



Maxim > Design Support > Technical Documents > Application Notes > Display Drivers > APP 1196

Keywords: LED display drivers, LED drivers, display drivers, SPI, serial, 7 segment, 7-segment

#### APPLICATION NOTE 1196

# Using the MAX7219/7221 to Drive Higher Voltage or Current

Sep 09, 2002

*Abstract: Techniques to amplify the current and voltage drive capabilities of the MAX7219 and MAX7221 serial interface LED drivers.*

The MAX7219/7221 is an 8-digit, 7-segment common-cathode multiplexed LED display driver which drives up to 40mA segment current while operating from a 4V to 5.5V supply. This application note discusses how the MAX7219/7221 can be used with external drive transistors for applications requiring higher peak segment currents and/or a higher drive voltage. LEDs using three or more LED dice per segment cannot be driven directly by the MAX7219/7221 from a 5V supply due to the multiple LED voltage drops.

The drivers shown in Figures 1 thru 4 interface a MAX7219/7221 operating at 4V to 5V to common anode displays operating at a higher segment current and/or drive voltage than the MAX7219/7221 can deliver. Eight instances of the low current cathode column driver, and eight instances of the high current anode digit driver are required.

The MAX7219/7221's PWM digital intensity control can still be used. The peak segment current, however, is now set by external current-limiting resistors in series with the LED cathodes instead of by resistor R<sub>SET</sub>.

To use these drivers, choose R<sub>1</sub> (see **Figure 4**) to set the desired peak LED segment current I<sub>SEG</sub> according to the driver supply voltage V<sub>driver</sub> and the LED forward voltage drop V<sub>LED</sub>:

$$I_{PEAK} = (V_{driver} - V_{LED} - V_{CE(sat)Q1}) / (R1 + R_{DS(on)Q2}) \text{ A}$$

Rate Q<sub>1</sub> at segment current I<sub>SEG</sub>, and rate Q<sub>2</sub> at digit current, which is 8 times I<sub>SEG</sub>.

Note that the display must be the common anode (CA) type to interface the drivers described here; the MAX7219/7221 directly drive common cathode (CC) displays, but these external drivers invert the digit/segment drive polarity.

## Digit Drivers

The digit drive outputs of the MAX7219/7221 are power switches which go active low one at a time to turn a digit on, and high impedance when off.

Three alternative digit drive circuits are suggested here. The simplest circuit (**Figure 1**) suits an application where a higher than 40mA segment current is desired, and yet the 4V-5V MAX7219/7221

supply voltage can be used to drive the LEDs. The active low MAX7219/7221 digit drive outputs directly drive logic level PFET Q2. Resistor R3 turns Q2 off when the digit output is high impedance. The supply  $V_{driver}$  is the same supply as used by the MAX7219/7221.

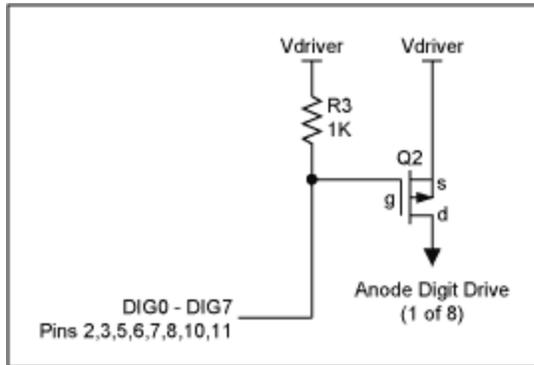


Figure 1. Current boosting the digit drive while retaining a low voltage LED supply.

The circuit of **Figure 2** includes a level shifter to allow a higher supply voltage than 5V to be used to drive the LEDs. Q3 operates as a common-base current switch, and sinks a collector current set by resistor R2 (about 5mA using  $V_{cascode} = 5V$ ) when the digit drive output is low. This current in turn develops about 5V across the 1k $\Omega$  of R3 to provide a consistent gate drive to logic level PFET Q2, independent of the fluctuations of the supply  $V_{driver}$ . Note, though, that the collector of Q3 can go no lower than  $V_{CE(sat)Q3}$  above it's emitter, which is at  $V_{BE}$  below  $V_{cascode}$ .

