
Crompton 9W LED Bulb PRO: Teardown and Reverse Engineering Report

Full report with appendices rendered from the structured engineering model



Product family: Crompton's current 9 W B22 lamp, Dynaray Ecoglo CDL (manufacturer's packshot). The unit torn down is the earlier 9W LED Bulb PRO, CDL, date code 02/19.

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Prepared from 54 photographs of one unit, datasheets and online research. Not affiliated with Crompton Greaves Consumer Electricals or Bright Power

Semiconductor. Inference is labelled as inference; nothing is verified against the physical unit.

Document control

Contents of this package

Part	Document	Source
I	Crompton 9W LED Bulb PRO: Teardown and Reverse Engineering Report	<code>report.md</code>
II	Appendices: the structured engineering model	<code>appendices.md</code>

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PART I

Crompton 9W LED Bulb PRO: Teardown and Reverse Engineering Report

Source: report.md

Analysis	TD-2026-CRM-001, per Copperhead RFC 1 v1.5
Declared level	4, Engineering Analysis; completeness 0.70
Subject	Crompton "9W LED Bulb PRO, CDL", B22, date code 02/19, BIS R-76000108; one unit
Evidence	54 phone photographs (2026-10-04 and 05, one with a mm ruler), BPS datasheets and product decks, online research
Not used	continuity, any electrical measurement, thermal imaging, X-ray, CAD
Status	Draft, unreviewed
Machine-readable model	the YAML files beside this report (<code>teardown.yaml</code> is the entry point)

Evidence states. Every claim carries one of these labels, following RFC 1 §4.

Label	Meaning
OBSERVED	Read directly from a photograph.
DERIVED	Computed from observed values; the method is given.
INFERRED	Engineering judgement.
CONFLICTING	The evidence disagrees.
UNKNOWN	There is not enough evidence.

Nothing in this report is VERIFIED against the physical unit. Confidences run from 0 to 1.

1. Executive summary

What it is. A 2019 Crompton 9 W GLS lamp (B22 cap), printed with 220–240 V 50 Hz, 855 lm, PF > 0.90, BEE 3-star and IS 16102 (Part 1).

- **Driver board:** single-sided, in the neck, NBL-DR180425V0.1, 48×24 mm.
- **LED board:** square, NBL7W9S1P2835V1.0, carrying nine 2835 LEDs in series. It is screwed to an aluminium cup.

Core architecture: a single-stage, non-isolated, high-power-factor buck (INFERRED 0.80).

- The rectified bus has **no electrolytic capacitor**, only two 0.1 μF film capacitors in a π filter. The converter therefore runs straight off the rectified sine, and the controller shapes the input current for $\text{PF} > 0.9$.
- The only bulk capacitance, 68 μF 100 V, sits across the LEDs.
- The driver IC is, **by best guess, a Bright Power BP2336J APFC buck with an internal 500 V MOSFET** (INFERRED 0.75).
 - **For it:** the circuit (five features of its application circuit), line 3 of the marking ending in J (the BP233xJ format), and no surface-mount alternative in the BPS range.
 - **Against it:** line 1's fourth character reads 6 or 8 in the photos, where BP2336 has a 3. The chip has 7 leads where BP2336J's datasheet shows 8, which BPS J-suffix parts often do.
 - The parts that line 1 alone would allow don't fit the board. BP2836D is DIP-8 and BP2836DJ DIP-7, both through-hole. BP2636 is a boost stage, which can't drive an ~81 V string through a 100 V capacitor (section 5).
 - Two continuity checks would confirm it (section 22).

Operating point (all DERIVED; the first figure depends on the IC identification):

Quantity	Value	How it was derived
LED current	~100 mA	$0.200 \text{ V} \div 2.0 \Omega$ sense resistor
String voltage	~81 V	power balance
Power per LED	~0.9 W	8.1 W across nine LEDs
Power vs. LED-board label	~8.1 W into a board printed 7W	

The centre LED shows a **burn spot over a die**. A public repair video of a flickering Crompton lamp shows a second unit with the same LED board and the same burn mark on a different LED.

Largest risks:

Id	Severity	Finding
RISK-01	high	LEDs driven about 16% over their board's printed rating; burnt die observed on this unit and on a second unit online
RISK-02	medium	Open-LED overvoltage setpoint (~108 V) is above the output capacitor's 100 V rating (conditional on the FB-divider inference)
RISK-03	medium	Surge margin unverified: MOV clamp vs. 500 V MOSFET, with only 0.2 μF on the bus
RISK-04	medium	Estimated 17–25% flicker at 100 Hz (weak estimate)

Done well:

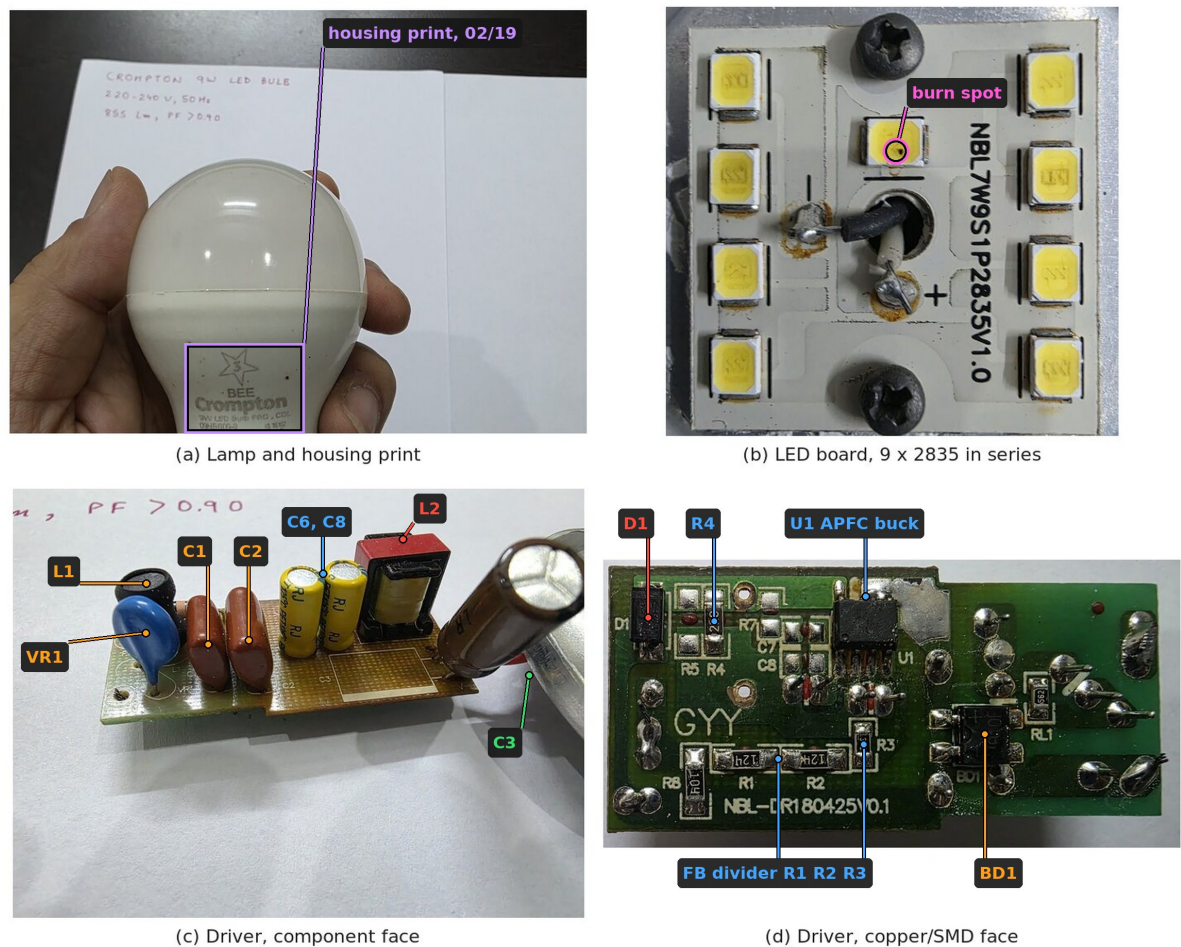
- About 20 parts in all.
- $\text{PF} > 0.9$ without a bus electrolytic.
- A sound Indian-market input stage: a 68 Ω fusible resistor, a 510 V MOV and a π filter.
- One wave-solder pass.
- Dual footprints for second-sourcing.
- Drain copper sized for heat, as the datasheet asks.

Completeness and next steps. Completeness is 0.70 against Level 4. Connectivity (0.40) is the weak category: every net is mapped from the reference design, none traced. Three things would move it most:

1. A raking-light macro of U1, to settle the third marking digit (UNK-002).

2. A 40-probe continuity pass (UNK-003).
3. A qualified operator’s powered measurement of LED current and voltage (UNK-004).

Overview: the lamp, its LED board and both faces of the driver



■ mechanical, identity
 ■ finding
 ■ input and protection
 ■ control, sense, feedback
 ■ power stage
 ■ output and LEDs

Each part is shown in detail with its role in \$3, \$5, \$9 and \$10.

Overview, labelled: (a) lamp and housing print, (b) LED board, (c) driver component face, (d) driver copper/SMD face

2. Product overview

Housing print (OBSERVED, fig 1, fig 2):

Field	Value
Brand	BEE 3-star mark, Crompton
Name	9W LED Bulb PRO, CDL
Model code	09NB?0?-9, best read 09NBS09-9 (INFERRED 0.50). Our photographs read 09N5609-2 and 09NB600-9; a sibling lamp online prints 09LBS09-9 in the same layout (UNK-008)
Ratings	220–240 V, 50 Hz; 855 lm; PF > 0.90

Field	Value
Standard	IS 16102 (Part-1)
Origin	Made in India
Date code	02/19
BIS registration	R-76000108

- **Efficacy** = $855 \text{ lm} \div 9 \text{ W} = \mathbf{95 \text{ lm/W}}$ (DERIVED). This sits in BEE's 2018 3-star band (90–105 lm/W), consistent with the printed 3 stars.
- **Context from online research** (vendor and third-party claims, not observed on this unit):
 - Crompton's current 9 W lines list 945 lm and 105 lm/W, and claim 4 kV surge protection. This 2019 "PRO" unit prints no surge claim.
 - No written teardown of any Crompton bulb exists online. A targeted search (board silkscreens, product name, candidate driver ICs; blogs, forums, Reddit, YouTube) found none, and no schematic.
 - Repair videos are the only third-party evidence. They were read from thumbnails, the first minute of one video at 720p, and 160×90 storyboard frames; YouTube refused full downloads.
 - * **Same LED board, same failure** (EVD-036): IE181, "Flickering Crompton LED bulb repair", shows NBL7W9S1P2835V1.0 with a burn spot over a die on the second LED of the right column.
 - * **Sibling lamp** (EVD-037): IE200 shows a Crompton 9W CDL lamp made for the government UJALA scheme. Its print reads 09LBS09-9, 900 lm, PF > 0.90, in the same layout and with the same marks as ours.
 - * **Drivers** (EVD-038): other Crompton 9 W drivers show the same part mix (red-cored inductor, blue MOV, orange film capacitors, green SMD face), but too coarsely to confirm the same board or IC. One video shows a different design entirely, so Crompton used more than one driver.
 - The OEM is unknown. "NBL" is printed on both boards and "GY" on the driver (UNK-013).

3. Physical construction

The parts, from outside in (OBSERVED):

1. Diffuser dome.
2. White plastic housing with a crimped B22 cap.
3. Pressed aluminium cup with two screw holes and a central wire hole.
4. LED board, held by two self-tapping screws over thermal grease.
5. Driver board in the neck, connected by flying leads to the cap and to the LED board.

The housing rim cracked when the lamp was opened. The EE inductor had been desoldered before the exploded-view photographs.

Board	Size (DERIVED)	Layers	Material	Finish	Identity
DRV	48.4 × 23.5 mm, narrowing to 20.2 mm for the last 19.2 mm (input end), stepped on both long edges (±2%)	1 (INFERRED 0.85)	CEM-1 class (INFERRED 0.55: woven texture on the component face)	green mask on the copper face only	NBL-DR180425V0.1, "GY"

Board	Size (DERIVED)	Layers	Material	Finish	Identity
LED	25.3 × 26.0 mm; two 2.6 mm screw holes, 4.3 mm wire hole (±2%)	1 (INFERRED 0.80)	aluminium MCPCB (INFERRED 0.70)	white mask	NBL7W9S1P2835V1.0

- **Scale.** Measured against a mm ruler photographed beside both boards.
 - The driver rests on its parts above the ruler, so its scale comes from U1's 1.27 mm lead pitch (31.2 px/mm). That is 4% above the ruler's own.
 - The LED board lies at ruler level. Its 2835 LEDs measure 2.9 × 3.6 mm against a nominal 2.8 × 3.5.
 - Earlier versions scaled from U1's body and came out 14% small: the span used was the 6.0 mm lead span, not the 4.90 mm body.
- **Driver assembly.** Through-hole parts sit on the bare-laminate face (side A). SMD parts sit on the copper face (side B), glued with red adhesive that also marks the empty footprints. This is a classic single-wave-pass, mixed-technology build (INFERRED 0.85).

4. System architecture

Domain	Present?
Power input, protection, power conversion	Yes
Sensing	Only inside the converter loop (current sense, output-voltage sense)
Processing, memory, communications, wireless, user interface, programming/debug, timing, test infrastructure	No; no programmable device was found

The full list of mandatory domains is in `architecture/architecture.yaml`.

5. Component overview

Ref	Marking (OBSERVED)	Identification	State	Conf.
U1	BP2 + 6/8 + 3 + 5/6, 1BD96CS, H1AM46J; SOP-8 body, 7 leads (none at position 7)	BP2336J APFC buck (best guess)	INFERRED	0.75
R4	2R0	2.0 Ω current-sense resistor	DERIVED / INFERRED	0.95 / 0.85
R1, R2	124, 124	120 kΩ + 120 kΩ in series, FB divider upper leg	INFERRED	0.75
R3	362	3.6 kΩ, FB divider lower leg	INFERRED	0.70
R8	104	100 kΩ output bleeder	INFERRED	0.55
RL1	562	5.6 kΩ damping resistor across L1	INFERRED	0.45
C6, C8	1 uF 50 V, 2.2 uF 50 V; brand partly legible ("..PAXCON..", probably Capxon)	VCC and COMP capacitors (which is which unknown)	INFERRED	0.75

Ref	Marking (OBSERVED)	Identification	State	Conf.
C3	68 μ F 100 V 105 degC, "LR"	Output capacitor, the only bulk storage	INFERRED	0.85
D1	ES1J	1 A 600 V superfast rectifier, freewheel diode	OBSERVED / INFERRED	0.95 / 0.80
L2	SM 19-like	EE-core buck inductor; value and pins unknown	INFERRED	0.85
BD1	MB10F, "+"	1000 V 0.8 A bridge	OBSERVED	0.85
FR1 (provisional ref)	blue, grey, black, gold, black bands; pink body	68 Ω $\pm$ 5% fusible flameproof resistor	DERIVED 0.70 / INFERRED 0.80	
VR1	07D511K, 18 10	7 mm, 510 V varistor	DERIVED	0.90
C1, C2	WEIDY 2S104J	0.1 μ F $\pm$ 5% film; voltage code "2S" unknown	DERIVED	0.85
L1	none	π -filter drum inductor	INFERRED	0.80
R5, R7, C7, C8 (SMD)	empty pads	Not fitted: sense-resistor trim and SMD alternates	INFERRED	0.50–0.70
LED1–9	none legible	2835 white, about 3 dies each, ~9 V class	INFERRED	0.70

Unlabelled close-ups: U1, C3, C6/C8, VR1, FR1, C2.

What U1 is. Best guess: BP2336J. Line 1 of the marking does not fully agree.

The marking (four photo sets and four reads by eye) reads "BP2", then a 6 or 8, a 3, and a 5 or 6. The 7 + 7 character lines 2–3 don't help: BP2336J, BP2636B and BP2866A all print that form. An earlier revision of this report counted it as proof of BP2336J, and that claim is withdrawn.

Board feature	BP2836D	BP2636	BP233x (BP2336J)
4th marking character (6 or 8 in every shot)	✓ 8	✓ 6	× 3
SOP-8 body with 7 leads, none at position 7	× DIP-8 only	× pins 5–8 all DRAIN; this board's pin 8 is on its own pad	~ datasheet shows 8 leads
Two 50 V capacitors at pins 1–4	× needs one	–	✓ COMP and VCC
240 k Ω / 3.6 k Ω resistor chain	× as its OVP resistor, a trip point $\geq$ 333 V	–	✓ feedback divider, OVP 108 V
No bulk capacitor, PF > 0.90 printed	× no PFC (~0.72)	✓	✓ active PFC
Line 3 ends in J (read H1AM46J)	× ends in a date digit	× ends in B/C/D	✓ the BP233xJ format
100 V output capacitor, ~81 V string	✓	× a boost stage outputs above the 325 V peak	✓

How the record handles it.

