

Using the MAX7219/7221 to Drive Higher Voltage or Current

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_{SET} .

To use these drivers, choose $R1$ (see Figure 4) to set the desired peak LED segment current I_{SEG} according to the driver supply voltage V_{driver} and the LED forward voltage drop V_{LED} :

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

Rate Q1 at segment current I_{SEG} , and rate Q2 at digit current, which is 8 times I_{SEG} .

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.

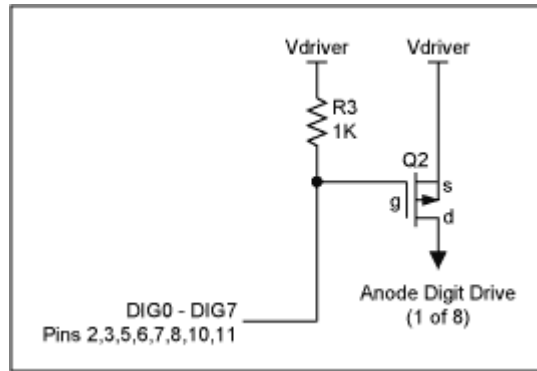


Figure 1. Current boosting the digit drive while retaining a low voltage LED supply

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 $V_{\text{cascode}} = 5\text{V}$) when the digit drive output is low. This current in turn develops about 5V across the $1\text{k}\Omega$ of R3 to provide a consistent gate drive to logic level PMOS Q2, independent of the fluctuations of the supply V_{driver} . Note, though, that the collector of Q3 can go no lower than $V_{\text{CE(sat)Q3}}$ above it's emitter, which is at V_{BE} below V_{cascode} .

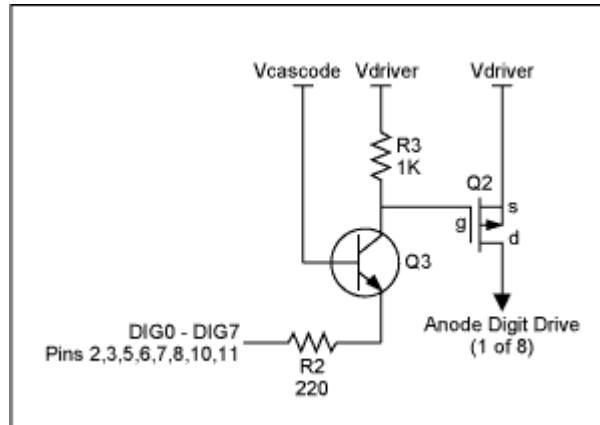


Figure 2. Current boosting the digit drive using an LED supply 10V or higher

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.

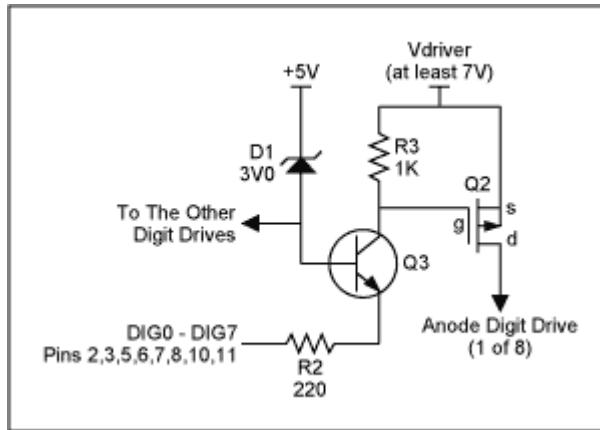


Figure 3. Current boosting the digit drive using an LED supply below 10V

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).

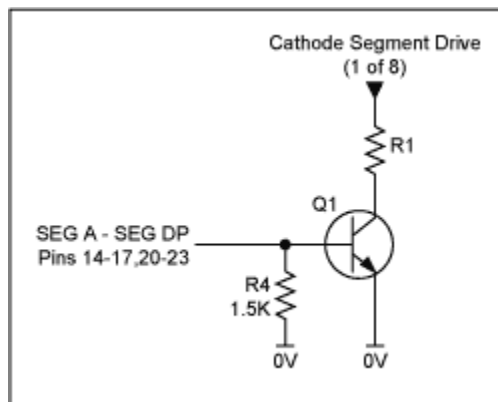


Figure 4. Current boosting the segment drive

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 Ω is a good starting point.

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