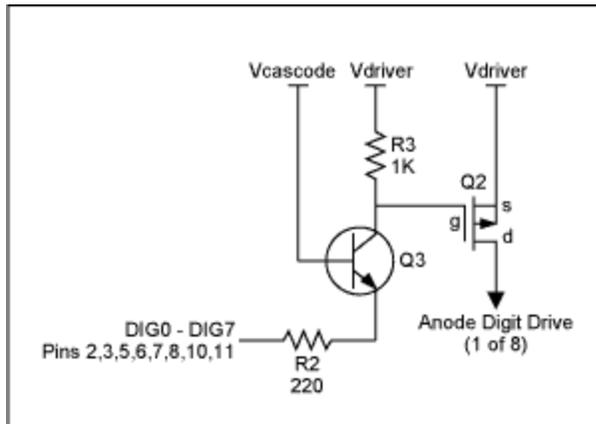


Figure 2. Current boosting the digit drive using an LED supply 10V or higher.

As R3 is dropping 5V, this places the lower limit for the supply  $V_{driver}$  at about 10V if  $V_{cascode}$  is set to 5V. 5V was picked as a convenient voltage for  $V_{cascode}$  because it's likely to be the supply for the MAX7219/7221. However  $V_{cascode}$  can be set to a lower voltage, such as 2V, by simply dropping the 5V supply through a zener diode (**Figure 3**). Only one zener diode is needed to serve all the digit drivers.

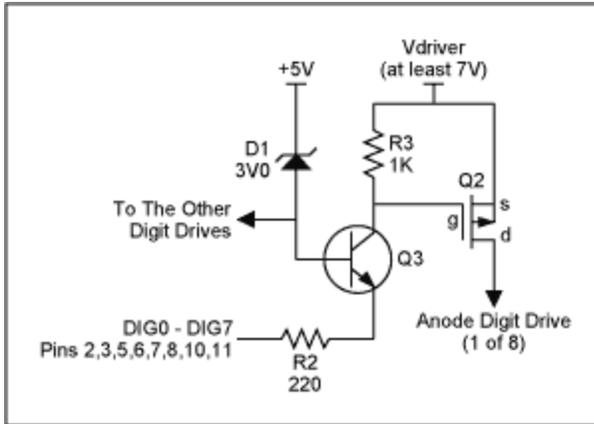


Figure 3. Current boosting the digit drive using an LED supply below 10V.

## Segment Drivers

The MAX7219/7221 segment drive outputs are current sources, which drive a constant current set by resistor  $R_{SET}$  connected to the  $I_{SET}$  pin of the MAX7219/7221. The maximum segment current is 40mA. To drive a higher segment current, external transistors and segment current limiting resistors are needed (Figure 4).

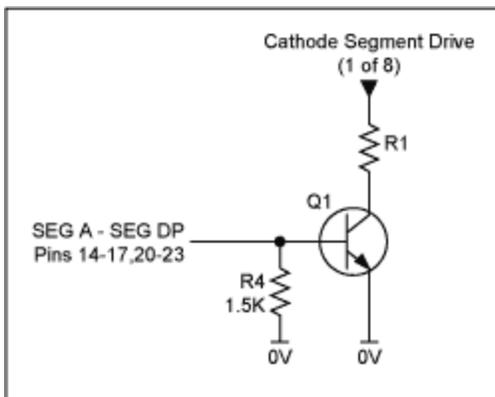


Figure 4. Current boosting the segment drive.

By setting the MAX7219/7221 segment drive current source correctly, a base current limiting resistor is not required for the segment drive switch Q1. The segment drive current can be set to be an appropriate value using  $R_{SET}$  to turn Q1 on hard. Resistor R4 is needed to ensure Q1 turns off reasonably fast at the end of each digit's multiplex cycle. An  $R_{SET}$  value around 150k $\Omega$  is a good starting point.

### Related Parts

<a href="#">MAX7219</a>	Serially Interfaced, 8-Digit, LED Display Drivers	<a href="#">Free Samples</a>
<a href="#">MAX7221</a>	Serially Interfaced, 8-Digit, LED Display Drivers	<a href="#">Free Samples</a>

### More Information

For Technical Support: <http://www.maximintegrated.com/support>  
For Samples: <http://www.maximintegrated.com/samples>  
Other Questions and Comments: <http://www.maximintegrated.com/contact>

---

Application Note 1196: <http://www.maximintegrated.com/an1196>  
APPLICATION NOTE 1196, AN1196, AN 1196, APP1196, Appnote1196, Appnote 1196  
Copyright © by Maxim Integrated Products  
Additional Legal Notices: <http://www.maximintegrated.com/legal>