

MM74C912

6-Digit BCD Display Controller/Driver

General Description

The MM74C912 display controllers are interface elements, with memory, that drive a 6-digit, 8-segment LED display.

The display controllers receive data information through 5 data inputs A, B, C, D and DP, and digit information through 3 address inputs K1, K2 and K3.

The input data is written into the register selected by the address information when CHIP ENABLE, (\overline{CE}), and WRITE ENABLE, (\overline{WE}), are LOW and is latched when either \overline{CE} or \overline{WE} return HIGH. Data hold time is not required. A self-contained internal oscillator sequentially presents the stored data to a decoder where 4 data bits control the format of the displayed character and 1 bit controls the decimal point. The internal oscillator is controlled by a control input labeled OSCILLATOR ENABLE, (\overline{OSE}), which is tied LOW in normal operation. A high level at \overline{OSE} prevents automatic refresh of the display.

The 7-segment plus decimal point output information directly drives an LED display through high drive (100 mA

typ.) output drivers. The drivers are active when the control pin labeled SEGMENT OUTPUT ENABLE, (\overline{SOE}), is LOW and go into 3-STATE when \overline{SOE} is HIGH. This feature allows for duty cycle brightness control and for disabling the output drivers for power conservation.

The MM74C912 segment decoder converts BCD data into 7-segment format.

All inputs are TTL compatible and do not clamp to the V_{CC} supply.

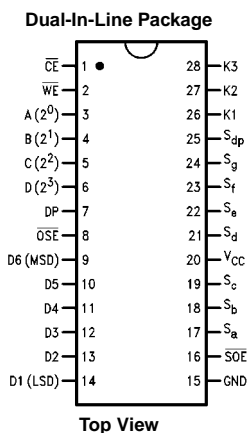
Features

- Direct segment drive (100 mA typ.) 3-STATE
- 6 registers addressed like RAM
- Internal oscillator and scanning circuit
- Direct base drive to digit transistor (20 mA typ.)
- Internal segment decoder
- TTL compatible inputs

Ordering Code:

| Order Number | Package Number | Package Description |
|--------------|----------------|--|
| MM74C912N | N28B | 28-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-010, 0.600" Wide |

Connection Diagram



Truth Tables

Input Control

| \overline{CE} | Digit Address | | | \overline{WE} | Operation |
|-----------------|---------------|----|----|-----------------|------------------|
| | K3 | K2 | K1 | | |
| 0 | 0 | 0 | 0 | 0 | Write Digit 1 |
| 0 | 0 | 0 | 0 | 1 | Latch Digit 1 |
| 0 | 0 | 0 | 1 | 0 | Write Digit 2 |
| 0 | 0 | 0 | 1 | 1 | Latch Digit 2 |
| 0 | 0 | 1 | 0 | 0 | Write Digit 3 |
| 0 | 0 | 1 | 0 | 1 | Latch Digit 3 |
| 0 | 0 | 1 | 1 | 0 | Write Digit 4 |
| 0 | 0 | 1 | 1 | 1 | Latch Digit 4 |
| 0 | 1 | 0 | 0 | 0 | Write Digit 5 |
| 0 | 1 | 0 | 0 | 1 | Latch Digit 5 |
| 0 | 1 | 0 | 1 | 0 | Write Digit 6 |
| 0 | 1 | 0 | 1 | 1 | Latch Digit 6 |
| 0 | 1 | 1 | 0 | 0 | Write Null Digit |
| 0 | 1 | 1 | 0 | 1 | Latch Null Digit |
| 0 | 1 | 1 | 1 | 0 | Write Null Digit |
| 0 | 1 | 1 | 1 | 1 | Latch Null Digit |
| 1 | X | X | X | X | Disable Writing |

X = Don't Care

Output Control

| \overline{SOE} | \overline{OSE} | Operation |
|------------------|------------------|--------------------------|
| 0 | 0 | Refresh Display |
| 0 | 1 | Stop Oscillator (Note 1) |
| 1 | 0 | Disable Segment Outputs |
| 1 | 1 | Standby Mode |

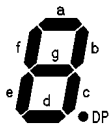
Note 1: Segment drive may exceed maximum display dissipation.

