

## MM74C911 4-Digit Expandable Segment Display Controller

### General Description

The MM74C911 display controller is an interface element with memory that drives a 4-digit, 8-segment LED display. The MM74C911 allows individual control of any segment in the 4-digit display. The number of segments per digit can be expanded without any external components. For example, two MM74C911's can be cascaded to drive a 16-segment alpha-numeric display.

The display controllers receive data information through 8 data lines a, b...DP, and digit information through 2 address inputs K1 and K2. The input data is written into the register selected by the address information when  $\overline{\text{CHIP}} \text{ ENABLE}$ ,  $\overline{\text{CE}}$ , and  $\overline{\text{WRITE ENABLE}}$ ,  $\overline{\text{WE}}$ , are LOW and is latched when either  $\overline{\text{CE}}$  or  $\overline{\text{WE}}$  return HIGH. Data hold time is not required.

A self-contained internal oscillator sequentially presents the stored data to high drive (100 mA typ.) 3-STATE output drivers which directly drive the LED display. The drivers are active when the control pin labeled  $\overline{\text{SEGMENT OUTPUT ENABLE}}$ ,  $\overline{\text{SOE}}$ , is LOW and go into 3-STATE when  $\overline{\text{SOE}}$  is HIGH. This feature allows for duty cycle brightness control, or for disabling the output drive for power conservation.

The digit outputs directly drive the base of the digit transistor when the control pin labeled  $\overline{\text{DIGIT INPUT OUTPUT}}$ ,  $\overline{\text{DIO}}$ , is LOW. When  $\overline{\text{DIO}}$  is HIGH, the digit lines turn into inputs and the internal scanning multiplexer is disabled.

When any digit line is forced HIGH by an external device, usually another MM74C911, the data information for that digit is presented to the output. In this manner, 16-segment alpha-numeric displays, 24- or 32-segment displays, or an array of discrete LED's can be controlled by the simple cascading of expandable segment display controllers. All inputs except digit inputs are TTL compatible and do not clamp input voltages above  $V_{\text{CC}}$ .

### Features

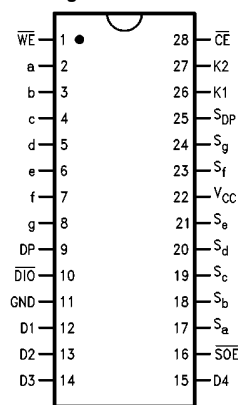
- Direct segment drive (100 mA typ.) 3-STATE
- 4 registers addressed like RAM
- Internal oscillator and scanning circuit
- Direct base drive to digit transistor
- Segment expandability without external components
- TTL compatible inputs
- Power saver mode—5  $\mu\text{W}$  (typ.)

### Ordering Code:

Order Number	Package Number	Package Description
MM74C991N	N28B	28-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-010, 0.600" Wide

### Connection Diagram

Pin Assignments for DIP



Top View

### Truth Tables

Input Control				Output Control						
CE	Digit Address		WE	DIO	SOE	Digit Lines				Operation
	K2	K1				D4	D3	D2	D1	
0	0	0	0	0	0	R	R	R	R	Refresh Display
0	0	0	1	0	1	R	R	R	R	Disable Segment Outputs
0	0	1	0	1	0	0	0	0	0	Digits Are Now Inputs
0	0	1	1	1	0	0	0	0	1	Display Digit 1
0	0	1	1	1	0	0	0	1	0	Display Digit 2
0	1	0	0	1	0	0	1	0	0	Display Digit 3
0	1	0	1	1	0	1	0	0	0	Display Digit 4
0	1	1	0	1	1	0	0	0	0	Power Saver Mode
0	1	1	1	1	1	0	0	0	0	Power Saver Mode
1	X	X	X	1	1	0	0	0	0	Power Saver Mode

R = Refresh (digit lines sequentially pulsed)  
X = Don't Care

### Functional Description

The MM74C911 display controller is manufactured on standard metal gate CMOS technology. A single 5V 74 series TTL supply can be used for power and should be bypassed at the V<sub>CC</sub> pin to suppress current transients.

