NXP high voltage power bipolar transistors BUJ & PHx series

High voltage power bipolar transistors for lighting

Our high voltage power bipolar transistors are part of our industry-leading portfolio for energy-efficient lighting. Designed to support electronic ballast and transformer applications, they are available in versions from 700 to 1200 V and deliver very high efficiency with exceptional reliability.

Key Features

- Planar technology
  - Market benchmark process technology
  - Best cost-performance ratio of all technologies
- High voltage capability
  - V_{CESM} up to 1200 V
  - Suitable for push-pull topologies
- Fast switching and low V_{CEsat}
  - Low fall time (t_f) at turn-off reduces switching loss
  - Low saturation voltage (V_{CEsat}) reduces conduction loss
- Well-controlled h_{FE}
  - h_{FE} distribution is well controlled by design and production
  - Tight parameter control reduces the need for banding or selection
  - Design-in to customers' circuits is easy
  - Design-in for life – extended reliability
- Integrated diode versions
  - Reduced component count
  - Simpler circuits
  - Improved performance and reliability

Key Benefits

- Competitive and customer-oriented product portfolio
- Experienced development team with deep understanding on device physics
- Excellent application know-how and instant technical support
- Well-controlled manufacturing and robust supply chain

The NXP BUJ and PHx series of high voltage power bipolar transistors use planar technology that delivers industry-leading cost-performance ratios. The high-voltage (up to 1200 V) capability is suitable for push-pull technologies. Fast switching times and low V_{CEsat} ratings combine to reduce switching and conduction losses. The well-controlled h_{FE} parameter reduces the need for banding or selection, making design-in easier and extending reliability. Versions with integrated diodes reduce component count and simplify the design even further.

How to design the base drive

Figure 1 shows a typical CFL drive circuit. Minimum power loss can be achieved by choosing the optimum base drive for the high voltage transistors.

Figure 2 shows power loss as a function of base drive. Weak base drive (too low a base current) causes too high a saturation voltage (V_{CEsat}), which results in higher than necessary conduction loss. Strong base drive (too high a base current) causes too much stored charge in the transistor when it's in the on-state. As long as the transistor is conducting, that's not a problem, but when the transistor has to be turned off, the excess charge that needs to be removed from the base can cause a longer fall time and higher switching losses. The base drive is normally optimized for a 'typical' transistor – that is, a transistor from normal production with a typical gain (h_{FE}).

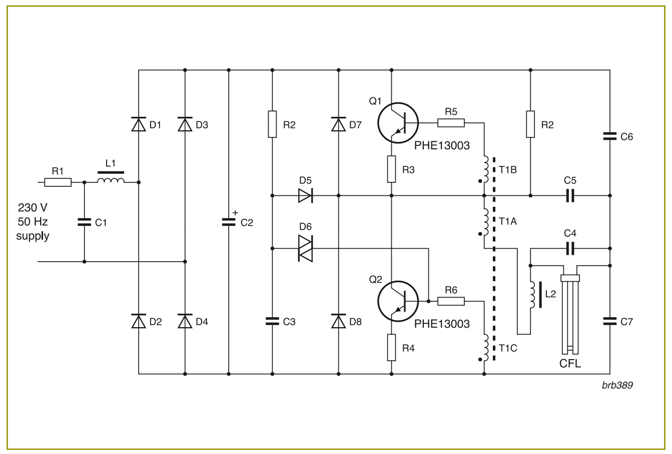


Figure 1. Typical CFL drive circuit.

