



MM5450/5451

LED Display Driver

General Description

The MM5450 and MM5451 LED display drivers are monolithic MOS IC's fabricated in an N-Channel, metal-gate process. The technology produces low-threshold, enhancement-mode, and ion-implanted depletion-mode devices.

A single pin controls the LED display brightness by setting a reference current through a variable resistor connected to the supply.

Applications

- Industrial control indicator
- Relay driver
- Digital clock, thermometer, counter, voltmeter
- Instrumentation readouts

Features

- Continuous brightness control
- Serial data input
- No load signal requirement
- Enable (on MM5450)
- Wide power supply operation
- TTL compatibility
- 34 or 35 outputs, 15mA capability
- Alphanumeric capability

Ordering Information

Part Number		Junction Temp. Range	Package
Standard	Pb-Free		
MM5450BN	MM5450YN	-40°C to +85°C	40-pin PDIP
MM5451BN	MM5451YN	-40°C to +85°C	40-pin PDIP
MM5450BV	MM5450YV	-40°C to +85°C	44-pin PLCC
MM5451BV	MM5451YV	-40°C to +85°C	44-pin PLCC

Block Diagram

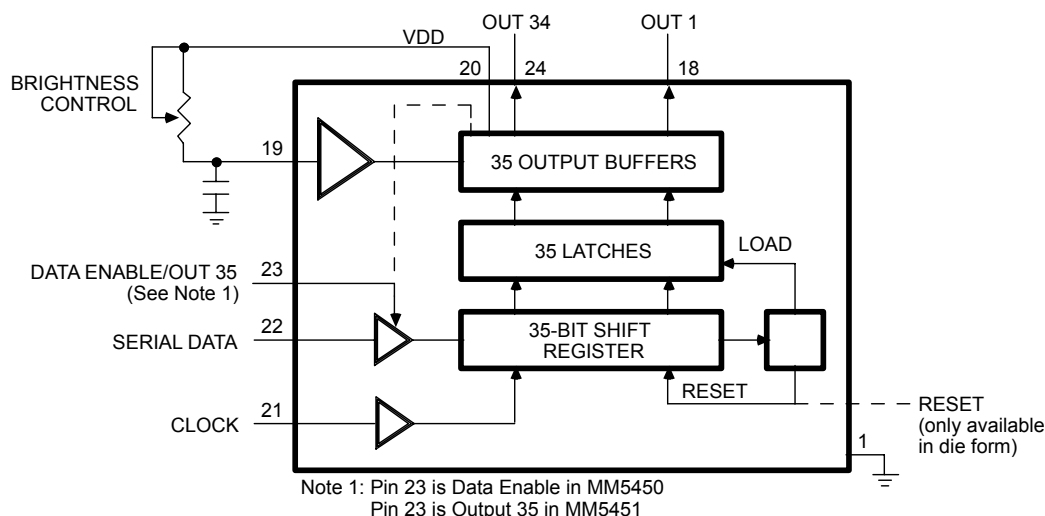


Figure 1.

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Connection Diagram: Die

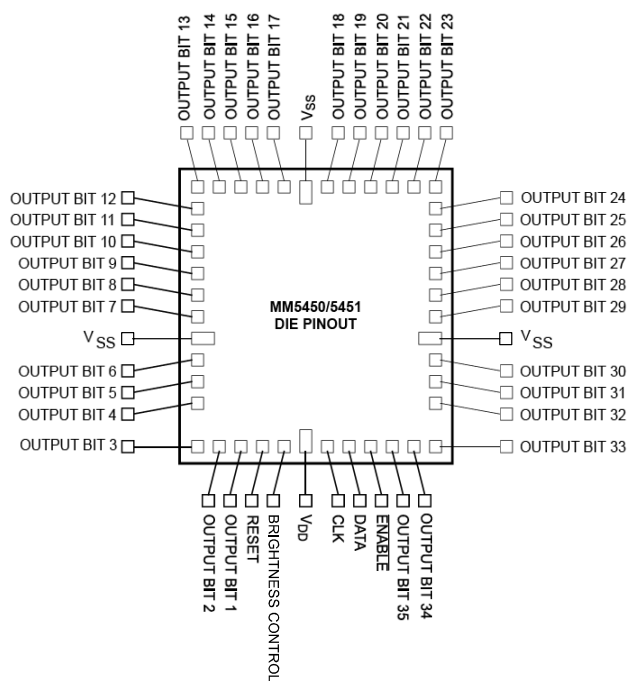


Figure 2.

