**National Semiconductor**

# MM5480 LED Display Driver

## General Description

The MM5480 is a monolithic MOS integrated circuit utilizing N-channel metal gate low threshold, enhancement mode and ion-implanted depletion mode devices. It utilizes the MM5451 die packaged in a 28-pin package making it ideal for a 3½ digit display. The MM5480 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 either to $V_{DD}$ or to a separate supply of 11V maximum.

## Features

■ Continuous brightness control
■ Serial data input

■ No load signal required
■ Wide power supply operation
■ TTL compatibility
■ Alphanumeric capability
■ 3½ digit displays

## Applications

■ COPS™ microcontrollers or microprocessor displays
■ Industrial control indicator
■ Relay driver
■ Digital clock, thermometer, counter, voltmeter
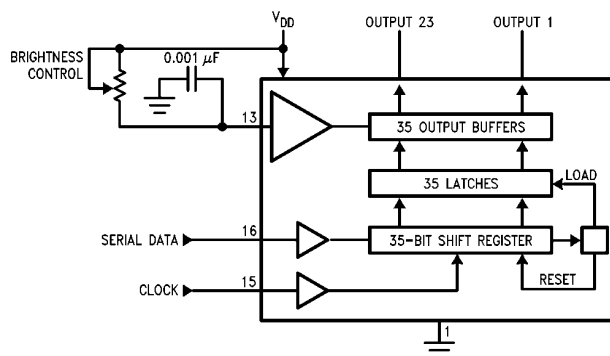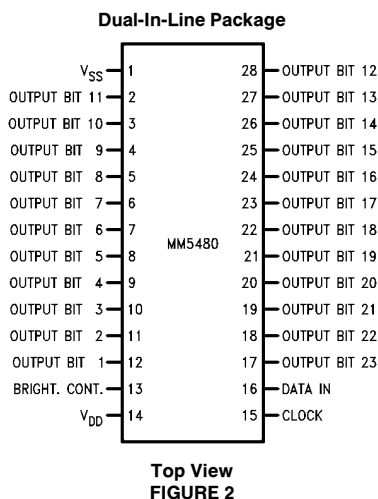■ Instrumentation readouts

## Block Diagram



FIGURE 1

TL/F/6138–1

## Connection Diagram

**Dual-In-Line Package**



**Order Number MM5480N
See NS Package Number N28B**

TL/F/6138–2

**Top View
FIGURE 2**

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## 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 $V_{SS} + 12V$ |
| Storage Temperature | $-65°C$ to $+150°C$ |

| | |
|---|---|
| Power Dissipation at 25°C | |
|   Molded DIP Package, Board Mount | 2.4W* |
|   Molded DIP Package, Socket Mount | 2.1W** |
| Junction Temperature | 150°C |
| Lead Temperature (Soldering, 10 sec.) | 300°C |

*Molded DIP Package, Board Mount, $\theta_{JA} = 52°C/W$, Derate 19.2 mW/°C above 25°C.

**Molded DIP Package, Socket Mount, $\theta_{JA} = 58°C/W$, Derate 17.2 mW/°C above 25°C.

## Electrical Characteristics

$T_A = -25°C$ to $+85°C$, $V_{DD} = 4.75V$ to 11.0V, $V_{SS} = 0V$ unless otherwise specified

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $V_{DD}$ | Power Supply | | 4.75 | | 11 | V |
| $I_{DD}$ | Power Supply Current | Excluding Output Loads | | | 7 | mA |
| $V_{IL}$ | Input Voltage Logical "0" Level | $\pm 10 \mu A$ Input Bias | −0.3 | | 0.8 | V |
| $V_{IH}$ | Input Voltage Logical "1" Level | $4.75V \leq V_{DD} \leq 5.25V$ | 2.2 | | $V_{DD}$ | V |
| | | $V_{DD} > 5.25V$ | $V_{DD} - 2$ | | $V_{DD}$ | V |
| $I_{BR}$ | Brightness Input Current (Note 2) | | 0 | | 0.75 | mA |
| $I_{OH}$ | Output Sink Current (Note 3) Segment OFF | $V_{OUT} = 3.0V$ | | | 10.0 | $\mu A$ |
| $I_{OL}$ | Output Sink Current (Note 3) Segment ON | $V_{OUT} = 1V$<br>  Brightness Input $= 0 \mu A$<br>  Brightness Input $= 100 \mu A$<br>  Brightness Input $= 750 \mu A$ | <br>0<br>2.0<br>15.0 | <br><br>2.7<br> | <br>10.0<br>4.0<br>25.0 | <br>$\mu A$<br>mA<br>mA |
| $V_{IBR}$ | Brightness Input Voltage (Pin 13) | Input Current $= 750 \mu A$ | 3.0 | | 4.3 | V |
| OM | Output Matching (Note 1) | | | | $\pm 20$ | % |