- U1 is recorded as BP2336J at 0.75, a best guess made on the owner's instruction to proceed without more bench data (v3.3). BP2336J's datasheet supplies the pinout, and BP2335J's (the same family) supplies the equations.
- The remaining 0.25 is split between BP2338J and BP2335J (pin-compatible, 0.05 each), BP28xx/BP26xx (0.03) and an unidentified part (0.12).
- **Two continuity checks would confirm it:** whether the yellow capacitors land on U1 pins 1 and 3, and whether pin 4 meets the R3/R2 junction. Those are checks 1 and 5 in probe-guide.

Exploded view, from outside in

Exploded view, labelled in the order of the list below

```

B22 cap (L, N)
|
FR1 68 Ω fusible resistor (in L)
|
VR1 MOV 07D511K across L-N
|
BD1 MB10F bridge → rectified bus, 0..340 V, NO bulk capacitor
|
π filter: C1 0.1 μF – L1 (RL1 5.6 kΩ across, INFERRED) – C2 0.1 μF
|
U1 BP2336J APFC floating buck (best guess), critical conduction
    L2 EE inductor · D1 freewheel · R4 2.0 Ω sense
    C6/C8 VCC + COMP · R1+R2 / R3 FB divider (OVP ≈ 108 V, conditional)
|
C3 68 μF 100 V || R8 100 kΩ bleeder
|
LED board: 9 × 2835 in series (9S1P), ≈ 81 V at ≈ 100 mA

Non-isolated: every node, including the LED board, sits at mains potential.

```

- Everything below that uses a BP233x equation (LED current, OVP setpoint) inherits the 0.75.

6. Power architecture

Rail	Nominal	Source	State
AC in	230 V, ~44 mA rms ($9\text{ W} \div (230\text{ V} \times 0.9)$)	B22 cap	DERIVED 0.60
Rectified bus	0–325 V peak (339 V at 240 V), unsmoothed	BD1	INFERRED 0.80
LED	~81 V (76–90 V) at ~100 mA (92–108 mA)	U1 buck	DERIVED 0.70 / 0.75
VCC	7.4–12 V, referenced to U1's floating ground	U1 internal	INFERRED 0.50

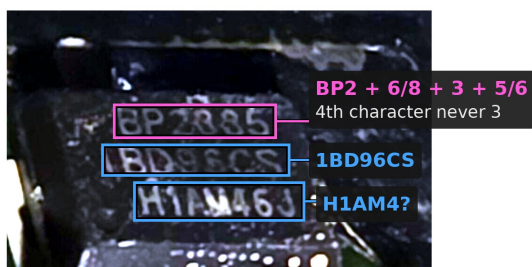
These are the key calculations. All 11, with assumptions, are in `architecture/power-tree.yaml`.

- **LED current.** $I = V_{\text{REF}} \div R_{\text{cs}} = 0.200\text{ V} \div 2.0\ \Omega = \mathbf{100\text{ mA}}$. The 92–108 mA range comes from V_{REF} of 0.194–0.206 V and a $\pm 5\%$ resistor. A three-digit 2R0 code is the 5% convention.
- **String voltage.** $V = (9\text{ W} \times 0.90) \div 0.100\text{ A} = \mathbf{81\text{ V}}$, about 9 V per LED. This is consistent with three dies per 2835 package, and with the designer choosing a 100 V output capacitor.
- **Why a buck reaches PF > 0.9 here.** It only draws power while $|v_{\text{in}}| > V_{\text{out}}$. At 81 V against a 325 V peak, the dead zone is $\text{asin}(81/325) = \mathbf{14.4^\circ}$ at each zero crossing. A 150 V string would not allow this.
- **Loss budget.** FR1 0.13 W, bridge 0.05 W, U1 0.10–0.25 W, D1 0.10 W, L2 0.10–0.20 W, sense resistor 0.04 W, bleeders $\leq 0.17\text{ W}$. Efficiency comes out at 0.90–0.93, consistent with the 0.90 assumed above.

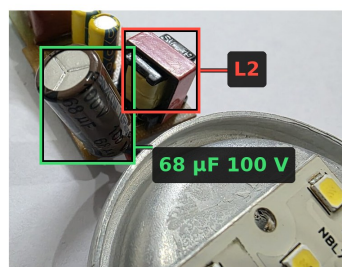
7. Compute architecture

None. There is no MCU, memory, clock or programming access, and so no firmware (RFC 1 §16 is not applicable).

Marking close-ups, read and decoded



U1: line 1 CONFLICTS with the circuit
BP233x-class by circuit, 0.55; continuity decides (UNK-002)



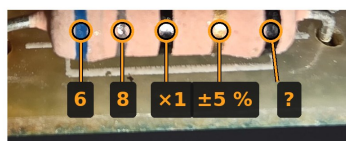
C3: 68 μ F 100 V 105 °C, "LR"
output capacitor, the only bulk storage



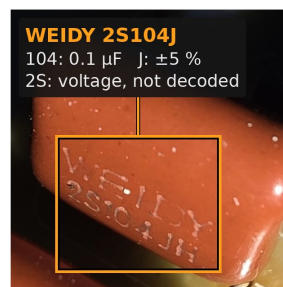
C6, C8: 1 μ F and 2.2 μ F, 50 V
VCC and COMP capacitors; which is which unknown



VR1: 07D511K varistor
7 mm, 510 V, across L-N (DERIVED 0.90)



FR1: blue, grey, black, gold, black
68 Ω ± 5 % fusible; 5th band not decoded



C2 (C1 alike): WEIDY 2S104J
0.1 μ F ± 5 % film (DERIVED 0.85)

Readings OBSERVED; values DERIVED from the standard codes. The U1 crop is brightened; the evidence crops in evidence/figures/ are unaltered.

Marking close-ups, each read and decoded

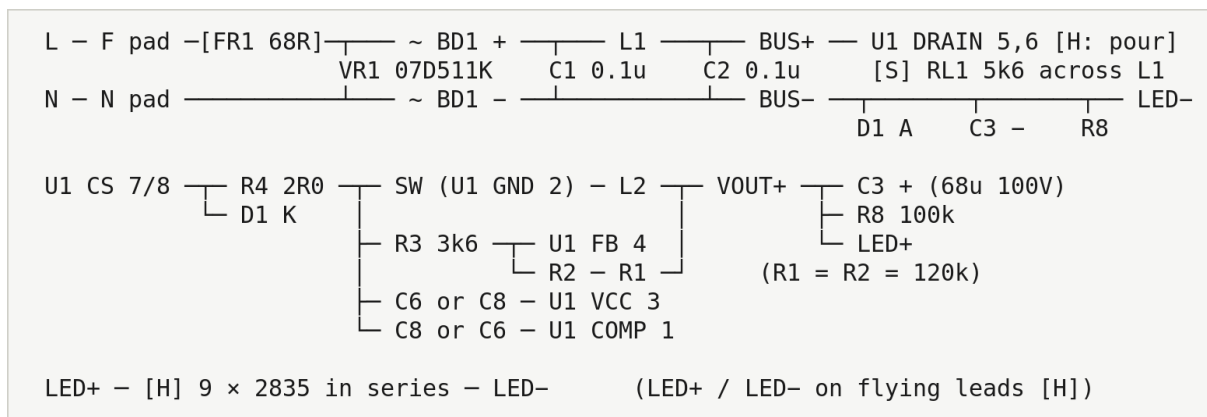
8. Interfaces

Id	Interface	Pins	Protection	State
IF-MAINS-01	B22 cap to driver pads "F" and "N"	L, N	FR1, VR1; π filter	INFERRED 0.80
IF-LED-01	Driver "V+/"V-" to LED board "+"/"-", soldered flying leads (red, black)	LED+, LED-	U1 OVP (inferred), R8	INFERRED 0.80

9. Circuit analysis

Reconstructed schematic. The text below is mapped from the reference design. Net states:

- [H]: HIGH_CONFIDENCE, seen directly.
- Unmarked: LIKELY, mapped from the BP233xJ family application.
- [S]: SPECULATIVE.



D1, C3 and R8 are drawn at both ends: once where each connects to the control side, once on BUS-.

APFC buck, CKT-PWR-001. U1's ground floats on the switch node, so the sense resistor sees the inductor current in both phases. The datasheet credits this for precise current regulation.

- Open-LED overvoltage.** $V_{OVP} = 1.6 \text{ V} \times (240 \text{ k} + 3.6 \text{ k}) \div 3.6 \text{ k} = \mathbf{108 \text{ V}}$ (DERIVED 0.45). In normal operation FB sits at 1.20 V, 25% below the trip point. At 108 V, though, the trip is **8% above C3's 100 V rating**.
- FB resistor stress.** R1+R2 carry about 244 V during the on-time. That exceeds one 1206 resistor's 200 V working rating, which explains why the upper leg is two resistors.

Deviations from the reference application:

Id	Deviation
DEV-001	A fusible resistor replaces the fuse.
DEV-002	A MOV is added.
DEV-003	A π filter replaces the single bus capacitor.
DEV-004	Trim and alternate footprints and the bleeder are added.

Id	Deviation
DEV-005	The FB upper leg is split into two resistors.

Input stage, CKT-PROT-001. FR1 dissipates about 0.13 W and also limits surge current into VR1. As an illustration, a 1 kV combination wave with a $2\ \Omega$ source impedance gives at most about 14 A before the MOV conducts.

LED string, CKT-LED-001. Nine LEDs at ~ 0.9 W each, about 8.1 W in total, on a board printed 7W. At the LED level the rated figures give $855\text{ lm} \div 8.1\text{ W} = 106\text{ lm/W}$, plausible for 2019 mid-power 2835 parts at 6500 K.

10. PCB placement and routing

Placement (INFERRED; coordinates in `pcb/placement-analysis.yaml`):

- The input stage occupies the narrow end and the converter the wide end, a clean separation.
- C6/C8 leads land right beside U1's pin-1–4 side (good).
- R4 sits 5–6 mm from D1 (acceptable).
- The FB divider's R3 is about 9 mm from the FB pin (acceptable).
- U1's drain pins sit on a large pour (good). In the floating-ground topology the drain is the bus, which moves only at 100 Hz, so the pour spreads heat without adding a switching antenna.

Routing: UNKNOWN. The copper is under an opaque green mask. Contrast stretching, colour-channel separation and raking light did not resolve the traces.

11. Grounding and signal integrity

- **Grounding.** There are no planes. The ground net is BUS—, which is also the LED cathode. U1 references its floating ground (SW), and the VCC capacitor, COMP capacitor and lower FB resistor return to SW, as the datasheet requires. Nothing is earthed.
- **Signal integrity.** Not applicable: there are no data signals.

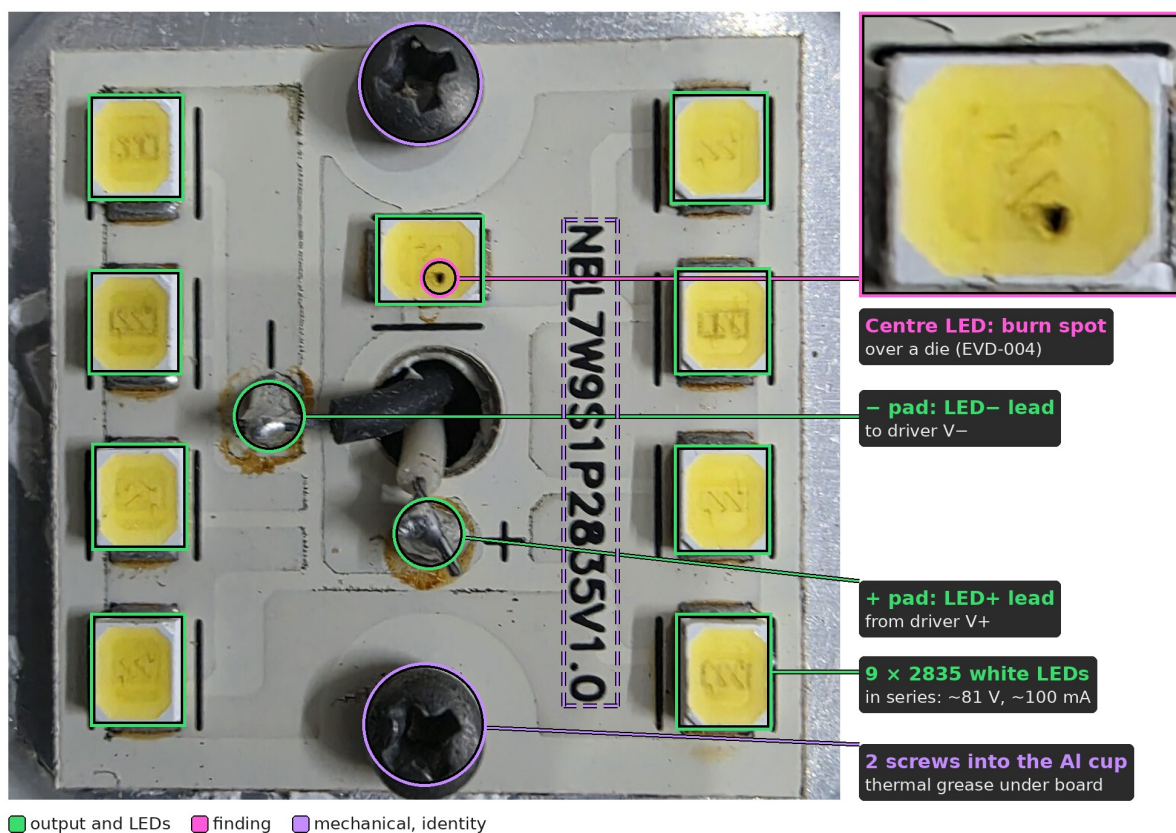
12. Thermal architecture

Estimated heat (DERIVED):

Source	Heat	Path
LED board	$\sim 5.7\text{ W}$ ($8.1\text{ W electrical} \times \sim 0.70\text{ non-radiant}$)	grease $\rightarrow$ aluminium cup $\rightarrow$ plastic housing
U1	0.10–0.25 W	drain pour; $\theta_{JA}\ 145\text{ }^{\circ}\text{C/W}$ gives a 15–36 $^{\circ}\text{C}$ rise over neck air, so it stays under the 140 $^{\circ}\text{C}$ thermal-regulation point if the neck stays below $\sim 100\text{ }^{\circ}\text{C}$
L2, FR1, D1	$\sim 0.1\text{ W}$ each	

Assessment.

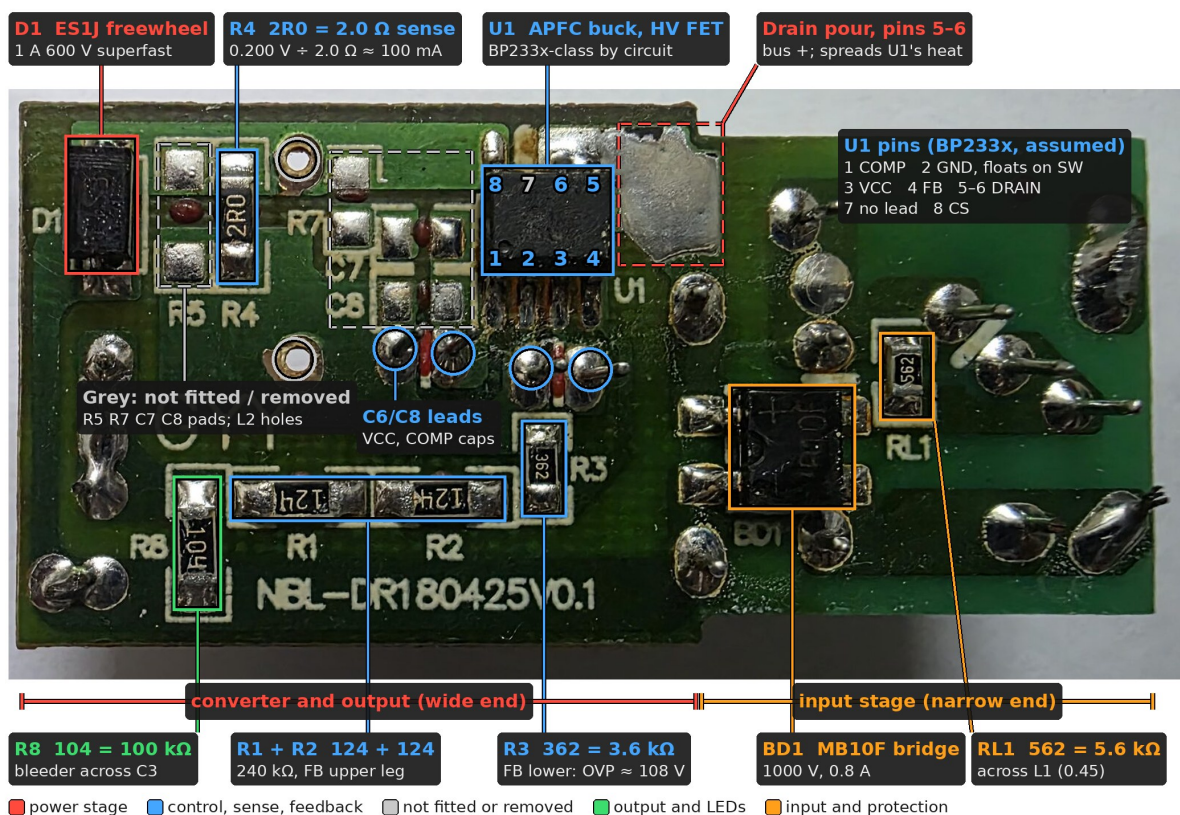
- The LEDs are **marginal**: about 0.9 W per 2835 package on a board printed 7W, with a burnt die visible.
- C3, a 105 $^{\circ}\text{C}$ electrolytic in the sealed neck, is **marginal**.
- U1 is **acceptable**.

