) | -0.5V to +20V |
| Voltages referenced to V _{SS} Terminal) | |
| 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 |

OPERATING CONDITIONS AT T_A = 25°C Unless Otherwise Specified

For maximum reliability, nominal operating conditions should be selected so that operation is always within the following ranges

| Characteristic | V _{DD} | Min. | Max. | Units |
|---|-----------------|------|------|-------|
| Supply Voltage Range (T _A): (Full Package-Temperature Range) | — | 3 | 18 | V |
| Set-Up Time (t _S) | 5 | 150 | — | ns |
| | 10 | 70 | — | ns |
| | 15 | 40 | — | ns |
| Hold Time (t _H) | 5 | 0 | — | ns |
| | 10 | 0 | — | ns |
| | 15 | 0 | — | ns |
| Strobe Pulse Width (t _W) | 5 | 400 | — | ns |
| | 10 | 160 | — | ns |
| | 15 | 100 | — | ns |

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STATIC ELECTRICAL CHARACTERISTICS

| CHARACTERISTIC | TEST CONDITIONS | | | | LIMITS AT INDICATED TEMPERATURES (°C) | | | | | | | Units | |
|---|-------------------------|-----------------------|------------------------|------------------------|---------------------------------------|-------|-------|-------|-------|-------------------|------|-------|---|
| | I _{OH} (mA) | V _o (V) | V _{IN} (V) | V _{DD} (V) | -55 | -40 | +85 | +125 | +25 | | | | |
| | | | | | | | | | Min. | Typ. | Max. | | |
| Quiescent Device Current: I _{DD} Max. | - | - | - | 5 | 5 | 5 | 150 | 150 | - | 0.04 | 5 | μA | |
| | - | - | - | 10 | 10 | 10 | 300 | 300 | - | 0.04 | 10 | | |
| | - | - | - | 15 | 20 | 20 | 600 | 600 | - | 0.04 | 20 | | |
| | - | - | - | 20 | 100 | 100 | 3000 | 3000 | - | 0.08 | 100 | | |
| 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 | | |
| High-Level V _{OH} Min. | - | - | 0.5 | 5 | 4 | 4 | 4.2 | 4.2 | 4.1 | 4.55 | - | V | |
| | - | - | 0.10 | 10 | 9 | 9 | 9.2 | 9.2 | 9.1 | 9.55 | - | | |
| Input Low Voltage, V _{IL} Max. | - | 0.5, 3.8 | - | 5 | 1.5 | | | | - | - | 1.5 | V | |
| | - | 1.8, 8 | - | 10 | 3 | | | | - | - | 3 | | |
| Input High Voltage, V _{IH} Min. | - | 1.5, 13.8 | - | 15 | 4 | | | | - | - | 4 | V | |
| | - | 0.5, 3.8 | - | 5 | 3.5 | | | | 3.5 | - | - | | |
| | - | 1.8, 8 | - | 10 | 7 | | | | 7 | - | - | V | |
| | - | 1.5, 13.8 | - | 15 | 11 | | | | 11 | - | - | | |
| Output Drive Voltage: High Level V _{OH} Min. | 0 | - | - | 5 | 4.0 | 4.0 | 4.20 | 4.20 | 4.10 | 4.55 | - | V | |
| | 5 | - | - | | - | - | - | - | - | 4.25 | - | | |
| | 10 | - | - | | 3.80 | 3.80 | 3.90 | 3.90 | 3.90 | 3.90 | 4.10 | | - |
| | 15 | - | - | | - | - | 3.50 | 3.50 | - | 3.95 | - | | |
| | 20 | - | - | | 3.55 | 3.55 | 3.30 | - | 3.40 | 3.75 | - | | |
| | 25 | - | - | | 3.40 | 3.40 | - | - | 3.10 | 3.55 | - | | |
| | 0 | - | - | 10 | 9.0 | 9.0 | 9.20 | 9.20 | 9.10 | 9.55 | - | V | |
| | 5 | - | - | | - | - | - | - | 9.25 | - | | | |
| | 10 | - | - | | 8.85 | 8.85 | 9.00 | 9.00 | 9.00 | 9.15 | - | | |
| | 15 | - | - | | - | - | - | - | 9.05 | - | | | |
| | 20 | - | - | | 8.70 | 8.70 | 8.40 | 8.40 | 8.60 | 8.90 | - | | |
| | 25 | - | - | | 8.60 | 8.60 | - | - | 8.30 | 8.75 | - | | |
| 0 | - | - | 15 | 14.0 | 14.0 | 14.20 | 14.20 | 14.10 | 14.55 | - | V | | |
| 5 | - | - | | - | - | - | - | 14.30 | - | | | | |
| 10 | - | - | | 13.90 | 13.90 | 14.0 | 14.0 | 14.0 | 14.20 | - | | | |
| 15 | - | - | | - | - | - | - | 14.10 | - | | | | |
| 20 | - | - | | 13.75 | 13.75 | 13.50 | 13.50 | 13.70 | 13.95 | - | | | |
| 25 | - | - | | 13.65 | 13.65 | - | - | 13.50 | 13.80 | - | | | |
| 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 | - | | |
| Input Current, I _{IN} Max. | - | 0.18 | 0.18 | 18 | ±0.1 | ±0.1 | ±1 | ±1 | - | ±10 ⁻⁵ | ±0.1 | μA | |



