

PD-LED

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<http://www.pinballcontrollers.com>

General Driver Board Description:

The P-ROC Driver Boards are used to control the activation of connected devices by turning on or off power to the devices in response to commands from a P-ROC. The boards receive commands from the P-ROC over an RS-485 serial bus which allows many boards to be chained together and used simultaneously. There are multiple types of Driver Boards that can be used to make up a chain including: Master, Power Driver 16, Power Driver Matrix 8x8, and PD-LED.

PD-LED Overview:

The PD-LED has 84 individual drive pins and can therefore control up to 84 individual LEDs. Each drive pin operates independently, based on commands sent to the board from an external RS-485 bus master. The commands are interpreted by an FPGA (Field Programmable Gate Array), which then turns the individual drive pins on or off as necessary.

The FPGA can be programmed to set the intensity level of an LED to one of 256 levels. Level 0 is off, meaning the FPGA will drive the pin low (ground). Level 255 is on, meaning the FPGA will drive the pin high (3.3v). All other levels result in the FPGA driving the pin on and off repeatedly, where the on and off times are different, depending on the level. High level values have long on times and short off times, and low level values have short on times and long off times. The resulting PWM (pulse width modulation) determines the intensity of the LED.

The FPGA can also be programmed to fade the intensity level from one level to another. When fading, the FPGA will increment or decrement the drive intensity level, at a programmable rate, one level at a time until the final level is reached.

RGB (Red-Green-Blue) LEDs:

Since RGB LEDs are essentially 3 LEDs in one package, this board can control up to 28 RGB LEDs ($84 / 3 = 28$). 256 levels per LED results in a possible color depth for RGB LEDs of 16M colors ($256 * 256 * 256$).

Power / Current:

Each LED output is limited to 22mA of current. For designs requiring more current to be delivered to one or more LEDs, we recommend using the PD-LED boards LED outputs to turn on/off transistors or FETs, through which more current can be supplied from a power source.

Connectors:

J1	Logic Power	Required
2-pin Molex: 0.156" spacing		
1	5V	I
2	Ground	I

J2	Serial Data In	Required
2-pin Molex: 0.100" spacing		
1	Serial+	I
2	Serial-	I

J3	Serial Data Out	Not Required
2-pin Molex: 0.100" spacing		
1	Serial+	O
2	Serial-	O

J5	Burst Switches				
20-pin Header: 0.100" spacing					
1	3.3V	O	2	LED 0	O
3	LED 1	O	4	LED 2	O
5	Ground	O	6	3.3V	O
7	LED 3	O	8	LED 4	O
9	LED 5	O	10	Ground	O
11	3.3V	O	12	LED 6	O
13	LED 7	O	14	LED 8	O
15	Ground	O	16	3.3V	O
17	LED 9	O	18	LED 10	O
19	LED 11	O	20	Ground	O

J9	Burst Switches				
20-pin Header: 0.100" spacing					
1	3.3V	O	2	LED 12	O
3	LED 13	O	4	LED 14	O
5	Ground	O	6	3.3V	O
7	LED 15	O	8	LED 16	O
9	LED 17	O	10	Ground	O

11	3.3V	0	12	LED 18	0
13	LED 19	0	14	LED 20	0
15	Ground	0	16	3.3V	0
17	LED 21	0	18	LED 22	0
19	LED 23	0	20	Ground	0

J6 Burst Switches					
20-pin Header: 0.100" spacing					
1	3.3V	0	2	LED 24	0
3	LED 25	0	4	LED 26	0
5	Ground	0	6	3.3V	0
7	LED 27	0	8	LED 28	0
9	LED 29	0	10	Ground	0
11	3.3V	0	12	LED 30	0
13	LED 31	0	14	LED 32	0
15	Ground	0	16	3.3V	0
17	LED 33	0	18	LED 34	0
19	LED 35	0	20	Ground	0

J10 Burst Switches					
20-pin Header: 0.100" spacing					
1	3.3V	0	2	LED 36	0
3	LED 37	0	4	LED 38	0
5	Ground	0	6	3.3V	0
7	LED 39	0	8	LED 40	0
9	LED 41	0	10	Ground	0
11	3.3V	0	12	LED 42	0
13	LED 43	0	14	LED 44	0
15	Ground	0	16	3.3V	0
17	LED 45	0	18	LED 46	0
19	LED 47	0	20	Ground	0

J7 Burst Switches					
20-pin Header: 0.100" spacing					
1	3.3V	0	2	LED 48	0
3	LED 49	0	4	LED 50	0
5	Ground	0	6	3.3V	0
7	LED 51	0	8	LED 52	0
9	LED 53	0	10	Ground	0
11	3.3V	0	12	LED 54	0
13	LED 55	0	14	LED 56	0

