National Semiconductor

February 1995

MM5481 LED Display Driver

General Description

The 5481 is a monolithic MOS integrated circuit utilizing N-channel metal gate low threshold, enhancement mode and ion-implanted depletion mode devices. It utilizes the MM5450 die packaged in a 20-pin package making it ideal for a 2 digit display. The MM5481 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.

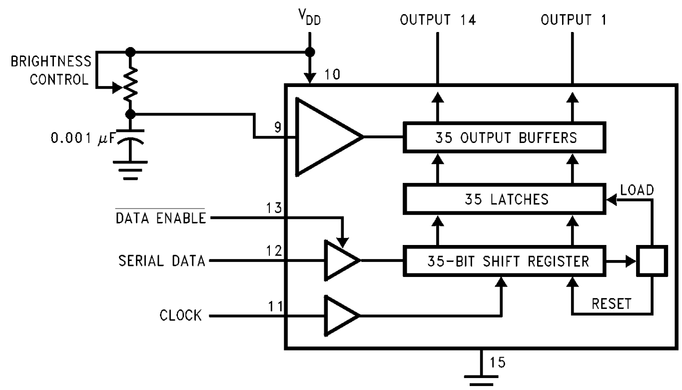
Features

- Continuous brightness control
- Serial data input
- No load signal required
- Data enable
- Wide power supply operation
- TTL compatibility
- Alphanumeric capability
- 2 digit LED driver

Applications

- COPS or microprocessor displays
- Industrial control indicator
- Relay driver
- Instrumentation readouts

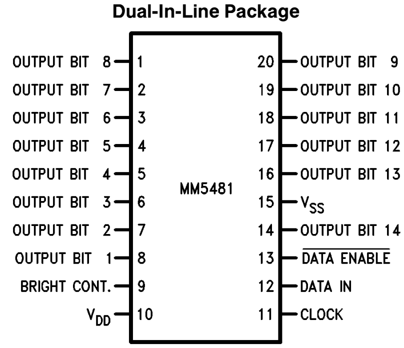
Block and Connection Diagrams



TL/F/6139–1

FIGURE 1

Dual-In-Line Package



TL/F/6139–2

Top View
FIGURE 2

Order Number MM5481N
See NS Package Number N20A

 RRD-B30M105/Printed in U. S. A.

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} to V_{SS} + 12V

Storage Temperature — −65°C to +150°C

Power Dissipation at 25°C

- Molded DIP Package, Board Mount — 2W*
- Molded DIP Package, Socket Mount — 1.8W**

Junction Temperature — +150°C

Lead Temperature (Soldering, 10 sec.) — 300°C

*Molded DIP Package, Board Mount, θ_{JA} = 61°C/W, Derate 16.4 mW/°C above 25°C.

**Molded DIP Package, Socket Mount, θ_{JA} = 67°C/W, Derate 14.9 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 Voltages Logical "0" Level	±10 μA Input Bias	−0.3		0.8	V
V_{IH}	Logical "1" Level	$4.75 \leq V_{DD} \leq 5.25$	2.2		V_{DD}	V
		$V_{DD} > 5.25$	$V_{DD} - 2$		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	μA
I_{OL}	Segment ON	V_{OUT} = 1V (Note 4) Brightness Input = 0 μA Brightness Input = 100 μA Brightness Input = 750 μA	 0 2.0 15.0	 2.7 	 10.0 4.0 25.0	 μA mA mA
V_{IBR}	Brightness Input Voltage (Pin 9)	Input Current = 750 μA	3.0		4.3	V
OM	Output Matching (Note 1)				±20	%

AC Electrical Characteristics

T_A = −25°C to +85°C, V_{DD} = 5V ± 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} t_{DH}	Data Input Set-Up Time Hold Time		 300 300			 ns ns
t_{DES}	Data Enable Input Set-Up Time		 100			 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 compiled 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% ± 10% duty cycle.

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

Functional Description

The MM5481 uses the MM5450 die which is packaged to operate 2-digit alphanumeric displays with minimal interference to 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 μF capacitor should be connected to brightness control, pin 9, 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 9, which is set by an external variable resistor. There is an internal limiting resistor of 400Ω nominal value.