Fig. 1 - Typical output low (sink) current characteristics.

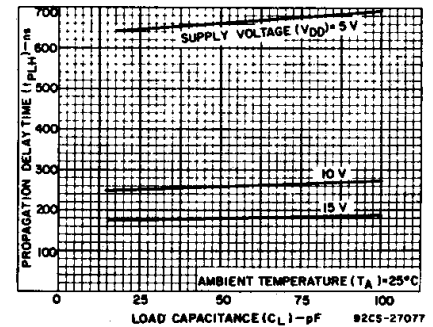


Fig. 2 - Typical data-to-output, low-to-high-level propagation delay time as a function of load capacitance.

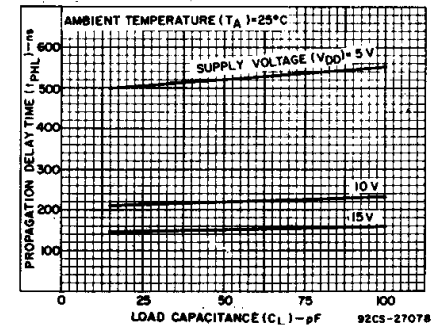


Fig. 3 - Typical data-to-output, high-to-low-level propagation delay time as a function of load capacitance.

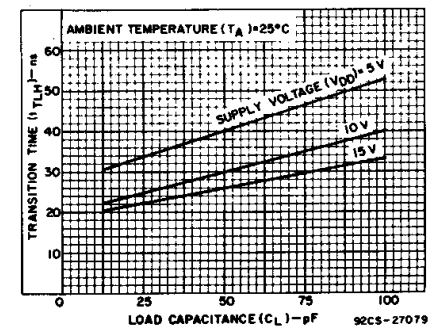


Fig. 4 - Typical low-to-high-level transition time as a function of load capacitance.

CD4511B Types

DYNAMIC ELECTRICAL CHARACTERISTICS at $T_A = 25^\circ\text{C}$, Input $t_r, t_f = 20\text{ ns}$,
 $C_L = 50\text{ pF}$, $R_L = 200\text{ k}\Omega$

| CHARACTERISTIC | Test Conditions | LIMITS All Packages | | | UNITS |
|---|-----------------|------------------------|------|------|-------|
| | | V_{DD} Volts | Min. | Typ. | |
| Propagation Delay Time: (Data) High-to-Low Level, t_{PHL} | 5 | — | 520 | 1040 | ns |
| | 10 | — | 210 | 420 | |
| | 15 | — | 150 | 300 | |
| Low-to-High Level, t_{PLH} | 5 | — | 660 | 1320 | ns |
| | 10 | — | 260 | 520 | |
| | 15 | — | 180 | 360 | |
| Propagation Delay Time: (BL) High-to-Low Level, t_{PHL} | 5 | — | 350 | 700 | ns |
| | 10 | — | 175 | 350 | |
| | 15 | — | 125 | 250 | |
| Low-to-High Level, t_{PLH} | 5 | — | 400 | 800 | ns |
| | 10 | — | 175 | 350 | |
| | 15 | — | 150 | 300 | |
| Propagation Delay Time: (LT) High-to-Low Level, t_{PHL} | 5 | — | 250 | 500 | ns |
| | 10 | — | 125 | 250 | |
| | 15 | — | 85 | 170 | |
| Low-to-High Level, t_{PLH} | 5 | — | 150 | 300 | ns |
| | 10 | — | 75 | 150 | |
| | 15 | — | 50 | 100 | |
| Transition Time: Low-to-High Level, t_{TLH} | 5 | — | 40 | 80 | ns |
| | 10 | — | 30 | 60 | |
| | 15 | — | 25 | 50 | |
| High-to-Low Level, t_{THL} | 5 | — | 125 | 310 | ns |
| | 10 | — | 75 | 185 | |
| | 15 | — | 65 | 160 | |
| Minimum Set-Up Time, t_S | 5 | 150 | 75 | — | ns |
| | 10 | 70 | 35 | — | |
| | 15 | 40 | 20 | — | |
| Minimum Hold Time, t_H | 5 | 0 | -75 | — | ns |
| | 10 | 0 | -35 | — | |
| | 15 | 0 | -20 | — | |
| Strobe Pulse Width, t_W | 5 | 400 | 200 | — | ns |
| | 10 | 160 | 80 | — | |
| | 15 | 100 | 50 | — | |
| Input Capacitance, C_{IN} | | — | 5 | 7.5 | pF |



Fig. 5 - Typical high-to-low transition time as a function of load capacitance.



