

## MM145453 Liquid Crystal Display Driver

Check for Samples: [MM145453](#)

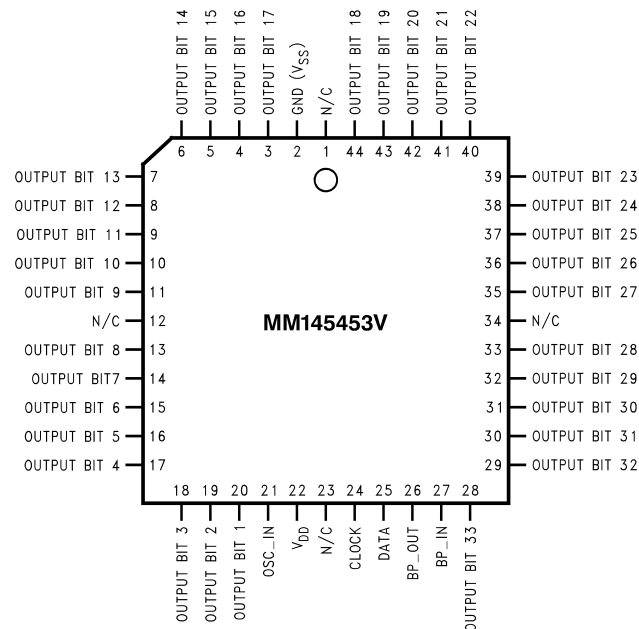
### FEATURES

- Serial Data Input
- Wide Power Supply Operation
- TTL Compatibility
- Up to 33 LCD Segments
- Alphanumeric or Bar Graph Capability
- Cascaded Operation Capability
- Pin Compatible with MC145453

### APPLICATIONS

- COPS or Microprocessor Displays
- Industrial Control Indicator
- Digital Clock, Thermometer, Counter, Voltmeter
- Instrumentation Displays
- Remote Displays

### Connection Diagram



**Figure 1. Top View**  
See Package Number FN0044A

### DESCRIPTION

The MM145453 is a monolithic integrated circuit utilizing CMOS metal gate, low threshold enhancement mode devices. The chip can drive up to 33 LCD segments and can be paralleled to increase this number. The chip is capable of driving a 4½ digit 7-segment display with minimal interface between the display and the data source.

The MM145453 stores display data in latches after it is clocked in, and holds the data until new display data is received.

The MM145453 is available in a molded 44 pin surface mount PLCC package. The MM145453 is pin out and functionally compatible with the MC145453.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

All trademarks are the property of their respective owners.



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

### Absolute Maximum Ratings <sup>(1)(2)</sup>

|                                       |                 |
|---------------------------------------|-----------------|
| Voltage at Any Pin, Referenced to Gnd | -0.3V to +10V   |
| Storage Temperature                   | -65°C to +150°C |
| Power Dissipation at 25°C             | 350mW           |
| Power Dissipation at 70°C             | 300mW           |
| Junction Temperature                  | +150°C          |
| Lead Temperature (Soldering, 10s)     | 300°C           |

- (1) "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" specifies conditions of device operation.
- (2) If Military/Aerospace specified devices are required, please contact the TI Sales Office/ Distributors for availability and specifications.

### Recommended Operating Conditions

|                       |               |
|-----------------------|---------------|
| V <sub>DD</sub>       | 3V to 10V     |
| Operating Temperature | -40°C to 85°C |

### Electrical Characteristics

The following specifications apply for T<sub>A</sub> within operation range, V<sub>DD</sub> = 3.0V to 10V, V<sub>SS</sub> = 0V, unless otherwise specified.