## AC Electrical Characteristics

$T_A = -25°C$ to $+85°C$, $V_{DD} = 5V \pm 0.5V$

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $f_C$ | Clock Input Frequency | (Notes 5 and 6) | DC | | 500 | kHz |
| $t_h$ | High Time | | 950 | | | ns |
| $t_l$ | Low Time | | 950 | | | ns |
| $t_{DS}$ | Data Input Set-Up Time | | 300 | | | ns |
| $t_{DH}$ | Data Input Hold Time | | 300 | | | ns |

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

**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:** Absolute maximum for each output should be limited to 40 mA.

**Note 4:** The $V_{OUT}$ voltage should be regulated by the user.

**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.

## Functional Description

The MM5480 is specifically designed to operate 3½-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 $\mu$F ceramic or mica disc capacitor should be connected to brightness control, pin 13, to prevent possible oscillations.

A block diagram is shown in *Figure 1*. The output current is typically 20 times greater than the current into pin 13, which is set by an external variable resistor. There is an internal limiting resistor of 400$\Omega$ nominal value.

*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.

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 5* shows the Output Data Format for the 5480. Because it uses only 23 of the possible 35 outputs, 12 of the bits are 'Don't Cares'.

*Figure 3* shows the timing relationships between data and clock. A maximum clock frequency of 0.5 MHz 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.

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

where:

$T_j$ = junction temperature, 150°C max.
$V_{OUT}$ = the voltage at the LED driver outputs
$I_{LED}$ = the LED current
$\theta_{JA}$ = thermal coefficient of the package
$T_A$ = ambient temperature
$\theta_{JA}$ (Socket Mount) = 58°C/W
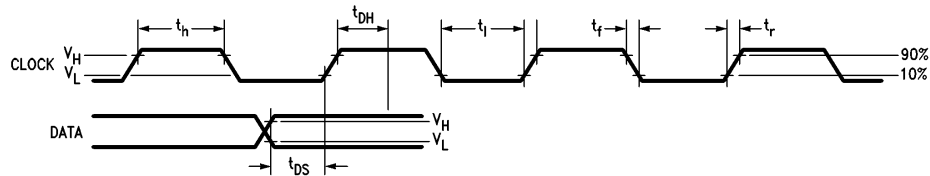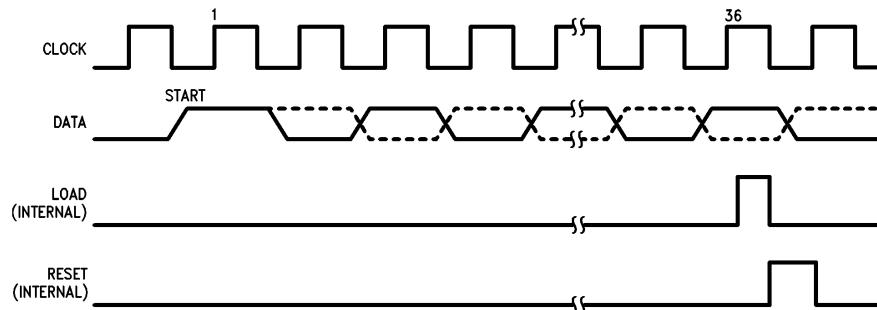$\theta_{JA}$ (Board Mount) = 52°C/W