The digit outputs directly drive the base of a grounded emitter digit transistor without the need of a Darlington configuration. If an MM74C911 is driving a digit transistor and also supplying digit information to a cascaded MM74C911, base resistors are needed in the digit transistors to provide an adequate high level to the digit inputs of the cascaded MM74C911.

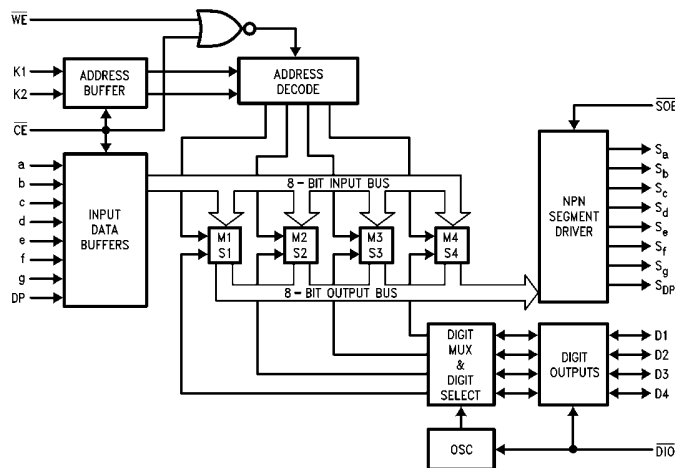
As seen in the Block Diagram, these display controllers contain four 8-bit registers; any one may be randomly writ-

ten into. In normal operation, the internal multiplexer scans the registers and refreshes the display. In cascaded operation, 1 MM74C911 serves as a master refresh device and cascaded MM74C911's are slaved to it through digit lines operating as inputs.

The MM74C911 appears to a microprocessor as memory and to the user as a self-scan display. Since every segment is under microprocessor control, great versatility is obtained.

Low power standby operation occurs with both SOE and DIO inputs HIGH. This condition forces the MM74C911 to a quiescent state typically drawing less than 1 μA of supply current with a standby supply voltage as low as 3V.

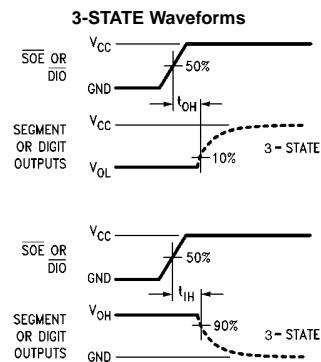
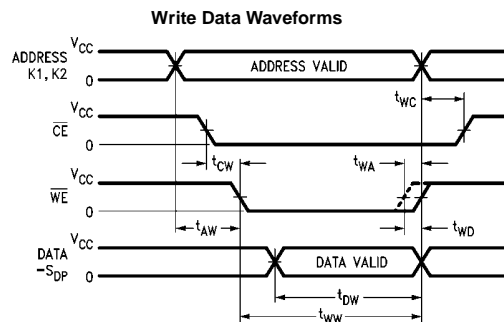
### Logic Diagram