Functional Description

Character Font

| MM74C912 | Hi-Z | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | o | ° | - | - | . |
|--------------------------------|------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Input A 2 ⁰ | X | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
| Data B 2 ¹ | X | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 |
| C 2 ² | X | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| D 2 ³ | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| DP | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| OUTPUT ENABLE \overline{SOE} | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Segment Identification



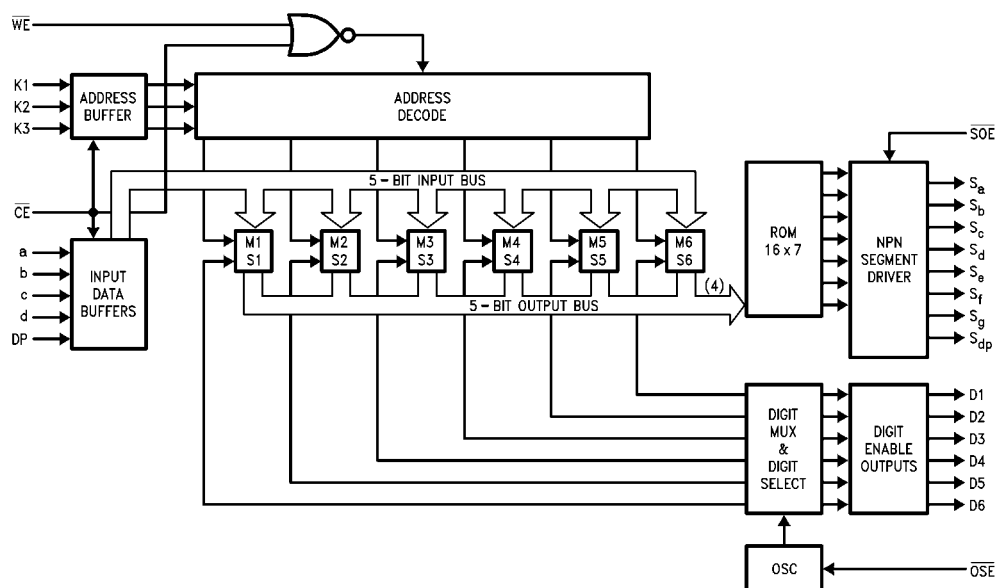
The MM74C912 display controller is manufactured using metal gate CMOS technology. A single 5V 74 series TTL supply can be used for power and should be bypassed at the V_{CC} pin.

All inputs are TTL compatible; the segment outputs drive the LED display directly through current limiting resistors. The digit outputs are designed to directly drive the base of

a grounded emitter digit transistor without the need of a Darlington configuration.

As seen in the block diagram, these display controllers contain six 5-bit registers; any one of which may be randomly written. The internal multiplexer scans the registers and refreshes the display. This combination of write only memory and self-scan display makes the display controller a "refreshing experience" for an over-burdened microprocessor.

Block Diagram



Absolute Maximum Ratings(Note 2)

(Note 3)

| | |
|-----------------------------|--------------------------------------|
| Voltage at Any Pin | |
| Except Inputs | −0.3V to $V_{CC} + 0.3V$ |
| Voltage at Any Input | −0.3V to +15V |
| Operating Temperature | |
| Range (T_A) | −40°C to +85°C |
| Storage Temperature | |
| Range (T_S) | −65°C to +150°C |
| Power Dissipation (P_D) | Refer to $P_{D\ MAX}$ vs T_A Graph |

| | |
|-------------------------------|----------|
| Operating V_{CC} Range | 3V to 6V |
| Absolute Maximum (V_{CC}) | 6.5V |
| Lead Temperature | |
| (Soldering, 10 seconds) | 260°C |

Note 2: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Range" they are not meant to imply that the device should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 3: All voltages reference to ground.

