

## MM5450/MM5451 LED Display Drivers

### General Description

The MM5450 and MM5451 are monolithic MOS integrated circuits utilizing N-channel metal-gate low threshold, enhancement mode, and ion-implanted depletion mode devices. They are available in 40-pin molded or cavity dual-in-line packages. The MM5450/MM5451 is designed to drive common anode-separate cathode LED displays. A single pin controls the LED display brightness by setting a reference current through a variable resistor connected to  $V_{DD}$ .

### Applications

- COPSTM or microprocessor displays
- Industrial control indicator
- Relay driver
- Digital clock, thermometer, counter, voltmeter
- Instrumentation readouts

### Features

- Continuous brightness control
- Serial data input
- No load signal required
- Enable (on MM5450)
- Wide power supply operation
- TTL compatibility
- 34 or 35 outputs, 15 mA sink capability
- Alphanumeric capability
- $\theta_{JA}$  DIP

Board = 49°C/W  
Socket = 54°C/W

### Block Diagram

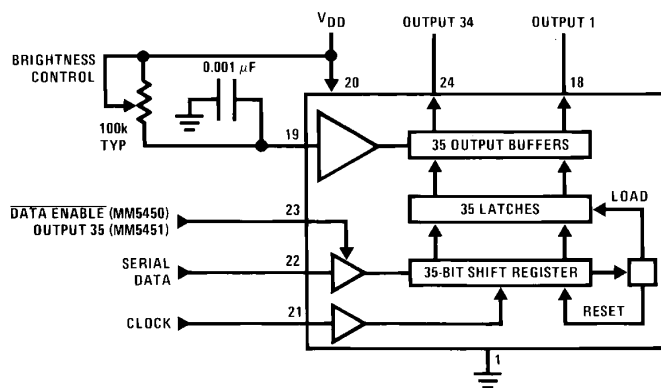


FIGURE 1

TL/F/6136-1

COPSTM is a trademark of National Semiconductor Corporation.

## Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Voltage at Any Pin	$V_{SS} - 0.3V$ to $V_{SS} + 12V$
Operating Temperature	$-25^{\circ}C$ to $+85^{\circ}C$
Storage Temperature	$-65^{\circ}C$ to $+150^{\circ}C$
Junction Temperature	$+150^{\circ}C$
Lead Temperature (Soldering, 10 sec.)	$300^{\circ}C$

Power Dissipation at  $+25^{\circ}C$

Molded DIP Package, Board Mount	2.5W*
Molded DIP Package, Socket Mount	2.3W**

\*Molded DIP Package board mount,  $\theta_{JA} = 49^{\circ}C/W$ , Derate 20.4 mW/ $^{\circ}C$  above  $25^{\circ}C$ .

\*\*Molded DIP Package, socket mount,  $\theta_{JA} = 54^{\circ}C/W$ , Derate 18.5 mW/ $^{\circ}C$  above  $25^{\circ}C$ .

## Electrical Characteristics

$T_A$  within operating range,  $V_{DD} = 4.75V$  to  $11.0V$ ,  $V_{SS} = 0V$  unless otherwise specified

Parameter	Conditions	Min	Typ	Max	Units
Power Supply		4.75		11	V
Power Supply Current	Excluding Output Loads			7	mA
Input Voltages					
Logical "0" Level ( $V_L$ )	$\pm 10 \mu A$ Input Bias	-0.3		0.8	V
Logical "1" Level ( $V_H$ )	$4.75V \leq V_{DD} \leq 5.25V$	2.2		$V_{DD}$	V
	$V_{DD} > 5.25V$	$V_{DD} - 2V$		$V_{DD}$	V
Brightness Input (Note 2)		0		0.75	mA
Output Sink Current				10	$\mu A$
Segment OFF	$V_{OUT} = 3.0V$				
Segment ON	$V_{OUT} = 1V$ (Note 3)			10	$\mu A$
	Brightness Input = $0 \mu A$	0	2.7	4	mA
	Brightness Input = $100 \mu A$	2.0		25	mA
	Brightness Input = $750 \mu A$	15			
Brightness Input Voltage (Pin 19)	Input Current $750 \mu A$	3.0		4.3	V
Output Matching (Note 1)				$\pm 20$	%
Clock Input	(Notes 5 and 6)			500	kHz
Frequency, $f_C$		950			ns
High Time, $t_H$		950			ns
Low Time, $t_L$					
Data Input					
Set-Up Time, $t_{DS}$		300			ns
Hold Time, $t_{DH}$		300			ns
Data Enable Input					
Set-Up Time, $t_{DES}$		100			ns

**Note 1:** Output matching is calculated as the percent variation  $(I_{MAX} + I_{MIN})/2$ .

**Note 2:** With a fixed resistor on the brightness input pin, some variation in brightness will occur from one device to another. Maximum brightness input current can be 2 mA as long as Note 3 and junction temperature equation are complied with.

