Pinball *Logic*

Universal WPC Power Board

One Board to Light Them All

WPC89 & WPC95 Compatible Power / Driver Assembly

Pinball Logic LLC

READ ME BEFORE YOU FLIP

Contents

1. Overview

What This Board Is

The **Universal WPC Power Board** is a drop-in, modern replacement for Bally/Williams WPC89 and WPC95 power / driver boards. Instead of hunting for the right revision, you set a few jumpers and this single board covers **all supported titles** from the WPC era.

1.1 Design Goals

Over three years of development, the board was tuned with four main goals:

- **Universal fit:** Works in WPC89 and WPC95 machines via jumpers.

- **Modern electronics:** Surface-mount components, high-efficiency regulators, and FET-based drivers.

- **Higher reliability:** Larger electrical headroom and cooler operation to keep your machine happy in the long run.

- **LED-friendly:** 240 Hz scanning, dimming profiles, and GI brightness controls give smooth, flicker-free LED behavior.

1.2 Big Picture Feature List

Here is the full list of upgrades bundled into the Universal WPC board:

1. **WPC89 & WPC95 compatibility** in a single board — just move a few jumpers.

2. **On-board flipper drivers** integrated into the power / driver board.

3. **Surface-mount components** used wherever feasible for improved manufacturability and consistency.

4. **Increased reliability** with higher-spec parts and thermal headroom.

5. **Lamp Matrix Driver**

   a) Scan rate boosted to **240 Hz** to eliminate LED flicker, using a small on-board micro-controller.

   b) Darlington drivers replaced with **FETs** (smaller, cooler, and easier to drive).

   c) SMT devices and reduced component count for easier manufacturing.

   d) **Per-lamp dimming profile** controlled via USB and a CSV file.

6. **Solenoid Drive**

    a) Darlingtons replaced with **FETs**.

    b) Direct drive from the **AHCT374 latch**, reducing part count.

7. **Inrush current limiter** added to all supplies to reduce stress on rectifiers.

8. **Rectifier Circuits**

    a) Large, hot bridge rectifiers replaced by SMT **Schottky** diodes.

    b) Improved efficiency and the removal of rectifier heat sinks.

    c) Higher-reliability capacitors specified.

9. **5 V Regulator**

    a) Linear regulator replaced by an efficient **switching** regulator.

    b) Runs much cooler, improving reliability.

    c) No heat sink required.

    d) Implemented entirely with SMT components.

10. **12 V Regulator**

    a) Linear regulator replaced by an efficient **switching** regulator.

    b) Cooler operation and higher reliability.

    c) No heat sink required.

    d) Implemented with SMT components.

11. **Per-solenoid fuse LEDs** to visually show when a fuse has blown.

12. **Fuse values printed** clearly on the silkscreen.

13. **General Illumination (GI) Driver**

    a) GI changed from AC drive to **DC drive** using rectifier and bulk capacitance.

    b) Triac drivers replaced with FETs.

    c) GI heat sinks eliminated.

    d) GI banks scanned at **240 Hz** with a dedicated microcontroller for LED-friendly behavior.

    e) Independent **manual brightness adjustment** for each of the five GI outputs.

14. Fuses standardized to compact **5 mm × 20 mm** sizes.

Important Compatibility Notice

- If your game has a separate **Fliptronics flipper board**, it must be **disconnected and removed** when installing the Universal WPC Power Board.

- If your game uses an aftermarket **LED OCD** or similar LED driver, it must be **removed**. The Universal WPC Power Board already provides LED-friendly drive and dimming.

- Leaving these add-on boards in-circuit can cause **unreliable operation or damage** and is **not supported**.

2. Board Compatibility & Jumpers

One Board, Three Modes

The Universal WPC Power Board supports:

- **WPC89 Rev 1**

- **WPC89 (standard)**

- **WPC95**

You simply move the labeled jumpers to match your machine family.

2.1 Jumper Map

Use the table below to set the board for your game. "IN" means the jumper is installed or the wire link is present; "OUT" means it is removed or cut. Numeric values refer to specific pin selections on multi-position jumpers.