TL/F/6138–3

FIGURE 3



TL/F/6138–4

FIGURE 4. Input Data Format

| START | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 5451 |
| START | X | 1 | 2 | 3 | 4 | 5 | 6 | 7 | X | X | X | 8 | 9 | 10 | 11 | X | X | X | X | 12 | 13 | 14 | 15 | 16 | 17 | X | 18 | X | X | 19 | 20 | 21 | 22 | 23 | X | 5480 |

FIGURE 5. Output Data Format

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## Functional Description (Continued)



$$I_{19} = \frac{\Delta V}{1k}$$
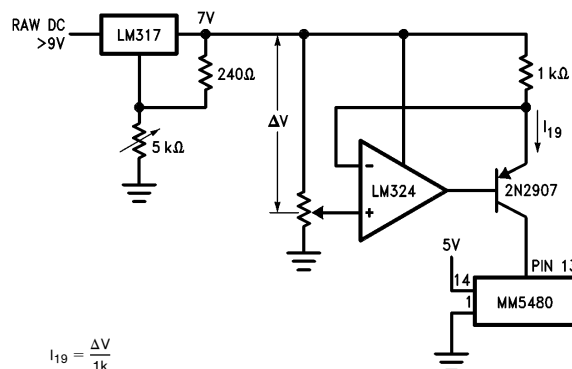
TL/F/6138–5

**FIGURE 6. Typical Application of Constant Current Brightness Control**



TL/F/6138–6
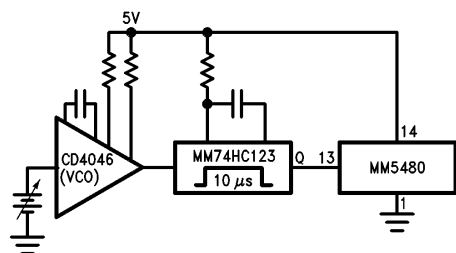
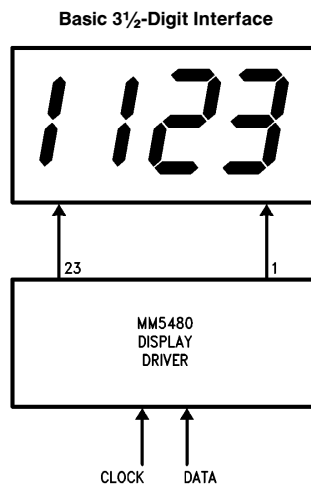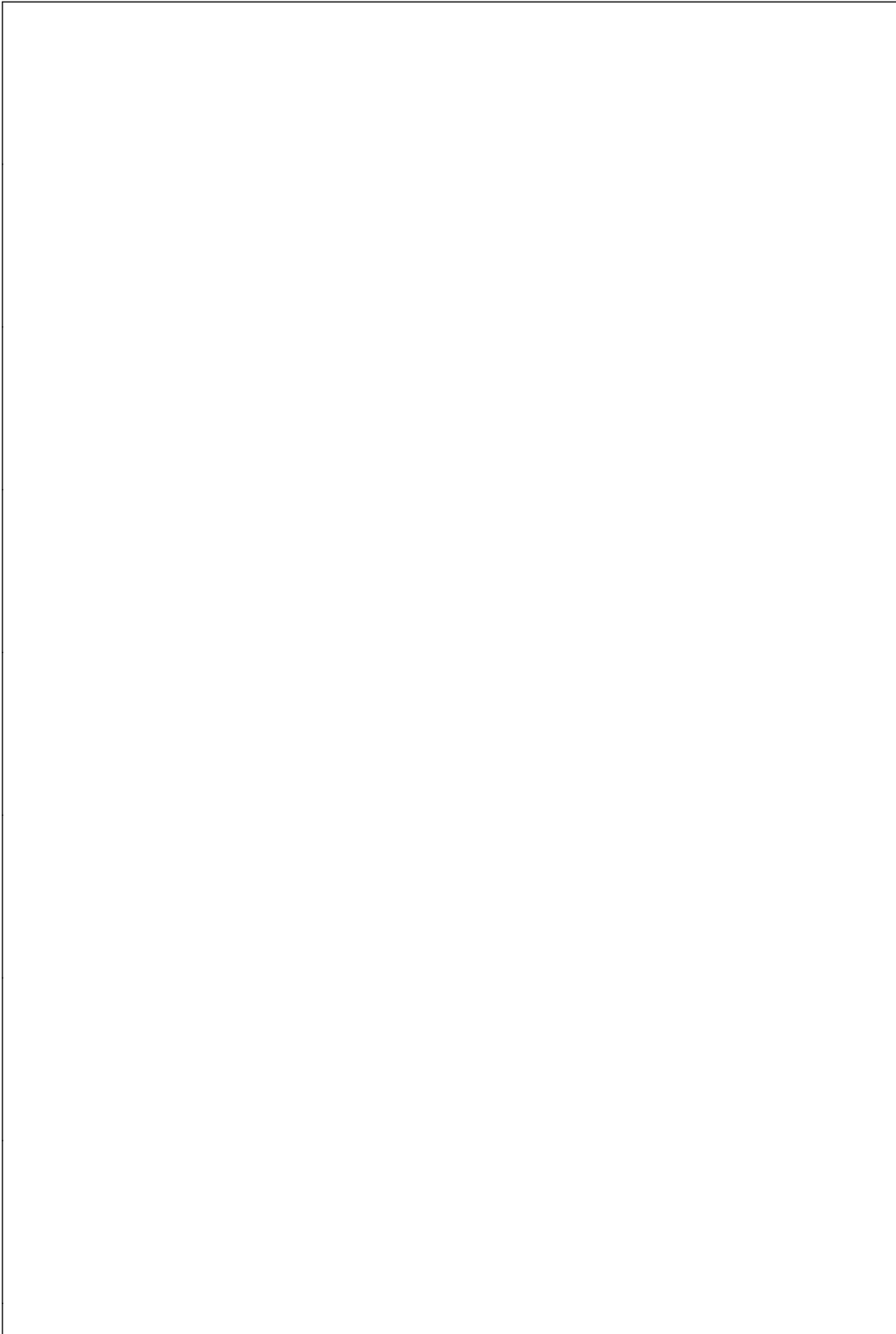**FIGURE 7. Brightness Control Varying the Duty Cycle**