Fig. 6 - Typical voltage drop (V_{DD} to output) vs. output source current as a function of supply.

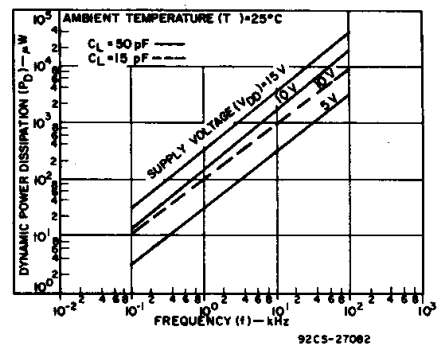


Fig. 7 - Typical dynamic power dissipation characteristics.

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Fig. 8 - Logic diagram.

TRUTH TABLE

| LE | BI | LT | D | C | B | A | a | b | c | d | e | f | g | Display |
|----|----|----|---|---|---|---|---|---|---|---|---|---|---|---------|
| X | X | 0 | X | X | X | X | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 |
| X | 0 | 1 | X | X | X | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Blank |
| 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 2 |
| 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 3 |
| 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 4 |
| 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 5 |
| 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 6 |
| 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 7 |
| 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 8 |
| 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 9 |
| 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Blank |
| 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Blank |
| 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Blank |
| 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Blank |
| 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Blank |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Blank |
| 1 | 1 | 1 | X | X | X | X | * | * | * | * | * | * | * | * |

X = Don't Care * Depends on BCD code previously applied when LE = 0
 Note: Display is blank for all illegal input codes (BCD > 1001).

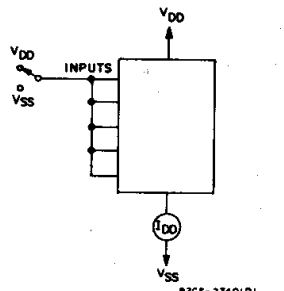


Fig. 9 - Quiescent device current.

TEST CIRCUITS

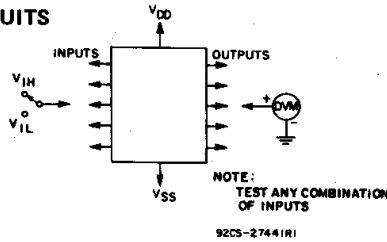


Fig. 10 - Input voltage.

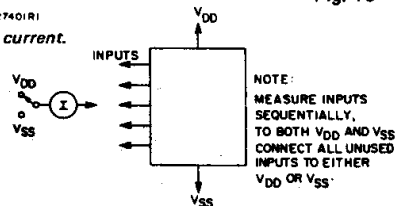


Fig. 11 - Input current.



Fig. 12 - Data propagation delay.

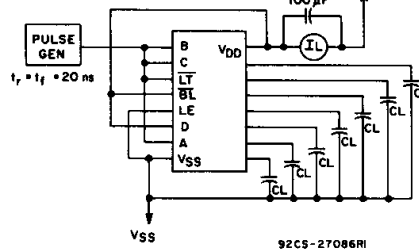
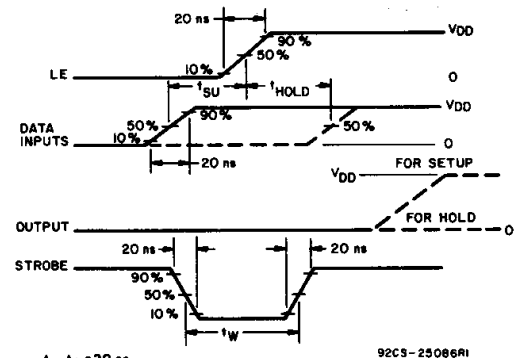


Fig. 13 - Dynamic power dissipation.



$t_r, t_f = 20 \text{ ns}$



$t_r, t_f = 20 \text{ ns}$

Fig. 14 - Dynamic waveforms.

