

Drivers For Light Emitting Displays Appnote 24

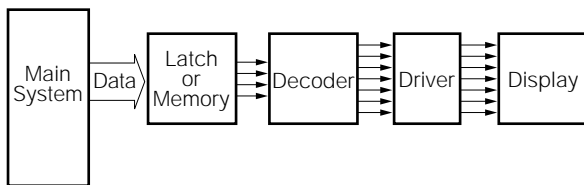
by Dave Takagishi

The purpose of this application note is to provide some information on the integrated circuits presently available to drive Light Emitting Diodes (LED) displays and how to interface them to the various displays.

Background

LED displays come in various sizes (0.1" to 0.8"), colors (red, high-efficiency red, green, yellow and blue), fonts (7/9/14/16 segment, dot-matrix, or bargraph), and types (common anode, common cathode, multi-digit). The brightness is essentially proportional to the current through an LED and each element within a display should have the same current or a brightness variation may be apparent. A display subsystem can be made up from several elements.

Figure 1. Display system



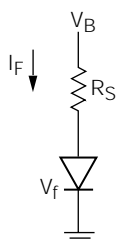
The partitioning of these elements are dependent on the drivers used; therefore the display driver chosen is dependent on the specifications of the display and the application. Also some types of displays require using a multiplexing technique because of the internal interconnections. This is only applicable for multi-digit displays.

Typical Circuits

Figure 2 shows a very basic circuit for driving an LED. The series resistance can be easily calculated from the following formula.

$$R_s = \frac{V_b - V_f}{I_f}$$

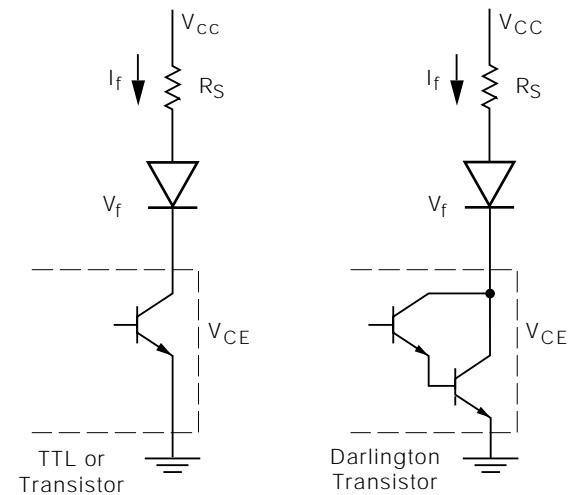
Figure 2. Basic circuit to drive an LED



For circuits using TTL logic or transistors, see Figure 3.

$$R_s = \frac{V_{CC} - V_{CE} - V_f}{I_f}$$

Figure 3. Circuits for TTL or transistor and darlington transistor



It can be seen that V_{ce} (saturation voltage) for the driver is going to be a factor in determining the series limiting resistor. Therefore a darlington versus a single output transistor will have different current limiting resistor values to maintain a constant current through the LED.

Figure 4. Common cathode display

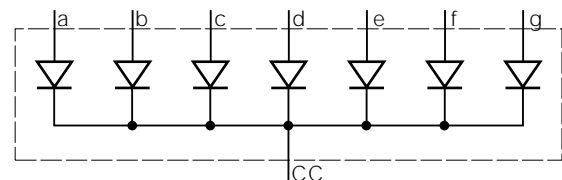


Figure 5. Common anode display

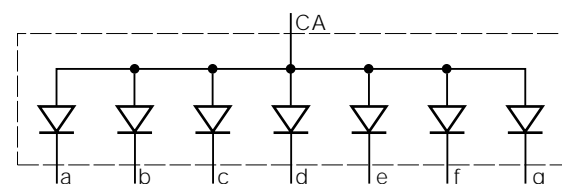


Figure 6. Common cathode display with driver

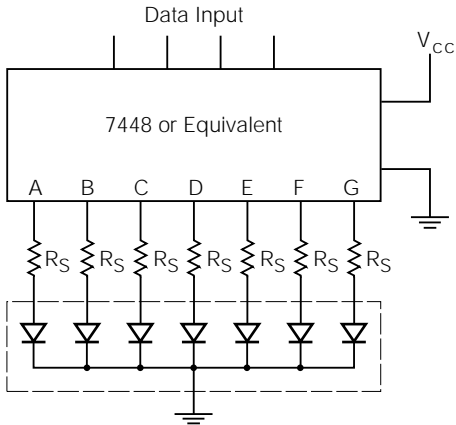
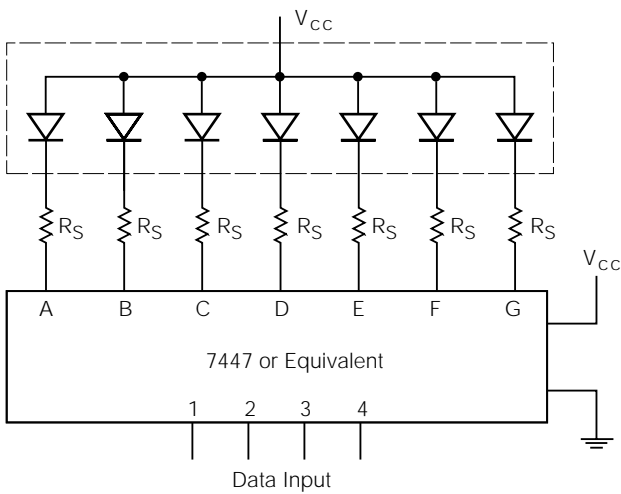