Jumper	WPC89 Rev1	WPC89	WPC95
JMP1	1	1	3
JMP3	1	1	3
JMP4	1	1	3
JMP5	1	1	3
JMP9	IN	OUT	OUT
JMP10	IN	OUT	OUT
WPC95	OUT	OUT	IN
Blackout	N/A	N/A	IN
W4	IN	OUT	OUT
W5	IN	OUT	OUT

Quick Setup Trick

Before you pull the original board, take a clear photo of its jumpers and connectors. Then match the new board to the correct configuration using this table. It keeps swaps fast and mistake-free.

3. General Illumination (GI) Control

The Universal WPC board has **five** independent GI banks. Each bank has its own brightness control pot and is driven by a FET under microcontroller supervision at 240 Hz.

3.1 GI Brightness Pots T0–T4

On the board you will find five trimmer potentiometers labeled:

T0, T1, T2, T3, T4

Each pot controls the DC brightness of a single GI bank:

- Turning clockwise increases brightness.

- Turning counterclockwise decreases brightness.

> **Recommended Adjustment Flow**
>
> 1. Set all five pots to the mid position.
>
> 2. Start a game and enter lamp test in diagnostics.
>
> 3. Adjust each pot so the GI looks balanced with the playfield inserts.
>
> 4. Fine-tune for LED vs. incandescent preference.

3.2 Why DC GI?

Traditional WPC GI is AC-driven via triacs, which works but tends to run hot and can flicker with LED bulbs. The Universal WPC board:

- Rectifies GI AC into DC.

- Filters the DC with a capacitor bank.

- Switches each bank with a FET at 240 Hz.

The result: lower heat, more control, and smooth LEDs without shimmer.

4. Lamp Matrix Brightness Profiles

The lamp matrix driver on the Universal WPC board has its own microcontroller running a 240 Hz scan. On top of that, you get per-lamp brightness control using a simple CSV file and a USB cable.

4.1 What You Can Do

- Adjust the brightness of **each individual insert**.

- Create a "warm incandescent" profile or a bright "arcade showtime" profile.

- Store multiple CSV files on your PC and swap profiles in seconds.

4.2 Required Tools

- A computer with a USB port.

- A standard terminal program such as **Tera Term**.

- Your `.CSV` brightness file (for example, `MatrixBrightness.csv`).

4.3 CSV Format (Conceptual)

Each line of the CSV represents one lamp in the matrix. A simple conceptual format is:

<div align="center">

`row,column,brightness_percent`

</div>

For example:

```
0,0,100
0,1,80
0,2,40
```

The exact mapping may differ per game: use the supplied template and documentation that ships with your board as the authoritative reference.

4.4 Downloading the CSV via USB

Follow these steps to send a brightness profile to the board:

1. Connect a USB cable from your PC or laptop to the connector labeled **LAMP_USB** on the Universal WPC board.

2. Open **Tera Term** (or an equivalent terminal program).

3. Go to **Settings → Serial**.

4. Select the serial port named **USB Serial (COMx)**.

5. Set the serial parameters to:

   <div align="center">

   115200 baud, 8 data bits, no parity, 1 stop bit (115200 N81).

   </div>

6. Once connected, the board sends an asterisk (`*`) every second. If you see this on your terminal screen, communication is working.

7. In Tera Term, go to **File → Send**.

8. Browse to your `.CSV` file (for example, `MatrixBrightness.csv`) and send it.

9. The board reads the file, updates its internal brightness table, and the new lamp levels take effect immediately.

> **Pro Tip: Back Up Your Favorite Profiles**
>
> Keep a small folder of CSV profiles on your PC:
>
> - `my_game_classic.csv` (dim warm look)
>
> - `my_game_tournament.csv` (bright, high contrast)
>
> - `my_game_party.csv` (extra flashy)
>
> You can swap them in seconds.

5. Solenoid & Flipper Drivers

5.1 From Darlingtons to FETs

The original WPC designs used Darlington transistor arrays for solenoid and flipper control. The Universal WPC board:

- Replaces these arrays with **MOSFET** drivers.

- Uses **direct drive** from an **AHCT374** latch for the solenoid lines.

- Reduces component count and voltage drop.

> **What You Gain**
>
> - Cooler operation and less stress on the board.
>
> - Cleaner, more consistent power delivery to coils.
>
> - Fewer parts to age and fail.

5.2 Integrated Flipper Drivers

Flipper drivers are now built into the Universal WPC power / driver board:

- Simplifies wiring and reduces the number of boards in the backbox.

- Keeps the entire high-current coil system in one place.