| Parameter  | Conditions  | Min  | Typical | Max   | Units |
|--|---|------|---------|-------|-------|
| Supply Voltage, V <sub>DD</sub>                          |   | 3    |         | 10    | V     |
| Average Supply Current, I <sub>DD</sub>                  | All Outputs Open, Clock=Gnd,<br>Data=Gnd, OSC=Gnd, BP_IN @ 32Hz |      |         |       |       |
|  | V <sub>DD</sub> = 5V  |      |         | 10    | μA    |
|  | V <sub>DD</sub> = 10V   |      |         | 40    | μA    |
| Input Logical '0' Voltage, V <sub>IL</sub>               | V <sub>DD</sub> = 3V  |      |         | 0.4   | V     |
|  | V <sub>DD</sub> = 5V  |      |         | 0.8   | V     |
|  | V <sub>DD</sub> = 10V   |      |         | 0.8   | V     |
| Input Logical '1' Voltage, V <sub>IH</sub>               | V <sub>DD</sub> = 3V  | 2.0  |         |       | V     |
|  | V <sub>DD</sub> = 5V  | 2.0  |         |       | V     |
|  | V <sub>DD</sub> = 10V   | 8.0  |         |       | V     |
| Segment Sink Current, I <sub>OL</sub>                    | V <sub>DD</sub> = 3V, V <sub>OUT</sub> = 0.3V                   | -20  | -40     |       | μA    |
| Segment Source Current, I <sub>OH</sub>                  | V <sub>DD</sub> = 3V, V <sub>OUT</sub> = 2.7V                   | 20   | 40      |       | μA    |
| Backplane Out Sink Current, I <sub>OL</sub>              | V <sub>DD</sub> = 3V, V <sub>OUT</sub> = 0.3V                   | -320 | -500    |       | μA    |
| Backplane Out Source Current, I <sub>OH</sub>            | V <sub>DD</sub> = 3V, V <sub>OUT</sub> = 2.7V                   | 320  | 500     |       | μA    |
| Segment Output Offset Voltage                            | Segment Load = 250pF <sup>(1)</sup>                             |      |         | +/-50 | mV    |
| Backplane Output Offset Voltage                          | Backplane Load = 8750pF <sup>(1)</sup>                          |      |         | +/-50 | mV    |
| Backplane Out Frequency                                  | R <sub>OSC_IN</sub> = 50kΩ, C <sub>OSC_IN</sub> = 0.01μF        |      | 75      |       | Hz    |
| Clock Input Frequency, f <sub>CLOCK</sub> <sup>(2)</sup> | V <sub>DD</sub> = 3V <sup>(1)</sup> <sup>(3)</sup>              |      |         | 500   | kHz   |
|  | V <sub>DD</sub> = 5V <sup>(1)</sup>                             |      |         | 750   | kHz   |
|  | V <sub>DD</sub> = 10V <sup>(1)</sup>                            |      |         | 1.0   | MHz   |
| Clock Input Duty Cycle <sup>(2)</sup>                    |   | 40   |         | 60    | %     |
| Data Input Set-Up Time, t <sub>DS</sub>                  |   | 300  |         |       | ns    |
| Data Input Hold Time, t <sub>DH</sub>                    |   | 300  |         |       | ns    |

- (1) This parameter is guaranteed (but not production tested) over the operating temperature range and the operating supply voltage range. Not to be used in Q.A. testing.
- (2) Clock input rise time (t<sub>r</sub>) and fall time (t<sub>f</sub>) must not exceed 300ns
- (3) AC input waveform for test purposes: t<sub>r</sub> ≤ 20ns, t<sub>f</sub> ≤ 20ns, f<sub>CLOCK</sub> = 500kHz, Duty Cycle = 50% ±10%

Timing Diagram

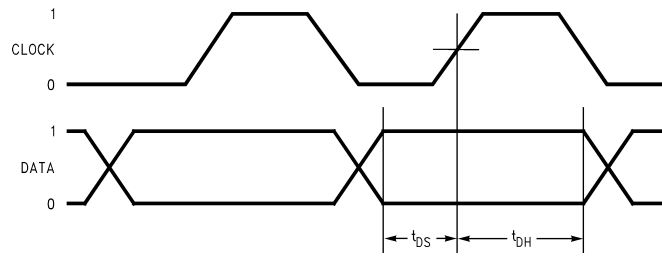


Figure 2.

Block Diagram

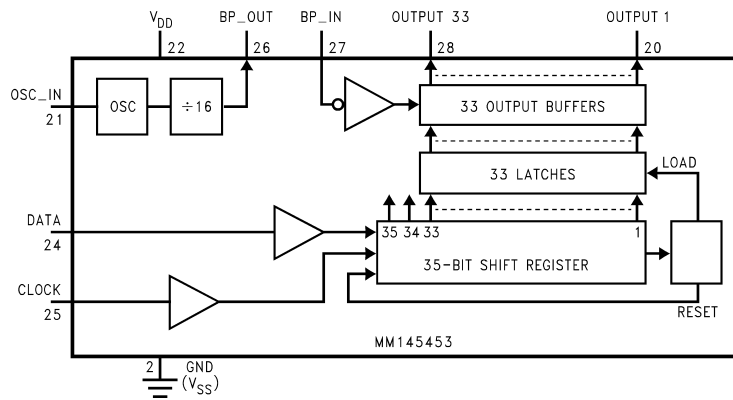


Figure 3.