**Safe Operating Area**



TL/F/6138–7

**Basic 3½-Digit Interface**



TL/F/6138–8

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2f_
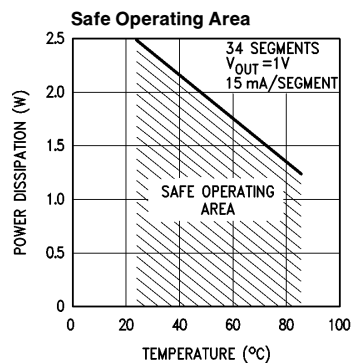
**MM5480 LED Display Driver** *(vertical side text)*

## Physical Dimensions inches (millimeters)

0.062
(1.575) RAD

0.510 ± 0.005
(12.95 ± 0.127)

PIN NO. 1 IDENT

1.393 – 1.420
(35.38 – 36.07)

0.030
(0.762) MAX

0.600 – 0.620
(15.24 – 15.75)

95° ± 5°

0.009 – 0.015
(0.229 – 0.381)

0.580
(14.73) MIN

$0.625 \begin{smallmatrix} +0.025 \\ -0.015 \end{smallmatrix}$

$\left(15.88 \begin{smallmatrix} +0.635 \\ -0.381 \end{smallmatrix}\right)$

0.145 – 0.210
(3.683 – 5.334)

0.050
(1.270) TYP

0.125 – 0.165
(3.175 – 4.191)

0.020
(0.508) MIN

0.050 ± 0.015
(1.270 ± 0.381)

0.100 ± 0.010
(2.540 ± 0.254)

0.018 ± 0.003
(0.457 ± 0.076)

86° 94° TYP

0.125 – 0.145
(3.175 – 3.683)

N28B (REV E)

**Dual-In-Line Package (N)**
**Order Number MM5480N**
**NS Package Number N28B**

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