**Note 3:** See Figures 5, 6, and 7 for Recommended Operating Conditions and limits. Absolute maximum for each output should be limited to 40 mA.

**Note 4:** The  $V_{OUT}$  voltage should be regulated by the user. See Figures 6 and 7 for allowable  $V_{OUT}$  vs  $I_{OUT}$  operation.

**Note 5:** AC input waveform specification for test purpose:  $t_r \leq 20$  ns,  $t_f \leq 20$  ns,  $f = 500$  kHz, 50%  $\pm 10\%$  duty cycle.

**Note 6:** Clock input rise and fall times must not exceed 300 ns.

## Connection Diagrams

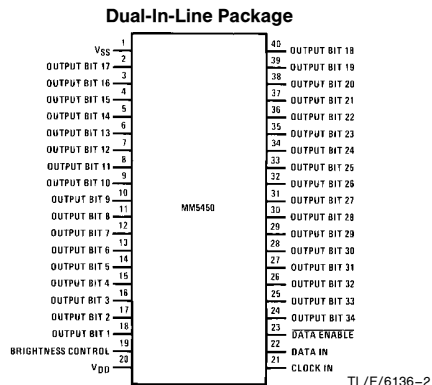


FIGURE 2a

Order Number MM5450N, MM5451N, MM5450V or MM5451V  
See NS Package Number N40A or V44A

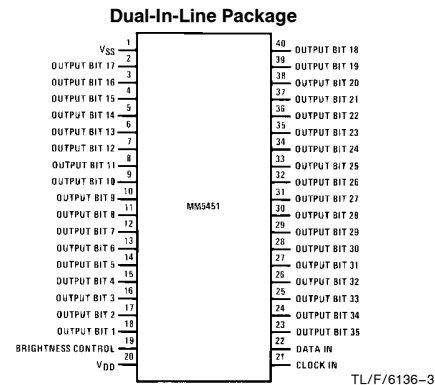
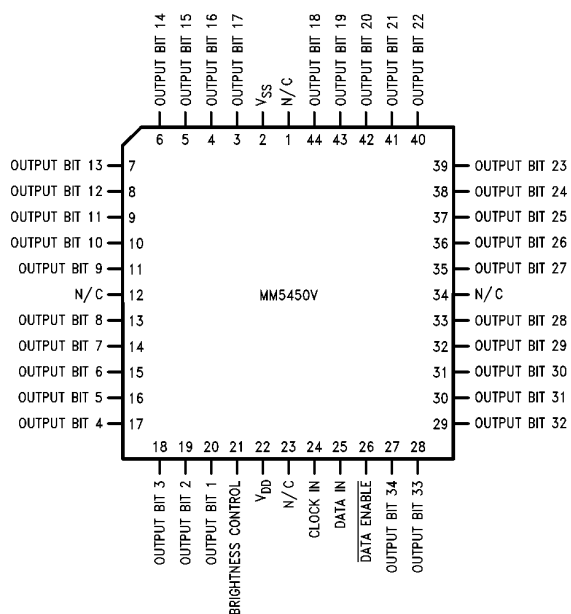


