LED Drivers

A Practical Understanding for Lighting Applications

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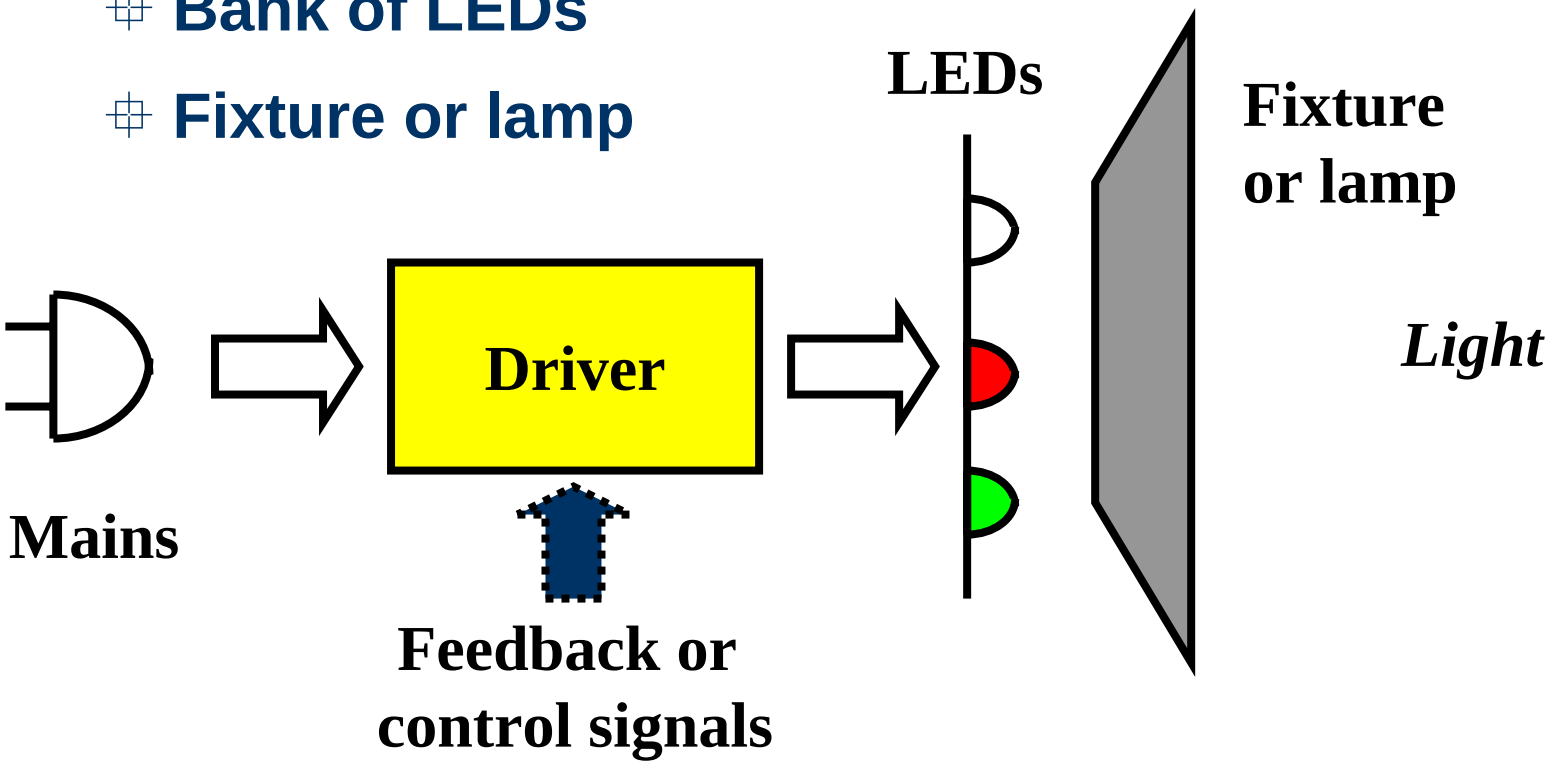
Outline

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

Typical SSL system

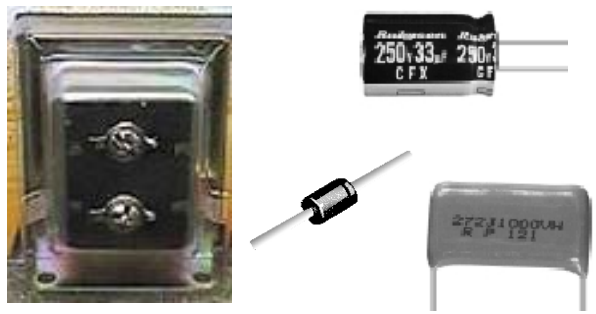
- Driver
- Bank of LEDs
- Fixture or lamp



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)

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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

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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 (?)