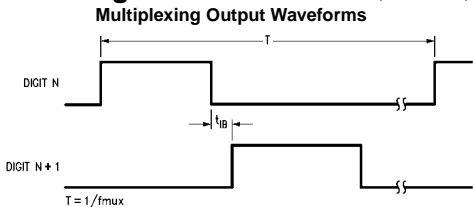
<b>Absolute Maximum Ratings</b> (Note 1)		Operating $V_{CC}$ Range	3V to 6V			
(Note 2)		Absolute Maximum $V_{CC}$	6.5V			
Voltage at Any Pin except Inputs	-0.3V to $V_{CC} + 0.3V$	Lead Temperature (Soldering, 10 seconds)	260°C			
Voltage at Any Input except Digits	-0.3V to +15V	<b>Note 1:</b> "Absolute 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.				
Operating Temperature Range, ( $T_A$ )	-40°C to +85°C	<b>Note 2:</b> All voltage reference to ground.				
Storage Temperature Range	-65°C to +150°C					
Power Dissipation ( $P_D$ )	Refer to $P_{D(MAX)}$ vs $T_A$ Graph					
<b>DC Electrical Characteristics</b>						
Min/Max limits apply at $-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$ , unless otherwise noted						
Symbol	Parameter	Conditions	Min	Typ	Max	Units
$V_{IN(1)}$	Logical "1" Input Voltage	$V_{CC} = 5V$	3.0			V
$V_{IN(0)}$	Logical "0" Input Voltage				1.5	V
$I_{IN(1)}$	Logical "1" Input Current	$V_{CC} = 5V, V_{IN} = 15V$		0.005	1.0	$\mu\text{A}$
$I_{IN(0)}$	Logical "0" Input Current	$V_{CC} = 5V, V_{IN} = 0V$	-1.0	-0.005		$\mu\text{A}$
$I_{CC}$	Supply Current (Normal)	$V_{CC} = 5V$ , Outputs Open		0.50	2.5	mA
$I_{CC}$	Supply Current (Power Saver)	$V_{CC} = 5V$ , SOE, $\overline{DI0} = "1"$ , D1, D2, D3, D4 = "0"		1	600	$\mu\text{A}$
$I_{OUT}$	3-STATE Output Current	$V_O = 5V$ $V_O = 0V$	-10	0.03 -0.03	10	$\mu\text{A}$
<b>CMOS/LPTTL INTERFACE</b>						
$V_{IN(1)}$	Logical "1" Input Voltage	$V_{CC} = 4.75V$	$V_{CC} - 2$			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	$V_{CC} = 5V, V_O = 3.4V$ $T_J = 25^\circ\text{C}$ $T_J = 100^\circ\text{C}$	-60 -40	-100 -60		mA mA
$I_{DH}$	HIGH Level Digit Current	$V_{CC} = 5V, V_O = 3V$ $T_J = 25^\circ\text{C}$ $T_J = 100^\circ\text{C}$ $V_{CC} = 5V, V_O = 1V$ $T_J = 25^\circ\text{C}$ $T_J = 100^\circ\text{C}$	-10 -7 -15 -10	-20 -10 -40 -15		mA mA mA mA
$V_{OUT(1)}$	Logical "1" Output Voltage, Any Digit	$V_{CC} = 5V, I_O = -360 \mu\text{A}$	4.6			V
$V_{OUT(0)}$	Logical "0" Output Voltage, Any Output	$V_{CC} = 5V, I_O = 360 \mu\text{A}$			0.4	V
$\theta_{JA}$	Thermal Resistance	(Note 3)		100		$^\circ\text{C/W}$
<b>Note 3:</b> $\theta_{JA}$ measured in free-air with device soldered into printed circuit board.						

**AC Electrical Characteristics** (Note 4) $V_{CC} = 5V$ ,  $t_r = t_f = 20$  ns,  $C_L = 50$  pF

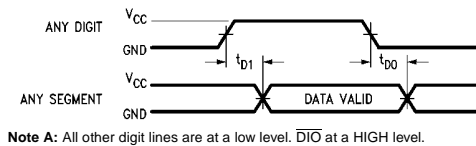
Symbol	Parameter	Conditions	Min	Typ	Max	Units
$t_{CW}$	Chip Enable to Write Enable Set-Up Time	$T_J = 25^\circ C$	35	15		ns
		$T_J = 125^\circ C$	50	20		ns
$t_{AW}$	Address to Write Enable Set-Up Time	$T_J = 25^\circ C$	35	15		ns
		$T_J = 125^\circ C$	50	20		ns
$t_{WW}$	Write Enable Width	$T_J = 25^\circ C$	400	225		ns
		$T_J = 125^\circ C$	450	250		ns
$t_{DW}$	Data to Write Enable Set-Up 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	$T_J = 25^\circ C$	55	30		ns
		$T_J = 125^\circ C$	75	40		ns
$t_{1H}, t_{0H}$	Logical "1", Logical "0" Levels into 3-STATE	$R_L = 10k, C_L = 10$ pF				
		$T_J = 25^\circ C$		275	500	ns
$t_{H1}, t_{H0}$	3-STATE to Logical "1" or Logical "0" Levels	$R_L = 10k, C_L = 10$ pF				
		$T_J = 25^\circ C$		325	600	ns
$t_{D1}, t_{D0}$	Propagation Delay from Digit Input to Segment Output	$T_J = 25^\circ C$		500	1000	ns
		$T_J = 125^\circ C$		700	1400	ns
$t_{IB}$	Interdigit Blanking Time	$T_J = 25^\circ C$	5	10		$\mu s$
		$T_J = 125^\circ C$	10	20		$\mu s$
$f_{MUX}$	Multiplex Scan Frequency	$T_J = 25^\circ C$		525		Hz
		$T_J = 125^\circ C$		375		Hz
$C_{IN}$	Input Capacitance	(Note 5)		5	7.5	pF
$C_{OUT}$	3-STATE Output Capacitance	(Note 5)		30	50	pF