DC Electrical Characteristics

Min/Max limits apply at 40°C ≤ T_J ≤ 85°C, unless otherwise noted

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|-----------------------------|---|--|----------------|---------------|-----|----------|
| CMOS TO CMOS | | | | | | |
| $V_{IN(1)}$ | Logical "1" Input Voltage | $V_{CC} = 5V$ | 3.0 | | | V |
| $V_{IN(0)}$ | Logical "0" Input Voltage | $V_{CC} = 5V$ | | | 1.5 | V |
| $I_{IN(1)}$ | Logical "1" Input Current | $V_{CC} = 5V, V_{IN} = 15V$ | | 0.005 | 1.0 | μA |
| $I_{IN(0)}$ | Logical "0" Input Current | $V_{CC} = 5V, V_{IN} = 0V$ | −1.0 | −0.005 | | μA |
| I_{CC} | Supply Current | $V_{CC} = 5V$, Outputs Open | | 0.5 | 2 | mA |
| I_{OUT} | 3-STATE Output Current | $V_{CC} = 5V, V_O = 5V$ $V_{CC} = 5V, V_O = 0V$ | −10 | 0.03 −0.03 | 10 | μA |
| CMOS/LPTTL INTERFACE | | | | | | |
| $V_{IN(1)}$ | Logical "1" Input Voltage | $V_{CC} = 4.75V$ | $V_{CC} - 2.0$ | | | V |
| $V_{IN(0)}$ | Logical "0" Input Voltage | $V_{CC} = 4.75V$ | | | 0.8 | V |
| OUTPUT DRIVE | | | | | | |
| I_{SH} | High Level Segment Current | $V_{CC} = 5V, V_O = 3.4V$ $T_J = 25^\circ C$ $T_J = 100^\circ C$ | −60 −40 | −100 −60 | | mA mA |
| I_{DH} | High Level Digit Current | $V_{CC} = 5V, V_O = 1V$ $T_J = 25^\circ C$ $T_J = 100^\circ C$ | −10 −7 | −20 −15 | | mA mA |
| $V_{OUT(1)}$ | Logical "1" Output Voltage Any Digit | $V_{CC} = 5V, I_O = -360\mu A$ | 4.6 | | | V |
| $V_{OUT(0)}$ | Logical "0" Output Voltage Any Digit | $V_{CC} = 5V, I_O = 360\mu A$ | | | 0.4 | V |
| θ_{JA} | Thermal Resistance | (Note 4) | | 100 | | °C/W |

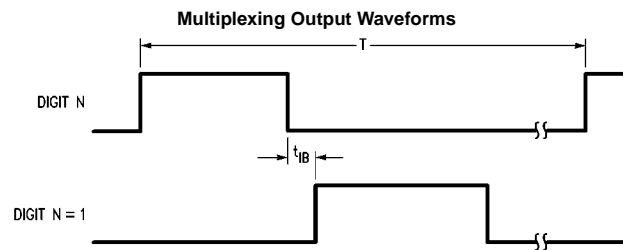
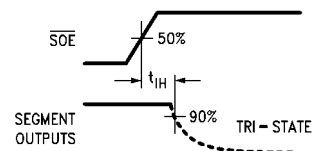
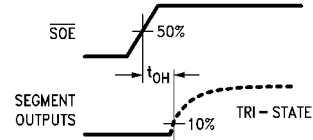
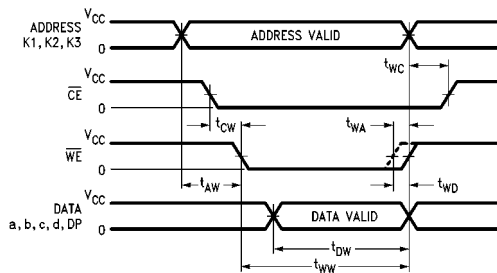
Note 4: θ_{JA} measured in free air with device soldered into printed circuit board.