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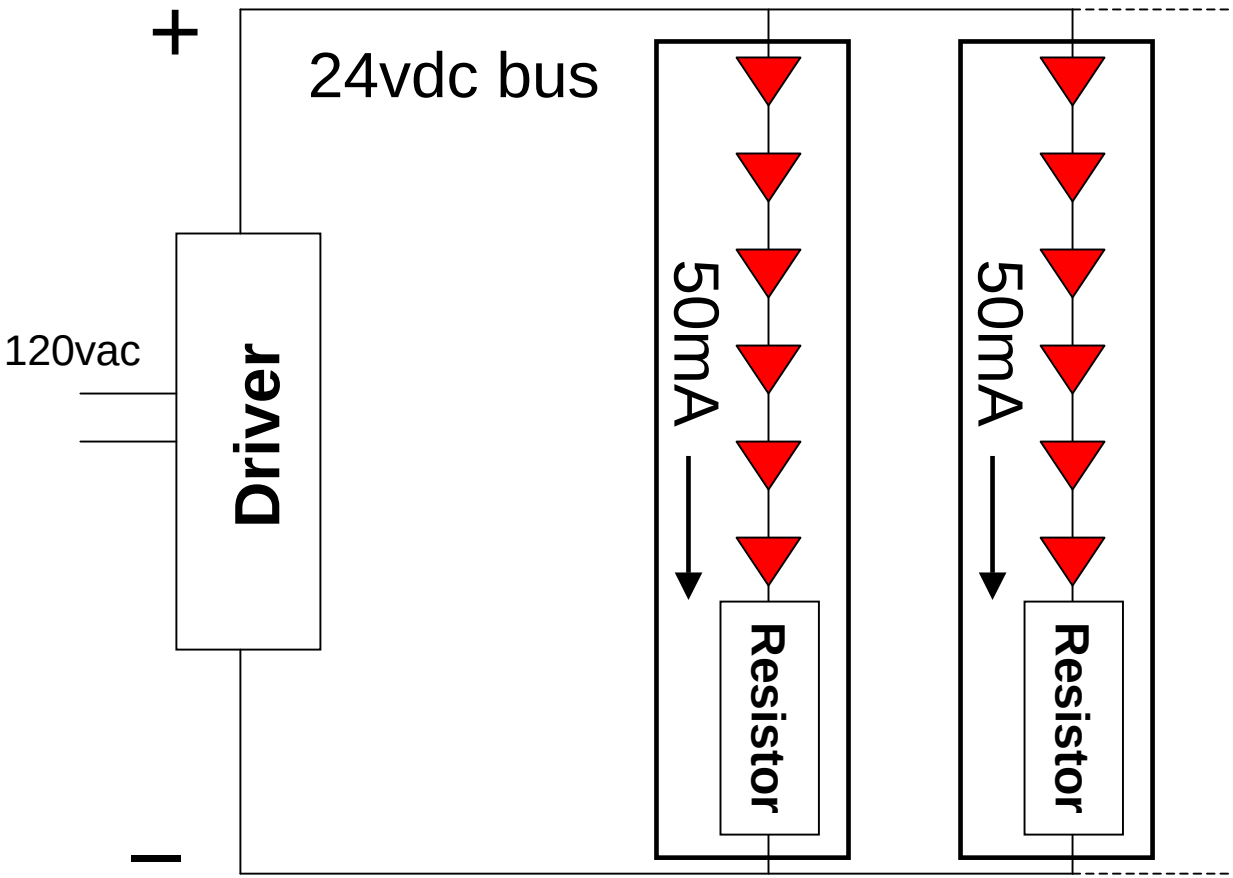
Operation Type:Voltage Regulated

