



LED Drivers

***A Practical Understanding
for Lighting Applications***

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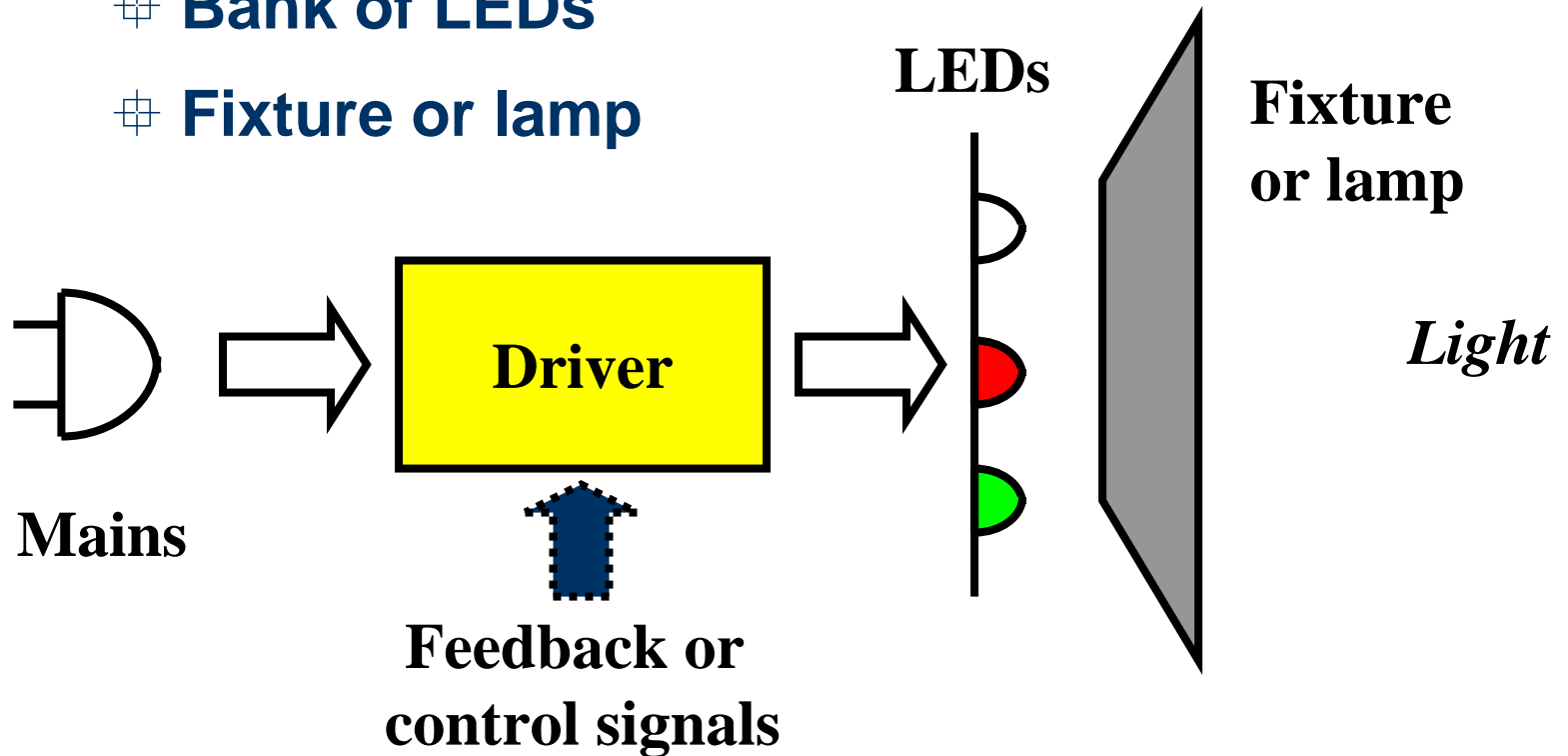
Al Marble, Philips-Advance