**Note 4:** AC Parameters are guaranteed by DC correlated testing.**Note 5:** Capacitance guaranteed by periodic testing.**Switching Time Waveforms**

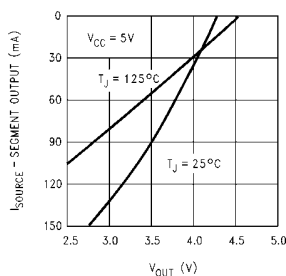
### Switching Time Waveforms (Continued)



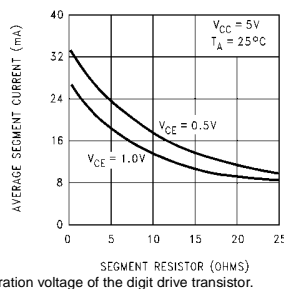
### Read Data Waveforms



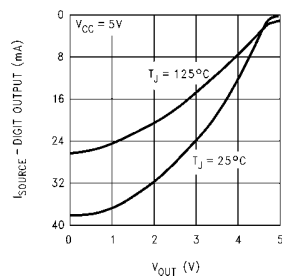
### Typical Performance Characteristics



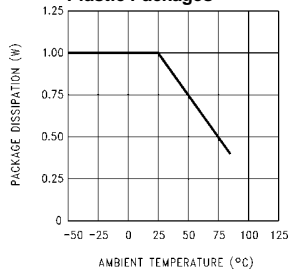
Segment outputs if shorted to ground will exceed maximum power dissipation of the device.



V<sub>CE</sub> is the saturation voltage of the digit drive transistor.