LED board: 9 × 2835 in series, burnt centre LED

Dashed: silkscreen NBL7W9S1P2835V1.0, read as a 7 W board, 9 LEDs in series × 1 string, 2835 package. This lamp drives it at ~8.1 W, ~0.9 W per LED (DERIVED; RISK-01). A repair video shows the same board with the same burn on a different LED (EVD-036). The order of the LEDs along the string is not traced (UNK-003).

LED board, labelled, with the centre LED's burn spot enlarged

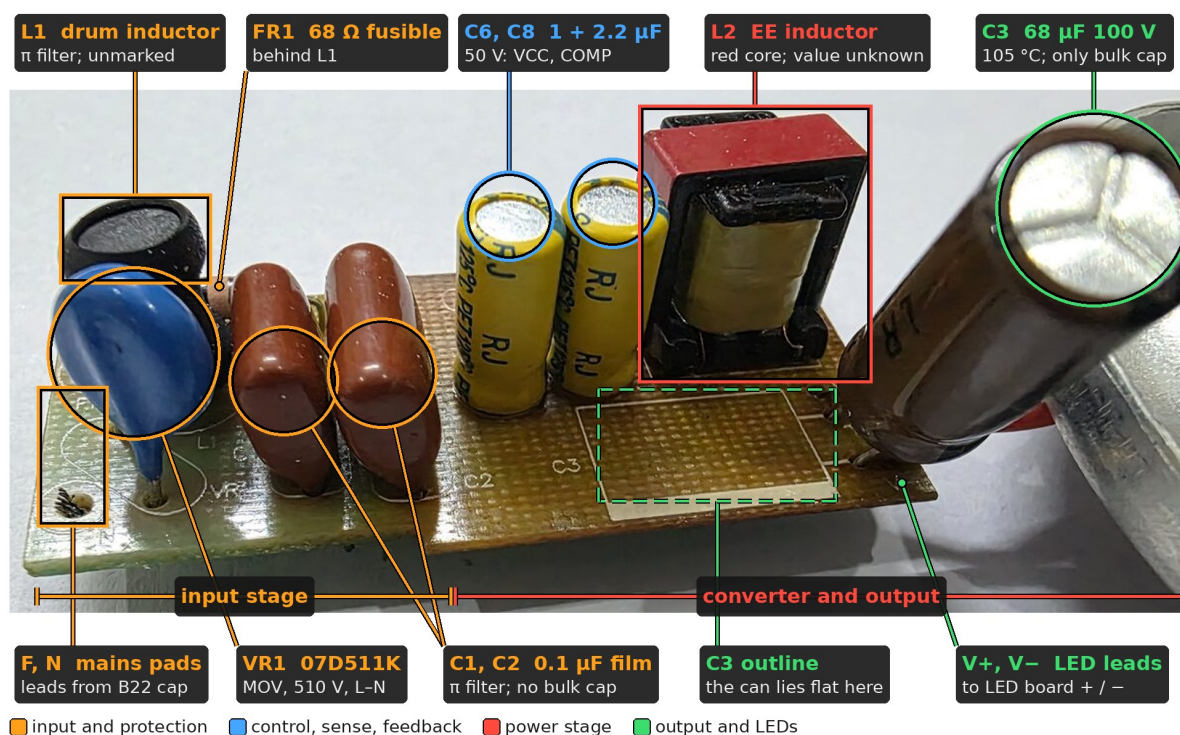
Driver, side B (copper/SMD face): parts and their roles



Markings OBSERVED; values DERIVED from them; roles INFERRED from the BP233x application circuit (§5, §9). U1 is BP233x-class by its circuit (INFERRED 0.55); its marking conflicts (UNK-002), and the pin map, 100 mA and OVP use that family's datasheet. RL1's role 0.45; OVP setpoint 0.45 (RISK-02). The two holes are the removed L2's footprint (UNK-019). No trace was followed: the mask is opaque (§10).

Driver, copper/SMD face: each part labelled with its role, and U1's assumed pin map

Driver, side A (component face): parts and their roles



Through-hole parts sit on bare laminate (woven texture: CEM-1 class, INFERRED 0.55). Identities from the close-up markings (§5); C1/C2 order from the silkscreen. Which yellow capacitor is C6 and which C8 is unknown. L2 was desoldered after this photograph.

Driver, component face: each part labelled with its role

No temperature was measured (UNK-015).

13. Protection architecture

Threat	Protection	Assessment
Overcurrent / short	FR1 68 Ω fusible	acceptable
Surge L–N	VR1 07D511K, FR1, π filter	unknown (RISK-03)
Line overvoltage	MOSFET 500 V vs 339 V peak	acceptable
Undervoltage	U1 UVLO (datasheet)	good*
LED open	U1 FB OVP $\approx$ 108 V	marginal* (RISK-02)
LED short, CS open	U1 (datasheet)	good*
Driver over-temperature	U1 thermal regulation, 140 °C	acceptable*
LED over-temperature	none	poor
ESD / EFT	IC 2 kV HBM / π filter	acceptable / unknown
Inductive kick	D1	good

* These rows rest on the BP233xJ family datasheets.

14. Mechanical integration

- The driver hangs on its wires in the neck; there are no mounting holes. C3 is laid flat over its silkscreen outline (INFERRED 0.8).
- The aluminium cup is enclosed by the dome and housing and is not user-accessible. It is live when the lamp is powered (non-isolated).
- The lamp is not serviceable without damage. The LED board is the swappable part: two screws and two wires, which is what repair videos replace.

15. Manufacturing analysis

The driver is a single-sided CEM-1-class board with THT parts on side A and glued SMD parts on side B, soldered in one wave pass. The LED board is reflowed SMT on MCPCB. Neither board has fiducials, test pads or fine pitch; the finest is U1's 1.27 mm SOP.

DFM choices observed:

- **Cost reduction:** no bus electrolytic, no X or Y capacitor, a fusible resistor instead of fuse plus NTC, and a 7W LED board reused.
- **Assembly:** a single wave pass.
- **Sourcing:** dual THT/SMD capacitor footprints and an R5 trim position.

16. BOM and sourcing

The BOM has about 20 driver parts plus nine LEDs (components/). BOM risk:

- **HIGH** for U1: single-source BPS and identity unresolved.
- **MEDIUM** for L2 (a custom wound part), C3 (unknown "LR" brand, voltage margin) and the LEDs (unknown maker).

- **LOW** elsewhere.

Cost was not estimated. No pricing source was consulted, and an unsourced number would read as fact. This is a recorded deviation (RFC 1 §17.3 is a SHOULD).

17. Test and debug strategy

There are no test pads, programming access or measurement points, The two empty holes on the copper side are the removed inductor L2's footprint, not test points. Production test is presumably an end-of-line light-up of the finished lamp, plus the BIS and BEE type tests (INFERRED 0.5).

18. Design philosophy

The design is **cost-optimized and manufacturing-optimized** (INFERRED 0.75). The evidence:

- one copper layer, about 20 parts, no bus electrolytic, no X or Y capacitors;
- a single wave pass;
- dual footprints;
- an LED board reused from a 7 W design.

It is **compliance-aware rather than reliability-first**:

- PF > 0.9 is met (the IS 16102-2 requirement), and so is the BEE 3-star efficacy band.
- The LEDs run hot relative to their board's own label.
- The output capacitor's margin depends on the OVP setpoint.

19. Risks and weaknesses

Id	Sev.	Conf.	Risk	Recommendation
RISK-01	high	0.65	LEDs ~16% over the board's printed rating; burnt die here and on a second unit online	Lower I_LED or use a board rated for the power
RISK-02	medium	0.45	OVP $\approx$ 108 V above C3's 100 V	C3 at 160 V
RISK-03	medium	0.50	Surge: MOV clamp vs 500 V MOSFET, 0.2 μ F bus	IEC 61000-4-5 test
RISK-04	medium	0.35	Flicker $\approx$ 17–25% at 100 Hz	Flicker-meter check; larger C3
RISK-05	low	0.50	C3 is the life-limiting part in a hot neck	Long-life series
RISK-06	info	0.85	Non-isolated: LED board and cup at mains potential	Process note for any powered work
RISK-07	medium	0.70	U1 not identified; every figure that uses its equations rests on the circuit	UNK-002

20. What Copperhead would change

Change	Current	Proposed	Benefit	Downside	Conf.	Validate by
Output capacitor margin	68 μ F 100 V	68 μ F 160 V, long-life	Open-LED events no longer overstress C3	Larger can, small cost	0.45	Open-LED test, scope V _{out}
LED operating point	~100 mA into nine LEDs on a 7W board	10–12 LEDs, or R _{cs} 2.4 Ω (~83 mA)	Lower junction temperature, longer life	More LEDs, or ~15% fewer lumens	0.55	Solder-point temperature measurement; LM-80 data for the chosen LED
Flicker	68 μ F output only	Larger C3, or a ripple-cancelling linear stage	Less 100 Hz modulation	Size, cost, some efficiency	0.35	Flicker meter
Surge	07D511K, rating not stated	Test first; if needed a 471K MOV or a bus TVS	Protects the 500 V MOSFET	Cost; MOV continuous-voltage margin	0.40	IEC 61000-4-5 at 1 and 2.5 kV

21. Reusable engineering learnings

All learnings enter Cortex as CANDIDATE. Detail is in `learnings/`.

Learnings:

Id	Learning
LRN-001	A single-stage APFC buck with a string at about a quarter of the line peak reaches PF > 0.9 with no bus electrolytic. The cost is 100 Hz ripple, which lands on the output capacitor.
LRN-002	Dual footprints and trim positions let one board cover several variants.
LRN-003	The Indian-market lamp input stage: fusible resistor, MOV, bridge, π filter.
LRN-004	An LED board's label is not its operating point.
LRN-005	Split the FB upper leg on floating-ground bucks.
LRN-006	Marking reads disagree, by camera and by eye alike. Accept a read only when the board agrees with it: here the package, marking format, support parts and divider values identified the IC.

Check-rule candidates:

Id	Check
RULE-CAND-001	Output capacitor voltage rating $\geq 1.1 \times$ OVP setpoint.
RULE-CAND-002	Power per LED package against its rating.
RULE-CAND-003	Flicker estimate for designs without bulk capacitance.
RULE-CAND-004	Working voltage per resistor in HV divider chains.
RULE-CAND-005	MOV clamp voltage against MOSFET BVDSS.

22. Unknowns

Of 19 unknowns, 15 are open. Four are resolved: UNK-001 (photographs), UNK-010 (D1 is ES1J), UNK-014 (dimensions, measured against a ruler) and UNK-019 (the two holes are L2's footprint). The full register, with methods, is in `teardown.yaml`. The ones that matter:

Id	Question	How to resolve
UNK-002	U1 identity (best guess BP2336J, 0.75; line 1 partly legible)	Continuity: yellow caps to U1 pins 1 and 3; pin 4 to the R3/R2 junction
UNK-003	Are the 16 reconstructed nets real?	Unpowered continuity pass after discharging the capacitors (~40 probe pairs)
UNK-004 / 012	LED current and voltage; PF, THD, efficiency, flicker	Powered measurement by a qualified operator with an isolation transformer
UNK-005	State of the burnt LED	Current-limited supply across that LED alone
UNK-011	Copper pattern	Transmitted-light photo through the driver board
UNK-015	Temperatures in operation	Thermocouples on the LED solder point and in the neck, qualified operator

The continuity checks for UNK-002 and UNK-003 are marked on this unit's photographs in probe-guide/, with a results sheet in its README. Most of them are on the copper side:



Unplug. Short the big brown capacitor (C3) legs through a 1 k resistor for 5 s. Meter on beep / ohms. Report each pair: beeps or not.

- [1] U1 pin 4 -> R3 top, R3 bottom, R2 right
- [2] R1 left, R1 right -> C3 leg A, C3 leg B (see component-side map); R1 right -> R2 left
- [3] U1 pin 8 -> R4 top, R4 bottom; R4 top / bottom -> D1 top / bottom
- [4] U1 pin 2 -> R4 top, R4 bottom; U1 pin 2 -> L2 hole a, L2 hole b
- [5] U1 pin 1 -> A1, A2, B1, B2; U1 pin 3 -> A1, A2, B1, B2 (A, B = legs of the two yellow capacitors)
- [6] U1 pin 5/6 copper -> BD1 + pin (expect a few ohms: it runs through the black drum inductor)
- [7] RL1 top, RL1 bottom -> BD1 + pin and -> pin 5/6 copper; R8 top, R8 bottom -> C3 leg A, C3 leg B

Probe map, driver copper side: each probe point colour-coded by check, with the check list

23. Completeness and confidence

Completeness against Level 4 is **0.70**:

Category	Score
Product	0.92
Components	0.85
Connectivity	0.40
Architecture	0.85
Power	0.80
Circuits	0.65
PCB	0.45
Protection	0.72
Manufacturing	0.60
Evidence	0.85
Unknowns	1.00

Self-assessed quality is **0.81**:

Dimension	Score
Evidence integrity	0.85
Traceability	0.85
Engineering depth	0.70
Uncertainty handling	0.85
Claim correctness	unscored; there is no ground truth

Nothing is VERIFIED; Level 5 is not claimed.

24. Sources and evidence

- **Photographs:** 54, each SHA-256 hashed in `input/manifest.yaml`.
 - They are referenced in place in `../../../../Crompton 9W LED Bulb/` rather than copied.
 - Their EXIF GPS tags are present but all zero, so no location is embedded.
 - The figures in `evidence/figures/` are EXIF-stripped crops, kept unlabelled as evidence.
 - The labelled figures in this report are drawn on those crops by `annotated/make-annotated.py`. Each label's evidence state is on the label or in the figure's footnote.
- **Evidence records:** 51, in `evidence/evidence.yaml`.
- **Sources:** 27 in `evidence/sources.yaml`. The principal ones:
 - BPS BP2336J datasheet Rev 2.2 (SRC-024), the BP2335J and BP2338J family datasheets (SRC-001, SRC-021) and the rejected BP2636B (SRC-027); all in `research/datasheets/`
 - BPS BP2866A datasheet Rev 1.0 (SRC-002)
 - BPS product overview, 2019-01-07 (SRC-003)
 - IS 16102 parts 1 and 2 (SRC-010, SRC-011)
 - BEE Schedule 20 (SRC-012)
 - Crompton product pages (SRC-007) and repair videos (SRC-009, SRC-017 to SRC-019); the videos corroborate the LED board, the sibling model and the burnt-LED failure, nothing else
- **Deviations from RFC 1:**

- The record lives in research/teardown/, not .copperhead/teardown/ (engagement rule).
- The photographs are not copied into the record.
- No .kicad_sch: it would imply certainty the connectivity does not have.
- No BOM cost estimate.
- **Legal and safety (RFC 1 §30).** How the unit was acquired is unrecorded (UNK-016). The BPS datasheets are referenced, not redistributed. This reconstruction is not to be presented as a Copperhead design. Every powered step listed is for a qualified operator.

PART II

Appendices: the structured engineering model

Source: appendices.md

These appendices are generated from the machine-readable model beside `report.md` (analysis TD-2026-CRM-001, source revision `sha256:0c05c311836db65a...`, the SHA-256 of `input/manifest.yaml`). Nothing here is new analysis: each table is one YAML file, rendered. Evidence states and confidences carry the meanings given at the head of the report.

A. Component inventory

Source: `components/components.yaml`. References are board-scoped (DRV = driver, LED = LED board). "provisional" designators were assigned here because the silkscreen is hidden or absent.