Outline

- # **What is a driver?**
- # **Design types**
- # **Constant current vs. constant voltage**
- # **Standards/compliance to codes**
- # **Environmental/temperature ratings**
- # **Power factor correction**

Typical SSL system

- # Driver
- # Bank of LEDs
- # Fixture or lamp

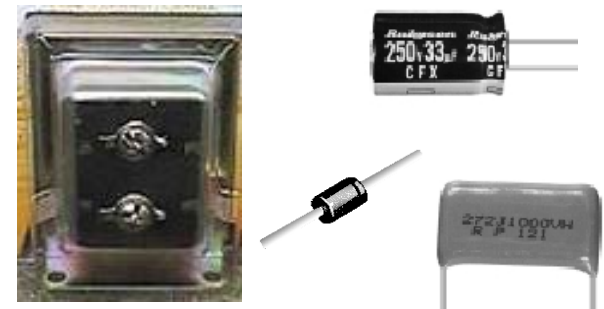


Purpose and Function

- ⊠ “Driver” term adopted from electronic component terminology
- ⊠ Similar function as ballast
 - ⊠ Processes line voltage into power usable by LED’s
 - ⊠ Regulates and controls current to LED’s



Switch-mode electronic solutions



Magnetic solutions

Resistor/Cap/Diode combination

✚ *Example*

- ✚ Film capacitor to drop mains voltage
- ✚ Rectify signal with diodes
- ✚ Use resistor to limit current

✚ *Advantages*

- ✚ Inexpensive & small

✚ *Disadvantages*

- ✚ Limited power range
- ✚ Inefficient (~50%)
- ✚ No LED brightness regulation
- ✚ No power factor correction
- ✚ Susceptible to line transients
- ✚ High LED ripple current (high crest factor)



Design Type: Magnetic

⊠ Example

- ⊠ Use 60Hz step down transformer
- ⊠ Rectify signal with diode bridge
- ⊠ Use capacitor to filter ripple

⊠ Advantages

- ⊠ Low cost (?)

⊠ Disadvantages

- ⊠ Limited LED current regulation
- ⊠ Weight & Size
- ⊠ Low power factor
- ⊠ Power de-rating
- ⊠ Safety concerns



Design Type: Switch-Mode Electronic

⊠ Example

- ⊠ Flyback converter
- ⊠ PF correction IC
- ⊠ MOSFET or BJT switch

⊠ Advantages

- ⊠ High efficiency
- ⊠ Small size & weight
- ⊠ Power factor correction
- ⊠ Regulation & Controllability

