### **Test Report — Photodiode IR-Drop-Detector Breadboard**

*(23 May 2025, DFA, 22 °C, overhead LED lighting)*

#### **1 Objective**

Validate a simple reverse-biased photodiode stage and choose the **bias resistor, AC-coupling constant and comparator hysteresis** that give reliable detection of IV-drip “shadow” pulses. The data will freeze the analogue front-end values for PCB Rev A.

#### **2 Set-up**

| **Item** | **Value / Part** | **Notes** |
| --- | --- | --- |
| Photodiode | Vishay **BPV10NF** | Capacitance 11 pF typ. |
| LED drive | 100 Ω in series, **18.8 mA** forward current | Held constant for all runs |
| Supply | 3 V 3 bench supply, <10 mV p-p ripple |  |
| Scope | Keysight MSOX-3024T, 5 ms/div, 500 mV/div, 1 MSa/s, 1 Mpts |  |
| Environment | 22 °C, overhead LED panels | Phone charger nearby introduced ≈ 5 mV bursts (EMI) |
| File set† | • 9 waveform CSV for R = 2 k0, 2 k7, 3 k3, 4 k7 Ω (three trials each‡) |  |
| • **bright\_R2700**, **dark\_R2700** reference traces | † All passives 0603; filenames in data/raw\_data/2025-05-23\_PD\_experiment/. |  |
|  |  |  |

#### **3 Raw observations (hand-cursor readings)**

| **R<sub>BIAS</sub> (Ω)** | **V<sub>baseline</sub> (V)** | **V<sub>peak</sub> (V)** | **ΔV<sub>pp</sub> (mV)** | **10-90 % rise (ms)** |
| --- | --- | --- | --- | --- |
| 2 000 | 2.76 | 3.12 | **360** | 2.8 |
| 2 700 | 2.53 | 2.96 | **500** | 2.9 |
| 3 300 | 2.40 | 3.04 | **640** | 2.6 |
| 4 700 | 2.38 | 3.16 | **780** | 2.8 |

*Ambient-light references* (R = 2 k7):  
 dark pk-pk ≈ 140 mV, bright pk-pk ≈ 160 mV (FFT peaks at 50 Hz & 150 kHz).

#### **4 Interpretation & design decisions**

| **Design element** | **Calculation / Reasoning** | **Preliminary value** |
| --- | --- | --- |
| **Bias resistor R<sub>B</sub>** | Choose smallest R with ΔV ≥ 0.40 V → **2 k7 Ω** (E24). | 2 k7 Ω (0603) |
| Photocurrent I<sub>ON</sub> | (3.30 V – 2.53 V)/2 k7 ≈ **285 µA** | – |
| **AC-coupling τ** | Require τ ≈ 5 × 2.9 ms ≈ 15 ms. | C<sub>SER</sub> ≈ 15 ms / 2 k7 ≈ **5.6 µF** → fit **4.7 µF X5R (0805)** ‖ 100 nF (0603) |
| **Comparator threshold** | AC coupling centres waveform ≈ 1.65 V. | Divider 47 k / 47 k to 1.65 V |
| **Hysteresis** | σ<sub>noise</sub> (dark) ≈ 12 mVrms → 6σ ≈ 70 mV. | R<sub>HYS</sub> ≈ 1 MΩ (gives ±70 mV) |
| **Comparator** | Open-collector, 3 V 3, cheap | LM393 (SOIC-8) |
| *Optional* TIA pads | Head-room 2.6 V, I<sub>ON</sub> 0.285 mA → R<sub>f</sub> ≈ 9.1 kΩ. BW ≥ 5/2.9 ms ≈ 1.7 kHz → C<sub>f</sub> ≈ 10 nF. | Footprints only; DNI in Rev A |

#### **5 Conclusions**

1. **R<sub>B</sub> = 2 k7 Ω** gives ≥ 0.5 V swing with ample rail head-room and lowest permissible noise.
2. An **AC-coupling network 4.7 µF ‖ 100 nF / 2 k7 Ω** preserves the full 3 ms edge yet resets within 50 ms (for future 5 Hz drip-rate).
3. A **hardware comparator** (LM393) with **70 mV hysteresis** eliminates MCU sampling burden; GPIO interrupt latency no longer matters.
4. EMI observed from a phone charger indicates that PCB trace pairs to LED and photodiode **must be ≤ 30 mm and routed as a tight differential pair**; series 10 Ω bead or Ferrite optional.