WALL DISPLAY
For
COMPETITION BUZZER SET

Assembly Manual

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List of Tables and Figures

Wall Display Operation

This document describes a wall mounted display that allows "College Bowl" style contest participants and audience to immediately see which contestant was the first to "ring-in" with the answer. The display is used with the *Competition Buzzer Set*, designed by Richard Davis and JR Denison of Utah State University.

The wall display is a 12" x 18" wall mounted display panel. Eight wide-angle light emitting diodes (LEDs), visible to audience members within a 120-degree viewing angle, are mounted on the display panel. The face of the display includes room to show contestants' names and team affiliations next to each the associated LED.

The LEDs are powered through a multi-conductor cable attached to the main control panel. When the first contestant "rings-in" by depressing the handheld pushbutton, one of the eight LEDs will light indicating the successful contestant. The wall display unit is set up as shown in Figure 1. Figure 2 is a photograph of the wall display.

Circuit Description

The original *Competition Buzzer Set* includes eight small LEDs (Control Panel LEDs) mounted on the face of the main control. Output pins 22 - 19, and 17 - 14 of the Programmable Logic Device (PLD) mounted on the main circuit board drives these LEDs. The pins are normally held "high". When a contestant "rings in" by depressing a handheld push button, the corresponding PLD output pin goes "low", thereby sinking current from the +5 VDC power source. The current passes through the LED associated with that contestant, causing it to light.

A simple modification to the original circuit is required to enable the wall display, consisting of adding two 74LS07 hex buffers with high voltage open collector outputs, eight current limiting resistors, and connections to the PLD output pins listed above. Each 74LS07 includes six independent gates which buffer operation of the wall display from the PLD, assuring that the wall display will not damage or interfere with operation of the PLD. Each 14-pin 74LS07 includes 6 input pins (A1 through A6), 6 open collector pins (Y1 through Y6), a ground, pin and +5 VDC pin.

As shown in the schematic diagram (Figure 3), four of the six available input and output pins are used with each IC, providing a total of eight pairs. Input pins on the 74LS07 are wired to the PLD output pins. When a PLD output goes "low" in response to a contestant depressing a handheld pushbutton, the 74LS07 input also goes low. This closes the corresponding 74LS07 open collector output to ground, thereby sinking current through the corresponding LED and current limiting resistor from the +9 VDC power source source.

Parts

Table 1 list the parts required to build the wall display unit. Suggested suppliers, catalog numbers, and approximate costs are also listed. Most of the parts can be obtained from Jameco (www.jameco.com) or other electronic suppliers. The LEDs are available from Mouser Electronics (www.mouser.com) or DigiKey (www.digikey.com) .

Assembly Procedure

The wall display system consists of three components: 1) the driver circuit housed inside the main control panel; 2) the 9-conductor cable connecting the main control panel to the display; and 3) the display itself. The procedures for constructing these three components are provided below.

The Driver Circuit

The driver circuit consists of all wall display system components that are mounted on or inside the main control panel enclosure. These are the perforated circuit board (perf board); two 74LS07 buffer drivers;

two 8-conductor male headers and housings; one 2-conductor male terminal and housing; crimp terminals; eight 180 Ω resistors; color–coded hookup wire; and the 9-pin female D-Sub connector.

1. Cut two 12 to 16-inch long pieces of 9-conductor cable. The actual required length will depend on the size of the existing control panel enclosure, and the component locations you select. Pull the individual conductors out of the casing. These conductors are color-coded, and will be used for connecting the wall display drivers to the main circuit board and to the D-Sub connector.

2. Strip 1/8" of insulation from one end of each piece of color-coded wire. Tin the stripped ends.

3. Select nine unique pieces of color-coded wire. Solder the tinned ends of each to one of the female D-Sub connector solder cups. Cut nine ½" long pieces of heat shrink tubing and install over the solder cup connections

4. Determine appropriate locations for the perf board and D-Sub connector. Install the female D-Sub connector on the side of the enclosure. Install the perf board later.