FIGURE 2b

## Connection Diagrams (Continued)

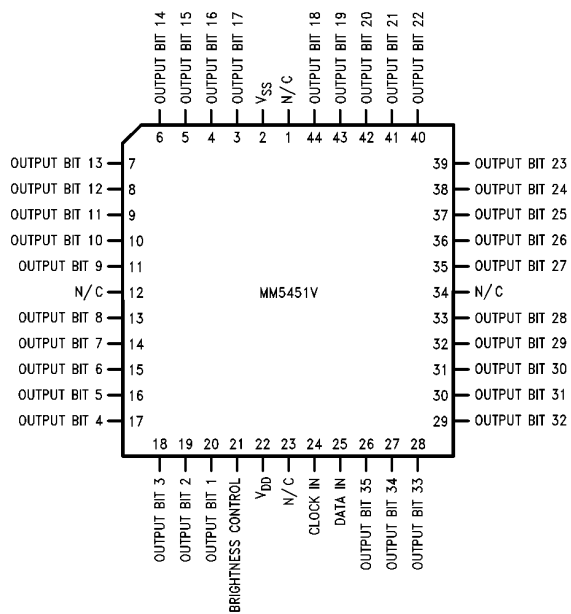
### Plastic Chip Carrier



TL/F/6136-13

### Top View

### Plastic Chip Carrier



TL/F/6136-14

### Top View

Both the MM5450 and the MM5451 are specifically designed to operate 4- or 5-digit alphanumeric displays with minimal interface with the display and the data source. Serial data transfer from the data source to the display driver is accomplished with 2 signals, serial data and clock. Using a format of a leading "1" followed by the 35 data bits allows data transfer without an additional load signal. The 35 data bits are latched after the 36th bit is complete, thus providing non-multiplexed, direct drive to the display. Outputs change only if the serial data bits differ from the previous time. Display brightness is determined by control of the output current for LED displays. A 0.001 capacitor should be connected to brightness control, pin 19, to prevent possible oscillations.

Figure 4 shows the input data format. A start bit of logical “1” precedes the 35 bits of data. At the 36th clock a LOAD signal is generated synchronously with the high state of the clock, which loads the 35 bits of the shift registers into the latches. At the low state of the clock a RESET signal is generated which clears all the shift registers for the next set of data. The shift registers are static master-slave configuration. There is no clear for the master portion of the first shift register, thus allowing continuous operation.

When the chip first powers ON an internal power ON reset signal is generated which resets all registers and all latches. The START bit and the first clock return the chip to its normal operation.

Figure 3 shows the timing relationships between data, clock and DATA ENABLE. A max clock frequency of 0.5 MHz is assumed.

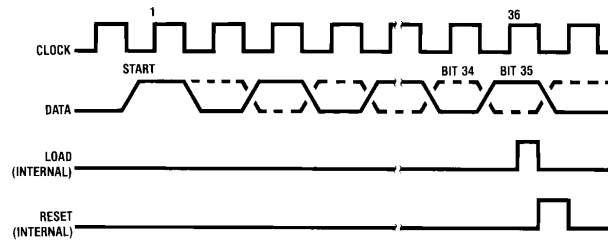
$$T_j = (V_{OUT}) (I_{LED}) (\text{No. of segments}) (\theta_{JA}) + T_A$$

where:

$$\theta_{JA} \text{ (Board Mount)} = 49^{\circ}\text{C/W}$$

TI /E/6136-4

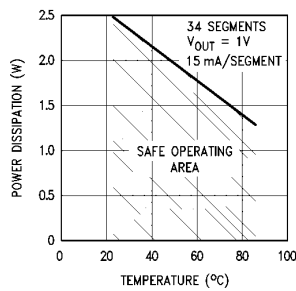
## Functional Description (Continued)



