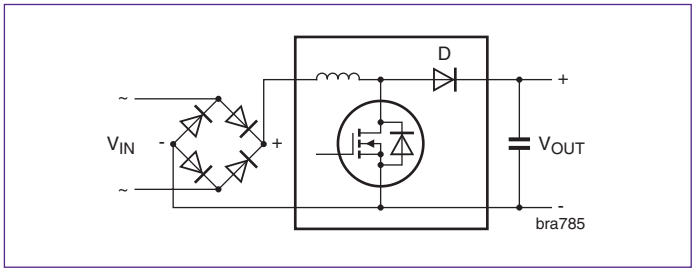
Bipolar power diodes and transistors for electronic ballast

# Understanding PFC - Lighting applications

### What is Power Factor Correction (PFC)

- It can be defined as the reduction of the harmonic content, and/or the aligning of the phase angle of incoming current
- PFC is required to reduce disturbance on the AC distribution net and maximize the real power drawn by the power supply from the AC line.

### Boost PFC circuit

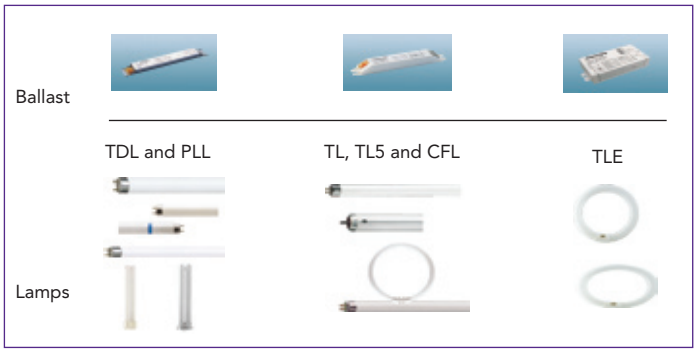



### PFC benefits

- Fully compliant with regional regulations imposing restrictions on power factor and total harmonic distortion (THD) in high-power applications (>75W), including:
  - CCC or '3'C in China
  - IEC1000-3-2/EN61000-3-2 in Europe
  - '80plus policy' in America
  - JICC61000-3-2 in Japan
- Meets energy saving and 'green energy' trends to reduce electricity costs
- Optimizes and improves circuit performance
  - reduces mains harmonic content
  - decreases peak current at mains frequency
  - minimizes the electrolytic bulk capacitor used at PFC stage output
  - shrinks mains transformer size and weight
  - improves output regulation of downstream DC/DC converters