Refer to the silkscreen and the flipper section of the schematic for exact connector pinouts and coil references.

6. Power, Rectifiers, & Regulators

6.1 Inrush Current Limiting

Every supply rail on the Universal WPC board passes through an inrush current limiter. This device:

- Smooths the surge current at power-up.
- Reduces stress on the new Schottky rectifiers and filter capacitors.
- Contributes to overall long-term reliability.

6.2 Rectifier Upgrades

Instead of large, lossy bridge rectifiers with heat sinks, the Universal WPC board uses surface-mount **Schottky** diodes:

- Lower forward voltage drop.
- Improved efficiency and reduced heat.
- No rectifier heat sinks required.
- Paired with upgraded high-reliability capacitors.

6.3 5 V Switching Regulator

The 5 V digital supply is powered by a switching regulator module:

- Replaces the classic linear 5 V regulator.
- Runs cool and efficient under modern load conditions.
- Uses SMT components and requires no heat sink.

6.4 12 V Switching Regulator

Similarly, the 12 V supply is generated by a switching regulator:

- Cooler operation than legacy linear regulators.
- Improved stability with modern board loads.
- Implemented with SMT parts.

> **Note on Noise**
>
> Both switching regulators are designed with appropriate filtering and layout to remain pinball-quiet. If you hear hum or see video noise, re-check grounding and ensure all connectors are fully seated.

7. Fuse Chart & LEDs

7.1 Silkscreened Fuse Values

Fuse ratings are printed directly on the Universal WPC board silkscreen for quick reference. The table below summarizes them:

Fuse	Rating	Fuse	Rating
F100	25A	**F112**	7A
F101	4A	**F113**	5A
F102	4A	**F114**	8A
F103	4A	**F115**	3A
F104	4A	**F116**	3A
F105	4A	**F117__95**	4A
F106	5A	**F118__95**	4A
F107	5A		
F108	5A		
F109	5A		
F110	5A		
F111	5A		

7.2 Fuse Monitoring LEDs

Each solenoid fuse has a corresponding LED:

- When the fuse is good and the circuit is active, the LED should light.

- When the fuse is blown, the LED will remain off even when the circuit should be energized.

> **Checking a Suspected Fuse**
>
> If a coil or lamp bank is dead:
>
> 1. Put the game into coil test for that device.
>
> 2. Watch the LEDs next to the corresponding fuse.
>
> 3. If the LED stays dark, power down the game and check or replace the fuse.

7.3 Labeling Corrections

On some board revisions, the following silkscreen labels are known to be incorrect:

- **F117_95** is labeled but should read **F115_95**.

- **F118_95** is labeled but should read **F116_95**.

Use the fuse chart and any revision notes that shipped with your board if in doubt.

8. Installation Checklist

8.1 Before You Start

> **Safety First**
>
> - **Unplug the machine** before touching anything in the backbox.
>
> - Give high-voltage capacitors a few minutes to discharge.
>
> - Use the correct fuse ratings — never "size up" a fuse.

8.2 Step-by-Step

1. Power off and unplug the pinball machine.

2. Open the backbox and photograph the original power / driver board:

   - Jumper positions.
   - Connector positions and wire orientations.

3. Label any connectors if needed (especially if similar).

4. Remove all connectors from the old board.

5. Remove the mounting screws and take out the original board.

6. Set the jumpers on the Universal WPC board for your machine family (WPC89 Rev 1, WPC89, or WPC95) using the jumper table.

7. Mount the Universal WPC board using the existing hardware.

8. Reconnect all harnesses, ensuring each connector is fully seated and keyed correctly.

9. Double-check:

   - No extra standoffs behind the board.
   - No loose screws or washers.
   - Jumpers match your intended configuration.

10. Plug the machine back in and power it on.

11. Observe the board:

    - Check that LEDs look normal.
    - Confirm that fuses are not blowing.
    - Run through lamp, GI, and coil tests.

12. Adjust GI brightness (T0–T4) to taste.

13. Optionally, load a custom lamp matrix CSV to tune insert brightness.

9. Troubleshooting & FAQ

The board powers up but some coils do nothing.

- Check the fuse LED for the coil's supply rail.

- Verify the actual fuse rating and replace if blown.

- Confirm that the solenoid connectors are on the correct headers.

GI is uneven or too dim.

- Adjust the T0–T4 pots one at a time.

- Make sure GI connectors are firmly seated.