Ref	Marking / value	Package	Function	State	Evidence
DRV.U1	BP2??(5 6) / 1BD96CS / H1AM4?	SOP-8 body with 7 leads - position 7 has a pad but no lead (EVD-049); pins 5-6 on a large copper pour; pin 8 on its own pad	From the board, not the marking: a high-PF non-isolated buck controller with an internal HV MOSFET (BP233x-class APFC floating buck). The marking's 4th character (6/8) points to BPS's BP26xx (boost PFC) or BP28xx (low-PF buck) families instead; that conflict is unresolved.	INFERRED 0.75	EVD-007, EVD-008, EVD-009, EVD-031, EVD-039, EVD-045, EVD-049
DRV.R4	2R0 → 2 Ohm (DERIVED 0.95; EIA 3-digit R-notation)	1206	current-sense resistor R_{cs} between CS and the IC's floating ground; $I_{LED} = V_{REF} / R_{cs} = 0.200 / 2.0 = 100$ mA (SRC-001)	INFERRED 0.85	EVD-010
DRV.R5	not fitted		parallel trim position for R_{cs} (DNP)	INFERRED 0.7	EVD-010
DRV.R1	124 → 120 kOhm (DERIVED 0.95)	1206	upper FB divider resistor (RFBH, with R2 in series)	INFERRED 0.75	EVD-010

Ref	Marking / value	Package	Function	State	Evidence
DRV.R2	124 → 120 kOhm (DERIVED 0.95)	1206	upper FB divider resistor, series with R1, into U1 FB (pin 4)	INFERRED 0.75	EVD-010
DRV.R3	362 → 3.6 kOhm (DERIVED 0.95)	1206	lower FB divider resistor (RFBL), FB to the IC's floating ground	INFERRED 0.7	EVD-010
DRV.R8	104 → 100 kOhm (DERIVED 0.95)	1206	output bleeder across the LED string (discharges C3, prevents ghost glow)	INFERRED 0.55	EVD-010
DRV.RL1	562 → 5.6 kOhm (DERIVED 0.95)	1206	damping resistor across the pi-filter inductor L1	INFERRED 0.45	EVD-011
DRV.R7	not fitted		unknown (DNP)	UNKNOWN	EVD-010
DRV.C7	not fitted		SMD alternate footprint, probably for the VCC or COMP capacitor (DNP)	INFERRED 0.5	EVD-010
DRV.C8(SMD)	not fitted		SMD alternate footprint of C8; the THT C8 is fitted on the other face (EVD-015)	INFERRED 0.7	EVD-010, EVD-015
DRV.C6	one of "1 uF 50 V" and "2.2 uF 50 V"; which of the two is C6 is not resolved → candidates: 1 uF 50 V; 2.2 uF 50 V; status: OBSERVED; confidence: 0.85	radial electrolytic, approx 5 mm diameter	VCC bypass (pin 3) or COMP loop (pin 1) capacitor of U1; which is which is not resolved	INFERRED 0.75	EVD-014, EVD-015
DRV.C8	the other of "1 uF 50 V" and "2.2 uF 50 V"	radial electrolytic, approx 5 mm diameter	the other of the VCC and COMP capacitors (see DRV.C6)	INFERRED 0.75	EVD-014, EVD-015
DRV.D1	"ES1J"	SMA (DO-214AC), cathode band toward the board's top edge	buck freewheel diode, anode at bus return, cathode at the CS node, so R4 sees the inductor current in both phases (BP233xJ floating-ground buck)	INFERRED 0.8	EVD-010, EVD-050

Ref	Marking / value	Package	Function	State	Evidence
DRV.L2 (provisional)	"SM 19"-like print on one bobbin flange (low legibility) → 2.2 mH (INFERRED 0.4; best guess (A1): typical BP233x 9 W value; saturation must exceed U1's 0.75 A cycle limit (1.5 V / 2.0 ohm))	EE-class wound component, red-finished core, black bobbin, yellow tape; THT	buck power inductor from the IC's floating ground (switch node) to LED +	INFERRED 0.85	EVD-020, EVD-022
DRV.C3	"68 uF 100 V 105 C", series print "LR" → 68 uF (OBSERVED 0.9)	radial electrolytic, laid flat over the C3 outline when assembled (INFERRED 0.8)	output capacitor across the LED string (LED + to bus return); the only bulk capacitance in the driver - the bus has none, as single-stage PFC requires	INFERRED 0.85	EVD-012, EVD-013, EVD-021
DRV.BD1	"MB10F" with "+" mark	MBF (SOP-4 bridge)	mains bridge rectifier	INFERRED 0.85	EVD-011, EVD-051
DRV.FR1 (provisional)	colour bands blue, grey, black, gold, black (from the lead end) → 68 Ohm (tol 5%; DERIVED 0.7; colour code 6-8-x1-gold; the fifth (black) band is not decoded)	axial, pink flameproof coating, approx 1/2-1 W body	fusible input resistor (fuse + inrush/surge limiting)	INFERRED 0.8	EVD-018, EVD-017
DRV.VR1	"07D511K", certification marks, date "18 10" → varistor_voltage: 510 V; disc: 7 mm; tolerance: 10%; status: DERIVED; confidence: 0.9		line-to-line surge clamp	INFERRED 0.8	EVD-016
DRV.C1 (provisional)	assumed same as C2 (not read)	dipped metallized-film box	pi-filter / DC-bus capacitor (after the bridge)	INFERRED 0.75	EVD-020
DRV.C2	"WEIDY 2S104J" (a further character, H or similar, after J) → 100 nF (tol 5%; DERIVED 0.85; EIA 104 = 10×10^{-4} pF, J = 5%)	dipped metallized-film box	pi-filter / DC-bus capacitor	INFERRED 0.8	EVD-019
DRV.L1	none visible → status: UNKNOWN	radial drum (I-core) inductor, black sleeve	pi-filter EMI inductor between C1 and C2	INFERRED 0.8	EVD-017, EVD-020
DRV.J_IN			two solder pads for the flying leads from the B22 cap (line via "F", neutral "N")	OBSERVED 0.9	EVD-017
DRV.J_OUT			two pads for the LED-board leads	OBSERVED 0.75	EVD-013

Ref	Marking / value	Package	Function	State	Evidence
LED.LED1-LED9 (provisional)		2835 (2.8 x 3.5 mm) white SMD LED	silkscreen "9S1P" = 9 series, 1 parallel (OBSERVED marking, meaning INFERRED 0.85); voltage class 9 V	INFERRED 0.7	EVD-003, EVD-004, EVD-005
LED.PCB	"NBL7W9S1P2835V1.0", polarity "+" and "-"		LED carrier; see ../product/boards.yaml	OBSERVED 0.95	EVD-003

DRV.U1 candidates (mutually exclusive, confidences sum to ≤ 1.00):

Candidate	Conf.	For	Against
BPS BP2336J (incl. a 7-lead J/JS variant)	0.75		
BPS BP2338J	0.05		
BPS BP2335J	0.05		
BPS BP28xx / BP26xx	0.03		
unidentified part	0.12		

DRV.U1 identification reasoning:

- line 3 ends in J (2026-10-04 read H1AM46J, 0.85): the BP233xJ / BP2336J format; BP2636 ends in its variant letter B/C/D, BP2836D in a date digit - the last character discriminates where the 7 + 7 form does not
- BPS J-suffix parts often drop the lead between drain and CS for creepage (BP2866XJ SOP7, BP2836DJ DIP7): consistent with the 7-lead body (INFERRED 0.5)
- BP2836DJ is DIP7 through-hole: no surface-mount low-PF BP28xx with VCC/ROVP pins is known, so the BP28xx alternative loses its package
- circuit, for BP233x: two 50 V electrolytics at the pin-1..4 side (COMP + VCC), a 240 k / 3.6 k divider (FB, OVP 108 V just above the string), no bus electrolytic with PF > 0.90 printed, 2.0 ohm sense giving 100 mA
- marking, against BP233x: the 4th character reads 6 or 8 in every photograph and macro, not 3; and the part has 7 leads, BP2336J's datasheet shows 8
- BP26xx (e.g. BP2636B) ruled out: a boost PFC stage cannot drive an ~81 V string through a 100 V output capacitor, and its pins 5-8 are all DRAIN while this board's pin 8 is on its own pad (SRC-027)
- BP2836D ruled out: DIP-8 only
- the deciding test is continuity, not reading: do the yellow capacitors land on pins 1 and 3 (BP233x COMP and VCC), and does pin 4 join R3 and R2 (FB)? (probe guide checks 1 and 5)

A.1 Unidentified and partly identified parts

Ref	Marking	Likely function	Status	Resolve
DRV.U1	BP2 + 6/8 + 3 + 5/6, 1BD96CS, H1AM46J	high-PF buck controller	INFERRED 0.75 as BP2336J (best guess); line 1 of the marking stays CONFLICTING	UNK-002
DRV.L2	"SM 19"-like, low legibility	buck inductor	UNKNOWN (value and pin count)	UNK-006
DRV.L1	none visible	pi-filter inductor	UNKNOWN (value)	UNK-006
DRV.C1 / DRV.C2	WEIDY 2S104J (C2)	bus pi-filter capacitors, 0.1 uF	UNKNOWN (voltage rating)	UNK-007
LED.LED1- LED9	none legible	white LED, ~9 V class	UNKNOWN (maker, part, bin)	UNK-004
DRV.R7			UNKNOWN (DNP footprint, net unknown)	

A.2 Critical components and BOM risk

Ref	Why critical	BOM risk	Reason
DRV.U1	sets topology, PF, LED current, protections; holds the HV MOSFET	HIGH	identity a best guess (BP2336J, 0.75; line 1 of the marking partly legible); single-source BPS part
DRV.R4	sets LED current ($I_{LED} = V_{REF} / R_{cs}$)	LOW	commodity 1206; tolerance class matters (5% assumed)
DRV.L2	CRM operation and switching frequency follow from its inductance	MEDIUM	custom wound part, value unknown
DRV.D1	carries the freewheel current; recovery losses	LOW	ES1J, commodity, multi-source
DRV.C3	only bulk capacitor; sets flicker; life-limiting	MEDIUM	unknown brand LR; voltage margin vs OVP (RISK-02)
DRV.BD1	mains rectification	LOW	commodity MB10F class
DRV.FR1	the only overcurrent protection; must fail safe	MEDIUM	fusing characteristic not specified on the part
DRV.VR1	surge protection of the 500 V MOSFET	LOW	commodity, but clamp curve varies by vendor
LED.LED1- LED9	light output, efficacy, life	MEDIUM	unknown maker; driven near the top of 2835 ratings (RISK-01)

A.3 Board provisions and candidate substitutes

Footprint	Fitted	Purpose	Conf.
DRV.R5	no	parallel to R4 - trims LED current (e.g. 2.0 Ohm 20 Ohm = 1.82 Ohm -> 110 mA)	0.7
DRV.C7	no	SMD alternate for a VCC or COMP capacitor	0.5
DRV.C8 (SMD)	no	SMD alternate for THT C8	0.7
DRV.R7	no	unknown	0.2

For	Candidate substitute	State
DRV.U1	BPS BP2335J or BP2338J (same family, pinout and package; change Rcs if VREF differs)	INFERRED 0.55
DRV.C3	68 uF 160 V 105 C long-life radial (removes the RISK-02 margin issue)	INFERRED 0.6
DRV.D1	ES1J / US1M (1 A, 600-1000 V, fast)	INFERRED 0.6

B. Functional blocks and power calculations

Sources: `architecture/functional-blocks.yaml`, `architecture/power-tree.yaml`.

Block	Name	Inputs → outputs	Components	Conf.
BLK-PROT-001	input protection	AC_L, AC_N → AC_L_F	DRV.FR1, DRV.VR1	0.8
BLK-PWR-001	rectification and EMI filter	AC_L_F, AC_N → BUS_P, BUS_N	DRV.BD1, DRV.C1, DRV.L1, DRV.C2, DRV.RL1	0.8
BLK-PWR-002	APFC buck constant-current converter (BP2336J)	BUS_P, BUS_N → VOUT_P, BUS_N	DRV.U1, DRV.L2, DRV.D1, DRV.R4, DRV.R5, DRV.C6, DRV.C8, DRV.R1, DRV.R2, DRV.R3, DRV.C7, DRV.R7	0.85
BLK-PWR-003	output storage and bleed	VOUT_P, BUS_N → LED_P, LED_N	DRV.C3, DRV.R8	0.75
BLK-LOAD-001	LED string	LED_P, LED_N → light, heat to the aluminium cup	LED.LED1-LED9, LED.PCB	0.9

B.1 Rails

Rail	Name	Nominal	Source	Type
RAIL-AC	mains input	230 V (AC rms; rated 220-240 V)	component: B22 cap	AC mains
RAIL-BUS	rectified bus (BUS_P / BUS_N)	325 V (peak of a rectified, unsmoothed sine; 339 V at 240 V; average 207 V at 230 V)	component: DRV.BD1	rectified sine, film-capacitor filtered only (C1, C2 = 0.1 uF each)
RAIL-LED	LED string supply (VOUT_P to BUS_N)	81 V (range 76-90 V; DERIVED 0.7)	component: DRV.U1	buck, constant current, active PFC
RAIL-VCC	controller supply (referenced to the floating IC ground)	7.4-12 V (family UVLO 7.4 V, clamp 12 V (SRC-001 p5))	component: DRV.U1 internal HV JFET	internal regulator

B.2 Calculations

Every DERIVED number in the report comes from one of these. "basis: family" means the result uses a parameter from the BP233xJ family datasheet (BP2335J), assumed to hold for BP2336J.

CALC-01: LED current. Result: 0.1 A (range 0.092-0.108 A). State: DERIVED 0.75; basis: family.

- Method: $I_{OUT} = V_{REF} / R_{cs} = 0.200 \text{ V} / 2.0 \text{ Ohm}$ (SRC-001 p7). Range: V_{REF} 0.194-0.206 V (SRC-001 p5) and $R_{cs} \pm 5\%$
- Assumptions: BP2336J shares BP2335J's V_{REF} (family); R_4 is R_{cs} ; R_5 is not fitted

CALC-02: LED string voltage by power balance. Result: 81 V (range 76-90 V). State: DERIVED 0.7.

- Method: $V = P_{out} / I = (P_{in} \times \text{efficiency}) / I_{LED} = (9 \text{ W} \times 0.90) / 0.100 \text{ A}$
- Assumptions: input power equals the 9 W rating; efficiency 0.88-0.92
- Cross-checks: 3 dies per package $\times \sim 3 \text{ V} = \sim 9 \text{ V}$ per LED (EVD-005, low quality); C_3 is rated 100 V, so the designer expected the string below 100 V

CALC-03: power per LED and against the LED board's label. Result: per_led: 0.9 W; ratio_to_board_label: 1.16. State: DERIVED 0.6.

- Method: $8.1 \text{ W} / 9 \text{ LEDs}$; $8.1 \text{ W} / 7 \text{ W}$ printed in the LED board silkscreen
- Assumptions: "7W" in NBL7W9S1P2835V1.0 is the board rating (INFERRED 0.8)

CALC-04: open-LED overvoltage setpoint. Result: 108 V. State: DERIVED 0.55; basis: family.

- Method: $VOVP = V_{FB_OVP} \times (R_{FBH} + R_{FBL}) / R_{FBL} = 1.6 \text{ V} \times (240 \text{ k} + 3.6 \text{ k}) / 3.6 \text{ k} = 108.3 \text{ V}$ (SRC-001 p5, p8)
- Assumptions: $R_1 + R_2$ are R_{FBH} and R_3 is R_{FBL} (INFERRED 0.7); BP2336J shares the 1.6 V threshold (family)
- Normal operation: FB at 81 V string $= 81 \times 3.6 / 243.6 = 1.20 \text{ V}$, 25% below the 1.6 V trip
- Consequence: 8% above C_3 's 100 V rating - see RISK-02

CALC-05: MOSFET voltage stress. Result: 339 V. State: DERIVED 0.7.

- Method: peak of 240 V AC $= 240 \times \sqrt{2}$; in this buck the switch blocks the bus voltage
- Assumptions: no ringing above the bus; which the photographs cannot show

CALC-06: conduction dead zone (why PF can exceed 0.9 with a buck). Result: dead_angle: 14.4 deg; conducting_fraction_of_half_cycle: 0.84. State: DERIVED 0.7.

- Method: a buck transfers power only while $|v_{in}| > V_{out}$: $\text{asin}(81 / 325) = 14.4 \text{ deg}$ at each zero crossing
- Note: The low string voltage (81 V against a 325 V peak) keeps the dead zone small, so a constant-on-time controller can reach $PF > 0.9$. A string near 150 V would not.

CALC-07: input-stage dissipation. Result: FR_1 : 0.13 W. State: DERIVED 0.6.

- Method: $I^2 R = 0.0435^2 \times 68$

CALC-08: loss budget and efficiency. Result: losses: 0.5-0.8 W; efficiency: 0.91-0.94. State: DERIVED 0.4.

- Method: FR_1 0.13 W; bridge $\sim 0.05 \text{ W}$; U_1 0.06-0.20 W ($\sim 3 \text{ ohm } R_{ds_on}$ at ~ 0.10 - 0.13 A rms switch current, $\times 1.6$ hot, plus CRM valley-switching loss); D_1 $\sim 0.10 \text{ W}$ (0.065 A average $\times 1.2$ - 1.7 V); R_4 $\sim 0.04 \text{ W}$; L_2 0.10-0.20 W (unknown core); bleeders R_8 0.07 W and FB chain up to $\sim 0.1 \text{ W}$ average

CALC-09: FB resistor voltage stress. Result: across_ R_1 _ R_2 : 250 V (peak, during on-time). State: DERIVED 0.55.

- Method: In the floating-ground buck the FB chain spans VOUT_P to the switch node, which sits at the bus during the on-time: $325\text{ V} - 81\text{ V} = \sim 244\text{ V}$ across R1 + R2. That is above one 1206 resistor's 200 V working rating and within two in series - which is how the board does it.

CALC-10: 100 Hz LED current ripple (flicker estimate). Result: percent_flicker: 17-25%. State: DERIVED 0.35.