Figure 7. Common anode display with driver



Selection

One factor in choosing the display and/or driver will be whether the display is a common cathode or common anode type display. Another factor is that different drivers go low or high or can be wired into different configurations.

From Figures 6/7/8/9, it may appear obvious to combine the seven series resistors (R_s) into one common resistor in the common line. However this should not be done because of the possible variation in V_f from segment to segment. Variation in V_f can cause a variation in current, resulting in segment brightness differences.

Table 1 is list of some of the most common LED drivers available. Besides having different current drive capabilities, one product may have a feature which may make them easier to use in a particular application:

- Serial versus parallel input data
- Data latching type drivers
- Blanking
- Drive ripple blanking input (rbo) with pulse width modulation to vary brightness
- Multi-digit drivers
- Constant current drivers
- Advantage of a constant current driver as V_f may not affect brightness, important with different color LEDs.

Figure 8. Open collector type driver with common anode display

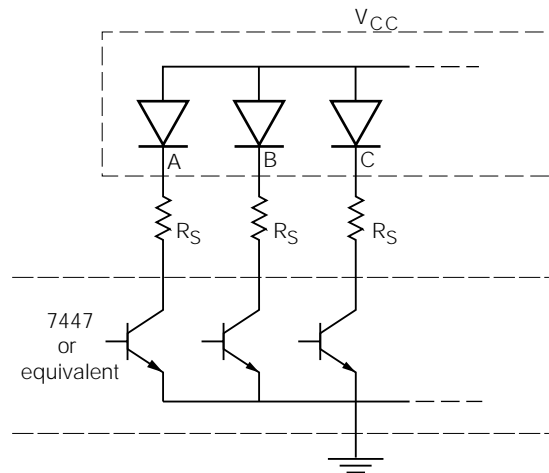
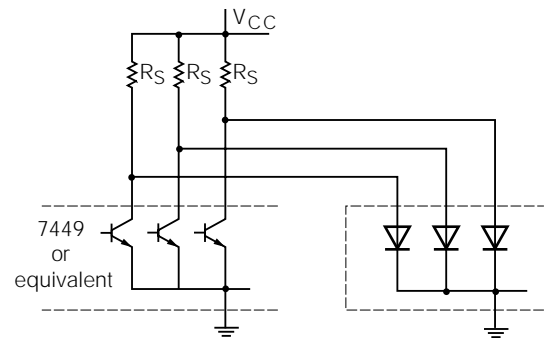


Figure 9. Open collector type driver with common cathode display



Multiplexing

In a multiplex system, the corresponding segment of each digit is bussed together and driven from one segment drive via the usual current limiting resistors. The display data is presented serially by digit to the decoder driver together with the appropriate digit signal (Figure 10). For more information multiplexing, see Appnote 3 (Multiplexing LED Displays).

One way to simplify the design procedure for alphanumeric displays would be to consider Siemens Intelligent Displays. This device family incorporates all necessary interface control with drivers and memory built-in with the display. This means the designer need not be concerned about the memory, multiplex circuitry, character generator, or drivers for these are provided inside a modular unit. More information on these products is available in Siemens Optoelectronics Data Book.

Circuits shown in this Appnote are for reference only and are not the responsibility of Siemens Optoelectronics. Products are continually being improved by vendors and/or are obsoleted; therefore consult the factory.

Figure 10. Block diagram—4 digit multiplexed display

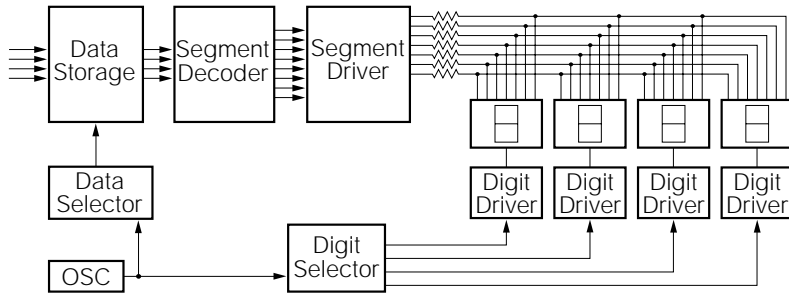


Table 1.