AC Electrical Characteristics (Note 5) $V_{CC} = 5V$, $t_r = t_f = 20$ ns, $C_L = 50$ pF

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|------------------|--|------------------------------------|-----|-----|-----|---------|
| t_{CW} | Chip Enable to Write Enable Setup Time | $T_J = 25^\circ C$ | 35 | 15 | | ns |
| | | $T_J = 125^\circ C$ | 50 | 20 | | ns |
| t_{AW} | Address to Write Enable Setup Time | $T_J = 25^\circ C$ | 35 | 15 | | ns |
| | | $T_J = 125^\circ C$ | 50 | 20 | | ns |
| t_{WW} | Write Enable Width | $T_J = 25^\circ C$ | 400 | 225 | | ns |
| | | $T_J = 125^\circ C$ | 450 | 250 | | ns |
| t_{DW} | Data to Write Enable Setup Time | $T_J = 25^\circ C$ | 390 | 225 | | ns |
| | | $T_J = 125^\circ C$ | 430 | 250 | | ns |
| t_{WD} | Write Enable to Data Hold Time | $T_J = 25^\circ C$ | 0 | -10 | | ns |
| | | $T_J = 125^\circ C$ | 0 | -15 | | ns |
| t_{WA} | Write Enable to Address Hold Time | $T_J = 25^\circ C$ | 0 | -10 | | ns |
| | | $T_J = 125^\circ C$ | 0 | -15 | | ns |
| t_{WC} | Write Enable to Chip Enable Hold Time | $T_J = 25^\circ C$ | 50 | 30 | | ns |
| | | $T_J = 125^\circ C$ | 75 | 40 | | ns |
| t_{1H}, t_{0H} | Logical "1", Logical "0" Levels into 3-STATE | $R_L = 10k, T_J = 25^\circ C$ | | 275 | 500 | ns |
| | | $C_L = 10$ pF, $T_J = 125^\circ C$ | | 325 | 600 | ns |
| t_{H1}, t_{H0} | 3-STATE to Logical "1" to Logical "0" Level | $R_L = 10k, T_J = 25^\circ C$ | | 325 | 600 | ns |
| | | $C_L = 50$ pF, $T_J = 125^\circ C$ | | 375 | 700 | ns |
| t_{IB} | Interdigit Blanking Time | $T_J = 25^\circ C$ | 5 | 10 | | μs |
| | | $T_J = 125^\circ C$ | 10 | 20 | | μs |
| f_{MUX} | Multiplex Scan Frequency | $T_J = 25^\circ C$ | | 350 | | Hz |
| | | $T_J = 125^\circ C$ | | 250 | | Hz |
| C_{IN} | Input Capacitance | (Note 6) | | 5 | 7.5 | pF |
| C_{OUT} | 3-STATE Output Capacitance | (Note 6) | | 30 | 50 | pF |

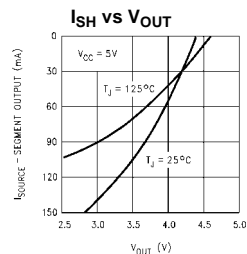
Note 5: AC Parameters are guaranteed by DC correlated testing.**Note 6:** Capacitance is guaranteed by periodic testing.

Switching Time Waveforms

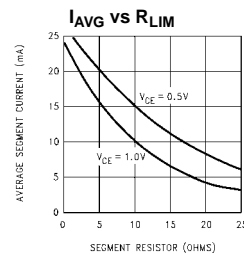


$$T = 1/f_{MUX}$$

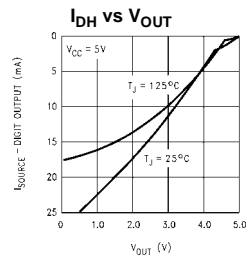
Typical Performance Characteristics



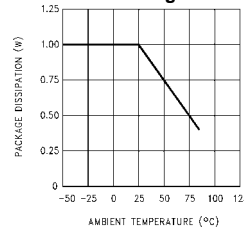
Segment outputs if shorted to ground will exceed maximum power dissipation of the device



V_{CE} is the saturation voltage of the digit drive transistor.