- Method: The APFC buck delivers output current shaped like $\sin^2$ at 100 Hz, whose 100 Hz component equals the average. C3 shunts it against the string's dynamic resistance: ripple fraction = $1 / \sqrt{1 + (w C r_d)^2}$, $w = 2\pi \cdot 100$, $C = 68\text{ uF}$, $r_d = 90\text{-}135\text{ Ohm}$.
- Assumptions: LED dynamic resistance 10-15 Ohm per 9 V package - an engineering estimate with no datasheet behind it

CALC-11: LED-board heat load. Result: 5.7 W (range 5.3-6.1 W). State: DERIVED 0.45.

- Method: 8.1 W electrical x (1 - 0.30 radiant efficiency); 30% is a typical mid-power white LED figure, not measured

C. Reconstructed connectivity

Sources: reconstruction/nets.yaml, reconstruction/connectivity.yaml. Single-sided board, copper under an opaque green mask; traces not resolvable at phone resolution with the lighting used. The netlist is the BP233xJ reference application (BP233xJ family, U1 = BP2336J) mapped onto the parts present and their placement. Totals: 16 nets, 0 CONFIRMED, 3 HIGH_CONFIDENCE, 13 LIKELY.

Net	Name	Members	State	Method
NET-AC_L	AC_L	cap L lead, DRV pad "F", DRV.FR1.1	LIKELY 0.7	visual, reference_mapping (the F pad sits beside FR1)
NET-AC_L_F	AC_L_F	DRV.FR1.2, DRV.VR1.1, DRV.BD1.AC1	LIKELY 0.6	reference_mapping
NET-AC_N	AC_N	cap N lead, DRV pad "N", DRV.VR1.2, DRV.BD1.AC2	LIKELY 0.65	visual, reference_mapping
NET-BUS_PR	BUS_P_RAW	DRV.BD1.+, DRV.C1.1, DRV.L1.1, DRV.RL1.1	LIKELY 0.55	reference_mapping
NET-BUS_P	BUS_P	DRV.L1.2, DRV.RL1.2, DRV.C2.1, DRV.U1.5, DRV.U1.6	LIKELY 0.6	reference_mapping
NET-BUS_N	BUS_N	DRV.BD1.-, DRV.C1.2, DRV.C2.2, DRV.D1.A, DRV.C3.- (leg B), DRV.R8.2, DRV pad "V-", LED pad "-"	LIKELY 0.6	reference_mapping
NET-CS	CS	DRV.U1.8, DRV.U1.7, DRV.R4.1, DRV.R5.1 (DNP), DRV.D1.K	LIKELY 0.65	reference_mapping, placement (R4, R5 and D1 sit together at the board's top-left)
NET-SW	SW (U1 floating GND)	DRV.U1.2, DRV.R4.2, DRV.R5.2 (DNP), DRV.L2 (hole a or b), DRV.R3.2, DRV.C6.-, DRV.C8.-	LIKELY 0.6	reference_mapping
NET-FB	FB	DRV.U1.4, DRV.R3.1, DRV.R2.2	LIKELY 0.6	reference_mapping
NET-FBH	FB_MID	DRV.R1.2, DRV.R2.1	LIKELY 0.75	visual (R1 and R2 abut end to end inside one silkscreen outline)

Net	Name	Members	State	Method
NET-VOUT_P	VOUT_P (= LED +)	DRV.L2 (other hole), DRV.R1.1, DRV.C3.+ (leg A), DRV.R8.1, DRV pad "V+", LED pad "+"	LIKELY 0.6	reference_mapping
NET-VCC	VCC	DRV.U1.3, DRV.C6.+ or DRV.C8.+	LIKELY 0.65	visual, reference_mapping
NET-COMP	COMP	DRV.U1.1, the other of DRV.C6.+ / DRV.C8.+	LIKELY 0.65	visual, reference_mapping
NET-DRAIN_POUR	(part of BUS_P)	DRV.U1.5, DRV.U1.6, large tinned pour	HIGH_CONFIDENCE 0.9	visual
NET-LED_STRING	LED chain	LED pad "+", LED1..LED9 in series, LED pad "-"	HIGH_CONFIDENCE 0.85	visual (9S1P silkscreen; LED order along the string not traced)
NET-LED_LEADS	LED leads	black lead - LED pad "-", white-sleeved lead - LED pad "+"	HIGH_CONFIDENCE 0.9	visual

C.1 Connection records

Id	From	To	State	Method
NETCON-001	DRV.U1.5	DRV.U1.6	HIGH_CONFIDENCE 0.9	visual_trace
NETCON-002	DRV.U1.5	DRV.C2.1	LIKELY 0.55	reference_mapping
NETCON-003	DRV.U1.8	DRV.R4.1	LIKELY 0.65	reference_mapping, placement
NETCON-004	DRV.R4.1	DRV.D1.K	LIKELY 0.6	reference_mapping, placement
NETCON-005	DRV.U1.2	DRV.R4.2	LIKELY 0.6	reference_mapping
NETCON-006	DRV.R4.2	DRV.L2.hole a or b	LIKELY 0.55	reference_mapping
NETCON-007	DRV.L2.other hole	DRV.C3.+ (leg A)	LIKELY 0.6	reference_mapping
NETCON-008	DRV.C3.+ (leg A)	LED.PCB.+	LIKELY 0.7	reference_mapping, silkscreen V+
NETCON-009	DRV.C3.- (leg B)	LED.PCB.-	LIKELY 0.7	reference_mapping, silkscreen V-
NETCON-010	DRV.D1.A	DRV.BD1.-	LIKELY 0.55	reference_mapping
NETCON-011	DRV.R1.2	DRV.R2.1	LIKELY 0.75	placement
NETCON-012	DRV.R2.2	DRV.R3.1	LIKELY 0.6	placement, reference_mapping
NETCON-013	DRV.R3.1	DRV.U1.4	LIKELY 0.6	reference_mapping
NETCON-014	DRV.R1.1	DRV.C3.+ (leg A)	LIKELY 0.55	reference_mapping

Id	From	To	State	Method
NETCON-015	DRV.U1.3	DRV.C6 or DRV.C8.+	LIKELY 0.65	placement, reference_mapping
NETCON-016	DRV.U1.1	DRV.C8 or DRV.C6.+	LIKELY 0.65	placement, reference_mapping
NETCON-017	DRV pad F.1	DRV.FR1.1	LIKELY 0.7	placement
NETCON-018	DRV.FR1.2	DRV.VR1.1	LIKELY 0.6	reference_mapping
NETCON-019	DRV.BD1.+	DRV.C1.1	LIKELY 0.55	reference_mapping
NETCON-020	DRV.L1.1	DRV.RL1.1	SPECULATIVE 0.45	designator_prefix
NETCON-021	DRV.R8.1	DRV.C3.+ (leg A)	LIKELY 0.55	reference_mapping
NETCON-022	LED.PCB.+	LED.LED1-LED9.string	HIGH_CONFIDENCE 0.85	silkscreen 9S1P, visual_trace

C.2 What would raise it

- **UNK-003:** unpowered continuity pass (capacitors discharged first) - the probe pairs in ../probe-guide/README.md. Effect: LIKELY -> CONFIRMED for each net that checks out.
- **UNK-011:** transmitted-light photo of DRV (bright light behind the board, side A toward the camera) - the copper pattern shows through CEM-1. Effect: LIKELY -> HIGH_CONFIDENCE without probing.

Schematic deviation. RFC 1 s11.4 says SHOULD, where practical. Not produced, because with no traced net a KiCad schematic would look more certain than the evidence (s11.4 forbids a schematic that implies certainty that does not exist). The report carries an annotated text schematic instead (report.md s9). Produce the .kicad_sch after the UNK-003 continuity pass.

D. PCB placement, thermal and manufacturing detail

Sources: pcb/*.yaml. Coordinates in the DRV board frame (mm, origin lower-left of the copper face as photographed, $\pm 5\%$).

Ref	X (mm)	Y (mm)	Fitted
DRV.D1	3	18.6	yes
DRV.R5	6.7	18.5	no
DRV.R4	9.1	18.3	yes
DRV.R7	13.9	19.4	no
DRV.C7	15.6	16.5	no
DRV.C8(SMD)	17.4	15.3	no
DRV.U1	22.2	18.2	yes
DRV.R8	6.8	4.7	yes
DRV.R1	11	6.4	yes
DRV.R2	17.1	6.4	yes
DRV.R3	21.9	8.5	yes

Ref	X (mm)	Y (mm)	Fitted
DRV.L2 hole a	11.8	12.2	yes
DRV.L2 hole b	11.3	20.7	yes
U1 drain pour (BUS_P, INFERRED)	27	19.4	yes
DRV.BD1	32.1	8.5	yes
DRV.RL1	37.6	11.4	yes

Component	Relationship	Distance	Assessment	Requirement
DRV.C6/C8	U1 VCC (pin 3) and COMP (pin 1)	< 3 (leads beside the pin-1..4 side)	good	VCC and COMP capacitors close to their pins (SRC-001 p8)
DRV.R4	U1 CS (pins 7-8) and D1	5-6 to D1, ~12 to U1 centre	acceptable	short, wide ground path for the sense resistor (SRC-001 p8)
DRV.R3	U1 FB (pin 4)	~9	acceptable	divider close to FB, away from the switch node (SRC-001 p8)
DRV.U1	drain copper	0	good	increase DRAIN copper for heat (SRC-001 p8)
input stage	converter	separate board section	good	

D.1 Heat sources and thermal risks

Source	Est. dissipation (W)	Method
LED.LED1-LED9	5.7 (5.3-6.1)	CALC-11
DRV.U1	0.17 (0.10-0.25)	CALC-08
DRV.L2	0.15 (0.10-0.20)	CALC-08
DRV.FR1	0.13	CALC-07
DRV.D1	0.1	CALC-08

Risk	Component	Assessment	Sev.	Conf.	Basis
RISK-THERM-001	LED.LED1-LED9	marginal	high	0.6	~0.9 W per 2835 package on a board printed for 7 W; a burnt die is visible on the centre LED (EVD-004) - consistent with thermal overstress; a second unit with the same board shows the same burn mark (EVD-036), though two samples still cannot separate overstress from defective LEDs
RISK-THERM-002	DRV.U1	acceptable	low	0.4	BP2336J ~3 ohm Rds_on; family SOP8 theta-JA 145 C/W gives a 10-30 C rise over neck air; Tj stays under the thermal-regulation point if neck air stays under ~100 C (SRC-001 p4, p6); neck air temperature UNKNOWN
RISK-THERM-003	DRV.C3	marginal	medium	0.45	105 C electrolytic in an enclosed neck shared with the inductor and IC; electrolytic life halves per ~10 C, so neck temperature decides lamp life

D.2 DFM observations

Intent	Observation	Conf.
reduce cost	single-sided CEM-1 board, no bus electrolytic (single-stage PFC), no X or Y capacitor, fusible resistor in place of a fuse plus NTC	0.8
reduce cost	LED board printed 7W reused in a 9W lamp	0.6
improve assembly	all SMD on one face with adhesive so one wave pass solders THT and SMD together	0.8
accommodate vendor capabilities / second source	dual footprints: C8 as THT and SMD; C7 SMD alternate; R5 parallel to the sense resistor for current trim	0.65
simplify testing	none - no test pads; production test is presumably a powered light-up test of the finished lamp	0.4

E. Verification: risks, protection, reference comparison, checks, claims

E.1 Risk register

RISK-01: LED string runs about 16% over its board's printed rating. Severity high, confidence 0.65, domain thermal / LED.

- The driver delivers ~100 mA into nine ~9 V LEDs, ~8.1 W, ~0.9 W per 2835 package. The LED board's own silkscreen reads 7W. The centre LED shows a burn spot over a die, and a public repair video of a flickering Crompton lamp shows a second unit with the same LED board and the same mark (EVD-036). In a series string one open die darkens the lamp.
- Potential effect: early lumen depreciation; die burn-out; lamp dark or flickering
- Recommendation: lower ILED (Rcs 2.4 Ohm -> ~83 mA) or use a board rated for the power (10-12 LEDs); confirm with Tsp measurement
- References: EVD-003, EVD-004, EVD-010, EVD-036, CALC-01, CALC-02, CALC-03, UNK-004, UNK-005, UNK-015

RISK-02: Open-LED overvoltage setpoint above the output capacitor's rating. Severity medium, confidence 0.55, domain power.

- R1+R2 / R3 is the FB divider of the BP233xJ controller; OVP trips at ~108 V, 8% above C3's 100 V rating. An open LED (RISK-01's failure mode) drives C3 to that level on every hiccup cycle.
- Potential effect: C3 overstress and early failure after an LED opens; possible venting
- Recommendation: C3 rated 160 V, or RFBL raised so VOVP is about 95 V while staying above the hot/cold string maximum
- References: EVD-010, EVD-012, EVD-025, CALC-04, UNK-003

RISK-03: Surge robustness unverified; MOV clamp likely above the 500 V MOSFET. Severity medium, confidence 0.5, domain protection.

- A 7 mm 510 V MOV clamps well above 500 V at amperes of surge current: a 07D511K's maximum clamp is 845 V at 10 A (Bourns MOV-07D, SRC-025; this lamp's MOV maker unknown). Behind the bridge the bus has only 0.2 uF of film capacitance to soak the residue. FR1 (68 Ohm) and L1 help. BP2336J's MOSFET is 500 V (a BP2338J would have 600 V). The lamp prints no surge rating; Crompton's current lines claim 4 kV, which this 2019 unit does not.

- Potential effect: MOSFET avalanche or breakdown on a line surge; FR1 opens; lamp dead
- Recommendation: surge test to IEC 61000-4-5 at 1 kV and 2.5 kV L-N; if it fails, a lower-voltage MOV or a TVS across the bus
- References: EVD-016, EVD-018, EVD-019, EVD-045, EVD-046, CALC-05, UNK-018

RISK-04: Noticeable 100 Hz flicker likely. Severity medium, confidence 0.35, domain power / light quality.

- Single-stage PFC delivers output current at 100 Hz; only 68 uF against the string's dynamic resistance smooths it. Estimated percent flicker 17-25%. IS 16102-2 sets no flicker limit, so this is a quality concern, not a compliance one.
- Potential effect: visible stroboscopic effect; camera banding; user complaints; worse as C3 ages
- Recommendation: measure with a flicker meter; if confirmed, larger C3 or a ripple-cancelling linear stage
- References: CALC-10, UNK-012

RISK-05: Output electrolytic is the life-limiting part in a hot, sealed neck. Severity low, confidence 0.5, domain reliability.

- C3 (68 uF 100 V 105 C, unknown "LR" brand) carries the full 100 Hz ripple next to L2 and U1 in an enclosed neck.
- Potential effect: capacitance loss; rising ripple and flicker; eventual failure
- Recommendation: use a long-life series; measure neck temperature
- References: EVD-012, EVD-013, UNK-015

RISK-06: Non-isolated driver - LED board and aluminium cup sit at mains potential. Severity info, confidence 0.85, domain safety.

- Normal for this class of lamp; insulation relies on the dome and housing. Anyone who opens the lamp (as for this teardown) or powers the LED board outside it is exposed. Powered work on this unit is for a qualified operator with an isolation transformer (RFC 1 s30).
- Potential effect: shock if the dome is broken or removed while powered
- Recommendation: none for the product class; process note for this engagement
- References: EVD-022

RISK-07: Driver IC identified by best guess (BP2336J, 0.75), not by a full marking read. Severity medium, confidence 0.7, domain sourcing.