- If using LEDs, verify that the bulbs themselves are good.

Lamp matrix looks fine with incandescent bulbs but odd with LEDs.

- Ensure your brightness CSV does not set any lamps to extremely low values if you expect them to be bright.

- Try a simpler test CSV where all lamps are at 100%.

I don't see the * characters in my terminal.

- Confirm you selected the *USB Serial (COMx)* port.

- Confirm the baud rate and settings: 115200 N81.

- Check the USB cable and try a different port if necessary.

10. Game Compatibility Chart

Supported Bally/Williams WPC89 and WPC95 Games

The Universal WPC Power Board is a direct replacement for all **WPC89 Rev-1**, **WPC89 Standard** (including WPC-S), and **WPC95** power/driver boards. Use the jumper settings in the Compatibility section to configure the board for each game.

Game Title	Year	Required Setting
FunHouse	1990	WPC89 Rev-1
Harley-Davidson	1991	WPC89 Rev-1
The Machine: Bride of Pin • Bot	1991	WPC89 Rev-1
Gilligan's Island	1991	WPC89 Standard
Terminator 2: Judgment Day	1991	WPC89 Standard
Hurricane	1991	WPC89 Standard
The Getaway: High Speed II	1992	WPC89 Standard
The Addams Family	1992	WPC89 Standard
The Party Zone	1992	WPC89 Standard
Black Rose	1992	WPC89 Standard
Fish Tales	1992	WPC89 Standard
Doctor Who	1992	WPC89 Standard
Creature from the Black Lagoon	1992	WPC89 Standard
White Water	1993	WPC89 Standard
Bram Stoker's Dracula	1993	WPC89 Standard
Twilight Zone	1993	WPC89 Standard
Indiana Jones: The Pinball Adventure	1993	WPC89 Standard
Judge Dredd	1993	WPC89 Standard
Star Trek: The Next Generation	1993	WPC89 Standard
Popeye Saves the Earth	1994	WPC89 Standard
Demolition Man	1994	WPC89 Standard
World Cup Soccer (WCS94)	1994	WPC89 Standard
The Flintstones	1994	WPC89 Standard
Red & Ted's Road Show	1994	WPC89 Standard
The Shadow	1994	WPC89 Standard
Dirty Harry	1995	WPC89 Standard
Theatre of Magic	1995	WPC89 Standard
No Fear: Dangerous Sports	1995	WPC89 Standard
Indianapolis 500	1995	WPC89 Standard
Johnny Mnemonic	1995	WPC89 Standard
Who Dunnit	1995	WPC89 Standard
Jack • Bot	1995	WPC89 Standard
Congo	1995	WPC95
Attack From Mars	1995	WPC95
Safecracker	1996	WPC95
Tales of the Arabian Nights	1996	WPC95
Scared Stiff	1996	WPC95
Junk Yard	1996	WPC95
NBA Fastbreak	1997	WPC95
Medieval Madness	1997	WPC95
Cirqus Voltaire	1997	WPC95
No Good Gofers	1997	WPC95
The Champion Pub	1998	WPC95
Monster Bash	1998	WPC95
Cactus Canyon	1998	WPC95

> **Important Notes**
>
> - Only **three** games use the early **WPC89 Rev-1** style power/driver configuration.
>
> - WPC-S titles (security CPU) still use standard WPC89-style power/driver boards; select **WPC89 Standard** for these games.
>
> - All other WPC89-family titles use the **Standard** jumper configuration.
>
> - All WPC95 titles use the **WPC95** jumper configuration.
>
> - This board replaces all three families with jumper selection — no other hardware needed.

11. Schematic Reference

The full schematic for the Universal WPC board is distributed in a separate PDF. Each sheet corresponds to a major functional block:

- Power input and rectifiers.

- 5 V and 12 V regulator stages.

- General illumination controller.

- Lamp matrix columns and rows.

- Solenoid banks, including flippers.

- MPU interface and control logic.

Use the schematic as the final authority for signal names and test points when performing deep diagnostics or board-level repair.

Thank You

> **From the Pinball Logic LLC Team**
>
> Thank you for trusting **Pinball Logic LLC** with your WPC-era games. This board was built by people who love pinball, for players and operators who want these machines to keep flipping for decades to come.
> If you have questions, ideas, or just want to show off a restored game using the Universal WPC Power Board, we would love to hear from you!