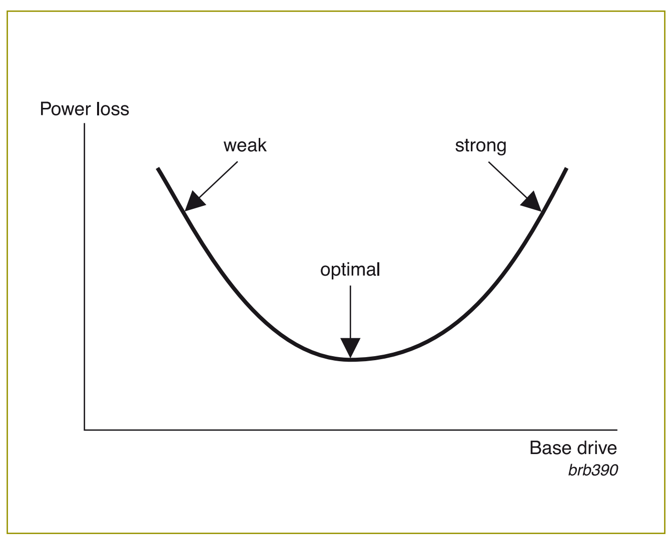


Figure 2. Power loss as a function of base drive.

Figure 3 shows how turn-off I_b affects the switching loss. All charge stored in the junction when the transistor is conducting should be removed again at turn-off. Apply a negative base current to ensure quick turn-off. The time needed to remove the base collector charge is called the storage time and depends on the amount of negative bias applied to the base during turn-off. The storage time directly influences the circuit's oscillating frequency. That is, a longer storage time leads to a longer delay and a lower frequency. As a result, transistor storage time plays an integral role in final circuit optimization.

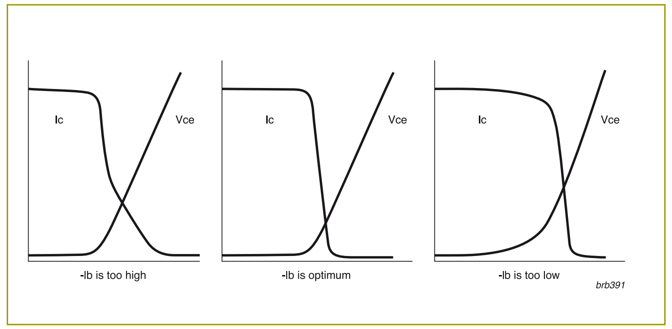


Figure 3. Effect of base drive on switching loss.

The influence of gain on power loss

The production spread of high voltage transistors causes some variation in their gain h_{FE} (this variation is already very low for NXP transistors). As the gain has a direct effect on the optimal base drive for an individual transistor, a deviation from the typical gain value can cause the circuit to operate below its optimal point. This can be resolved by adjusting the base drive for every transistor in every individual TL ballast or CFL, but in a production environment this is normally not a feasible solution.

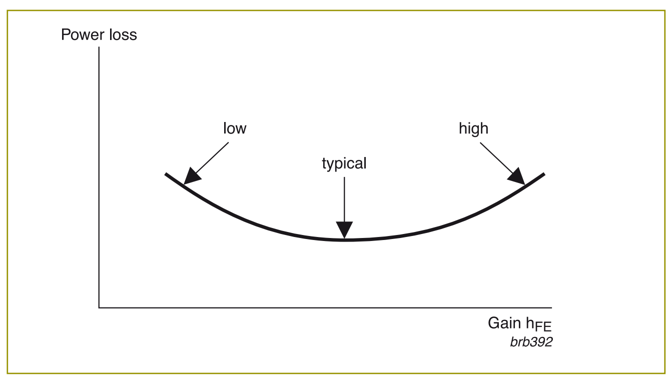


Figure 4. Power loss as a function of gain

The following is a recommended strategy for optimizing base drive for a given transistor. First, select typical transistors (that is, with a typical h_{FE}) and observe their operation.

- If the lamp goes off or flickers at minimum supply voltage (e.g. 150 V for a 230 V circuit), the oscillator is probably stalling. Increase the base drive.
- If, when mains power is removed, the lamp extinguishes but tries to restart a few times, resulting in flickering, then the oscillator is probably stalling prematurely, before the DC rail voltage has reduced to zero. Increase the base drive.
- If, at minimum supply voltage, the transistor temperature rise increases dramatically (possibly heading toward thermal runaway), and is often accompanied by premature turn-on of the transistors and very high turn-on losses, then the transistor turn-off drive is probably too weak. Increase the base drive.