TL/F/6136-5

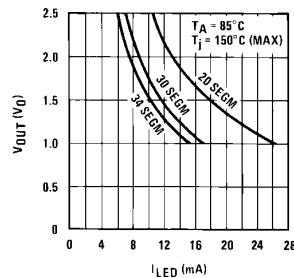
FIGURE 4. Input Data Format

## Typical Performance Characteristics



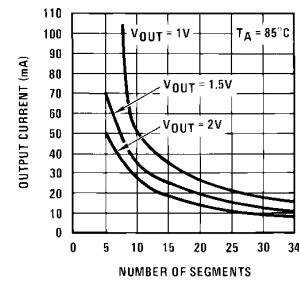
TL/F/6136-6

FIGURE 5



TL/F/6136-7

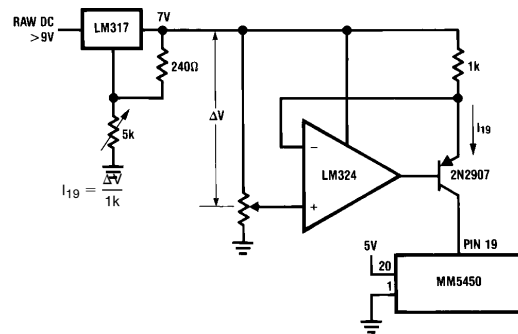
FIGURE 6



TL/F/6136-8

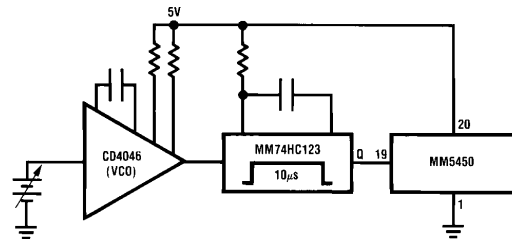
FIGURE 7

## Typical Applications



TL/F/6136-9

FIGURE 8. Typical Application of Constant Current Brightness Control

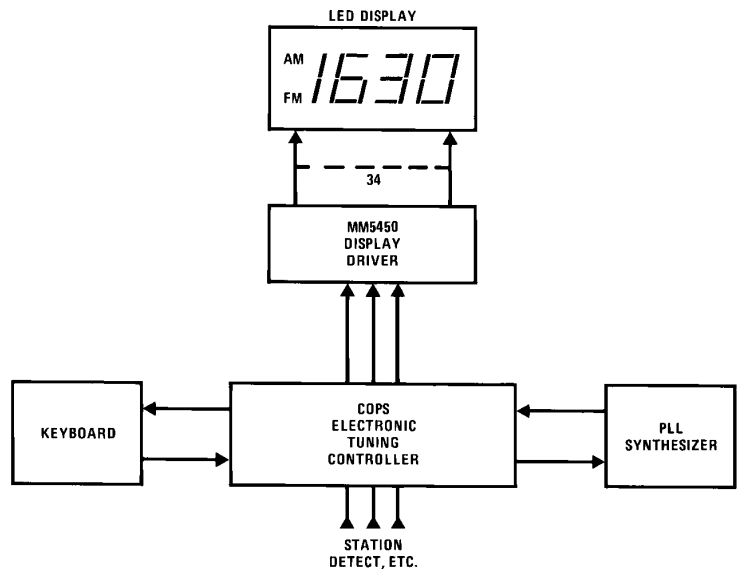


TL/F/6136-10

FIGURE 9. Brightness Control Varying the Duty Cycle

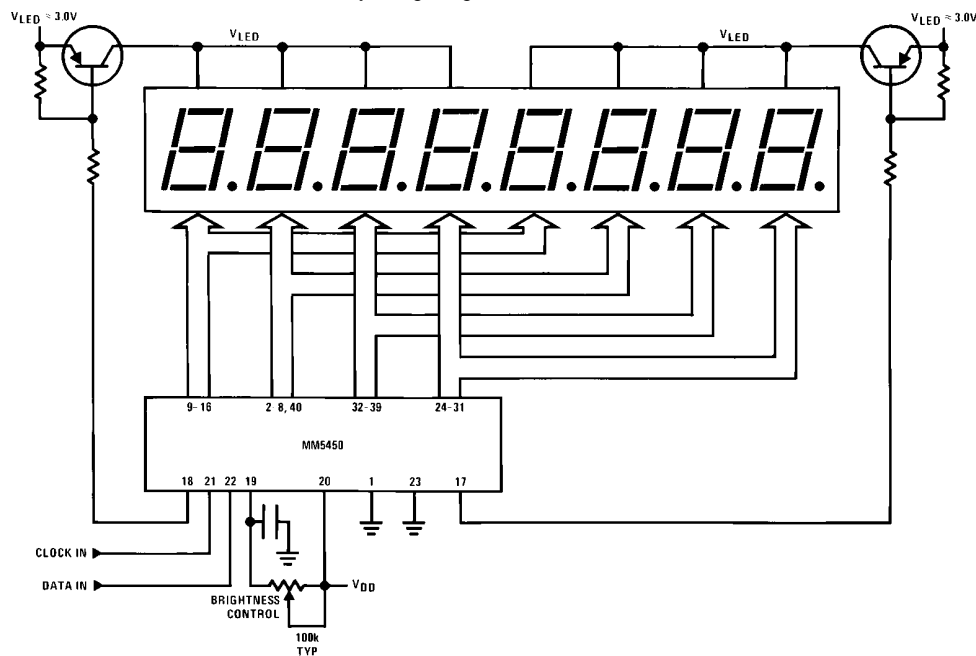
Typical Applications (Continued)