Connection Diagram: Dual-in-line Package

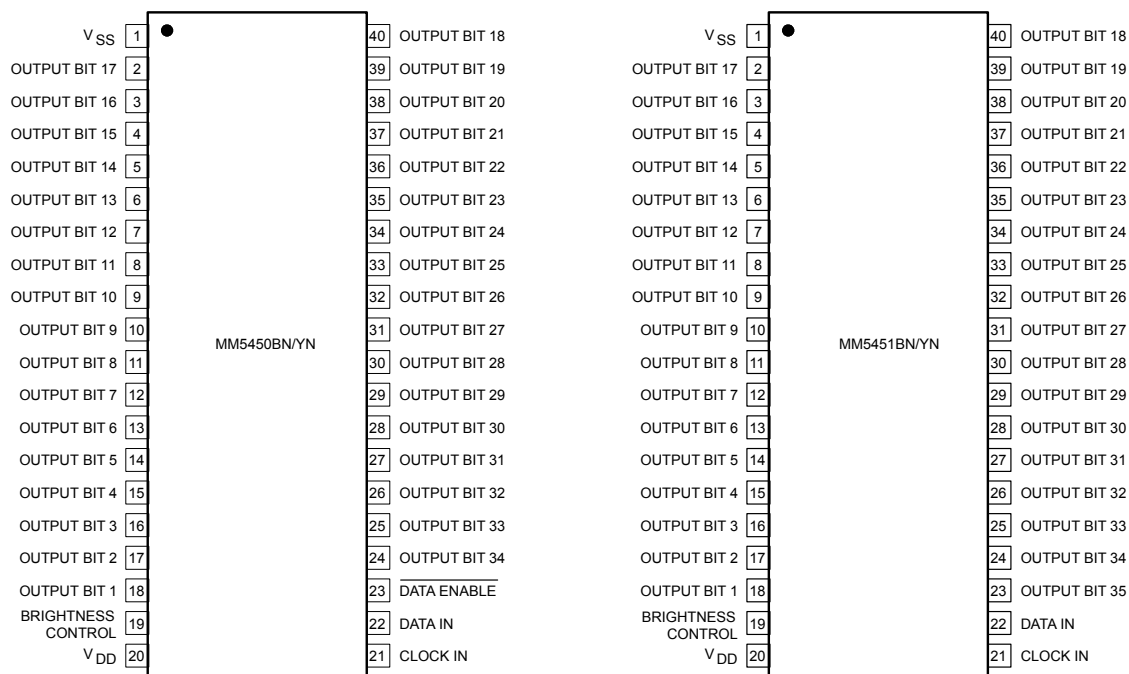


Figure 3a, 3b.

