

## 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  $CE$  or  $WE$  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

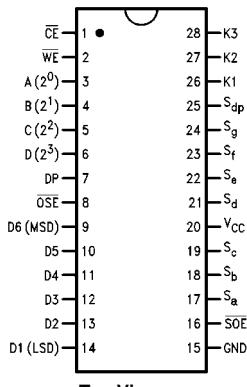
- Direct segment drive (100 mA typ.) 3-STATE
- 6 registers addressed like RAM
- Internal oscillator and scanning circuit
- Direct base drive to digit transistor (20 mA typ.)
- Internal segment decoder
- TTL compatible inputs

### 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

Dual-In-Line Package



## 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

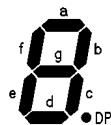
Note 1: Segment drive may exceed maximum display dissipation.

## Functional Description

Character Font

MM74C912	Hi-Z	0	1	2	3	4	5	6	7	8	9	o	0	-	-	-	.
Input A	2 <sup>0</sup>	X	0	1	0	1	0	0	0	1	0	1	0	1	0	1	1
Data B	2 <sup>1</sup>	X	0	0	1	1	0	1	1	1	0	0	1	1	0	1	1
C	2 <sup>2</sup>	X	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1
D	2 <sup>3</sup>	X	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
DP		X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OUTPUT ENABLE SOE		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Segment Identification



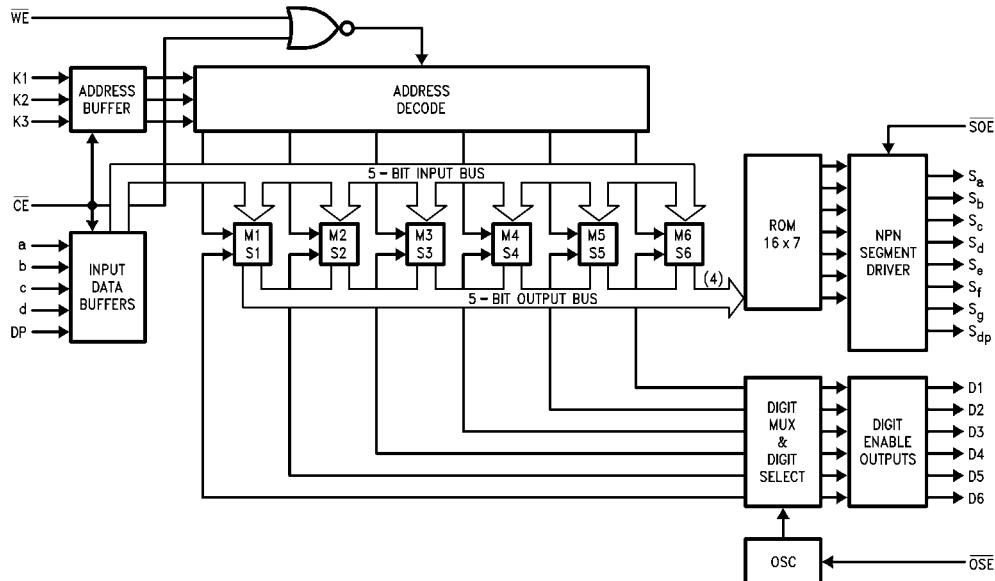
The MM74C912 display controller is manufactured using metal gate CMOS technology. A single 5V 74 series TTL supply can be used for power and should be bypassed at the  $V_{CC}$  pin.