5. Lay out the 150 Ω resistors and IC sockets on the perf board, and solder the pins and leads to the copper pads. This resistor value is appropriate if your power supply is producing 9V. If you are using an unregulated 9V supply, the voltage might be substantially higher. If so, 220 Ω resistors might be needed to reduce the current through the LEDs to below the maximum allowed.

6. Solder the two 8-pin male headers and one 2-pin male header to the board. Complete the circuit board by soldering #24-#28 gauge stranded hookup wire point-to-point, referring to the wiring schematic (Figure 3) and photograph (Figure 4) as a guide.

7. Select one of the nine wires connected to the D-Sub connector to deliver 9-volt power to the wall display. Cut the wire to an appropriate length, strip and tin the free end, and solder to the "IN" (9-volt) of the 7805 voltage regulator located on the main circuit board. Refer to Figure 5. Discard the remaining piece.

8. Eight pieces of unused color-coded hookup wire should remain. Solder the tinned ends to PLD output pins 14, 15, 16, 17, 19, 20, 21 and 22, as shown in Figure 6. Provide strain relief by securing the wires to the board using a thin bead of hot melt glue. Cut the wires to an appropriate length.

9. There should be 16 wires with free ends. Eight are soldered to the D-Sub connector, and eight to the PLD pins. Cut these wires to an appropriate length so that they easily and neatly reach the male headers on the circuit board without kinking or straining. Strip 1/8" of insulation from the free ends.

10. Cut two 12-16 inch long pieces of hookup wire. Strip 1/8" of insulation from one end of each, and tin. Solder the tinned end of the red wire to the "OUT" (+5 volt) terminal of the 7805 voltage regulator. Solder the black wire to the middle terminal (ground). Cut the wires to an appropriate length.

11. To function properly, the 74LS07 chips require a stable voltage from 4.75 V to 5.25. If you are using an unregulated 120-VAC / 9 VDC power adapter, it is important to remove the ripple voltage at the input to the 7805 voltage regulator. This may be done using a capacitor. Simply solder a 10 µF capacitor between the input (left pin) and ground (middle pin) of the 7805 regulator. If you are using a polarized capacitor, be sure to solder the positive lead of the capacitor to the input pin. The capacitor can be soldered directly to the pins on the top side of the circuit board, or to the corresponding points on the underside of the board.

12. Using an appropriate crimping tool (Jameco #227491CL) crimp the Molex contacts to the free ends of the eight wires soldered to the PLD output pins, eight wires soldered to the D-Sub connector, and to the +5 volt and ground wires. *Note - If you do not wish to buy the headers, housings, and*

crimp contacts, connections to the wall display driver circuit board can be made by simply soldering the conductors point-to-point.

13. Install the contacts in the housings. Select the order that they are placed in the 8-conductor housings so that the contestant numbers will be in some logical order, and the color-code is consistent.

The Cable

The cable consists of the 9-conductor cable and the 9-pin D-Sub connector installed at one end.

14. Cut the cable to an appropriate length. Remember to include enough length to span the total vertical and horizontal distance that you anticipate, plus 18 inches for wiring inside the wall display unit.

15. Carefully cut the outer housing 18 inches from one end. Pull off the outer housing, exposing the 9-color coded conductors.

16. Open the D-Sub connector housing. Lay the other end of the cable in the housing to determine where to cut the housing. You will probably need to remove about 1-1/2" of housing. Carefully cut and remove the housing.

17. Strip 1/8" of insulation from the ends of the individual wires. Tin the ends.

18. Solder each tinned end into the solder cups of the male D-Sub connecter. Be sure to carefully match a color-coded wire with a solder cup so that the color scheme is consistent with that adopted for wiring the circuit board.

19. Install the cable and connector in the housing, and secure with the provided hardware.

The Wall Display

The wall display consists of a acrylic faced wooden frame; wide angle LEDs, and associated wiring.

20. Cut 4 pieces of pine or hardwood; (2)18" x 2" x ¾", and (2)11-1/2" x 2" x ¾". Glue and screw together to make a 12" x 18" frame. Sand, prime and paint the frame as preferred.