Figure 4 shows the input data format. A start bit of logical ''1'' precedes the 35 bits of data. At the positive-going-edge of 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 a static master-slave configuration. There is no clear for the master portion of the first shift register, thus allowing continous operation.

There must be a complete set of 36 clocks (high/low edges) or the shift registers will not clear.

Data Enable

This active low signal enables the data input pin. If high, the shift register sees zeroes clocked in.

To blank the display at any time, (i.e., power on), clock in 36 or more zeroes, followed by a 'one' (start bit), followed by 36 or more zeroes.

Figure 5 shows the Output Data Format for the MM5481. Because it uses only 14 of the possible 34 outputs, 20 of the bits are 'Don't Cares'. Note that only alternate groups of 4 outputs are used.

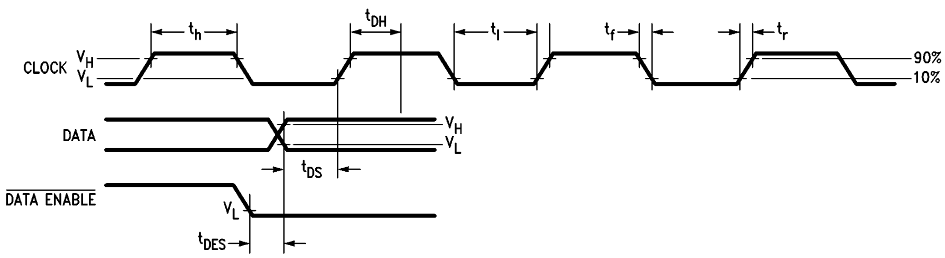
Figure 3 shows the timing relationships between data, clock, and data enable. A maximum clock frequency of 0.5 MHz is assumed.

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.

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

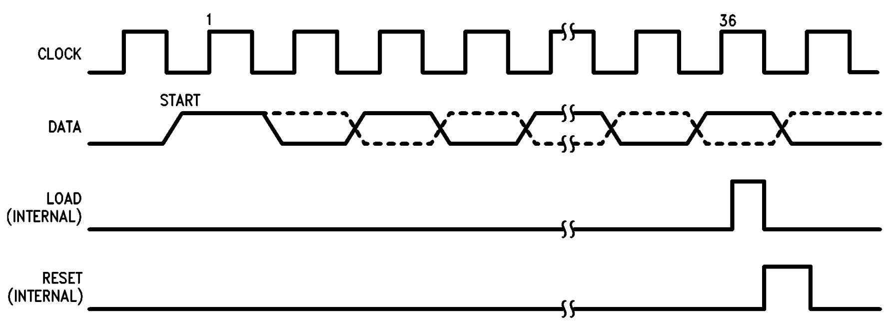
where:

- T_j = junction temperature, 150°C max.
- V_{OUT} = the voltage at the LED driver outputs
- I_{LED} = the LED current
- θ_{JA} = thermal coefficient of the package
- T_A = ambient temperature
- θ_{JA} (Socket Mount) = 67°C/W
- θ_{JA} (Board Mount) = 61°C/W



TL/F/6139–3

FIGURE 3. Timing



TL/F/6139–4

FIGURE 4. Input Data Format

Functional Description (Continued)

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	5450
START	X	X	X	X	1	2	3	4	X	X	X	X	5	6	7	8	X	X	X	X	9	10	11	12	X	X	X	X	13	14	X	X	X	X	5481