Connection Diagram: Plastic Leaded Chip Carrier

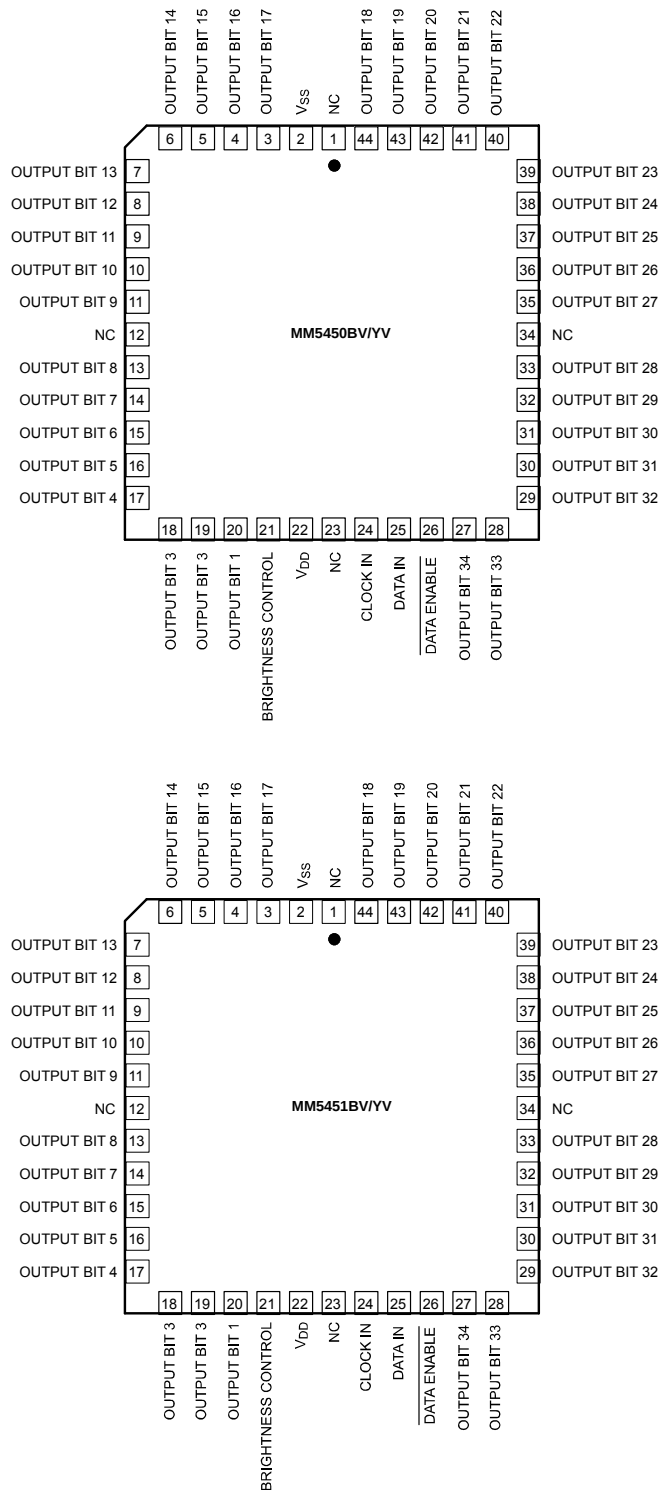


Figure 4a, 4b.

Absolute Maximum Ratings

Voltage (any pin) V_{SS} to $V_{SS} + 12V$
 Power Dissipation
 +25°C 1W
 +85°C 560mW
 Junction Temperature (T_J) +150°C
 Storage Temperature (T_S) -65°C to +150°C
 Lead Temperature (soldering, 10sec.) +300°C

Operating Ratings

Supply voltage ($V_{DD} - V_{SS}$) +4.75V to +11V
 Ambient Temperature Range (T_A) -40°C to +85°C

Electrical Characteristics

4.5V $\leq V_{DD} \leq 11V$, $V_{SS} = 0V$; $T_A = 25^\circ C$, **bold** values indicate $-40^\circ C \leq T_A \leq +85^\circ C$, unless otherwise noted.

Symbol	Parameter	Condition	Min	Typ	Max	Units
	Power Supply Current	-25°C to +85°C, excluding output loads -40°C to +85°C, excluding output loads			8.5 10	mA mA
V_L V_H	Data Input Voltage	logic-0 level, $\pm 10 \mu A$ input bias logic-1 level, $4.75V \leq V_{DD} \leq 5.25V$ $V_{DD} > 5.25V$	-0.3 2.2 $V_{DD} - 2$		0.8 V_{DD} V_{DD}	V V V
	Brightness Control Input Current	Note 2	0		0.75	mA
	Output Sink Current	segment off, $V_{OUT} = 3.0V$			10	μA
		segment on, $V_{OUT} = 1.8V$, Note 3 brightness input = $0 \mu A$ brightness input = $100 \mu A$ brightness input = $750 \mu A$	0 2.0 15	2.7	10 4 25	μA mA mA
	Brightness Control Input Voltage	input current = $750 \mu A$	3.0		4.3	V
	Output Matching	Note 1			± 20	%
f_C	Clock Input Frequency	Notes 5, 6			500	kHz
t_H	Clock Input High Time	Notes 5, 6	950			ns
t_L	Clock Input Low Time	Notes 5, 6	950			ns
t_{DS}	Data Input Setup Time		300			ns
t_{DH}	Data Input Hold Setup Time		300			ns
t_{DES}	Data Enable Input Setup Time		100			ns
	Reset Pad Current	die	8		8	μA