21. Drill a 5/16 hole through the bottom middle of the frame to accommodate the 9-conductor cable.

22. Cut a 12" x 18" piece of sheet acrylic. Neatly chamfer one side all around with a mill file.

23. Drill 3/32" diameter holes through the acrylic at even intervals, set 3/8" in from the edge. Screw the acrylic to the frame with #4x ½" wood screws.

24. Drill 20 mm holes through the acrylic to accommodate the LEDs. Locate the holes on 1-3/4" centers set approximately 2" in from the edge of the sheet. The holes can be drilled with a UnitBit (McMaster Carr # 89275A16), or a twist drill modified for drilling acrylic. To modify a twist drill, carefully grind or file a 1/32" wide flat on the cutting edge of the bit. The face of the flat should be parallel to the longitudinal axis of the bit. In either case, advance the bit slowly starting from the face of the sheet, and use care to avoid chipping out the back side.

25. Install the LEDs from the backside of the acrylic sheet. The LEDs can be secured to the acrylic face using a few dabs of hot melt glue.

26. Examine the leads for each LED. Trim the long lead (anode) to 3/4" long, and the short lead (cathode) to ½" long.

27. Cut 8 pieces of stranded hookup wire (red preferred). Strip and tin one end of each and solder to the anode of each LED. Gather the 8 wires and cut all to approximately 12 inches long. Cut eight 1-1/4" pieces of heat shrink tubing, and install over the solder connections

28. Pull the exposed cable wires through the hole in the bottom of the frame so that about 1" of the outer housing can be seen above the inside of the frame. Place two heavy-duty cable ties around the cable near the frame, and secure. The cable ties will provide strain relief.

29. Using the color code scheme adopted before, identify the wire that will be providing the 9-volt supply to the display. Cut to an appropriate length. Strip about ½" of insulation from the free end, and from the free ends of the eight anode wires installed in the previous step. Gather these nine wires, aligning the stripped ends. Twist the stripped ends and secure with a wire nut.

30. Identify the color-coded wire associated with contestant #1. Cut to an appropriate length, and strip about ¼" of insulation from the free end. Tin the free end. Slide a 1" long piece of heat shrink tubing over the wire. Solder the wire to the top LED. Install the heat shrink tubing over the solder connection.

31. Repeat the previous step for the remaining LEDs.

32. Cut a 12" x 18" piece of 1/8" Masonite. Drill a 1" diameter hole in the middle about 2" from the top edge. The hole can be used for hanging the display on the wall. Screw the Masonite panel to the back of the frame.

Operation

To use the wall display, simply connect the cable to the 9-pin connector on the side of the control panel enclosure. Turn the power on, and you should be ready to go.

Maintenance

The wall display should be stored so that the LEDs protruding from the face of the display are protected from damage. It may be helpful to keep it stored inside an old pillowcase, laid flat on its back or upright on a shelf. If you use a black acrylic face, periodic cleaning with an acrylic spray cleaner will remove dust, smudges, and prevent the buildup of static charges.