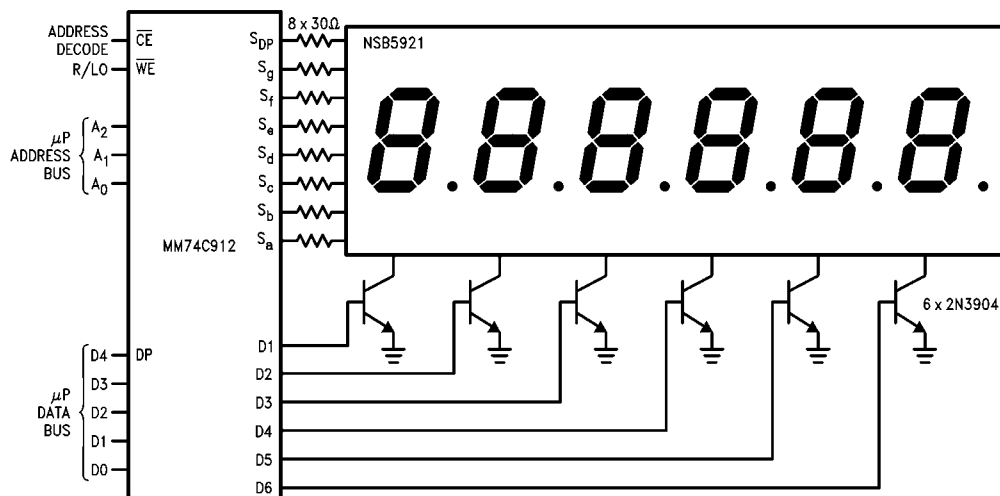
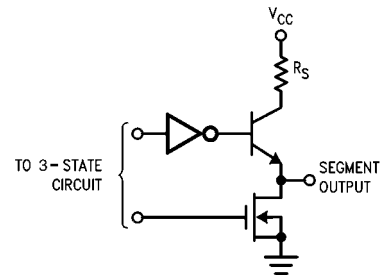
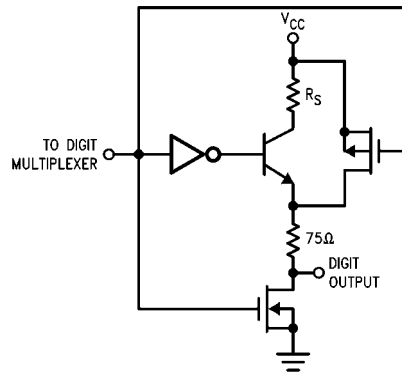


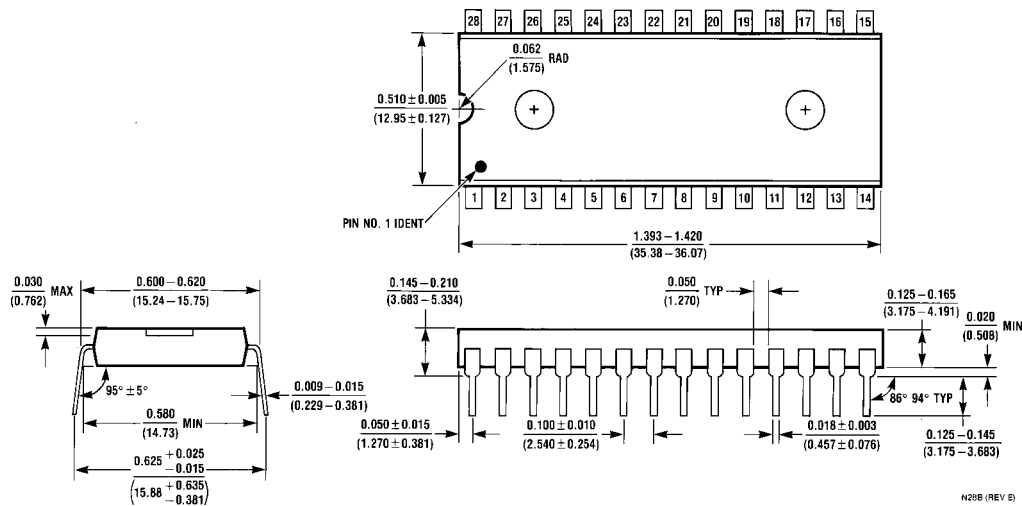
Power Dissipation vs. Temperature for Plastic Packages



MM74C912

Segment Output Structure



Physical Dimensions inches (millimeters) unless otherwise noted

**28-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-010, 0.600" Wide
Package Number N28B**

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