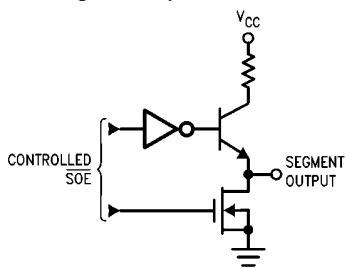


### Power Dissipation vs Temperature for Plastic Packages

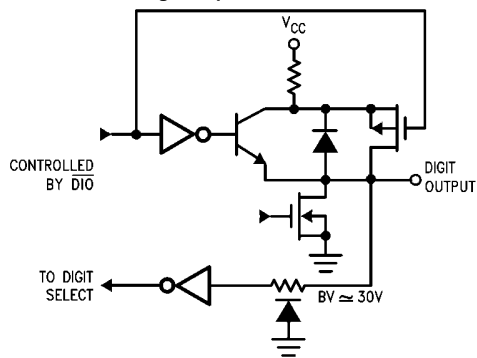


### Applications

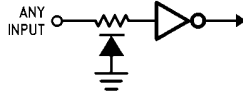
#### Segment Output Structure



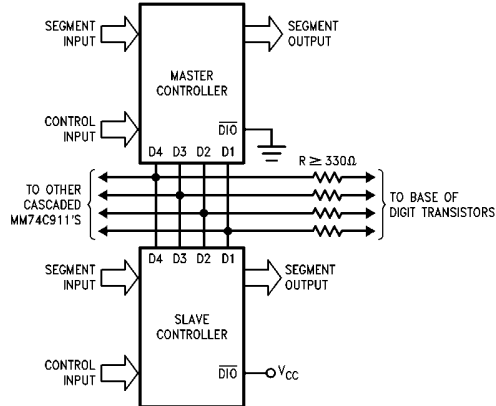