Table 1 – Materials List and Cost Estimate

Label	Part Description	Qty	Source	Part No.	Cost	Total Cost
	#4 wood screws	12	Hardware Store			
	#4 x ¼" machine screws	8	Hardware Store			
	Wire nut, size for 9 #22 AWG stranded wires	1	Hardware Store			
	Heavy Duty Cable Tie	2	Hardware Store			
	12" x 18" Masonite back	1	Home Improvement Store			
	Wood frame, 12" x 18" x 2"	1	Homemade			
U2, U3	74LS07 Hex Buffer/Driver, Open Collector, High Voltage	2	Jameco	46367CL	$0.84	$1.68
	D-Sub hood, 9 pin	1	Jameco	15721CL	$0.49	$0.49
	D-Sub male connector, 9 pin, solder cup	1	Jameco	15747CL	$0.56	$0.56
	D-Sub female connector, 9 pin, solder cup	1	Jameco	15771CL	$0.59	$0.59
	Cable, 9 conductor, 24 AWG	25 ft.	Jameco	31878CL	$11.25	$11.25
R1-R8	15 Ω ¼ watt resistors	8	Jameco	30162CR	$0.99/hundred	$0.99
	1/8 " heat shrink tubing	39 in.	Jameco	71280CL	$0.55/39 inches	$0.55
	Standoffs, 4-40 X ¼"	4	Jameco	139192CL	$0.16	$0.64
	Molex male header, 8 pin	2	Jameco	232320CL	$0.40	$0.80
	Molex housing, 8 pin	2	Jameco	234851CL	$0.54	$1.08
	Molex male header, 2 pin	1	Jameco	232266CL	$0.29	$0.29
	Molex housing, 2 pin	1	Jameco	234798CL	$0.29	$0.29
	Molex crimp contacts	18	Jameco	234923CL	$0.065	$1.30
	Ic socket, 14 pin	2	Jameco	112213CL	$0.10	$0.20
	12" x 24" x 0.177" black acrylic sheet	1	McMaster Carr	8505K823	$9.10	$9.10
D1-D4	Red LED, 20 mm, 120 deg. View angle	4	Mouser Electronics	696-SSL-LX20R6ID	$1.74	$6.96
D5-D8	Green LED, 20 mm, 120 degree view angle	4	Mouser Electronics	696-SSL-LX20R6GD	$1.74	$6.96
	Perf board, 2-7/8" x 1-7/8"	1	Radio Shack	276-149	$1.79	$1.79