Basic Electronically Tuned Radio System



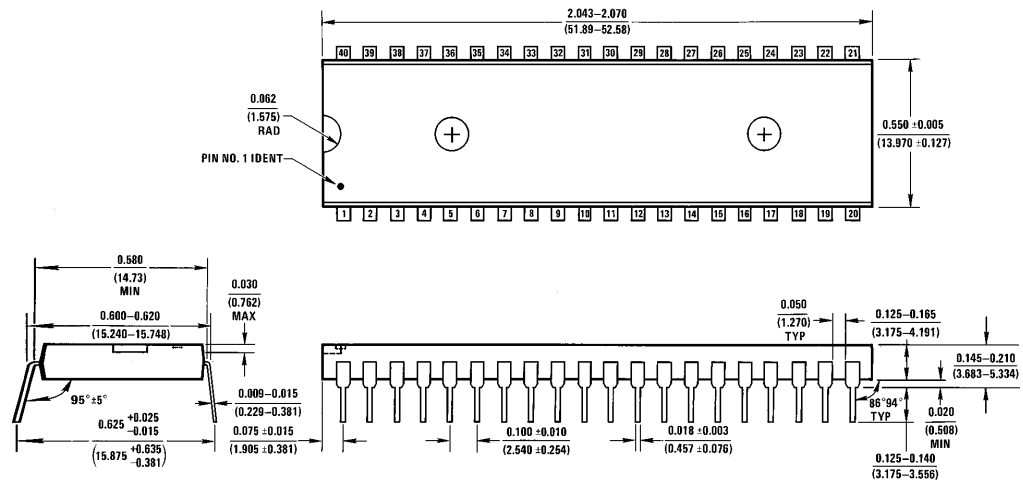
TL/F/6136-11

Duplexing 8 Digits with One MM5450



TL/F/6136-12

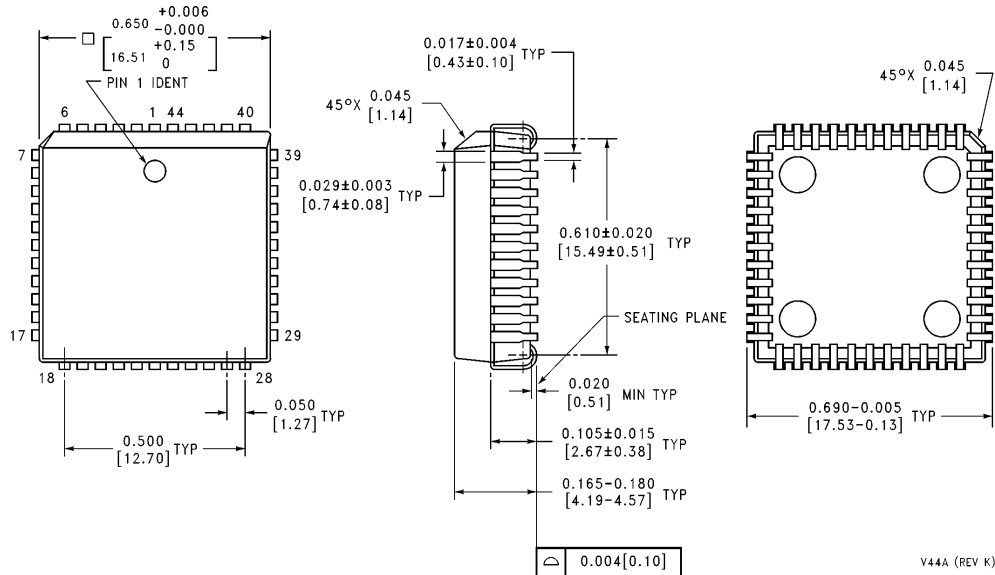
# Physical Dimensions inches (millimeters)



N40A (REV E)

**Molded Dual-In-Line Package (N)**  
**Order Number MM5450N or MM5451N**  
**NS Package Number N40A**

# Physical Dimensions inches (millimeters) (Continued)



**Plastic Chip Carrier (V)**  
**Order Number MM5450V or MM5451V**  
**NS Package Number V44A**

V44A (REV K)

## LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.



**National Semiconductor Corporation**  
 1111 West Bardin Road  
 Arlington, TX 76017  
 Tel: (800) 272-9959  
 Fax: 1(800) 737-7018

**National Semiconductor Europe**  
 Fax: (+49) 0-180-530 85 86  
 Email: cnjwge@tevm2.nsc.com  
 Deutsch Tel: (+49) 0-180-530 85 85  
 English Tel: (+49) 0-180-532 78 32  
 Français Tel: (+49) 0-180-532 93 58  
 Italiano Tel: (+49) 0-180-534 16 80

**National Semiconductor Hong Kong Ltd.**  
 19th Floor, Straight Block,  
 Ocean Centre, 5 Canton Rd.  
 Tsimshatsui, Kowloon  
 Hong Kong  
 Tel: (852) 2737-1600  
 Fax: (852) 2736-9960

**National Semiconductor Japan Ltd.**  
 Tel: 81-043-299-2309  
 Fax: 81-043-299-2408