Notes:

- Output matching is calculated as the percent variation $(I_{MAX} + I_{MIN}) / 2$.
- With a fixed resistor on the brightness input pin, some variation in brightness will occur among devices.
- See Figures 7, 8 and 9 for recommended operating conditions and limits. Absolute maximum for each output should be limited to 40mA.
- V_{OUT} should be regulated by user. See Figures 8 and 9 for allowable V_{OUT} vs. I_{OUT} operation.
- AC input waveform specification for test purpose: $t_R \leq 200ns$, $t_F \leq 20ns$, $f = 500kHz$, 50% $\pm 10\%$ duty cycle.
- Clock input rise and fall times must not exceed 300ns.

Functional Description

The MM5450 and MM5451 were designed to drive either 4- or 5-digit alphanumeric LED displays with the added benefit of requiring minimal interface with the display or data source.

Data is transferred serially via 2 signals; clock and serial data. Data transfer without the added inconvenience of an external load signal is accomplished by using a format of a leading "1" followed by the allowed 35 data bits. These 35 data bits are latched after the 36th has been transferred. This scheme provides non multiplexed, direct drive to the LED display. Characters currently displayed (thus, data output) changes only if the serial data bits differ from those previously transferred.

The MIC37252 regulator is fully protected from damage due to fault conditions. Current limiting is provided. This limiting is linear; output current during overload conditions is constant. Thermal shutdown disables the device when the die temperature exceeds the maximum safe operating temperature. Transient protection allows device (and load) survival even when the input voltage spikes above and below nominal. The output structure of these regulators allows voltages in excess of the desired output voltage to be applied without reverse current flow.

Control of the output current for LED displays provides for the display brightness. To prevent oscillations, a 1nF capacitor should be connected to pin 19, brightness control.

The block diagram is shown in Figure 1. For the MIC5450, the /DATA ENABLE is a metal option and is used instead of the 35th output. The output current is typically 20-times greater than the current into pin 19, which is set by an external variable resistor.

There is an external reset connection shown which is available on unpackaged (die) only. Figure 2 illustrates the die pad locations for bonding in "chip on board" applications.

Figure 5 shows the input data format. A leading "1" is followed by 35 bits of data. After the 36th has been transferred, a LOAD signal is generated synchronously with the clock high state. This loads the 35 bits of data into the latches. The low side of the clock is used to generate a RESET signal which clears all shift registers for the next set of data. All shift registers are static master-slave, with no clear for the master portion of the first register, allowing continuous operation.

There must be a complete set of 36 clocks or the shift registers will not clear.

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 and 4 show the pinout of the MIC5450 and MIC5451. Bit 1 is the first bit following the start bit and it will appear on pin 18. A logical "1" at the input will turn on the appropriate LED.

Figure 5 shows the timing relationships between data, clock and /DATA ENABLE. A maximum clock frequency of 0.5MHz is assumed.

For applications where a lesser number of outputs are used, it is possible to either increase the current per output, or operate the part at higher than 1V V_{OUT} . The following equation can be used for calculations.

$$T_J = (V_{OUT}) (I_{LED}) (\text{No. of segments}) (124^{\circ}\text{C/W}) + T_A$$

where:

T_J = junction temperature + 150°C max

V_{OUT} = the voltage at the LED driver outputs

I_{LED} = the LED current

124°C/W = thermal resistance of the package

T_A = ambient temperature

The above equation was used to plot Figures 7–9.

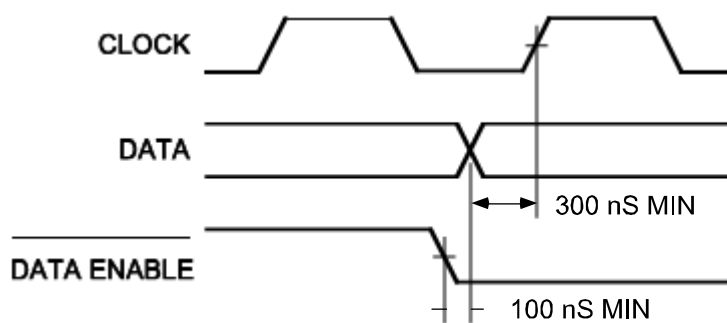


Figure 5.