FIGURE 5. Output Data Format

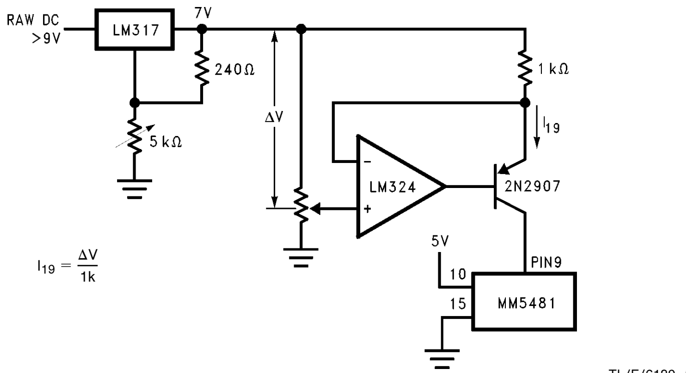


FIGURE 6. Typical Application of Constant Current Brightness Control

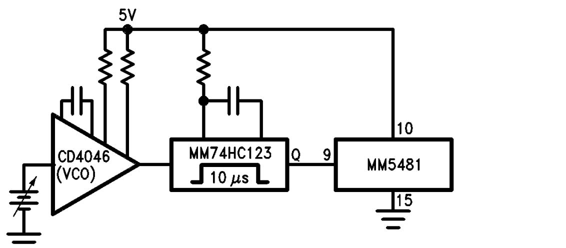
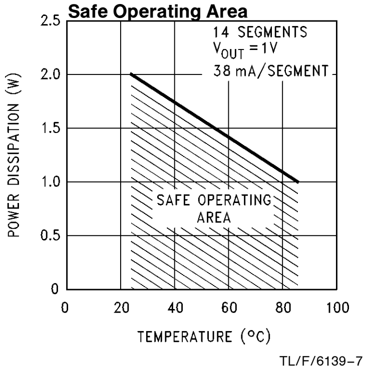
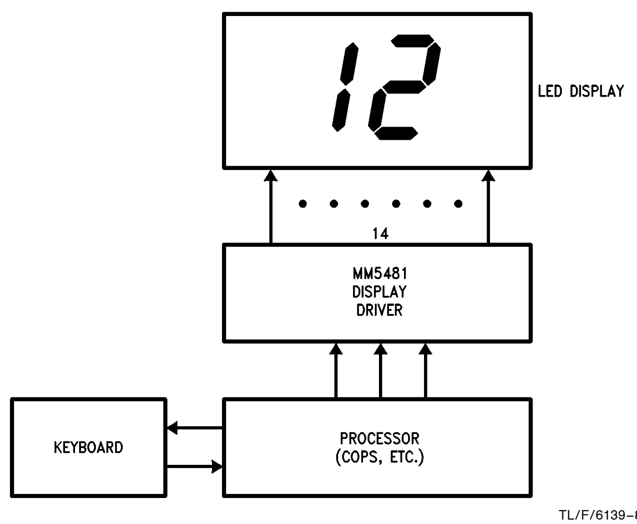


FIGURE 7. Brightness Control Varying the Duty Cycle

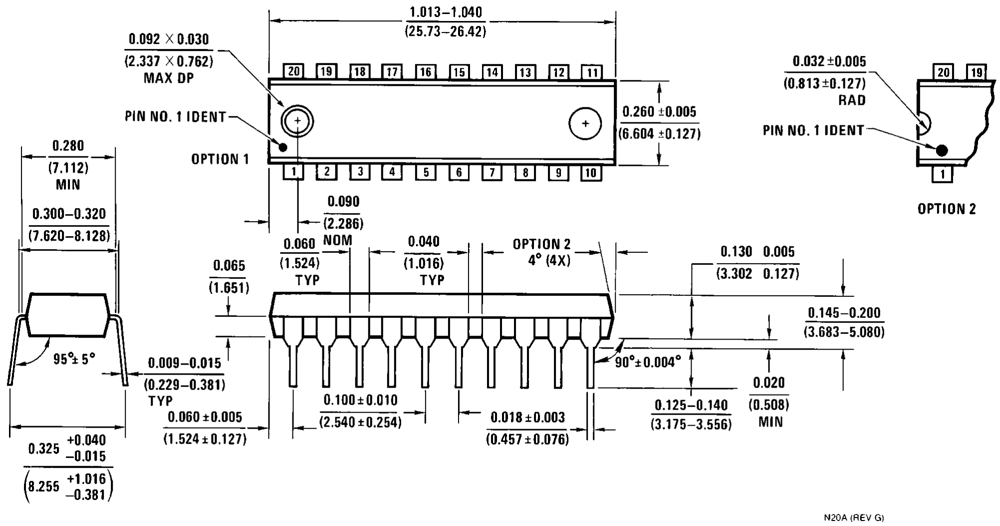
Safe Operating Area



Basic Electronically Tuned Television System



Physical Dimensions inches (millimeters)



Molded Dual-In-Line Package
Order Number MM5481N
NS Package Number N20A

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