## APPLICATIONS INFORMATION

The MM145453 is specifically designed to operate 4½ digit 7-segment displays with minimal interface with the display and 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 33 data bits and 2 trailing don't care bits, allows data transfer without the need of an additional Data Load signal. Since the MM145453 does not contain a character generator, the formatting of the segment information must be done prior to inputting the data to the MM145453. The transfer of the 33 data bits is complete at the falling edge of the 36th clock cycle, thus providing non-multiplexed, direct drive to the display. Outputs change only if the serial data bits differ from the previous time.

Figure 4 shows the data input format. A single start bit of logical '1' precedes the 33 bits of segment data for a total of 34 bits that need to be defined and clocked in. After the 34 bits are clocked in, 2 additional clock cycles are required. At the 36th clock cycle an internal LOAD signal is generated synchronously with the rising edge of the Clock In signal, which loads the 33 bits of segment data in the shift register into the latches. At the falling edge of the 36th clock cycle an internal 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. The data during the 35th and 36th clock cycles is "don't care", but setting data to logical '0' for these two clock cycles is the preferred format.

The data input bits map directly to the segment output pins and the display. The MM145453 does not have any format restrictions, as all outputs are controllable.

The MM145453 has an internal oscillator which can generate the required clock signal to drive the LCD back plane. The frequency of the internal oscillator is set by a pull-up resistor ( $R_{OSC\_IN}$ ) connected from the OSC\_IN pin to  $V_{DD}$ , and a capacitor ( $C_{OSC\_IN}$ ) connected from the OSC\_IN pin to Ground. Due to the current sink limitations of the OSC\_IN circuitry, the lowest recommended resistor value for setting the oscillator frequency is 9k $\Omega$ . It will typically take 2 to 4 RC time constants to charge the OSC\_IN pin from near 0V to within 1V of  $V_{DD}$  which is the high threshold voltage point for the OSC\_IN circuitry. An approximate calculation of  $f_{OSC}$  is:

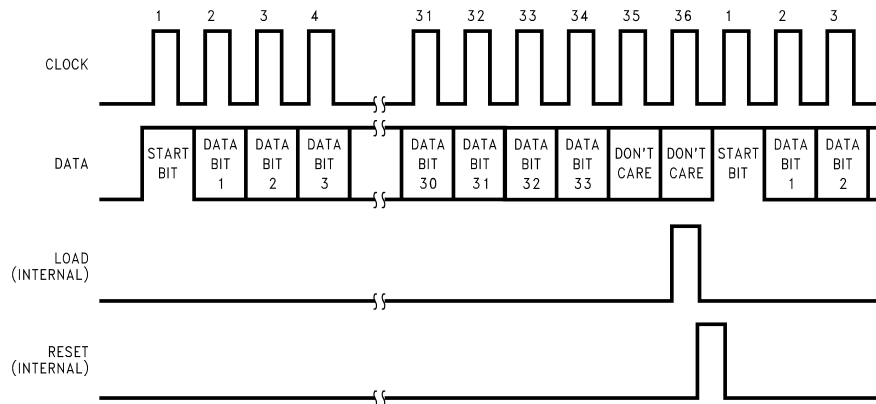
$$f_{OSC} = 1 / (\ln(V_{DD}/1V) \times R_{OSC\_IN} \times C_{OSC\_IN})$$

A  $R_{OSC\_IN}$  resistor value of 50k $\Omega$  with a  $C_{OSC\_IN}$  capacitor value of 0.01 $\mu$ F and a  $V_{DD}$  value of 5.00V would produce a typical oscillator frequency ( $f_{OSC}$ ) of about 1200Hz. The  $f_{OSC}$  signal is divided by 16 before it is presented at the BP\_OUT pin. For this example the approximate BP\_OUT frequency will be  $f_{OSC}/16$ , or about 75Hz.