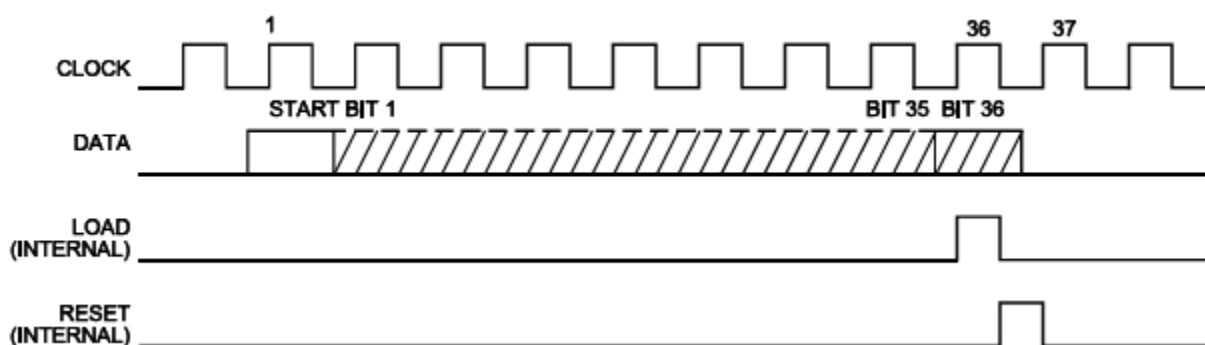


Figure 6. Input Data Format

A graph showing Output Current (mA) versus Number of Segments at $T_A = 85^\circ\text{C}$. The Y-axis ranges from 0 to 110 mA, and the X-axis ranges from 0 to 34 segments. Three curves are plotted for different output voltages:

- $V_{OUT} = 1V$: This curve starts at approximately 105 mA for 7 segments and decreases sharply.
- $V_{OUT} = 1.5V$: This curve starts at approximately 68 mA for 5 segments and decreases.
- $V_{OUT} = 2V$: This curve starts at approximately 50 mA for 5 segments and decreases.

Number of Segments	Output Current (mA) at $V_{OUT} = 1V$	Output Current (mA) at $V_{OUT} = 1.5V$	Output Current (mA) at $V_{OUT} = 2V$
5	-	~68	~50
7	~105	~55	~40
10	~55	~40	~30
15	~25	~25	~20
20	~18	~18	~15
25	~14	~14	~12
30	~11	~11	~10
34	~9	~10	~9

Figure 7.

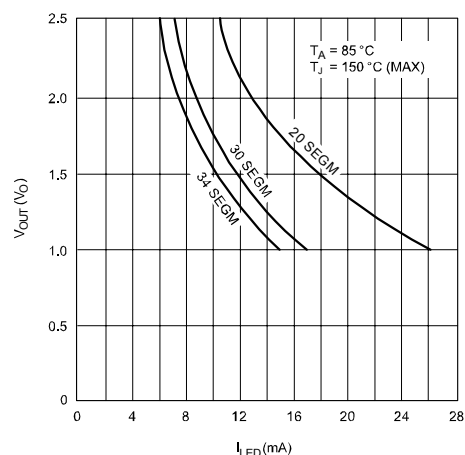


Figure 8.

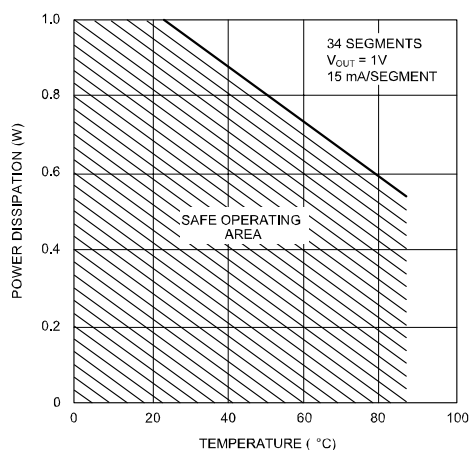


Figure 9.