15	Ground	0	16	3.3V	0
17	LED 57	0	18	LED 58	0
19	LED 59	0	20	Ground	0

J11	Burst Switches				
20-pin Header: 0.100" spacing					
1	3.3V	0	2	LED 60	0
3	LED 61	0	4	LED 62	0
5	Ground	0	6	3.3V	0
7	LED 63	0	8	LED 64	0
9	LED 65	0	10	Ground	0
11	3.3V	0	12	LED 66	0
13	LED 67	0	14	LED 68	0
15	Ground	0	16	3.3V	0
17	LED 69	0	18	LED 70	0
19	LED 71	0	20	Ground	0

J8	Burst Switches				
20-pin Header: 0.100" spacing					
1	3.3V	0	2	LED 72	0
3	LED 73	0	4	LED 74	0
5	Ground	0	6	3.3V	0
7	LED 75	0	8	LED 76	0
9	LED 77	0	10	Ground	0
11	3.3V	0	12	LED 78	0
13	LED 79	0	14	LED 80	0
15	Ground	0	16	3.3V	0
17	LED 81	0	18	LED 82	0
19	LED 83	0	20	Ground	0

Board Address:

In order to receive the correct data from the bus master, the board address needs to be set appropriately. The following table describes how to use the dipswitches to set the board address:

Dipswitch	Meaning
1	Address bit 0*
2	Address bit 1*
3	Address bit 2*
4	Address bit 3*
5	Address bit 4*

*On=1, Off=0

Registers Addresses:

Address	Meaning
0	LED Index
1	Color
2	Fade Destination Color
3	Fade Rate [7:0]*
4	Fade Rate [15:8]*

Note - Registers are all 8-bits wide.

* Fade Rates have 4ms resolutions (1 = 4ms, 2 = 8ms... 256 = 1s)

Status LEDs:

LED	Meaning
D1	3.3V
D2	5.0V
D3	Watchdog expired
D4	Ready

Dipswitches:

Switch	Meaning*
1	Address bit 0
2	Address bit 1
3	Address bit 2
4	Address bit 3
5	Address bit 4
6	LED reset value
7	Watchdog disable
8	Terminate serial bus

* On=1, Off=0

Serial Chain Termination:

The last board in the physical chain (not necessarily the highest address) needs to be set to terminate the serial chain. This is done by setting dipswitch 8 on.

PDB Protocol:

The PDB Protocol describes the format of data being received on the Data input pin (J8: pin-1). This is also the format of the serial data sent out on J10.

Serial Bus Protocol (PDB Protocol)	
Bit	Field
Byte 0	{0,0,Board Address[5:0]}
<between bytes>	1-5 IDLE clock cycles
Byte 1	{0,0,0,0,0,Command[2:0]}: 0: Read 1: Write 2: RESERVED 3: RESERVED 4: RESERVED 5: RESERVED 6: RESERVED 7: Clear all registers on board
<between bytes>	1-5 IDLE clock cycles
Byte 2	{0,0,Register Address[5:0]}: 0: Bank A 1: Bank B
<between bytes>	1-5 IDLE clock cycles
Byte 3	{0,0,0,0,Bank data bits[7:4]}
<between bytes>	1-5 IDLE clock cycles
Byte 4	{0,0,0,0,Bank data bits[3:0]}

Each byte is sent MSB first.

A transaction consists of 5 data bytes. There must be at least 10 IDLE cycles between transactions. Between each byte of a transaction there must be between 1 and 5 IDLE cycles.

The data signal must be high during all IDLE cycles.

Data must be sent at 8 MHz, 125ns per bit.

The Bank data bits in Bytes 3 and 4 are all active high. A '1' will turn the corresponding circuit on, and a '0' will turn the corresponding circuit off.

Hardware Installation:

- Mount the board using the 4 mounting holes.
- Connect a 5V supply to J1.
- Connect J2 to the previous board in your chain using a 2-wire cable. If the boards are separated by more than a few feet, a shielded & twisted pair is recommended. For short runs, any 2-wire cable should suffice.
- Connect LEDs to the appropriate pins of J5-J11.

Programmers Guide:

To set the intensity level of an LED:

1. Write the LED's index number to register address 0 (LED Index).
2. Write the desired intensity level to register address 1 (Color).

To fade an LED from its current intensity level to another:

1. (optional) Write the lower 8 bits of the fade rate to register address 3 (Fade Rate [7:0]).
2. (optional) Write the upper 8 bits of the fade rate to register address 4 (Fade Rate [15:8]).
3. Write the LED's index number to register address 0 (LED Index).
4. Write the destination intensity level to register address 1 (Fade Destination Color).