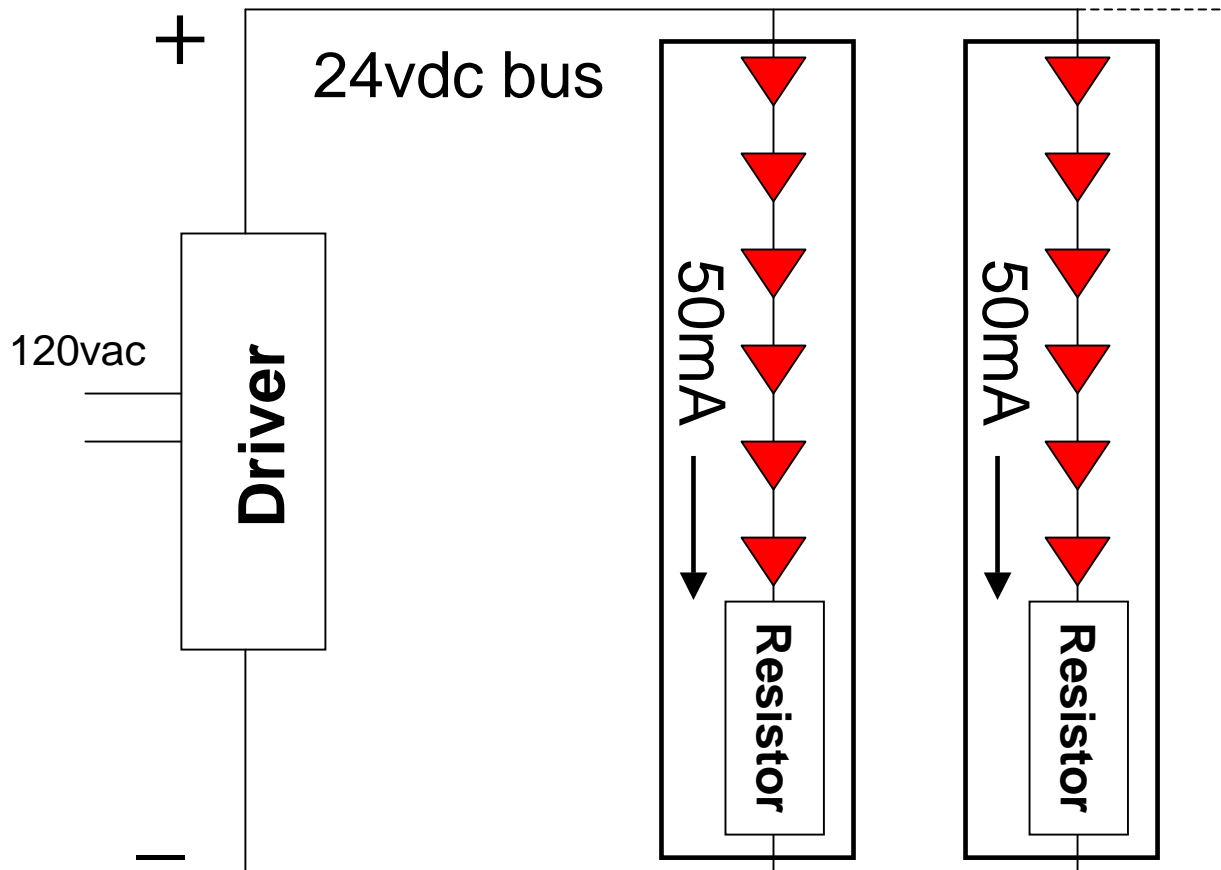
⊠ Disadvantages

- ⊠ Higher cost (?)



Operation Type: Voltage Regulated

- # Fixed output voltage (12vdc or 24vdc)
- # Load up to max current/power rating



Operation Type: Voltage Regulated

⊠ Advantage

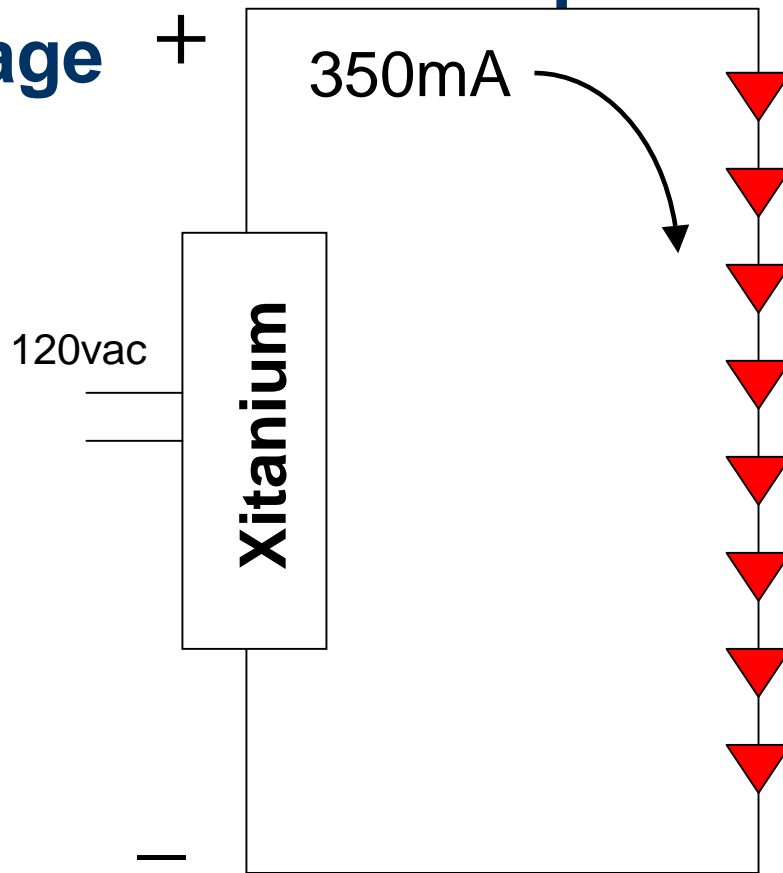
- ⊠ Flexibility to connect variable LED load
- ⊠ Simple application