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



<b>Absolute Maximum Ratings</b> (Note 2)		Operating $V_{CC}$ Range	3V to 6V
(Note 3)		Absolute Maximum ( $V_{CC}$ )	6.5V
Voltage at Any Pin Except Inputs	-0.3V to $V_{CC}$ + 0.3V	Lead Temperature (Soldering, 10 seconds)	260°C
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		

**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  $\leq T_J \leq$  85°C, unless otherwise noted

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>CMOS TO CMOS</b>						
$V_{IN(1)}$	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	$\mu A$
$I_{IN(0)}$	Logical "0" Input Current	$V_{CC} = 5V, V_{IN} = 0V$	-1.0	-0.005		$\mu A$
$I_{CC}$	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	$\mu A$ $\mu A$
<b>CMOS/LPTTL INTERFACE</b>						
$V_{IN(1)}$	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
<b>OUTPUT DRIVE</b>						
$I_{SH}$	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
$\theta_{JA}$	Thermal Resistance	(Note 4)		100		°C/W

**Note 4:**  $\theta_{JA}$  measured in free air with device soldered into printed circuit board.

### AC Electrical Characteristics (Note 5)

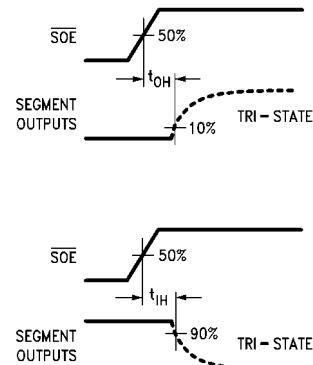
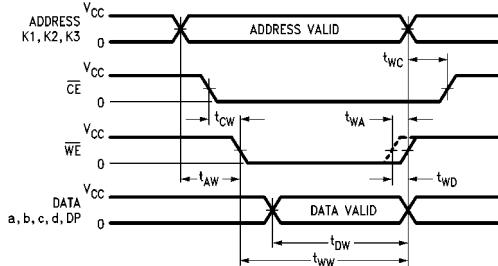
$V_{CC} = 5V$ ,  $t_r = t_f = 20$  ns,  $C_L = 50$  pF

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

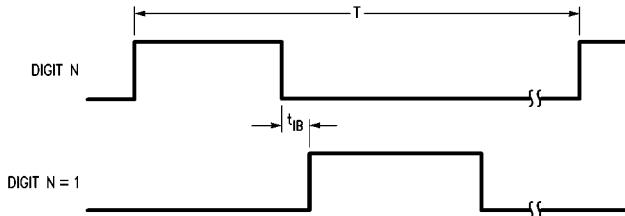
**Note 5:** AC Parameters are guaranteed by DC correlated testing.

**Note 6:** Capacitance is guaranteed by periodic testing.

## Switching Time Waveforms

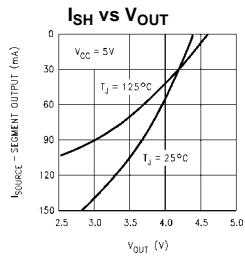


## Multiplexing Output Waveforms

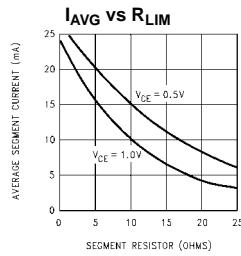


$$T = 1/f_{MUX}$$

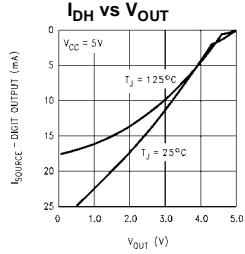
## Typical Performance Characteristics



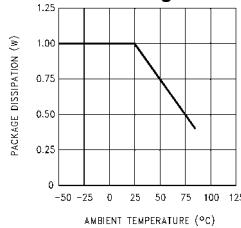
Segment outputs if shorted to ground will exceed maximum power dissipation of the device