Figure 1

The Wall Display and Competition Buzzer Set

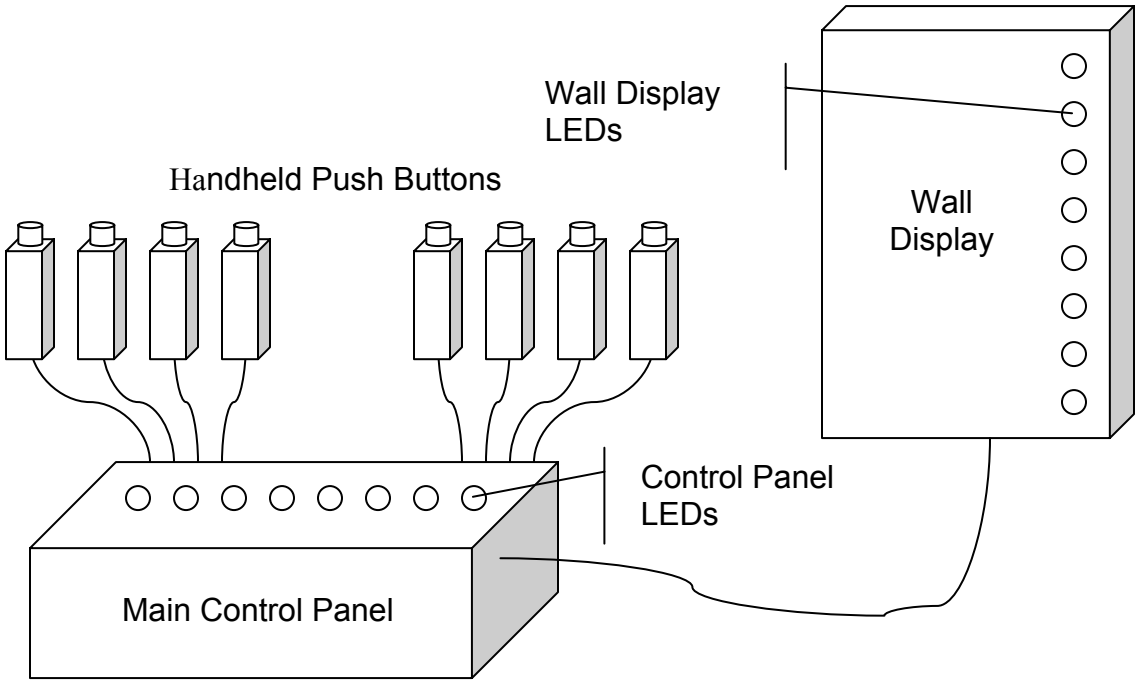

Figure 2
Completed Wall Display

Figure 3
Schematic Diagram