- U1 is BP2336J by best guess (0.75); line 1 of its marking is only partly legible. If continuity shows a different pin map, the reconstructed netlist changes.
- Recommendation: run probe-guide checks 1 and 5 before relying on the pin map
- References: EVD-049, EVD-045, EVD-039, UNK-002

E.2 Protection matrix

Threat	Present	Component	Assessment	Note
overcurrent / downstream short	yes	DRV.FR1 (68 Ohm fusible)	acceptable	I2t and opening behaviour unknown
surge (L-N)	yes	DRV.VR1 07D511K, FR1, L1/C1/C2	unknown	no rating printed; 500 V MOSFET; RISK-03

Threat	Present	Component	Assessment	Note
sustained line overvoltage	partial	U1 MOSFET 500 V vs 339 V peak at 240 V	acceptable	
undervoltage	yes (datasheet)	U1 VCC UVLO	good	
LED open circuit	yes	U1 FB OVP	marginal	setpoint ~108 V > C3 100 V; RISK-02
LED short circuit	yes (datasheet)	U1 LED-short protection	good	
CS resistor open	yes (datasheet)	U1	good	
thermal overload (driver)	yes (datasheet)	U1 thermal regulation	acceptable	
thermal overload (LEDs)	no	none	poor	U1 senses its own die, not the LED board
ESD	no dedicated	U1 2 kV HBM	acceptable	sealed lamp; no user-touchable circuit
EFT	partial	pi filter	unknown	
inductive kick	yes	DRV.D1 freewheel	good	
reverse polarity	not_applicable	AC input	not_applicable	
load dump	not_applicable		not_applicable	
battery faults	not_applicable		not_applicable	
connector abuse	not_applicable	soldered leads	not_applicable	

E.3 Reference-design comparison (BP233xJ family typical application)

Feature	Reference	Observed	Class
input fuse	fuse symbol on the AC line	FR1 68 Ohm fusible resistor	FUNCTIONALLY_MATCHES
surge clamp	none	VR1 07D511K	ADDED
bridge	4-diode bridge	BD1 MBF bridge	MATCHES
bus capacitor	one small capacitor	C1 0.1 uF - L1 - C2 0.1 uF pi filter, RL1 damping (inferred)	MODIFIED
VCC capacitor	one capacitor	C6 or C8 electrolytic; C7 SMD alternate DNP	MATCHES
COMP capacitor	one capacitor	C8 or C6 electrolytic; SMD C8 alternate DNP	MATCHES
current sense	one resistor	R4 2.0 Ohm + R5 DNP parallel trim	MODIFIED
freewheel diode	diode CS-node to bus return	D1 (SMA)	MATCHES
inductor	single winding	L2 EE wound part, 2 holes	FUNCTIONALLY_MATCHES
FB divider	two resistors	R1 + R2 (series, upper) and R3 (lower)	MODIFIED
output capacitor	one electrolytic	C3 68 uF 100 V	MATCHES
output bleeder	none	R8 100 kOhm (inferred)	ADDED
startup resistor	none (HV JFET)	none	MATCHES

Deviation	Component	Class	Severity	Analysis
DEV-001	DRV.FR1	FUNCTIONALLY_	low	Also limits inrush and surge current into VR1 and the bus, at a 0.13 W cost (CALC-07). A common Indian-market choice.
DEV-002	DRV.VR1	ADDED	low	Necessary for Indian mains; clamp level against the 500 V MOSFET is the open question (RISK-03).
DEV-003	DRV.C1/L1/C2	MODIFIED	low	Adds conducted-EMI attenuation for IS 16102-2 / CISPR limits without adding storage that would hurt PF.
DEV-004	DRV.R5, DRV.R8, DRV.C7, DRV.C8(SMD)	ADDED	low	One board serves several current settings and THT/SMD capacitor sources; R8 stops the string glowing from leakage when off.
DEV-005	DRV.R1, DRV.R2	MODIFIED	low	Splits ~244 V of on-time stress across two 200 V-rated 1206 parts (CALC-09). Good practice.

E.4 Identifying U1

Board feature	BP2336J	BP2338J	BP2836D	BP2636
surface-mount SOP-8 body	fits (SOP8)	fits (SOP8)	fails (DIP-8 only, through-hole)	fits (SOP8)
marking lines 2-3 "1BD96CS" / "H1AM4?" (7 + 7 form)	fits (XXXXXXYX / FGXXWWJ, SRC-024) - not discriminating	partial (XXXXXXY / WXYJJ, 6 + 5, SRC-021 Rev 1.0)	fails (format WWXYJ)	unknown
two 50 V electrolytics at the pin-1..4 side	fits (COMP pin 1, VCC pin 3)	fits	fails (one VCC capacitor)	unknown
240 kohm / 3.6 kohm resistor chain	fits (FB divider: OVP 108 V, just above the ~81 V string)	fits	fails (as its ROVP resistor the trip point is >= 333 V, above the bus)	possible as a CV divider, but see the next rows
no bus electrolytic, PF > 0.90 printed	fits (active PFC)	fits	fails (no PFC; ideal-model PF ~0.72)	fits (boost PFC)
100 V output capacitor, ~81 V LED string, 2.0 ohm sense	fits (buck; 0.200 V / 2.0 = 100 mA, ~8 W)	fits	partial (100 mA while switching, ~84 mA average)	fails (a boost PFC CV stage outputs above the 325 V peak into a 400 V-class capacitor and needs a second stage to drive LEDs)
marking digits	fits 'BP2?36' with ? = 3 (one owner read)	final 8 in one owner read only	fits 'BP2?36' with ? = 8 (one owner read)	fits 'BP2?36' with ? = 6 (one owner read)

Calibration record (RFC 1 s26.2):

Stage	Candidate	Prior conf.	Outcome
photographs only (v1.0)	BPS BP2335J / BP2335JS	0.55	right family and circuit, wrong last digit
owner's first read (v2.0)	BPS BP2836	0.85	wrong - withdrawn; DIP-8 low-PF part contradicted by package and circuit
owner's later reads + board (v3.0)	BPS BP2336J	0.85	overstated
datasheet marking format (v3.1)	BPS BP2336J	0.9	wrong basis - the 7 + 7 form is BPS-wide (SRC-027); withdrawn
U1 macros + ruler (v3.2)	BP233x-class, marking conflicting	0.55	superseded by v3.3
best guess (v3.3)	BPS BP2336J	0.75	pending continuity

A partly legible marking read by eye is not a verification: three direct reads of the same part disagreed in one digit. The board's own features (package, marking format, support parts, divider values, PF claim) discriminated between candidates better than any single read - and a marking format is only evidence if no other family shares it. Accept a marking read only when the circuit agrees with it (LRN-006).

Conclusion. The circuit fits a BP233x-class APFC buck and nothing else in hand, and line 3 of the marking ends in J, the BP233xJ format. Line 1 alone fits BP26xx or BP28xx parts that the circuit and package rule out; that read stays CONFLICTING. Best guess (v3.3, on the owner's instruction): BP2336J, INFERRED 0.75. Everything downstream uses it until the continuity checks confirm or overturn it. Weights in components.yaml DRV.U1.

Datasheet extraction for the critical component (RFC 1 §8.5; BP2336J, family datasheets):

Item	Value
pinout	1 COMP, 2 GND, 3 VCC, 4 FB, 5-6 DRAIN, 7-8 CS (SOP8)
absolute maximum ratings	VDS 500 V (BP2336J); COMP, FB, CS -0.3..6 V; VCC sink 20 mA; PD 0.45 W and theta-JA 145 C/W (family SOP8, SRC-001)
recommended operating conditions	family: ILED < 180 mA at Vout 72 V, 176 Vac input (BP2335J figure; BP2336J's lower Rds_on allows more)
power requirements	family: VCC on 9.9 V, UVLO 7.4 V, clamp 12 V, operating current 300 uA
initialization	HV JFET charges VCC; COMP pulled to 1.5 V; soft start from 10 kHz (family)
decoupling	VCC bypass close to the pin
support components	COMP capacitor, VCC capacitor, FB divider, Rcs, freewheel diode, inductor, output capacitor
thermal requirements	thermal regulation (family 140 C); enlarge drain copper
timing	family: Ton max 35 us, Toff 2.5-150 us, LEB 300 ns
interface standards	not applicable
layout constraints	see circuits/power/apfc-buck.yaml datasheet_requirements
application circuits	SRC-001 Fig. 1, SRC-021 Fig. 1
known errata	none found
lifecycle status	BP2336JC listed in BPS's 2019 high-PF range (SRC-003 p18); current status UNKNOWN

E.5 Consistency checks

Check	Name	Inputs	Result	Conf.
CHK-01	efficacy vs BEE star band	855 lm / 9 W = 95 lm/W; 3-star band 90-105 lm/W (SRC-012)	PASS	0.85
CHK-02	power balance	100 mA x 81 V = 8.1 W = 9 W x 0.90	PASS	0.6
CHK-03	output capacitor rating vs OVP	C3 100 V vs VOVP 108 V [conditional on R1+R2/R3 = FB divider]	FAIL	0.55
CHK-04	MOSFET VDS margin at high line	339 V vs 500 V	PASS	0.65
CHK-05	FB resistor working voltage	~244 V across two 1206 (200 V each)	PASS	0.55
CHK-06	PF plausibility	dead zone 14.4 deg per zero crossing at 81 V / 325 V	PASS	0.6
CHK-07	IS 16102-2 PF >= 0.9	printed PF > 0.90 (SRC-011 cl. 15.2)	PASS_AS CLAIMED	0.5
CHK-08	LED board rating vs delivered power	7W label vs ~8.1 W	WARN	0.6
CHK-09	recommended ILED for U1	100 mA vs < 180 mA at 72 V, 176 Vac (family, SRC-001 p4)	PASS	0.55
CHK-10	U1 power dissipation	0.06-0.20 W vs PDMAX 0.45 W (family SOP8)	PASS	0.45
CHK-11	marking vs datasheet and circuit	1BD96CS / H1AM46J vs BP2336J format XXXXXYX / FGXXWWJ; BP2?36 vs board features	PASS	0.9

E.6 Claims

CLM-001. The driver is a single-stage, non-isolated, high-PF buck with no bus electrolytic. State INFERRED, confidence 0.85; review UNREVIEWED.

- Evidence: EVD-019, EVD-020, EVD-012, EVD-001, EVD-014, EVD-043
- Reasoning: U1 is a BP233xJ active-PFC buck; only 2 x 0.1 uF film capacitance on the bus side; the only electrolytic of size is 68 uF 100 V on the output; the lamp prints PF > 0.90; VCC/COMP electrolytics at the IC

CLM-002. U1 is a BPS BP2336J APFC buck controller with an integrated 500 V MOSFET (best guess; the line-1 marking is only partly legible). State INFERRED, confidence 0.75; review UNREVIEWED.

- Evidence: EVD-049, EVD-039, EVD-045, EVD-007, EVD-008, EVD-009, EVD-043
- Reasoning: verification/datasheet-comparison.yaml
- Alternatives: BP2338J (0.05); BP2335J (0.05); BP28xx / BP26xx (0.03); unidentified (0.12)
- To settle: UNK-002

CLM-003. The LED current is about 100 mA (92-108 mA). State DERIVED, confidence 0.75; review UNREVIEWED.

- Evidence: EVD-010, EVD-024
- Reasoning: CALC-01
- To settle: UNK-004

CLM-004. The LED string is about 81 V (76-90 V), nine ~9 V 2835 LEDs in series. State DERIVED, confidence

0.7; review UNREVIEWED.

- Evidence: EVD-003, EVD-005, EVD-012
- Reasoning: CALC-02 and its cross-checks
- To settle: UNK-004

CLM-005. The 9 W lamp drives a LED board printed for 7 W at about 8.1 W, 0.9 W per LED. State DERIVED, confidence 0.6; review UNREVIEWED.

- Evidence: EVD-003
- Reasoning: CALC-03
- To settle: UNK-004

CLM-006. The centre LED has a burnt die; a second unit with the same LED board shows the same mark. State INFERRED, confidence 0.7; review UNREVIEWED.

- Evidence: EVD-004, EVD-036
- Reasoning: a dark crater-like spot on the phosphor over a bond-wire track; the classic burn mark
- Alternatives: surface contamination (0.20)
- To settle: UNK-005

CLM-007. Open-LED OVP is set near 108 V, above C3's 100 V rating. State DERIVED, confidence 0.55; review UNREVIEWED.

- Evidence: EVD-010, EVD-012, EVD-025
- Reasoning: CALC-04
- To settle: UNK-003

CLM-008. The input stage is a 68 Ohm fusible resistor, a 07D511K MOV, an MB10F-class bridge and a 0.1 uF - L - 0.1 uF pi filter. State INFERRED, confidence 0.75; review UNREVIEWED.

- Evidence: EVD-016, EVD-017, EVD-018, EVD-019, EVD-011
- To settle: UNK-003, UNK-007

CLM-009. The driver is a single-sided CEM-1-class board assembled THT-plus-glued-SMD in one wave pass, with dual footprints for second-sourcing. State INFERRED, confidence 0.7; review UNREVIEWED.

- Evidence: EVD-021, EVD-006, EVD-032, EVD-010, EVD-015

F. Unknowns register

Source: teardown.yaml. RFC 1 §21.

Id	Question	Importance	How to resolve
UNK-001	Photographs of the unit?	high	RESOLVED: 2026-10-04 23:08 +05:30, 46 photographs
UNK-002	U1 identity: best guess BP2336J (0.75); line 1 of the marking (BP2 + 6/8 + 3 + 5/6, 7 leads) is only partly legible	high	continuity: yellow capacitors to U1 pins 1 and 3; pin 4 to the R3/R2 junction (probe guide checks 1, 5); a sharper macro of line 1 under a loupe

Id	Question	Importance	How to resolve
UNK-003	Which of the 16 reconstructed nets are real?	high	unpowered continuity pass after discharging C1, C2, C3 - probe-guide/README.md
UNK-004	Actual LED current and string voltage?	high	powered measurement by a qualified operator with an isolation transformer (RFC 1 s30); or LED board alone on a current-limited 0-100 V bench supply at 10-100 mA - 81 V DC is still hazardous
UNK-005	Is the centre LED open, shorted or degraded, and does the lamp still light?	high	current-limited supply across that LED alone (a DMM diode test cannot light a 9 V LED)
UNK-006	Inductance of L1 and L2?	medium	LCR meter on the desoldered L2; photograph L2's pins
UNK-007	Voltage rating of C1/C2 (code 2S)?	medium	WEIDY catalogue lookup; read C1's marking
UNK-008	Model code on the housing?	low	re-photograph the print with raking light
UNK-009	LED board substrate - aluminium or FR-4?	medium	photograph the board edge and back
UNK-010	D1 part number?	low	RESOLVED: 2026-10-05: ES1J (EVD-050)
UNK-011	Hidden silkscreen (FR1, L2, C1 designators) and the copper pattern?	medium	photograph side A where L2 was removed; transmitted-light photo through the CEM-1 board
UNK-012	Input power, PF, THD, efficiency, flicker?	high	power analyser and flicker meter, qualified operator
UNK-013	Who is the OEM (NBL / GYY)?	low	trade search for NBL lighting boards; BIS registration lookup for R-76000108
UNK-014	True board dimensions?	low	RESOLVED: 2026-10-05: ruler photo - driver 48.4 x 23.5 mm, LED board 25.3 x 26.0 mm, +-2% (EVD-047, EVD-048)
UNK-015	LED solder-point and neck temperatures in operation?	high	thermocouples, sealed lamp, 1 h soak, qualified operator
UNK-016	How and when was the unit obtained (RFC 1 s30)?	low	ask the owner
UNK-017	Do later Crompton 9W lamps (2021+) use the same driver?	low	tear down a current Dynaray unit
UNK-018	MOV clamp curve and the lamp's surge withstand?	medium	MOV vendor datasheet; IEC 61000-4-5 surge test at 1 kV and 2.5 kV
UNK-019	Purpose of the two plated holes on DRV side B?	low	RESOLVED: 2026-10-05: L2's footprint: L2 is fitted in 20261004_230028 (23:00) and both holes are empty and desoldered in 20261004_230500 (23:05) (INFERRED 0.85)

G. Evidence index

Source: `evidence/evidence.yaml`. Image locations are pixels in the displayed (EXIF-auto-oriented) frame of the named photograph.

Id	Source	Location / section	Quality	Description
EVD-001	225613.jpg	x 1050, y 1720, 850×620	medium	Housing print: BEE 3-star, "Crompton", "9W LED Bulb PRO, CDL", "220-240V, 50Hz", "855 Lm, PF > 0.90", "IS 16102 (Part-1)", "Made in India", "02/19", "R-76000108".
EVD-002	225620.jpg	x 940, y 2370, 560×330	low	Model line reads like "09NB600-9"; the same line in 20261004_225613.jpg (x 1180, y 2140) reads like "09N5609-2".
EVD-003	225757.jpg	x 150, y 800, 2900×2700	high	LED board silkscreen "NBL7W9S1P2835V1.0", nine 2835 LEDs (4 + 4 + 1), "+" and "-" pads with leads through the centre hole, two screws, grease on the aluminium cup.
EVD-004	225757.jpg	x 1380, y 1450, 420×360	medium	Dark crater-like spot on the phosphor of the top-centre LED, over the die/bond-wire track.
EVD-005	225757.jpg	x 380, y 1030, 420×420	low	Die pattern under the phosphor of the top-left LED; about three elongated dies visible.
EVD-006	230500.jpg	x 500, y 640, 3050×1520	high	Driver side B: "NBL-DR180425V0.1", "GY", designators D1 R4 R5 R7 C7 C8 U1 R1 R2 R3 R8 BD1 RL1, green mask, stepped outline.
EVD-007	230532.jpg	x 1960, y 880, 420×260	low	U1 marking under raking light: "BP2?35" or "BP28?5" / "1BD96CS" / "H1AM46J".
EVD-008	230516.jpg	x 770, y 470, 400×290	low	U1 marking, side-lit: line 1 reads like "BP2865"; lines 2-3 as EVD-007.
EVD-009	230500.jpg	x 1640, y 680, 760×620	medium	U1 body with four leads on the pin-1 side; opposite side a lead at position 8, a flux-covered pad with no visible lead at position 7, two leads on a large tinned pour at positions 6 and 5.
EVD-010	230509.jpg	x 0, y 1100, 2400×1900	high	R4 "2R0"; R5, R7, C7, C8 pads empty with red adhesive dots; R1 "124", R2 "124", R3 "362", R8 "104"; D1 in an SMA-class body.
EVD-011	230513.jpg	x 1480, y 1080, 1950×1100	medium	BD1 marked "..10F" with "+"; RL1 "562".
EVD-012	230104.jpg	x 1400, y 700, 2600×2000	medium	Output capacitor sleeve "68 uF 100 V", "105 C".
EVD-013	230054.jpg	x 1700, y 1000, 1300×1100	medium	C3 sleeve "105 C" and series print "LR"; "+" by its pads; "C3" outline rectangle on side A.