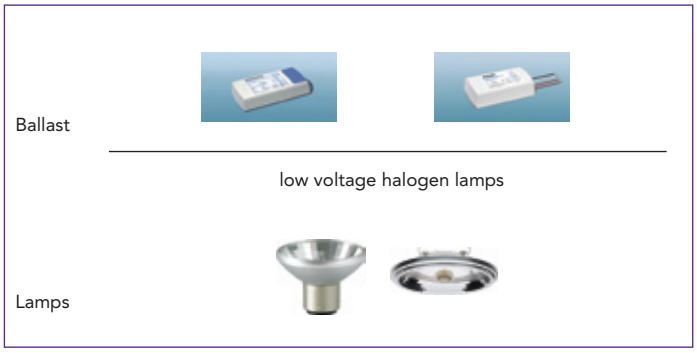
NXP founded by Philips

## Electronic ballast for fluorescent lamps

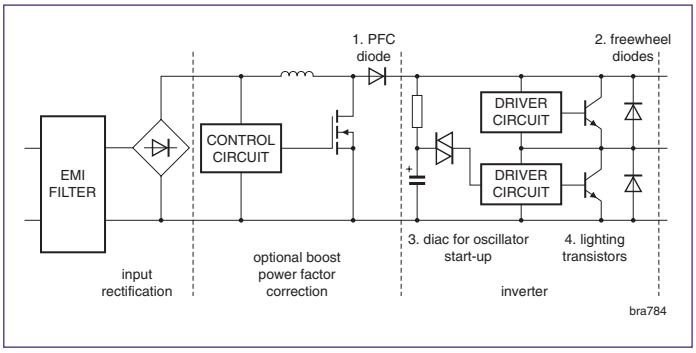



## Electronic ballast for high intensity discharge lamps


## Electronic ballast for halogen lamps




## Typical schematic for electronic ballast with PFC function




## Hyperfast & ultrafast recovery diodes for PFC

| $V_{RRM}$ (V) | $I_{F(AV)}$ (A) | $V_F$ (typ) @ 150C (V) | @ $I_F$ (A) | $t_{rr}$ (typ) @ 25C (ns) | SOD59 (TO220AC) | SOD113 (2-pin SOT186A) | SOT78 (TO220AB) | SOT186A (isolated TO220AB) | SOT404 ($D^2PAK$) |
|---|---|---|---|---|---|---|---|---|---|
| **Ultrafast diodes for Discontinuous or Critical Current Mode** | | | | | | | | | |
| 500 | 9 | 0.9 | 8 | 50 | BYV29-500 | BYV29X-500 | | | BYV29B-500 |
| 500 | 2 x 5 | 0.95 | 5 | 50 | | | BYT28-500 | | |
| 500 | 14 | 0.9 | 15 | 50 | BYT79-500 | | | | |
| 500 | 2 x 10 | 0.87 | 10 | 50 | | | BYV34-500 | | |
| 500 | 2 x 15 | 0.95 | 15 | 50 | | | BYV44-500 | | |
| 600 | 8 | 1.07 | 8 | 60 | BYR29-600 | BYR29X-600 | | | |
| 600 | 9 | 0.9 | 8 | 50 | **BYV29-600** | BYV29X-600 | | | BYV29B-600 |
| 600 | 14 | 0.9 | 15 | 50 | **BYT79-600** | **BYT79X-600** | | | |
| 600 | 2 x 10 | 0.87 | 10 | 50 | | | **BYV34-600** | **BYV34X-600** | |
| **Hyperfast diodes for Continuous Current Mode** | | | | | | | | | |
| 600 | 5 | 1.4 | 5 | 19 | BYC5-600 | **BYC5X-600** | | | BYC5B-600 |
| 600 | 8 | 1.4 | 8 | 19 | BYC8-600 | **BYC8X-600** | | | BYC8B-600 |
| 600 | 10 | 1.4 | 10 | 19 | BYC10-600 | **BYC10X-600** | | | BYC10B-600 |
| 600 | 2 x 5 | 1.4 | 5 | 19 | | | BYC10-600CT | | |