The diagram shows a precision current source circuit. A raw DC voltage $> 9V$ is connected to the ADJ pin of an LM317 voltage regulator. The LM317 is configured with a 7V output, achieved using a 240 Ω resistor and a 5k potentiometer. The output voltage is labeled ΔV . This ΔV is connected to the non-inverting input (+) of an LM324 operational amplifier. The LM324 is configured as a voltage follower, with its output connected to its inverting input (-). The output of the LM324 drives the base of a 2N2907 NPN transistor. The emitter of the transistor is connected to ground, and the collector is connected to a 1k resistor, which is in turn connected to the 7V output of the LM317. The current through this resistor is labeled I_{19} . The MM5450 integrated circuit is shown with its VCC pin (pin 20) connected to a 5V supply and its GND pin (pin 1) connected to ground. The output of the MM5450 (pin 19) is connected to the collector of the 2N2907 transistor.

Figure 10. Typical Application of Constant Current Brightness Control

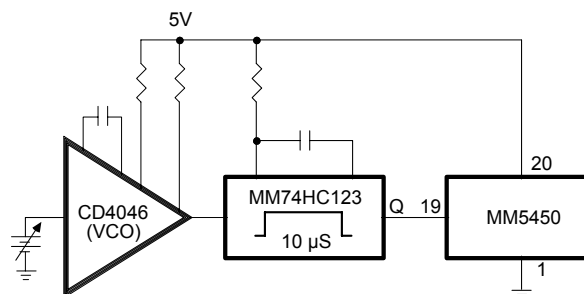


Figure 11. Brightness Control Varying the Duty Cycle

Typical Applications

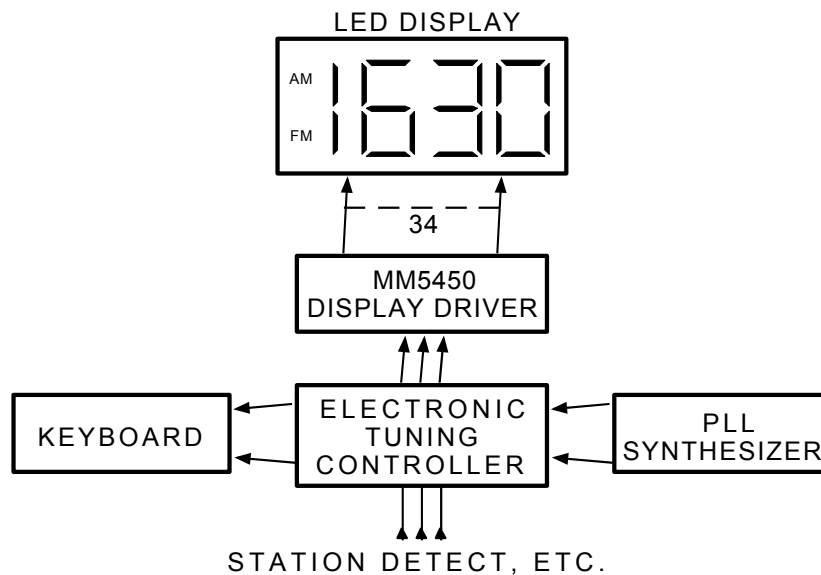


Figure 12. Basic Electronically Tuned Radio System

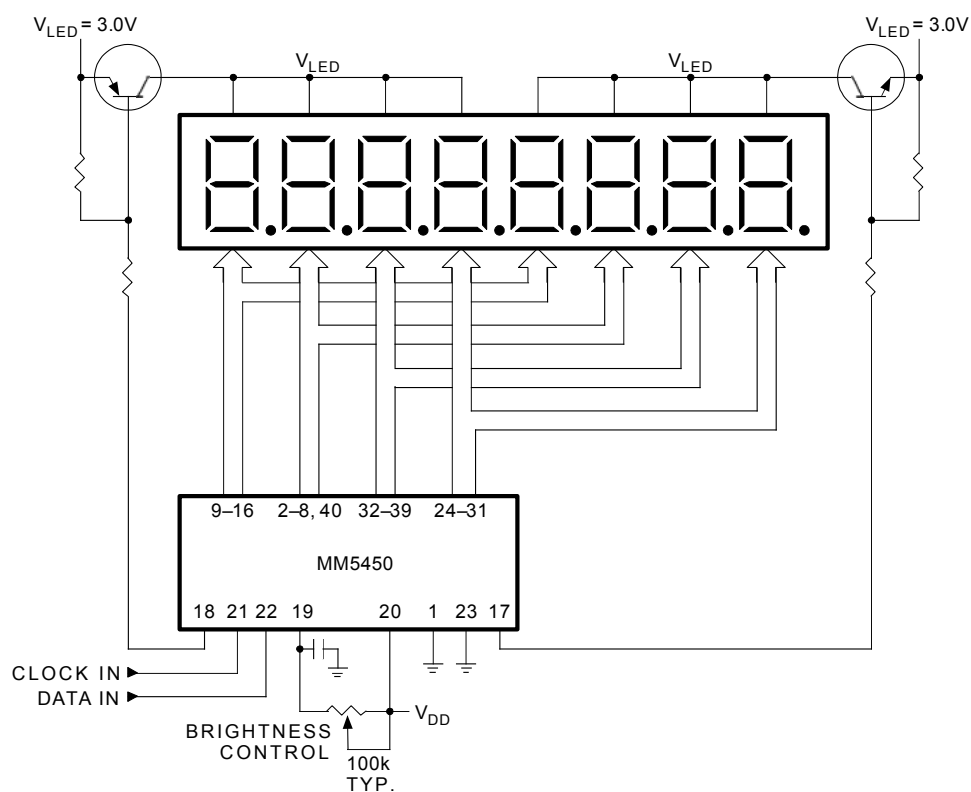
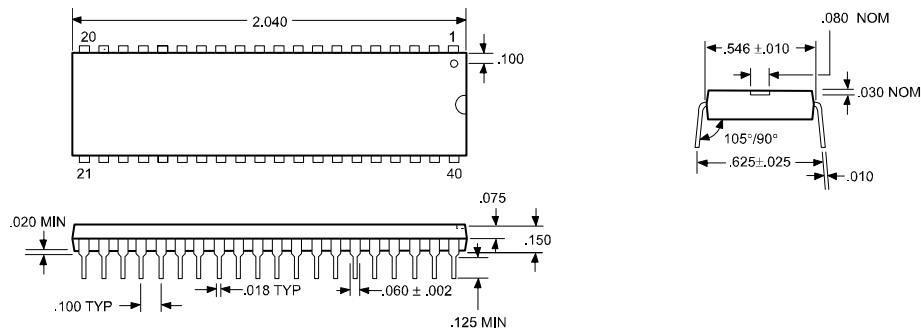
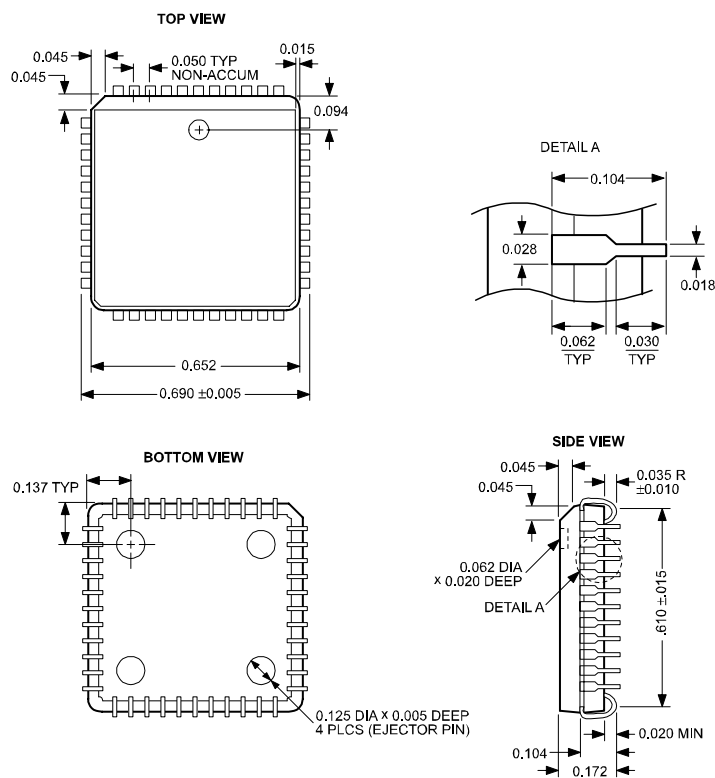


Figure 13. Duplexing 8 Digits with One MM5450

Package Information



40-Pin Plastic DIP (N)



44-Pin PLCC (V)

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