Id	Source	Location / section	Quality	Description
EVD-014	230300.jpg	x 800, y 900, 900×1100	medium	Two yellow electrolytics: "1 uF 50 V" and "2.2 uF 50 V", brand print "..PAXCON TOPA..".
EVD-015	230300.jpg	x 700, y 1950, 1700×700	medium	Side A silkscreen "C6" and "C8" beside the two yellow electrolytics (upside down in the frame).
EVD-016	230211.jpg	x 1700, y 1300, 1200×1000	high	Blue disc varistor "07D511K", certification marks, "18 10".
EVD-017	230044.jpg	x 1000, y 1900, 1100×900	medium	Input pads printed "F" and "N" with lead stubs; "VR1", "L1" and "C2" silkscreen.
EVD-018	230312.jpg	x 1700, y 2050, 1500×600	medium	Pink flameproof axial resistor, bands blue, grey, black, gold, black.
EVD-019	230232.jpg	x 850, y 1450, 900×900	medium	Dipped film capacitor printed "WEIDY" / "2S104J" plus a trailing character.
EVD-020	230038.jpg	x 686, y 257, 2514×1400	high	Side A elevation - drum inductor L1, VR1, two film capacitors, two yellow electrolytics, EE wound part, C3 folded off the end.
EVD-021	230028.jpg	x 1086, y 643, 1014×2328	medium	Side A overhead - bare laminate with woven texture and silkscreen only (no copper); C3 outline; "GYY".
EVD-022	230626.jpg	x 0, y 0, 3000×4000	high	Exploded view - dome, housing with B22 cap, aluminium cup (two screw holes, centre hole), two screws, LED board with red and black leads, driver, desoldered EE wound part.
EVD-023	BP2335J datasheet	Typical Application; Ordering Information; Pin Configuration and Marking		supports CLM-002
EVD-024	BP2335J datasheet	Electrical Characteristics (VREF 0.194-0.206 V); Constant Current Control (IOUT = VREF / Rcs)		supports CLM-003
EVD-025	BP2335J datasheet	Feedback (VFB_OVP 1.6 V); Feedback Network equation		supports CLM-007
EVD-026	BP2335J datasheet	Absolute Maximum Ratings; Power MOSFET; Thermal Regulation; PCB Layouts		
EVD-027	BP2866A datasheet	Features (no VCC capacitor); Pin Configuration (SOP7); Marking		
EVD-028	general product overview 2019.01.07	low-PF non-isolated: BP2865 (SOT33-5) / BP2866xJ (SOP7) / BP2867 (DIP7)		
EVD-029	general product overview 2019.01.07	high-PF non-isolated: BP233XJC / JF / JS; India market THD<15% BP233XJS		

Id	Source	Location / section	Quality	Description
EVD-030	SRC-009		low	Frames of a 2025 Crompton 9W repair video (Inside Electronics IE181) show an LED board printed "NBL7W9S1P2835V1.0" and a separate neck driver. Read from ~160x90 px storyboard frames by the research agent.
EVD-031	230513.jpg	x 943, y 286, 743×543	high	Large tinned copper pour continuous with U1 positions 5-6.
EVD-032	230500.jpg	x 500, y 640, 3050×1520	medium	Red adhesive dots under SMD parts and on empty SMD footprints (R5, C7, C8) on side B.
EVD-033	EVD-006, SRC-016	U1 body measured 336 x 271 px in the EVD-006 crop vs JEDEC MS-012 4.90 x 3.90 mm -> 68.6 / 69.5 px/mm; board outline 2907 x 1398 px -> 42.4 x 20.4 mm	medium	
EVD-034	BEE Schedule 20 LED lamps (2018)	star bands 3-star 90-105 lm/W		
EVD-035	IS 16102-2:2012	cl. 15.2 power factor >= 0.9		
EVD-036	SRC-017	thumbnail, x 330-890, y 90-570	medium	A second unit: LED board silkscreen "NBL7W9S1P2835V1.0" (same board as ours), 9 x 2835, screwed to the same aluminium cup. The second LED of the right-hand column shows a dark burn spot over a die; the repairer points at it. Video title: flickering Crompton LED bulb.
EVD-037	SRC-018	frames at 8 s and 18 s (720p)	medium	Sibling lamp, Government UJALA-scheme variant: housing print "BEE 3-star, Crompton, 9W LED Bulb, CDL, 09LBS09-9, 220-240V 50 Hz, 900 Lm, PF>0.90, IS 16102 (Part-1)", same print layout and marks as ours; registration number ends "...96000187".
EVD-038	SRC-018, SRC-019	storyboard frames ~211-221 s (SRC-018) and ~25-45 s (SRC-019)	low	Drivers of other Crompton 9W lamps at 160x90: long single-sided board, green SMD face, component side with a red-cored wound inductor, blue disc MOV and orange/brown film capacitors - the same part palette as ours. Too coarse to compare designators, IC marking or layout. A third driver (SRC-019 SUZc-gDzL3I thumbnail) is a different design: white board, transformer-style part labelled "9W LED", blue X-type capacitor.

Id	Source	Location / section	Quality	Description
EVD-039	engagement owner		high	Owner read U1 line 1 directly from the part, four times on 2026-10-05: "BP2836", then "BP2336 or BP2338", then "BP2636 ... something like that". Common to all reads: "BP2", a final "6" (3 of 4), and an unclear third digit (8, 3 or 6). The photographs read "BP2835 / BP2865 / BP2885" (EVD-007, EVD-008).
EVD-040	BP2836D datasheet	Typical application (Fig. 1); pin description: 1 GND, 2 ROVP, 3 NC, 4 VCC, 5-6 DRAIN, 7-8 CS		
EVD-041	BP2836D datasheet	Abs max (DRAIN 500 V, ICC 5 mA); electrical (VCS_TH 388/400/412 mV, VCC_ON 13.8 V, UVLO 9 V, clamp 16.8 V, TOFF_MIN 3 us, TOFF_MAX 240 us, TON_MAX 40 us, VROVP 0.5 V, RDS_ON 3 ohm, TREG 150 C); IPK = 400 mV / Rcs; ILED = IPK / 2		
EVD-042	BP2836D datasheet	OVP: $T_{ovp} = L \times V_{cs} / (R_{cs} \times V_{ovp})$, $R_{ovp}(kohm) = 5 \times T_{ovp}(us)$; start-up resistor from bus charges the VCC capacitor; PCB rules (VCC cap and ROVP close to the IC, NC to GND, drain copper for heat)		
EVD-043	BP2338J datasheet	Typical application; SOP8 pinout 1 COMP, 2 GND, 3 VCC, 4 FB, 5-6 DRAIN, 7-8 CS; marking BP2338 / XXXXXY / WXYJJ		
EVD-044	BP2336J summaries	SOP8 active-PFC floating-ground buck, 500 V MOSFET		
EVD-045	BP2336J datasheet	SOP8 pinout 1 COMP, 2 GND, 3 VCC, 4 FB, 5-6 DRAIN, 7-8 CS; marking BP2336 / XXXXXYX / FGXXWWJ (FGXX sign, WW week)		U1 lines 2-3 "1BD96CS" / "H1AM46J" fit the BP2336J format (7 + 7, the third line ending in J). NOT discriminating: BP2636B (SRC-027) and BP2866A (SRC-002) print the same 7 + 7 form; BP2335J and BP2338J Rev 1.0 sheets print 6 + 5. Line 3 reads FGXX = H1AM, WW = 46: week 46, which with the PCB date 180425, MOV 18 10 and lamp 02/19 fits November 2018 (INFERRED 0.6).
EVD-046	MOV-07D series	07D511K electrical characteristics: 845 V max clamp at 10 A		

Id	Source	Location / section	Quality	Description
EVD-047	025638.jpg	x 1764, y 637, 733×1511	high	Driver beside a mm ruler. Ruler cm lines at y = 717, 1021, 1321, 1619, 1917, 2213 ... 3688 px (29.7 px/mm mean, 3.7% perspective gradient). The board rests on its parts above the ruler, so its scale is taken from U1's 1.27 mm lead pitch: 39.7 px, i.e. 31.2 px/mm (+-2%), 4% above the local ruler scale. Outline: 48.4 mm long; wide section 23.5 mm wide x 29.2 mm long; narrow input section 20.2 mm wide, stepped in 1.5 mm and 1.8 mm on the two long edges.
EVD-048	025638.jpg	x 1781, y 2624, 745×765	high	LED board beside the ruler, flat at ruler level: 25.3 x 26.0 mm at 29.45 px/mm local scale (2835 LEDs measure 2.9 x 3.6 mm, nominal 2.8 x 3.5). Two 2.6 mm screw HOLES (not edge notches) at (13.3, 2.3) and (13.4, 23.7) mm; 4.3 mm wire hole at (13.4, 12.8); LED columns at x 3.6 and 22.7 mm, 5.9 mm pitch.
EVD-049	020417.jpg, 020422.jpg, 020425.jpg		medium	U1 macros under raking light. Line 1 reads BP2, then a 4th character with a closed lower loop (6 or 8, not 3), a 5th like 3, and a 6th 5 or 6. Line 2 1BD96CS (clear). Line 3 H1AM4 plus one or two unclear characters. Position 7 has a pad but no lead in all three shots: the part has 7 leads.
EVD-050	021428.jpg		high	D1 body printed "ES1J" (1 A, 600 V, 35 ns superfast rectifier, SMA).
EVD-051	021417.jpg, 021428.jpg		medium	BD1 body printed "+" and "MB10F" (first character partly worn).

H. Photograph index

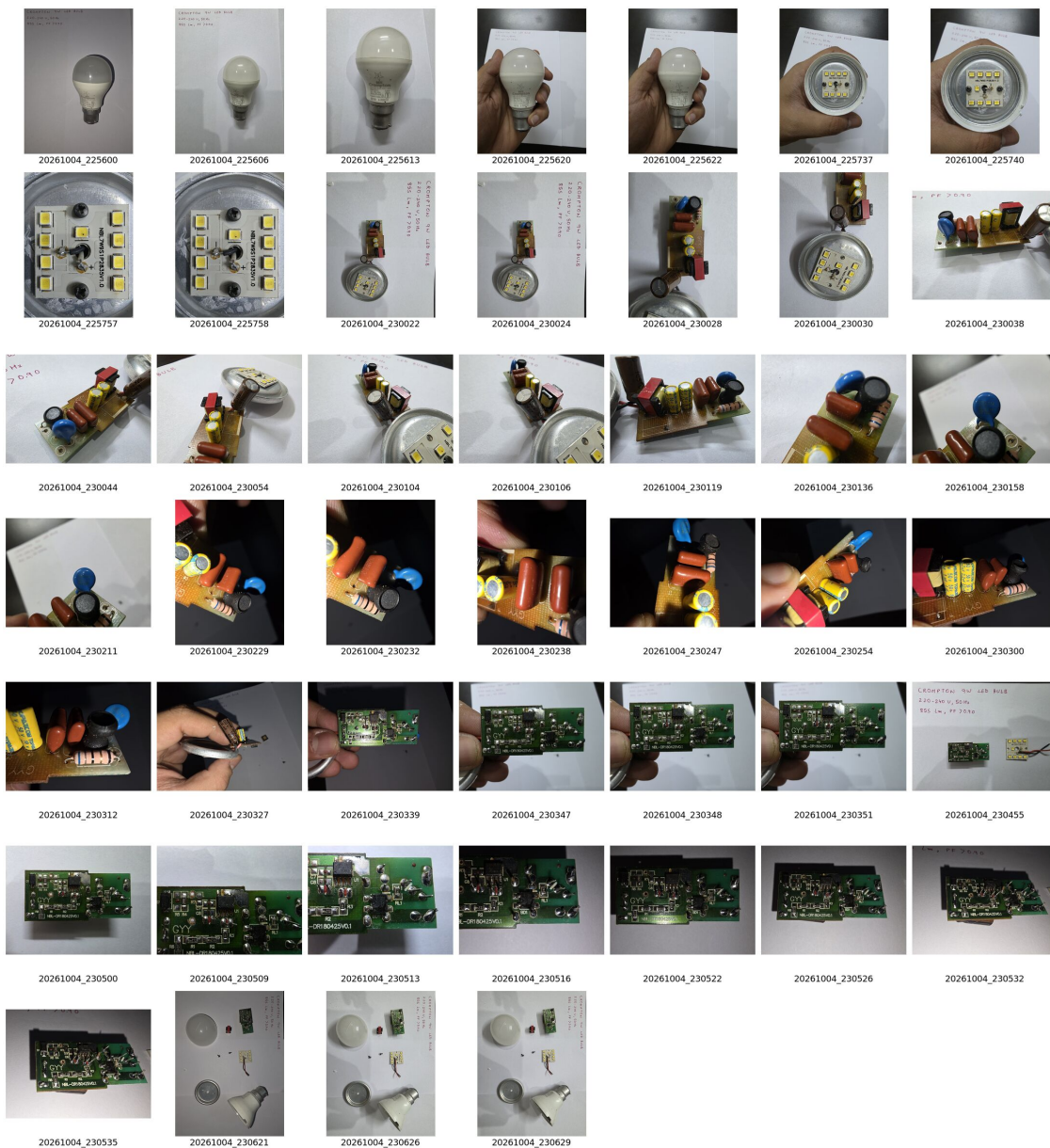
Source: input/manifest.yaml. Files sit in Crompton 9W LED Bulb/ at the engagement root and are pinned by SHA-256 (first 16 hex digits shown). Side: DRV.A = driver component face, DRV.B = driver copper/SMD face. EXIF GPS tags are present in every file and all zero.

File	Side	Subject	SHA-256 (prefix)
20261004_225600	n/a	whole lamp on paper with handwritten rating note	2e55d0c781159dac
20261004_225606	n/a	whole lamp on paper	b7a81556a3f6d8f3

File	Side	Subject	SHA-256 (prefix)
20261004_225613	n/a	housing print: model, ratings, BIS R-number, date code (key)	b0c1280cd97c08d3
20261004_225620	n/a	housing print, lamp in hand (key)	69c3ec4a75162223
20261004_225622	n/a	lamp in hand	0f8eb4c6b06af7eb
20261004_225737	n/a	diffuser removed, LED board in housing	8639ba57e393cc72
20261004_225740	n/a	diffuser removed, LED board in housing, angled	74b393aa8b4f378a
20261004_225757	LED.top	LED board, LED face, perpendicular (key)	aae1e2a92c16dbe4
20261004_225758	LED.top	LED board, LED face, perpendicular	8929ac47b1a19823
20261004_230022	DRV.A	driver component face and LED plate, overview	ac5a72151bfecd45
20261004_230024	DRV.A	driver component face and LED plate, overview	62e04cd95eb074c3
20261004_230028	DRV.A	driver component face, overhead (key)	0a4d444384479029
20261004_230030	DRV.A	driver component face with LED plate	7c1d6eef42d212fc
20261004_230038	DRV.A	driver component face, side elevation (key)	d59918b59e776893
20261004_230044	DRV.A	driver component face, angled; input pads F/N, VR1 (key)	27774df019cab7c2
20261004_230054	DRV.A	driver component face, angled; C3 and V+/V- pads	63fa0e32f3bcae06
20261004_230104	DRV.A	C3 sleeve: 68 uF 100 V (key)	24aaf694b13e740c
20261004_230106	DRV.A	driver component face, angled	305fda24c6354b5f
20261004_230119	DRV.A	driver component face, side elevation	876a4fed06d732a3
20261004_230136	DRV.A	L1, VR1, fusible resistor, C1/C2	2e36543ca6b8dae8
20261004_230158	DRV.A	VR1 marking	e7989da39a1eacb9
20261004_230211	DRV.A	VR1 marking 07D511K (key)	f17e076f075337fd
20261004_230229	DRV.A	C6/C8, C8 silkscreen	27b3e4049a3cb726
20261004_230232	DRV.A	film capacitor marking WEIDY 2S104J; fusible resistor bands (key)	f0ef864c92bdf542
20261004_230238	DRV.A	film capacitors, fusible resistor	48a4c77d7374dead
20261004_230247	DRV.A	component face close-up	b9cb5769e22bc638