The BP\_IN pin of the MM145453 can be used with an externally supplied signal, provided it has a duty cycle of 50%. Any deviation from a precise 50% duty cycle will result in an offset voltage on the LCD. The use of an external clock allows synchronizing the display drive with AC power, other internal clocks, or DVM integration time to reduce interference from the display. When using an external clock for the back plane drive the internal oscillator should be disabled by connecting the OSC\_IN pin directly to ground. This will prevent possible internal oscillations, and reduce device dissipation.

The MM145453 is a pin out variation of the MM5453. For additional applications information please refer to the [MM5453](#) data sheet.

**Input Data Format**



**Figure 4.**

## REVISION HISTORY

| Changes from Revision B (March 2013) to Revision C         | Page              |
|--|-------------------|
| • Changed layout of National Data Sheet to TI format ..... | <a href="#">5</a> |

**PACKAGING INFORMATION**

| Orderable Device | Status<br>(1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan<br>(2)         | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples        |
|------------------|---------------|--------------|-----------------|------|-------------|-------------------------|-------------------------|----------------------|--------------|-------------------------|----------------|
| MM145453V        | NRND          | PLCC         | FN              | 44   | 25          | TBD                     | Call TI                 | Call TI              | 0 to 70      | MM145453V               |                |
| MM145453V/NOPB   | ACTIVE        | PLCC         | FN              | 44   | 25          | Green (RoHS & no Sb/Br) | CU SN                   | Level-3-245C-168 HR  | 0 to 70      | MM145453V               | <b>Samples</b> |
| MM145453VX       | NRND          | PLCC         | FN              | 44   | 500         | TBD                     | Call TI                 | Call TI              | 0 to 70      | MM145453V               |                |
| MM145453VX/NOPB  | ACTIVE        | PLCC         | FN              | 44   | 500         | Green (RoHS & no Sb/Br) | CU SN                   | Level-3-245C-168 HR  | 0 to 70      | MM145453V               | <b>Samples</b> |

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSELETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and

continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.





## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

|                              |  |
|------------------------------|--|
| Audio                        | <a href="http://www.ti.com/audio">www.ti.com/audio</a>                               |
| Amplifiers                   | <a href="http://amplifier.ti.com">amplifier.ti.com</a>                               |
| Data Converters              | <a href="http://dataconverter.ti.com">dataconverter.ti.com</a>                       |
| DLP® Products                | <a href="http://www.dlp.com">www.dlp.com</a>   |
| DSP                          | <a href="http://dsp.ti.com">dsp.ti.com</a>   |
| Clocks and Timers            | <a href="http://www.ti.com/clocks">www.ti.com/clocks</a>                             |
| Interface                    | <a href="http://interface.ti.com">interface.ti.com</a>                               |
| Logic                        | <a href="http://logic.ti.com">logic.ti.com</a>                                       |
| Power Mgmt                   | <a href="http://power.ti.com">power.ti.com</a>                                       |
| Microcontrollers             | <a href="http://microcontroller.ti.com">microcontroller.ti.com</a>                   |
| RFID                         | <a href="http://www.ti-rfid.com">www.ti-rfid.com</a>                                 |
| OMAP Applications Processors | <a href="http://www.ti.com/omap">www.ti.com/omap</a>                                 |
| Wireless Connectivity        | <a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a> |

### Applications

|                               |  |
|-------------------------------|--|
| Automotive and Transportation | <a href="http://www.ti.com/automotive">www.ti.com/automotive</a>                         |
| Communications and Telecom    | <a href="http://www.ti.com/communications">www.ti.com/communications</a>                 |
| Computers and Peripherals     | <a href="http://www.ti.com/computers">www.ti.com/computers</a>                           |
| Consumer Electronics          | <a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>                   |
| Energy and Lighting           | <a href="http://www.ti.com/energy">www.ti.com/energy</a>                                 |
| Industrial                    | <a href="http://www.ti.com/industrial">www.ti.com/industrial</a>                         |
| Medical                       | <a href="http://www.ti.com/medical">www.ti.com/medical</a>                               |
| Security                      | <a href="http://www.ti.com/security">www.ti.com/security</a>                             |
| Space, Avionics and Defense   | <a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a> |
| Video and Imaging             | <a href="http://www.ti.com/video">www.ti.com/video</a>                                   |

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)