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

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Junction Temp. Range</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MM5450BN</td>
<td>–40°C to+85°C</td>
<td>40-pin PDIP</td>
</tr>
<tr>
<td>MM5450YN</td>
<td>–40°C to+85°C</td>
<td>40-pin PDIP</td>
</tr>
<tr>
<td>MM5451BN</td>
<td>–40°C to+85°C</td>
<td>44-pin PLCC</td>
</tr>
<tr>
<td>MM5451YN</td>
<td>–40°C to+85°C</td>
<td>44-pin PLCC</td>
</tr>
<tr>
<td>MM5450BV</td>
<td>–40°C to+85°C</td>
<td>44-pin PLCC</td>
</tr>
<tr>
<td>MM5451BV</td>
<td>–40°C to+85°C</td>
<td>44-pin PLCC</td>
</tr>
</tbody>
</table>

Block Diagram

Note 1: Pin 23 is Data Enable in MM5450
Pin 23 is Output 35 in MM5451

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)……………………………VSS to VSS + 12V
Power Dissipation
+25°C........................................................................1W
+85°C......................................................................560mW
Junction Temperature (TJ) ..............................+150°C
Storage Temperature (TS).........................–65°C to +150°C
Lead Temperature (soldering, 10sec.)...........+300°C

Operating Ratings
Supply voltage (VDD – VSS)...........................+4.75V to +11V
Ambient Temperature Range (TA)..............–40°C to +85°C

Electrical Characteristics
4.5V ≤ VDD ≤ 11V, VSS = 0V; TA = 25°C, bold values indicate –40°C ≤ TA ≤ +85°C, unless otherwise noted.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
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<tr>
<td></td>
<td>Power Supply Current</td>
<td>–25°C to +85°C, excluding output loads</td>
<td>8.5</td>
<td>10</td>
<td>mA</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>–40°C to +85°C, excluding output loads</td>
<td>mA</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>VL</td>
<td>Data Input Voltage</td>
<td>logic-0 level, ±10 µA input bias</td>
<td>–0.3</td>
<td>0.8</td>
<td>V</td>
<td></td>
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<tr>
<td>VH</td>
<td></td>
<td>logic-1 level, 4.75V ≤ VDD ≤ 5.25V</td>
<td>2.2</td>
<td>VDD</td>
<td>V</td>
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<td></td>
<td></td>
<td>VDD &gt; 5.25V</td>
<td>VDD –2</td>
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<tr>
<td></td>
<td>Brightness Control Input Current</td>
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<td>0</td>
<td>0.75</td>
<td>mA</td>
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<tr>
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<td>Output Sink Current</td>
<td>segment off, VOUT = 3.0V</td>
<td>10</td>
<td>µA</td>
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<tr>
<td></td>
<td></td>
<td>segment on, VOUT = 1.8V, Note 3</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td>brightness input = 0µA</td>
<td>2.0</td>
<td>VDD</td>
<td>V</td>
<td></td>
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<td></td>
<td></td>
<td>brightness input = 100µA</td>
<td>15</td>
<td>VDD</td>
<td>V</td>
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<td></td>
<td></td>
<td>brightness input = 750µA</td>
<td>VDD</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Brightness Control Input Voltage</td>
<td>input current = 750 µA</td>
<td>3.0</td>
<td>4.3</td>
<td>V</td>
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<td>Output Matching</td>
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<td>±20</td>
<td>%</td>
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<td>fC</td>
<td>Clock Input Frequency</td>
<td>Notes 5, 6</td>
<td>500</td>
<td>kHz</td>
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<td>tH</td>
<td>Clock Input High Time</td>
<td>Notes 5, 6</td>
<td>950</td>
<td>ns</td>
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<tr>
<td>tL</td>
<td>Clock Input Low Time</td>
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<td>ns</td>
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<tr>
<td>tDS</td>
<td>Data Input Setup Time</td>
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<td>ns</td>
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</tr>
<tr>
<td>tDH</td>
<td>Data Input Hold Setup Time</td>
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<td>ns</td>
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<td>tDES</td>
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<td>ns</td>
<td></td>
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<td>Reset Pad Current</td>
<td>die</td>
<td>8</td>
<td>µA</td>
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</tbody>
</table>

Notes:
1. Output matching is calculated as the percent variation (I_{MAX} + I_{MIN}) / 2.
2. With a fixed resistor on the brightness input pin, some variation in brightness will occur among devices.
3. See Figures 7, 8 and 9 for recommended operating conditions and limits. Absolute maximum for each output should be limited to 40mA.
4. VOUT should be regulated by user. See Figures 8 and 9 for allowable VOUT vs. IOUT operation.
5. AC input waveform specification for test purpose: tR ≤ 200ns, tF ≤ 20ns, f = 500kHz, 50% ±10% duty cycle.
6. 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 these regulators to survive 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 had 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\text{OUT}. The following equation can be used for calculations.

\[ T_J = (V\text{OUT}) (I\text{LED})(\text{No. of segments})(124\, ^\circ\text{C/W}) + T_A \]

where:
- \( T_J \) = junction temperature + 150\, ^\circ\text{C max} 
- \( V\text{OUT} \) = the voltage at the LED driver outputs 
- \( I\text{LED} \) = the LED current 
- 124\, ^\circ\text{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
Typical Performance Characteristics

Figure 7.

Figure 8.

Figure 9.

Typical Applications

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
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