File	Side	Subject	SHA-256 (prefix)
20261004_230254	DRV.A	C2/C3 silkscreen, C6/C8	dffbc8e818d0e0ab
20261004_230300	DRV.A	C6/C8 sleeves: 1 uF 50 V, 2.2 uF 50 V; C6/C8 silkscreen (key)	d5105447f83e846c
20261004_230312	DRV.A	fusible resistor colour bands (key)	ed43e4dfa1eb7888
20261004_230327	DRV.A	driver held, C3 sleeve	0d45498d96faba11
20261004_230339	DRV.B	SMD face, held	4cd94a1681a323af
20261004_230347	DRV.B	SMD face, held	65351a4ac7ef72e2
20261004_230348	DRV.B	SMD face, held	9d3f42d5a734ece1
20261004_230351	DRV.B	SMD face, held	5f34e4640d472273
20261004_230455	DRV.B	SMD face and LED board on paper, overview	46a800f037d88f10
20261004_230500	DRV.B	SMD face, perpendicular; reference image for the DRV board frame (key)	0709a301b986220c
20261004_230509	DRV.B	SMD face close-up, left and middle (key)	638bd25a0356ff6e
20261004_230513	DRV.B	SMD face close-up: U1, BD1, RL1 (key)	0a8ed337d7fc5349
20261004_230516	DRV.B	SMD face, side-lit: U1 marking (key)	d4cd6de3bf58b6c2
20261004_230522	DRV.B	SMD face	58c41da61a3ec961
20261004_230526	DRV.B	SMD face	6e79a63c50714c53
20261004_230532	DRV.B	SMD face, raking light: U1 marking (key)	99ed175c6b9624cb
20261004_230535	DRV.B	SMD face	5b76e4276044992b
20261004_230621	n/a	exploded view: dome, housing+cap, Al plate, LED board, driver, desoldered inductor, screws	40ffb3322ec53a5e
20261004_230626	n/a	exploded view (key)	72caef37308db3f7
20261004_230629	n/a	exploded view	c554636c90d90a5f
20261005_020417	DRV.B	U1 macro, raking light: marking BP26?5/6, 1BD96CS, H1AM4?; 7 leads, no lead at position 7 (key)	1689a0c398ba72e7
20261005_020422	DRV.B	U1 macro, raking light (key)	a1522176dc692490
20261005_020425	DRV.B	U1 macro, raking light	8a14f0ef569a9ffd
20261005_021417	DRV.B	copper side, wide section, even light: silkscreen, BD1 MB10F	ff6b10c0d1a6ec4d

File	Side	Subject	SHA-256 (prefix)
20261005_021428	DRV.B	copper side close-up: D1 marked ES1J, BD1, R1-R8 (key)	0b228617dac7d2c5
20261005_021727	DRV.B	copper side, handheld, blurred	c34a90479d694aa1
20261005_021800	DRV.B	copper side, handheld, angled	388ec6842398000b
20261005_025638	DRV.B + LED.top	both boards beside a mm ruler, straight down: the scale reference (key)	e02bd473103119c4



Photograph index: the first 46 inputs, labelled by file name

I. Close-up plates



(a) Housing print, macro



(b) Centre LED burn spot



(c) U1 marking, raking light

(d) C3 68 μ F 100 V

Plate A: (a) housing print, (b) centre LED burn spot, (c) U1 marking under raking light, (d) C3 68 μ F 100 V

J. Sources

Source: evidence/sources.yaml. Priority class per RFC 1 §5.4. BPS documents are referenced, not copied.

Id	Title	Class	Location
SRC-001	BP2335J Non-isolated Buck APFC LED Driver, datasheet Rev 1.0	1 manufacturer datasheet	https://5.imimg.com/data5/IM/TI/NH/SELLER-10637014/bp2335j-bp-semi-non-isolated-buck-apfc-led-driver.pdf
SRC-002	BP2866A Non-isolated Buck Offline LED Driver, datasheet Rev 1.0 (2 pages)	1 manufacturer datasheet	https://www.skytech.ir/Download/File/2482_Bp2866a.pdf

Id	Title	Class	Location
SRC-003	BPS general product overview, 2019-01-07	6 manufacturer design guide	https://dianyuan-public.oss-cn-shenzhen.aliyuncs.com/community/2019/04/25/1556153490-33602.pdf
SRC-004	"Win-win: LED chip thinking" (BPS presentation, 2018-08-31)	6 manufacturer design guide	https://www.big-bit.com/meeting/2018xm/images/hhbd/jfmyww.pdf
SRC-005	BPS high-performance luminaire product overview 2019.Q1	6 manufacturer design guide	https://dianyuan-public.oss-cn-shenzhen.aliyuncs.com/community/2019/04/25/1556152950-29615.pdf
SRC-006	alldatasheet / datasheet4u listings for BP2865, BP2865E (DIP7), BP2865XJ (SOT33-5)	14 general web source	https://www.alldatasheet.com/view.jsp?Searchword=BP2865
SRC-007	Crompton 9 W LED bulb collection and product pages	8 product documentation (vendor claims)	https://www.crompton.co.in/collections/9-watt-led-bulb
SRC-008	Retail listings (Amazon.in B0B6FFLBNL, B0DRSDV6JZ, B07NSRJH53; Flipkart; Moglix)	10 distributor (vendor claims)	https://www.amazon.in/dp/B0B6FFLBNL
SRC-009	YouTube repair videos of Crompton 9 W lamps (Inside Electronics IE181 and IE200; Abhishek Technical; Domestic Technician)	13 trusted engineering community (low-resolution frames only)	https://www.youtube.com/watch?v=VkNoUq8p3Is https://www.youtube.com/watch?v=ev-Ws4_awM0 https://www.youtube.com/watch?v=_1mgH--IVmI https://www.youtube.com/watch?v=0pF01TV-xJE https://www.youtube.com/watch?v=NzgpVC5FM3Y
SRC-010	IS 16102 (Part 1):2012 Self-ballasted LED lamps - safety	7 regulatory	https://law.resource.org/pub/in/bis/S05/is.16102.1.2012.pdf
SRC-011	IS 16102 (Part 2):2012 Self-ballasted LED lamps - performance	7 regulatory	https://law.resource.org/pub/in/bis/S05/is.16102.2.2012.pdf
SRC-012	BEE Schedule 20 - LED lamps star labelling (2018)	7 regulatory	https://www.beestarlabel.com/Content/Files/LED_schedule.pdf
SRC-013	BEE advisory BEE/S&L/52/LED/2023 (star table upgraded one level from 2023-07-01)	7 regulatory (via a test-lab copy)	https://labctl.in/wp-content/uploads/2023/07/E_NetDocsBEESL_Alerts06-23-23_052645_LED_Advisory1.pdf
SRC-014	Dixon Technologies lighting solutions	14 general web source	https://dixoninfo.com/lighting-solutions
SRC-015	LED bulb driver ICs and LED voltages	13 engineering community	https://320volt.com/en/led-bulb-driver-ics-and-led-voltages-led-lamp-repair/
SRC-016	JEDEC MS-012 (SOIC-8 narrow) nominal body 4.90 x 3.90 mm	11 engineering publication	standard package dimension, cited from engineering knowledge; not re-fetched

Id	Title	Class	Location
SRC-017	IE181: Flickering Crompton LED bulb repair (Inside Electronics), thumbnail 1280x720 and storyboard	13 trusted engineering community	https://www.youtube.com/watch?v=VkJNoUq8p3Is
SRC-018	IE200: Flickering Crompton 9W LED bulb repairing! (Inside Electronics), first 62 s at 720p and storyboard	13 trusted engineering community	https://www.youtube.com/watch?v=0pF01TV-xJE
SRC-019	Domestic Technician: Crompton 9W LED bulb repairing (two videos), thumbnails and storyboards	13 trusted engineering community	https://www.youtube.com/watch?v=_1mgH--IVmI https://www.youtube.com/watch?v=SUZc-gDzL3I
SRC-020	BP2836D non-isolated buck LED constant-current driver, datasheet Rev 1.0, Chinese	1 manufacturer datasheet	https://item.szlcsc.com/82773.html
SRC-021	BP2338J Non-isolated Buck APFC LED Driver, datasheet Rev 1.0 (2 pages)	1 manufacturer datasheet	https://eltsi.ru/upload/files/BP2338J.pdf
SRC-022	BP2336J Non-isolated Buck APFC LED Driver - distributor and datasheet-index summaries	10 distributor / 14 general web (full datasheet not retrieved - alldatasheet and datasheet4u return 403)	https://www.alldatasheet.com/datasheet-pdf/pdf/1141447/BPS/BP2336J.html https://datasheet4u.com/datasheets/BPS/BP2336J/1258897
SRC-023	BP2636B/C/D boost PFC constant-voltage driver - distributor and datasheet-index summaries	10 distributor	https://datasheet4u.com/datasheets/BPS/BP2636B/1545943 https://jlcpcb.com/partdetail/BPS_Bright_Power_Semicon-BP2636C/C5119893
SRC-024	BP2336J non-isolated buck active-PFC LED driver, datasheet Rev 2.2 (Chinese short form, 3 pages)	1 manufacturer datasheet	https://taoic.oss-cn-hangzhou.aliyuncs.com/8654/product/DDWDZ123_1628647841000.pdf
SRC-025	Bourns MOV-07D series metal oxide varistors (generic reference for 07D511K)	1 manufacturer datasheet (of the same part code, not this lamp's maker)	https://www.bourns.com/docs/product-datasheets/mov07d.pdf
SRC-026	Diodes Inc. MB10F bridge rectifier (generic reference)	1 manufacturer datasheet (of the same part code, not this lamp's maker)	https://www.diodes.com/assets/Datasheets/MB10F.pdf
SRC-027	BP2636B boost PFC constant-voltage driver, datasheet Rev 1.0 (Chinese, 10 pages)	1 manufacturer datasheet	https://www.bpsemi.com/upload/cn/file/2023-01-col355/1673430594587.pdf

K. Learnings, patterns, rules

All CANDIDATE state (RFC 4 §6): one unit, photographs only.

(e) C6/C8 1 μ F, 2.2 μ F 50 V

(f) VR1 07D511K



(g) FR1 bands: blue grey black gold



(h) C2 WEIDY 2S104J

Plate B: (e) C6/C8 1 μ F and 2.2 μ F 50 V, (f) VR1 07D511K, (g) FR1 colour bands, (h) C2 WEIDY 2S104J

Id	Domain	Pattern	Conf.
LRN-001	power_architecture	single-stage APFC buck with a low-voltage LED string and no bus electrolytic	0.7
LRN-002	manufacturing	dual footprints and trim positions for one board across variants and suppliers	0.6
LRN-003	protection	Indian-market lamp input stage	0.7
LRN-004	component_selection	LED boards reused across wattages	0.55
LRN-005	layout	FB upper resistor split across two parts	0.5
LRN-006	test	reading laser markings and copper under mask from phone photos	0.75

- **LRN-001.** Keeping the string near a quarter of the line peak (~81 V of 325 V) keeps the buck's dead zone small (14 deg), so PF > 0.9 is reachable with a buck - and the bus electrolytic disappears. The price is 100 Hz ripple, which lands on the output capacitor and shows up as flicker.
- **LRN-002.** One driver board covers several LED currents and both THT and SMD capacitor supply; empty footprints are set but glued.
- **LRN-003.** Fusible resistor in place of fuse + NTC; MOV across the input; pi filter after the bridge. The MOV clamp versus the IC's MOSFET rating is the weak link to check.
- **LRN-004.** A board printed 7W ships in a 9W lamp. A lamp's LED board label is not its operating point; compute power per package from the driver's current setting.
- **LRN-005.** In a floating-ground buck the FB chain sees bus-minus-output (~244 V) during on-time; two 1206 in series keep each under its 200 V working rating.
- **LRN-006.** Raking light read U1's marking where flat light could not, and four lightings gave four readings - recorded as CONFLICTING, not picked. Direct reads by eye were no better: the owner read the same part as BP2836, BP2336/BP2338 and BP2636 in turn, and v2.0 rebuilt the model on the first of those before the package and circuit ruled it out. Accept a marking read only when the board agrees with it; the board's own features (package, marking format, support parts, divider values, PF claim) identified the part (BP2336J) where no single read could. Copper under green mask did not resolve in any channel or contrast stretch; transmitted light or a continuity pass is needed for connectivity on single-sided boards.

Pattern	Name	Blocks	Conf.
PAT-001	APFC floating-ground buck LED driver (BP233xJ family, BP2336J here)	bridge; C-L-C pi filter; IC with integrated 500 V MOSFET; Rcs between CS and IC GND; freewheel diode to bus return; inductor from IC GND to LED+; output electrolytic; FB divider from LED+ to IC GND; VCC and COMP caps to IC GND	0.65
PAT-002	lamp input stage, India	fusible resistor in line; MOV across L-N; bridge; pi filter	0.7

Rule	Statement	From	Conf.
DR-001	In a non-isolated LED buck, the output capacitor's rated voltage shall exceed the open-LED OVP setpoint by at least 10%; compute the setpoint from the fitted parts, not the intended value.	RISK-02, CALC-04	0.6
DR-002	Size LED power per package from the driver's current setting and the string voltage, not from the LED board's label.	RISK-01, LRN-004	0.6

Rule	Statement	From	Conf.
DR-003	For a single-stage PFC LED driver without bulk capacitance, estimate the 100 Hz percent flicker from Cout and the string's dynamic resistance and state it.	RISK-04, CALC-10	0.5
DR-004	Check the working voltage and dissipation of every resistor that hangs off the rectified bus or a floating node (FB, start-up, bleed chains) per part, not per chain.	CALC-09	0.5
DR-005	Check MOV clamping voltage at the design surge current against the switch's BVDSS, accounting for bus capacitance.	RISK-03	0.55

Rule candidate	Check	Method	Priority
RULE-CAND-001	output_capacitor_voltage_vs_ovp	compute VOVP from the IC's OVP equation with the fitted parts (FB divider and threshold, or Rovp with L and Rcs); compare with Cout rated voltage x 0.9; flag a setpoint above the bus peak as no protection	high
RULE-CAND-002	per_package_power	ILED x Vf per package vs the LED's rated power; flag above 80%	high
RULE-CAND-003	estimated_percent_flicker	$1 / \sqrt{1 + (2 \pi 100 C_{out} r_d)^2}$ with rd from the LED datasheet; for a non-PFC buck without bulk capacitor, use the dead-zone droop instead	medium
RULE-CAND-004	working_voltage_per_part	worst-case voltage across the chain / number of parts vs the package's rated working voltage	medium
RULE-CAND-005	mov_clamp_vs_bvdss	MOV clamping voltage at the specified surge current minus bridge drop vs MOSFET BVDSS	medium

L. Completeness, quality, and the model files

Category	Score	Weight	Reason
product	0.92	0.05	ratings, BIS, date read; model code best-read 09NBS09-9
components	0.85	0.15	all parts inventoried; D1 ES1J and BD1 MB10F read; U1 a best guess (BP2336J, 0.75); L1/L2/LED values best guesses, not read
connectivity	0.4	0.15	no net traced; 13 of 16 nets mapped from the BP233x reference design (LIKELY)
architecture	0.85	0.1	blocks and diagram complete; topology INFERRED from the circuit
power	0.8	0.1	power tree and 11 calculations on the family datasheet; nothing measured
circuits	0.65	0.15	three circuits analysed; equations rest on the BP2336J best guess (0.75); best guesses do not raise completeness
pcb	0.45	0.1	outlines and placement measured against a ruler; routing, grounding, loops unknown
protection	0.72	0.05	full matrix; surge assessment unknown
manufacturing	0.6	0.05	process inferred; BOM cost not estimated
evidence	0.85	0.05	51 evidence records; ruler-scaled photographs
unknowns	1	0.05	19 unknowns tracked; 4 resolved

Overall completeness against Level 4: **0.7**.

Quality dimension	Score	Reason
evidence integrity	0.85	every input hashed; every image claim has a pixel location; crops EXIF-stripped
claim correctness	unknown	no ground truth; see confidence.yaml calibration
traceability	0.85	claims -> evidence -> sources chained; calculations name their inputs
engineering depth	0.7	datasheet-level circuit analysis and 11 calculations; no measurement, no traced nets
uncertainty handling	0.85	conflicting readings kept as CONFLICTING; candidate-conditional results labelled; Level 5 not claimed

Overall quality (self-assessed): **0.81**.

The model: 46 YAML files, each carrying a provenance block (RFC 1 §25.4).

File

```

architecture/architecture.yaml
architecture/functional-blocks.yaml
architecture/power-tree.yaml
architecture/signal-flow.yaml
circuits/index.yaml
circuits/other/led-string.yaml
circuits/power/apfc-buck.yaml
circuits/protection/input-stage.yaml
components/components.yaml
components/critical-components.yaml
components/substitutions.yaml
components/unidentified.yaml
evidence/citations.yaml
evidence/evidence.yaml
evidence/sources.yaml
input/manifest.yaml
learnings/circuit-patterns.yaml
learnings/design-rules.yaml
learnings/future-checks.yaml
learnings/learnings.yaml
metrics/completeness.yaml
metrics/confidence.yaml
metrics/quality-score.yaml
pcb/grounding-analysis.yaml
pcb/manufacturing-analysis.yaml
pcb/placement-analysis.yaml
pcb/power-integrity.yaml
pcb/routing-analysis.yaml
pcb/signal-integrity.yaml
pcb/stackup.yaml
pcb/thermal-analysis.yaml

```

File

product/boards.yaml
product/interfaces.yaml
product/mechanical.yaml
product/product.yaml
reconstruction/connectivity.yaml
reconstruction/inferred-netlist.yaml
reconstruction/nets.yaml
reconstruction/reconstruction-confidence.yaml
teardown.yaml
verification/checks.yaml
verification/datasheet-comparison.yaml
verification/findings.yaml
verification/protection-matrix.yaml
verification/reference-design-comparison.yaml
verification/risks.yaml