Once the base drive has been adjusted, recheck for acceptable operation and temperature rise at maximum supply voltage. Once operation at low voltage has been optimized, acceptable operation at high voltage usually follows.

If high and low gain transistor samples are available, the above tests can be repeated for further fine tuning of the base drive. (Note that high and low gain limit samples are not possible with NXP standard production, due to the tight process control. These samples are only available at initial product development, when high and low gain samples are "forced" by artificial adjustment of the production process.) With typical transistors, however, testing with high and low gain transistors is not as critical as the initial optimization. Any further changes to the base drive are usually minor, if needed at all. Once the circuit has been optimized for an NXP transistor, any individual transistor of the same type, with any h_{FE} will operate without problems in the application.

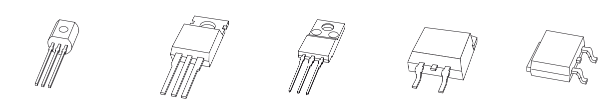
Complete portfolio

NXP supports all the leading applications for energy-efficient lighting, including CFL, HID igniters, HF-TL, electronic transformers for low-voltage lighting, and dimmers. We specialize in best-in-class efficiency and low-power discrete solutions. In addition to the high voltage transistors, we offer best-in-class PFC diodes, SCRs, and triacs.

Customer focus

NXP offers a roadmap of continuous process development and customer-driven innovation. Our experienced development teams have a deep knowledge and experience of bipolar technology, and we have specialists who proactively discuss technical details with customers.
We offer complete testing capabilities at our application labs, located in Europe and China. Furthermore, our well-controlled manufacturing processes and robust supply chain make us a trusted partner for quality, support and lead time.

High Voltage Power Bipolar Transistors for lighting, SMPS and industrial applications

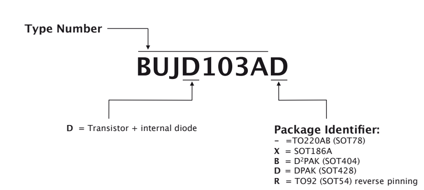


V_{CESM} (V)	$I_{C(DC)}$ (max) (A)	25 °C ind. t_f (typ) (ns)	@ I_C (A)	h_{FE} (typ)	@ I_C (A)	SOT54 (TO92)	SOT78 (TO220AB)	SOT186A (isolated TO220AB)	SOT404 (D^2PAK)	SOT428 (DPAK)
700	1	80	1	7.5	0.8	BUJ100LR				
	1	80	1	7.5	0.8	PHE13003A				
	1	50	1	14	0.75	BUJ100				
	1.5	100	0.5	9	1	**PHE13003C**				
	1.5	100	0.5	9	1	**PHD13003C***				
	4	30	2	12.5	3		BUJ103A	BUJ103AX		BUJ103AD
	4	30	2	12.5	3					BUJD103AD*
	4	100	2	17	2		PHE13005	PHE13005X		
	4	100	2	17	2		**PHD13005***			**PHD13005D***
	8	20	5	11	4		BUJ105A		BUJ105AB	BUJ105AD
	8	20	5	11	4					BUJD105AD*
	8	40	5	9	5		PHE13007			
	10	20	5	11	6		BUJ106A			
	12	100	5	6min - 30max	8		PHE13009			
1000	5	145	2.5	12	3		BUJ303A			
1050	5	200	2.5	10.5	3		BUJ303B			
1200	6	170	2.5	15.5	3		BUJ403A			

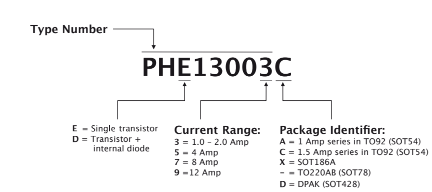
* Integrated diode

Types in **bold red** represent new products
Package drawings are not to scale

BUJ series part numbering



PHx series part numbering



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