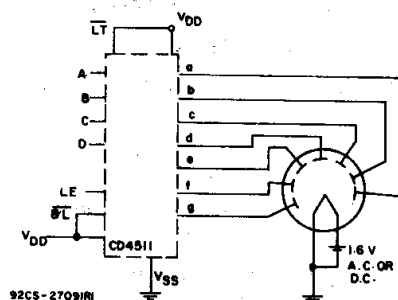
CD4511B Types

APPLICATIONS Interfacing with Various Displays



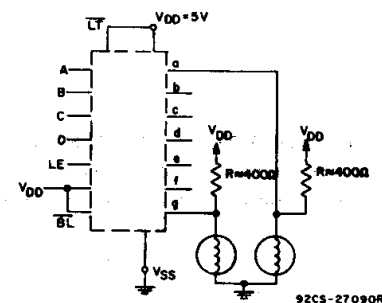
Duty Cycle = 100%
 $I_{SEG} = I_{DIODE\ AVG.} = 20\text{ mA at Luminous Intensity/Segment} = 250\text{ microcandles}$
 $R = \frac{V_{OH} - V_{DF}}{I_{SEG}}$

Fig. 15 - Driving common-cathode 7-segment LED displays (example Hewlet-Packard 5082-7740).

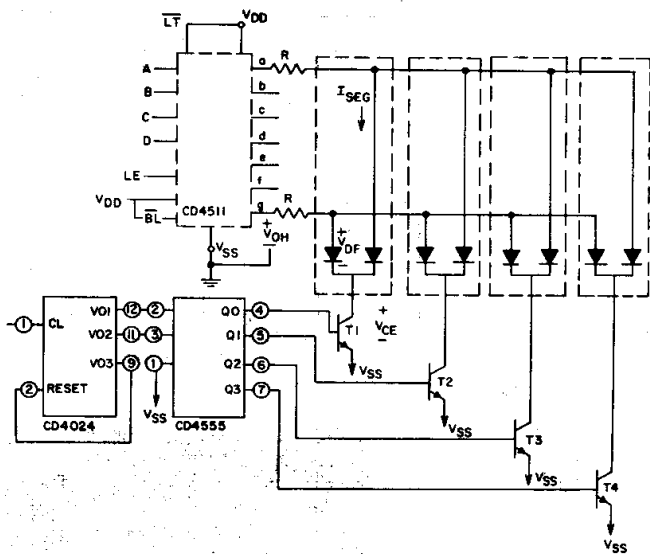


A medium-brightness intensity display can be obtained with low-voltage fluorescent displays such as the Tung-Sol Digivac S/G** Series.

**Trademark Tung-Sol Division Wagner Electric Co.
 Fig. 16 - Driving low-voltage fluorescent displays.



2 of 7 Segments Shown Connected
 Resistors R from V_{DD} to each 7-segment driver output are chosen to keep all Numitron segments slightly on and warm.
 Fig. 17 - Driving incandescent displays (RCA Numitron DR2000 series displays).

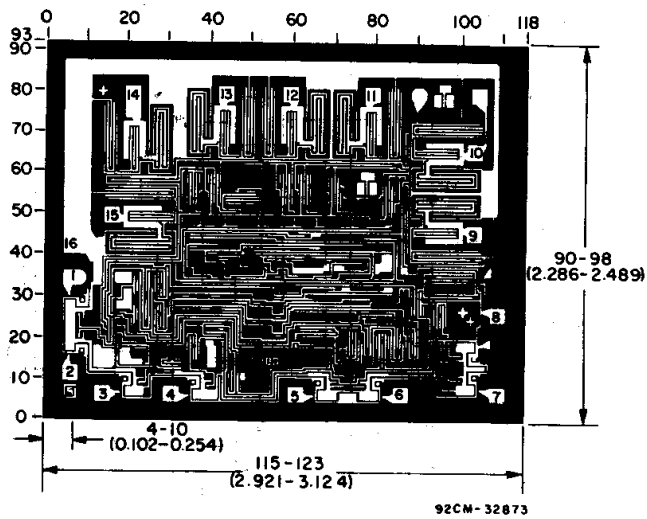


Multiplexing Scheme Showing 2 of 7 Segments Connected
 Transistors T₁-T₄ (RCA-2N3053 or 2N2102) have I_C Max. rating > 7x I_{SEG}

Duty Cycle = 25%
 $I_{SEG} = (I_{DIODE\ AVG.}) \times 4$
 $R = \frac{(V_{OH} - V_{DF} - V_{CE})}{I_{SEG}}$

All unused inputs on CD4555 are connected to V_{DD} or V_{SS}.

Fig. 18 - Multiplexing with common-cathode 7-segment LED displays (example Hewlet-Packard 5082-7404 4 character display or 4 discrete Monosanto Man 3 displays).



Dimensions and pad layout for CD4511B chip.

Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated. Grid graduations are in mils (10⁻³ inch).

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