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

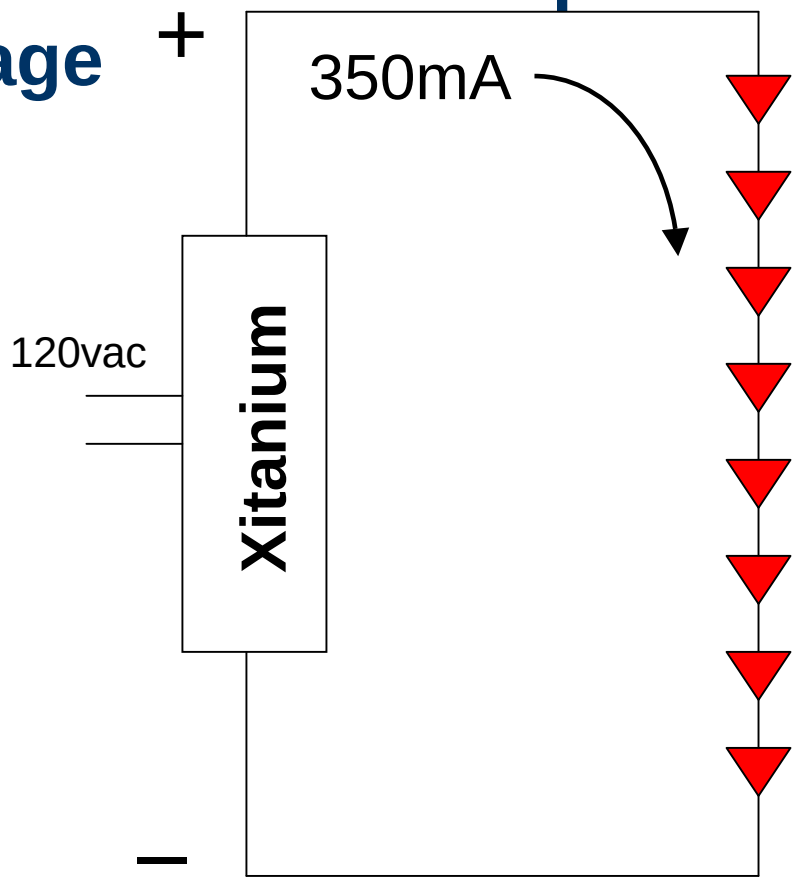


Operation Type:Voltage Regulated

- **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

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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

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Power Factor Correction

Concept:

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

- Power factor correction is <u>not</u> related to:
  - Wattage
  - Power supply losses (efficiency)
  - How the LEDs are driven

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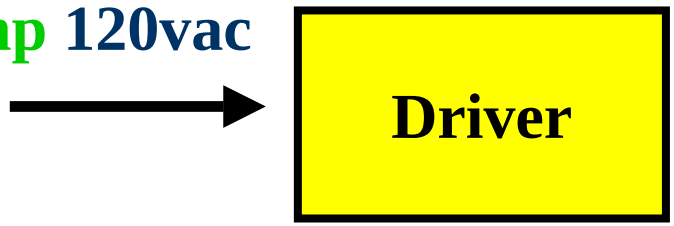
Power Factor Correction

60 Watt HPF Driver

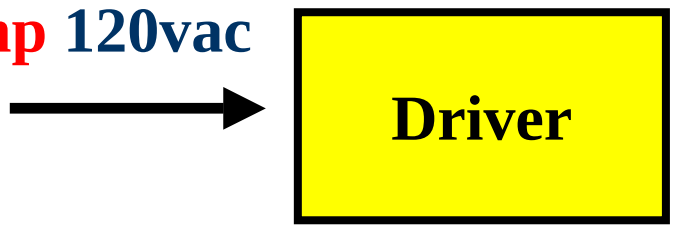
From Utility:
75 watt 0.7 amp 120vac



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

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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?

- **Whoever pays for installation**
  - 60 watt example: HPF driver draws 0.7 amps
    NPF driver draws 1.0 amps
  - 20 amp breaker: Load to 16 amps per NEC
    - HPF: Load 22 drivers on one circuit
    - NPF: Load 16 drivers on one circuit
  - Cost of a running a circuit……very high!

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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