Types in bold red represent new products

## Diac for oscillator start-up

| $I_{(FRM)}$ (A) | $V_{(BO)}$ (V) | $I_{(BO)}$ max (µA) | SOD27 |
|---|---|---|---|
| 2 | 28~36 | 50 | BR100/03 |

## Ultrafast recovery diodes (for freewheel diodes and output rectifiers)

| $V_{RRM}$ (V) | $I_{F(AV)}$ (A) | $V_F$ (typ) @150C (V) | @ $I_F$ (A) | $t_{rr}$ (typ) @ 25C (ns) | SOD59 (TO220AC) | SOD113 (2-pin SOT186A) | SOT78 (TO220AB) | SOT186A (isolated TO220AB) | SOT223 | SOT404 ($D^2$PAK) | SOT428 (DPAK) | SOT429 (TO247) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 | 8 | 0.8 | 8 | 20 | BYW29E-100 | | | | | | | |
| 100 | 2 x 10 | 0.72 | 8 | 20 | | | BYV32E-100 | | | | | |
| 150 | 2 x 0.75 | 0.5 | 0.5 | 10 | | | | | BYV40E-150 | | | |
| 150 | 8 | 0.8 | 8 | 20 | BYW29E-150 | | | | | | | |
| 150 | 2 x 10 | 0.72 | 8 | 20 | | | BYV32E-150 | | | | | |
| 150 | 2 x 15 | 0.78 | 15 | 20 | | | BYV42E-150 | | | | | |
| 200 | 8 | 0.8 | 8 | 20 | BYW29E-200 | BYW29EX-200 | | | | | BYW29ED-200 | |
| 200 | 2 x 5 | 0.8 | 5 | 15 | | | BYQ28E-200 | BYQ28EX-200 | | | BYQ28ED-200 | |
| 200 | 14 | 0.83 | 14 | 20 | BYV79E-200 | | | | | | | |
| 200 | 2 x 8 | 0.84 | 8 | 20 | | | BYQ30E-200 | | | | | |
| 200 | 2 x 10 | 0.72 | 8 | 20 | | | BYV32E-200 | | | BYV32EB-200 | | |
| 200 | 2 x 15 | 0.78 | 15 | 20 | | | BYV42E-200 | | | BYV42EB-200 | | |
| 200 | 2 x 15 | 0.83 | 15 | 20 | | | | | | | | BYV72EW-200 |
| 300 | 2 x 5 | 0.95 | 5 | 50 | | | BYT28-300 | | | | | |
| 400 | 9 | 0.9 | 8 | 50 | BYV29-400 | | | | | | | |
| 400 | 2 x 10 | 0.87 | 10 | 50 | | | BYV34-400 | | | | | |
| 400 | 2 x 15 | 0.95 | 15 | 50 | | | | | | | | BYV74W-400 |
| 500 | 9 | 0.9 | 8 | 50 | BYV29-500 | BYV29X-500 | | | | BYV29B-500 | | |
| 500 | 2 x 5 | 0.95 | 5 | 50 | | | BYT28-500 | | | | | |
| 500 | 14 | 0.9 | 15 | 50 | BYT79-500 | | | | | | | |
| 500 | 2 x 10 | 0.87 | 10 | 50 | | | BYV34-500 | | | | | |
| 500 | 2 x 15 | 0.95 | 15 | 50 | | | BYV44-500 | | | | | |
| 600 | 8 | 1.07 | 8 | 60 | BYR29-600 | BYR29X-600 | | | | | | |
| 600 | 9 | 0.9 | 8 | 50 | **BYV29-600** | BYV29X-600 | | | | BYV29B-600 | | |
| 600 | 14 | 0.9 | 15 | 50 | **BYT79-600** | **BYT79X-600** | | | | | | |
| 600 | 2 x 10 | 0.87 | 10 | 50 | | | **BYV34-600** | **BYV34X-600** | | | | |
| 800 | 8 | 1.07 | 8 | 60 | BYR29-800 | | | | | | | |