⊠ Disadvantage

- ⊠ More parts on LED array (current limiting resistors)
- ⊠ Not as energy efficient

Operation Type: Current Regulated

- ⊕ **Fixed output current (e.g., 350mA)**
- ⊕ **Add load in series up to max output voltage**



Operation Type: Current Regulated

⊠ Advantage

- ⊠ Greater energy efficiency (no current limiting resistors)

⊠ Disadvantage

- ⊠ Less flexibility in connecting variable number of LEDs

⊠ In general,

- ⊠ Constant Current for high flux LEDs and,
- ⊠ Constant Voltage for low flux LEDs

Standards/Compliance to Codes



⊕ **UL “Recognized Component” status**

- ⊕ UL not providing “Listing” for LED drivers
- ⊕ Key: Listing in Sign Accessory Manual (SAM)
- ⊕ Confusing to field inspectors

⊕ **UL Class 2 (defined in UL 1310)**

- ⊕ Load voltage <30vdc, load current <5 amps
- ⊕ Short circuit protection: Secondary fusing or inherent power limitation
- ⊕ Implies conduit on secondary not required, but many local codes require anyways

Environmental/Temperature Ratings

⊠ Environmental ratings

- ⊠ Dry location: Protected from any moisture
- ⊠ Damp location: Suitable for self-contained signs/raceway installation
 - ※ Mount ½-inch from bottom of enclosure!
 - ※ Referred in UL 935 as “Outdoor Type II”
- ⊠ Wet location: Weatherproof housing/enclosure

⊠ Temperature ratings

- ⊠ Case ratings used by OEMs, impractical for field use
- ⊠ Look for ambient rating for sign application

Power Factor Correction

- ⊕ **Best understood by thinking of it as “current factor correction”**
 - ⊕ Power factor corrected drivers have lower input amperage draw
- ⊕ **Lighting industry standards**
 - ⊕ High power factor (HPF): >90%
 - ⊕ Normal power factor (NPF): <90...60% typical

Power Factor Correction

Concept:

For a given LED load . . . HPF driver draws less input amps than NPF driver

⊕ Power factor correction is not related to:

- ※ Wattage
- ※ Power supply losses (efficiency)
- ※ How the LEDs are driven

Power Factor Correction

60 Watt HPF Driver

From Utility:

75 watt **0.7 amp** 120vac



LED Load:

60 watt 5 amp 12vdc



⊕ 60 Watt NPF Driver

From Utility:

75 watt **1.0 amp** 120vac



LED Load:

60 watt 5 amp 12vdc



Power Factor Correction

Who cares?

✦ The utility

- ✦ User pays utility for “wattage” (i.e., input power)
- ✦ Utility must generate “amperage,” so NPF with higher amperage more costly to utility for the same money received from customer

Power Factor Correction

Who cares?

Anyone concerned with the environment

Less amperage



Less generation requirement



Less pollutants

What to look for in a Driver

⊠ Performance

- ⊠ Regulated output
- ⊠ Power factor correction
- ⊠ Efficiency

⊠ Size

⊠ Life and Reliability

⊠ Environmental concerns

- ⊠ Temperature range
- ⊠ Dry, damp, or wet location

⊠ Safety

- ⊠ UL Recognition/SAM listing
- ⊠ Class 2



Questions?

www.LEDcentral.com