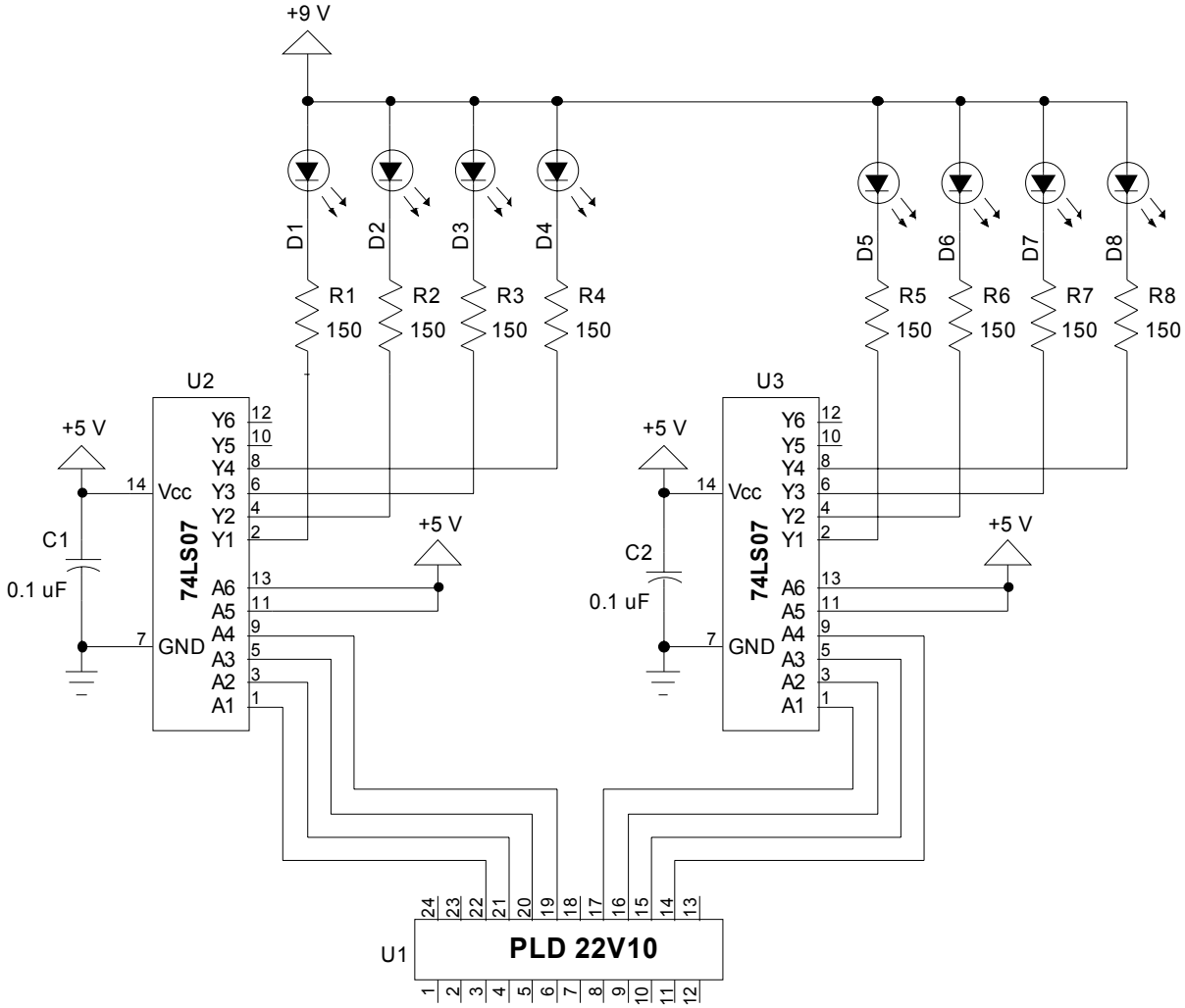

Figure 4

Completed Circuit Board

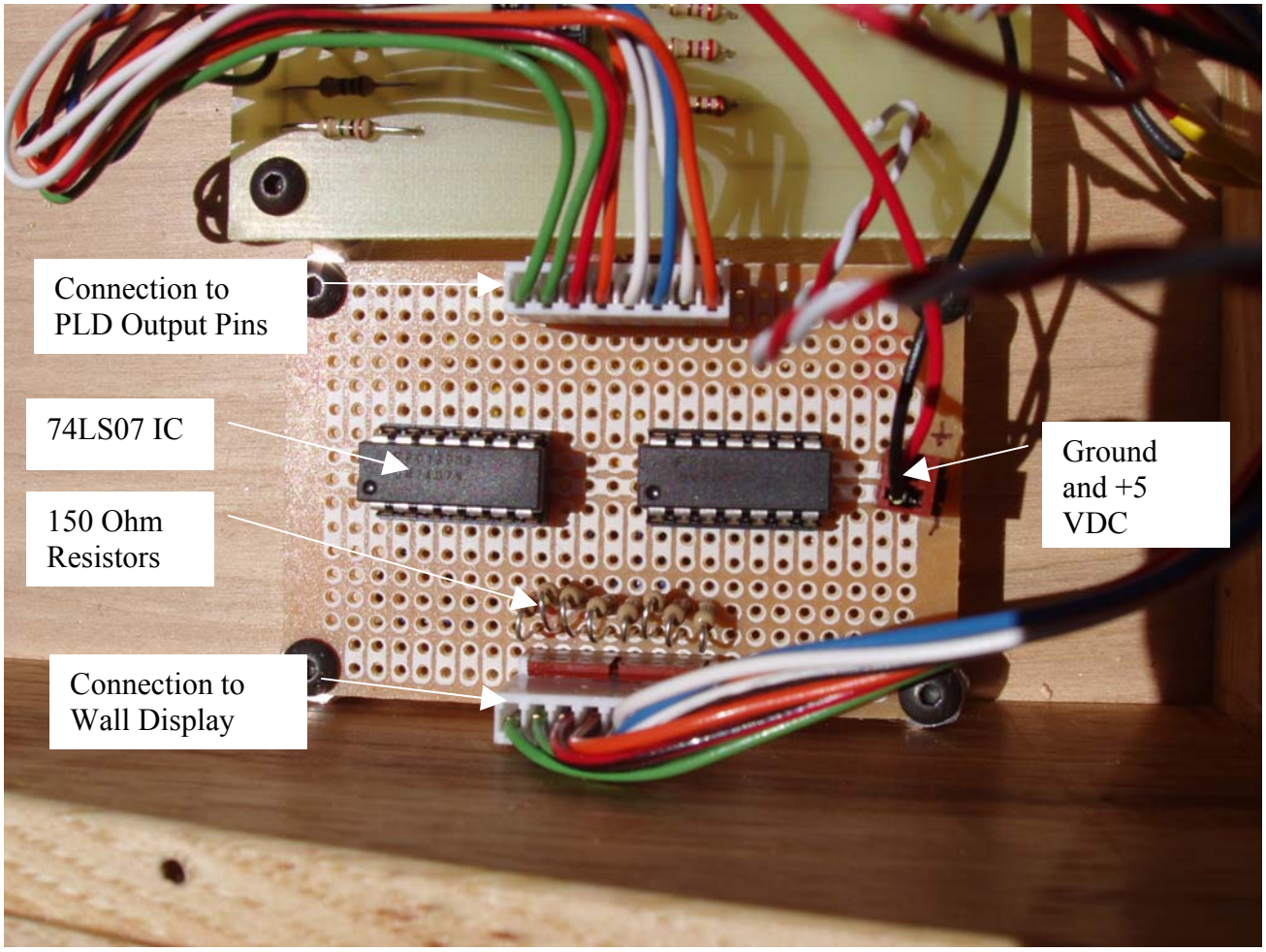

Figure 5
Voltage Regulator Connections