Types in bold red represent new products

## High voltage bipolar transistors for lighting, self oscillating power supplies & industrial applications

| $V_{CESM}$ (V) | $I_{C(DC)}$ (max) (A) | $t_f$ (typ) (ns) | @ $I_C$ (A) | $h_{FEsat}$ (typ) | SOT54 (TO92) | SOT78 (TO220AB) | SOT82 | SOT186A (isolated TO220AB) | SOT404 ($D^2$PAK) | SOT428 (DPAK) |
|---|---|---|---|---|---|---|---|---|---|---|
| 700 | 1 | 50 | 1 | 14 | BUJ100 | | | | | |
| 700 | 4 | 30 | 2 | 12,5 | | BUJ103A | | BUJ103AX | | BUJ103AD |
| 700 | 4 | 100 | 2 | 17 | | PHE13005 | | **PHE13005X** | | |
| 700 | 8 | 20 | 5 | 11 | | BUJ105A | | | BUJ105AB | BUJ105AD |
| 700 | 8 | 40 | 5 | 9 | | PHE13007 | | | | |
| 700 | 10 | 20 | 5 | 11 | | BUJ106A | | | | |
| 700 | 12 | 100 | 5 | 6min - 30max | | PHE13009 | | | | |
| 800 | 0.5 | 280 | 0.2 | 28 | | | BUX86P | | | |
| 1000 | 0,5 | 280 | 0,2 | 28 | | | BUX87P | | | |
| 1000 | 2 | 400 | 1 | 13 | | BUX85 | | | | |
| 1000 | 5 | 80 | 2,5 | 13 | | BUT11AI | | | | |
| 1000 | 5 | 80 | 2,5 | 13 | | BUT11A | | BUT11AX | | |
| 1000 | 5 | 145 | 2,5 | 12 | | BUJ303A | | | | |
| 1000 | 6 | 150 | 4 | 14 | | BUT18A | | | | |
| 1000 | 8 | 150 @ 100C | 5 | 10 | | BUT12AI | | | | |
| 1000 | 8 | 200 @ 100C | 5 | 16 | | | | BUT12AX | | |
| 1050 | 5 | 200 | 2,5 | 10,5 | | BUJ303B | | | | |
| 1200 | 6 | 170 | 2,5 | 15,5 | | BUJ403A | | | | |

Types in bold red represent new products

## Lighting transistor selection guide

| Topology | | Voltage fed push pull | | Current fed push pull | | Current fed half bridge | | Voltage fed half bridge | |
|---|---|---|---|---|---|---|---|---|---|
| A.C. Supply | 120V | BUJ100 | 25W | BUX87P | 13W | BUJ100 | 20W | BUJ100 | 13W |
| | | | | BUX85 | 55W | | | | |
| | | BUT11AI | 80W | BUT11A | 140W | BUT11AI | 70W | BUT11AI | 40W |
| | | PHE13005 | 100W | BUT11AI | 140W | PHE13005 | 80W | PHE13005 | 50W |
| | | BUJ103A | 110W | BUT11AX | 140W | BUJ103A | 90W | BUJ103A | 55W |
| | | BUT12AI | 120W | BUT18A | 160W | BUT12AI | 100W | BUT12AI | 60W |
| | | PHE13007 | 170W | BUJ303A | 170W | PHE13007 | 135W | PHE13007 | 85W |
| | | BUJ105A | 180W | BUJ303B | 170W | BUJ105A | 145W | BUJ105A | 90W |
| | | BUJ105AB | 180W | BUT12AI | 220W | BUJ105AB | 145W | BUJ105AB | 90W |
| | | PHE13009 | 210W | BUT12AX | 220W | PHE13009 | 165W | PHE13009 | 105W |
| | | BUJ106A | 220W | | | BUJ106A | 175W | BUJ106A | 110W |
| | 230V | BUJ403A | 215W | | | BUX87P | 13W | BUJ100 | 25W |
| | | | | | | BUX85 | 55W | BUJ100B | 25W |
| | | | | | | BUT11A | 140W | BUT11AI | 80W |
| | | | | | | BUT11AI | 140W | PHE13005 | 100W |
| | | | | | | BUT11AX | 140W | BUJ103A | 110W |
| | | | | | | BUT18A | 160W | BUT12AI | 120W |
| | | | | | | BUJ303A | 170W | PHE13007 | 170W |
| | | | | | | BUJ303B | 170W | BUJ105A | 180W |
| | | | | | | BUT12AI | 220W | BUJ105AB | 180W |
| | | | | | | BUT12AX | 220W | PHE13009 | 210W |
| | | | | | | | | BUJ106A | 220W |

## Bipolar diodes in various PFC power applications

| Computer | Consumer | Telecom | Lighting |
|---|---|---|---|
| Desktop<br>File server<br>Notebook adapter | Adapter<br>Plasma TV<br>LCD TV<br>CRT TV | AC/DC converter<br>UPS | Ballast |

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