| Single Digit Decoder/Drivers | | | | |
|------------------------------|-----------------------------------------------------------------------------|------------|------|-------------------------------------------------|
| Part Number | Manufacturer | If/Segment | Type | Comments |
| 7447 74247 7446 | Fairchild Hitachi Motorola National Signetics Teledyne TI | 40 mA | CA | BCD-to-7 segment, open coll, ripple blnkng |
| 7448 74248 | Fairchild Hitachi Motorola National Signetics TI | 6 mA | CC | BCD-to-7 segment, int pull-up, ripple blnkng |
| 7449 74249 | Fairchild Hitachi Motorola National Signetics TI | 8 mA | CC | BCD-to-7 segment, open coll, ripple blnkng |
| DS8857 | National | 60 mA | CA | BCD-to-7 segment, decoder, ripple blnkng |
| DS8858 | National | 50 mA | CC | BCD-to-7 segment, decoder, ripple blnkng |
| CD4511 4511 B MC14511 | Fairchild National Motorola | 25 mA | CC | BCD-to-7-segment, latched, blnkng |
| DS8647 DS8648 | National | 10 mA | CC | 9 segment drivers |
| NE587 | Signetics | 50 mA | CA | BCD-to-7-segment, latched, blnkng, vari current |
| NE589 | Signetics | 50 mA | CC | BCD-to-7-segment, latched, blnkng, vari current |
| CA3161E | RCA | 25 mA | CA | BCD-to-7-segment, constant current drivers |
| 9368 | Fairchild | 20 mA | CC | BCD-to-7-segment, ripple blnkng |
| 9374 | Fairchild | 15 mA | CA | BCD-to-7-segment, ripple blnkng |

Table 1. (continued)

| Multi-Digit Display Drivers | | | | |
|----------------------------------------------|---------------------|-------------------|-------------|-------------------------------------------------------------------------------------------------|
| Part Number | Manufacturer | If/Segment | Type | Comments |
| SDA2014 | Siemens | 12 mA | CC | 2 or 4 digit, serial bcd input |
| SDA2131 | Siemens | 20 mA | CA | 16 element serial input |
| MM5450 | National | 25 mA | CA | 34 segment serial input, brightness control |
| MM5451 | National | 25 mA | CA | 35 segment serial input, brightness control |
| MM74C912 | National | 100 mA | CC | 6 digit, 7 segment+decimal, BCD decoder, output enable |
| MM74C911 | National | 100 mA | CC | 4 digit, 8 segments controller/segment/driver |
| MM74917 | National | 100 mA | CC | 6 digit, 7 segments+decimal, Hex decoder, output enable |
| DS8669 | National | 25 mA | CA | Dual BCD-to-7 segment decoder/driver |
| CA3168E | RCA | 25 mA | CA | Dual BCD-to-7 segment decoder/driver |
| ICM7212 ICM7212A ICM7212M ICM7212AM | Intersil | 8 mA | CA | 4 digit, latched, 28 segment drivers, brightness cntl |
| ICM7218A | Intersil | 20 mA | CA | 8 digit, 8 segment (decoded/spcl), w/mem/drivers |
| ICM7218B | Intersil | 10 mA | CC | 8 digit, 8 segment (decoded/spcl), w/mem/drivers |
| ICM7218C | Intersil | 20 mA | CA | 8 digit, 8 segment (hex/bcd), w/mem/drivers |
| ICM7218D | Intersil | 10 mA | CC | 8 digit, 8 segment (hex/bcd), w/mem/drivers |
| ICM7218E | Intersil | 20 mA | CA | 8 digit, 8 segment (decoded/spcl), w/mem/drivers, cntls avble |
| TSC700A | Teledyne | 11 mA | CA | 4 digit decoder/driver, parallel output, brightness cntl |
| TSC7212A | Teledyne | 5 mA | CA | 4 digit decoder/driver, parallel output, brightness cntl |
| SAA1060 | Signetics | 40 mA | CA | 16 element serial in/parallel out driver |
| Other Drivers | | | | |
| XR-2000 | Exar | 400 mA | sink | 5 darlington transistors, MOS-to-LED |
| XR-2201 XR-2202 XR-2203 XR-2204 | Exar | 500 mA | sink | 7 darlington transistors, open collector w/diodes, TTL-to-LED, compatible to Sprague (ULN-xxxx) |
| CA3081 | RCA | 100 mA | sink | 7 common emitter transistor array |
| CA3082 | RCA | 100 mA | source | 7 common emitter transistor array |
| 9665 9667 | Fairchild | 250 mA | sink | 7 common emitter darlington transistor array |
| Bar Graph Drivers | | | | |
| UAA180 | Siemens | 10 mA | n.a. | 12 element bar driver |
| LM3914 | National | 2–20 mA | n.a. | 10 element dot/bar linear output driver |
| LM3915 | National | 1–30 mA | n.a. | 10 element dot/bar linear output driver |