#### Digit Output Structure



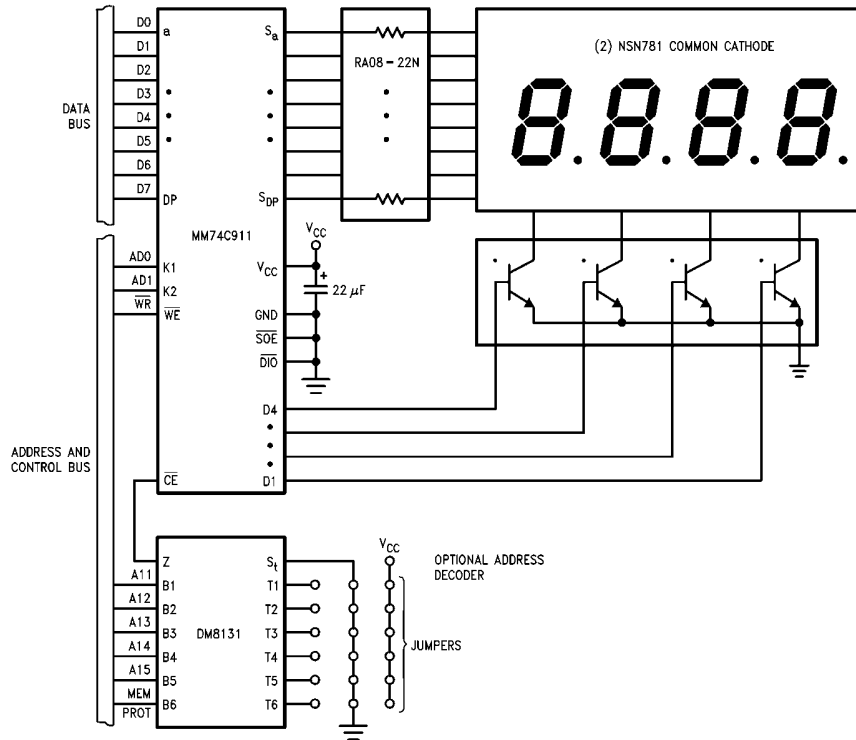
**Input Protection**



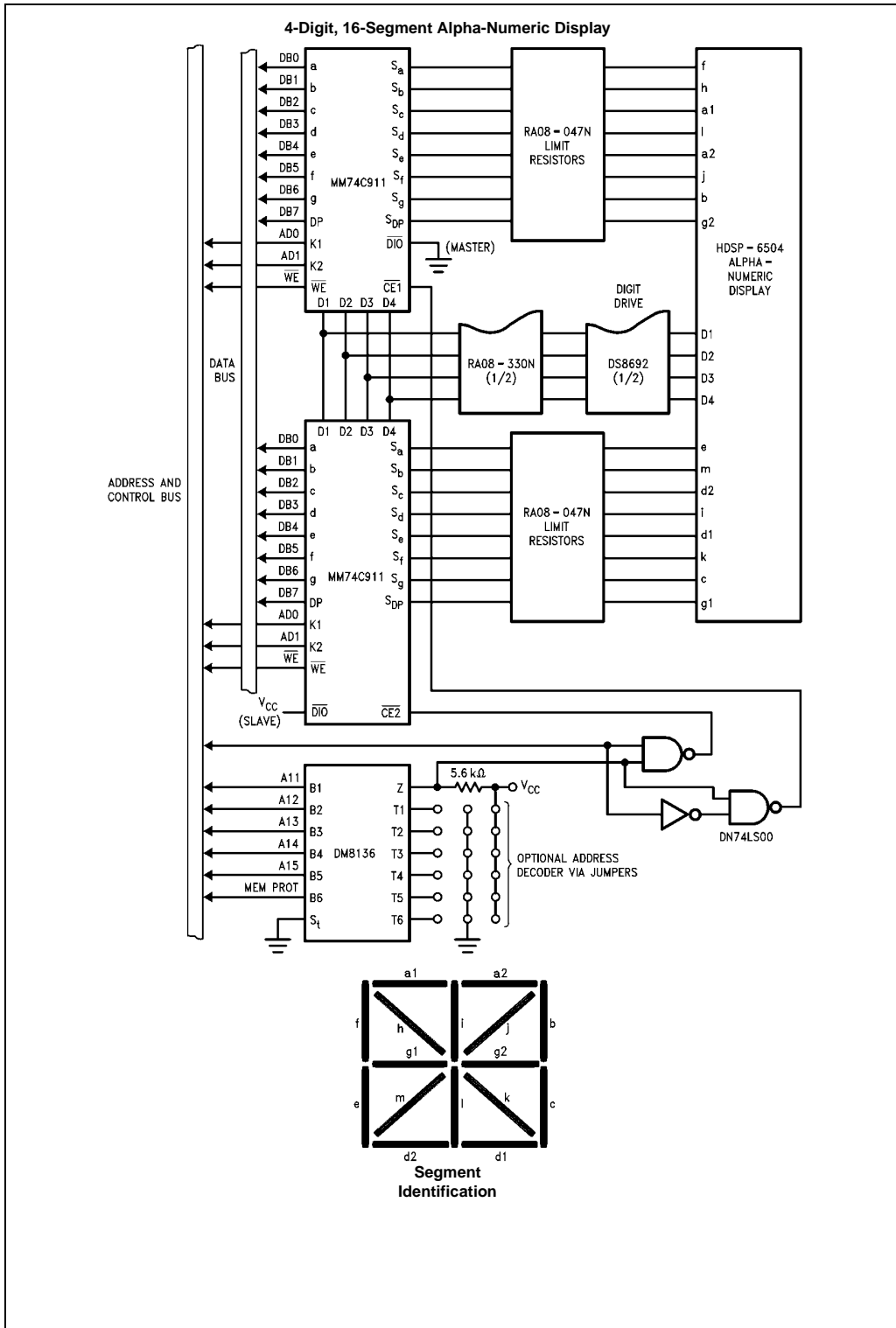
**Segment Expansion**

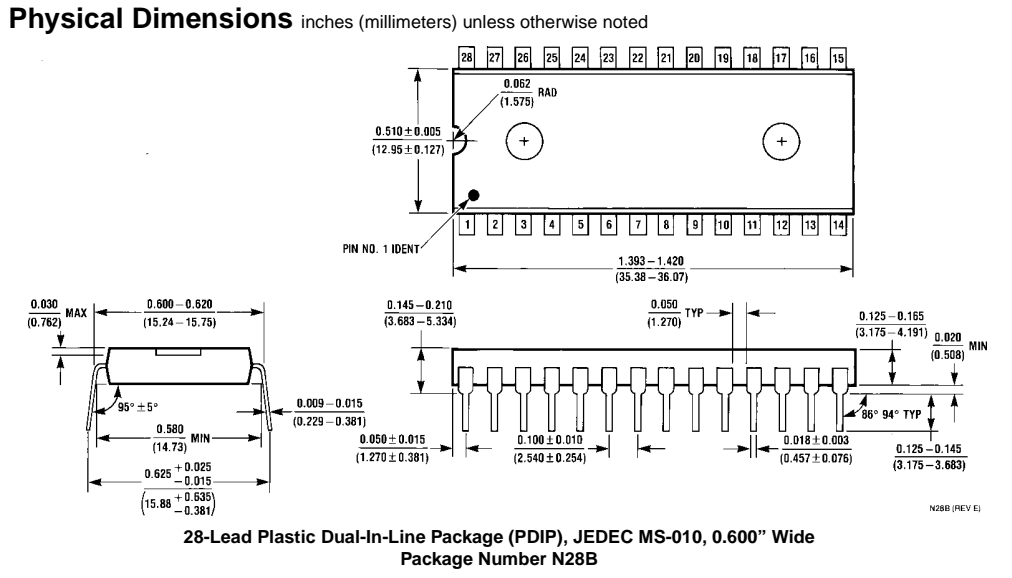


**Typical Application**



\*Base resistors may be necessary to limit base current.





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