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

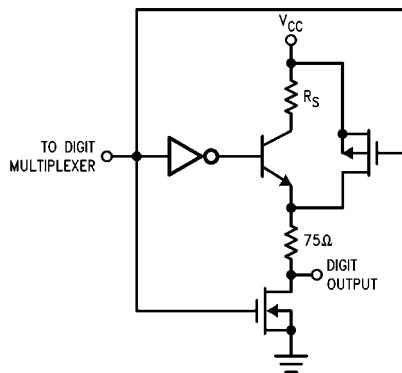


## Power Dissipation vs. Temperature for Plastic Packages

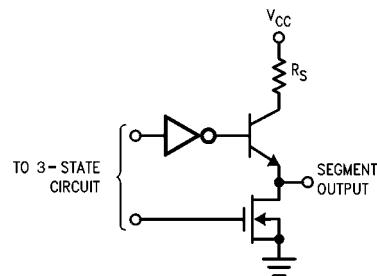


## Typical Applications

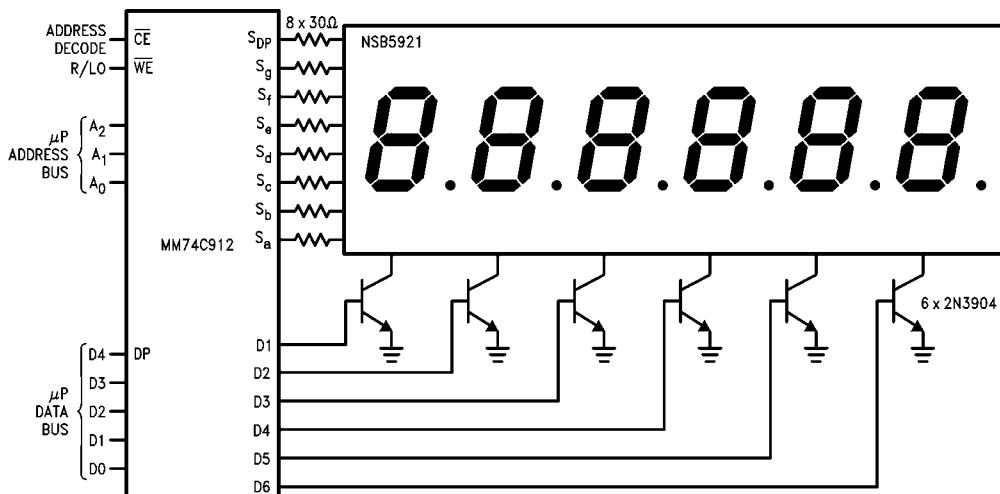
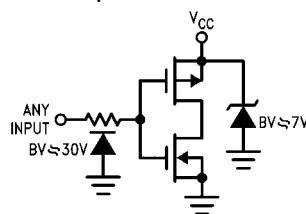
Digit Output Structure



Segment Output Structure

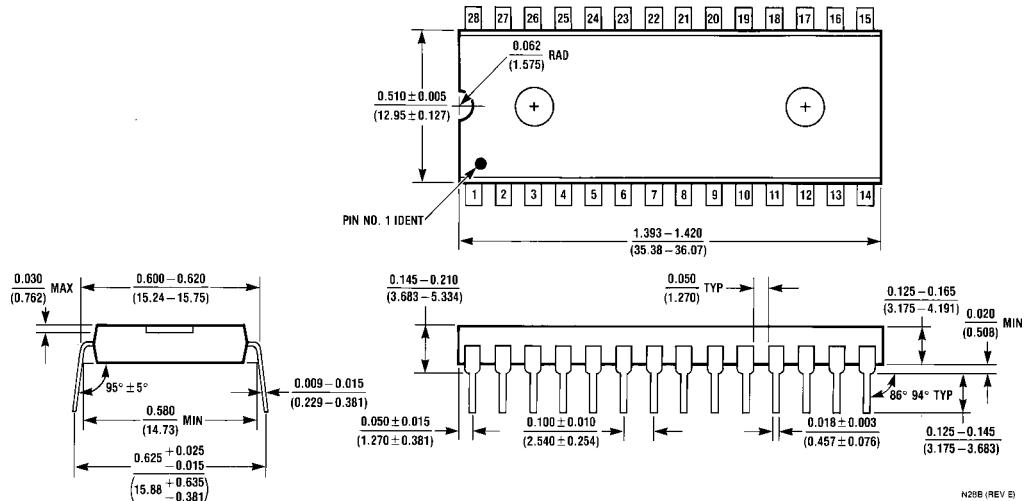


Input Protection



## Physical Dimensions

inches (millimeters) unless otherwise noted



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

H28B (REV E)

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