

A Comparison of the Philips Tornado Compact Fluorescent Lamp with the new High Power-Factor Eco-Bulb

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1. Aim and Test Conditions

The purpose of this study was to compare the harmonic performance of the new high power-factor Eco Bulb to the Philips tornado compact fluorescent lamp (CFL). Two samples of each bulb were available and used. It should be noted that a regulated power supply was not used but direct connection to the electrical network, with the inherent distortion (flat-topping of supply voltage). This test condition gives a closer representation of what will be experienced in a typical domestic installation, however, the exact harmonic current levels generated by the bulb is dependent on the supply voltage distortion.

The relevant details of the voltage waveform are:

Table 1 Supply Voltage

Parameter		Value
RMS		234.2 Volts
Peak		320.3 Volts
Crest Factor		1.37
THD		3.35
Individual Harmonic Components (Volts)	Fund.	234.05
	3 rd	1.00
	5 th	6.05
	7 th	4.02
	9 th	2.22
	11 th	1.41
	13 th	0.58

2. Results

The recorded results are summaries in Figures 1 to 3 and Table 2.

Table 2 Summary of Readings

	Philips B1	Philips B2	Eco HPF B1	Eco HPF B1	
THD (%fund.)	124.74	124.62	16.85	17.40	
Angle	32° lead	31° lead	22° lead	22° lead	
DPF	0.84	0.86	0.93	0.93	
PF	0.53	0.54	0.91	0.91	
RMS Current (mA)	124.9	124.5	72.71	75.39	
Peak Current (mA)	410.8	406.2	121.96	131.03	
Crest Factor	3.29	3.26	1.68	1.74	
Power (Watts)	15.6	15.7	15.56	16.14	
K-factor	OL	OL	3.87	3.82	
Individual Harmonic Components (mA)	Fund.	77.50	77.50	71.68	74.24
	3 rd	59.13	58.88	2.54	2.95
	5 th	39.13	38.88	9.31	10.16
	7 th	38.50	38.44	3.44	3.52
	9 th	35.06	35.13	1.67	1.52
	11 th	24.75	24.88	3.42	3.67
	13 th	19.13	19.19	1.94	1.76

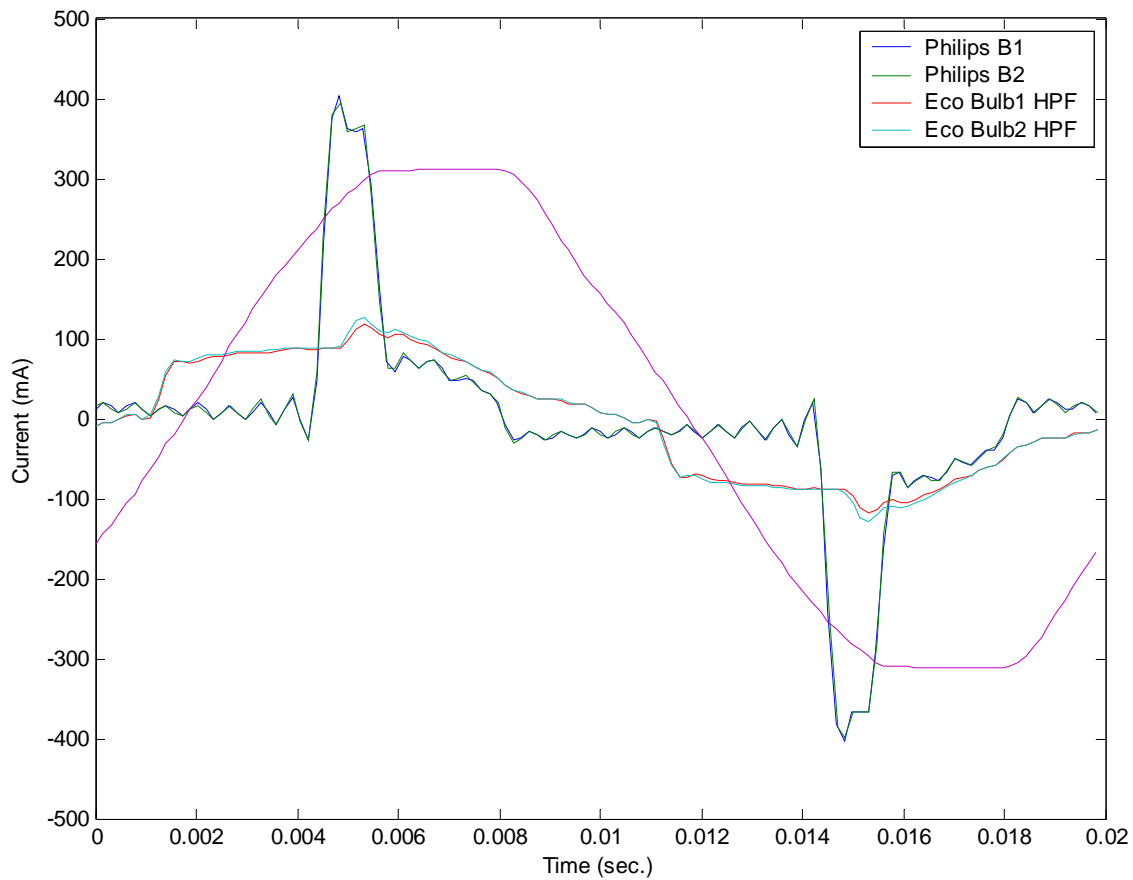


Figure 1. Comparison of Current Waveforms for sample CFLs (a scaled version of voltage waveform superimposed to show relative phase angle of currents to the supply voltage).

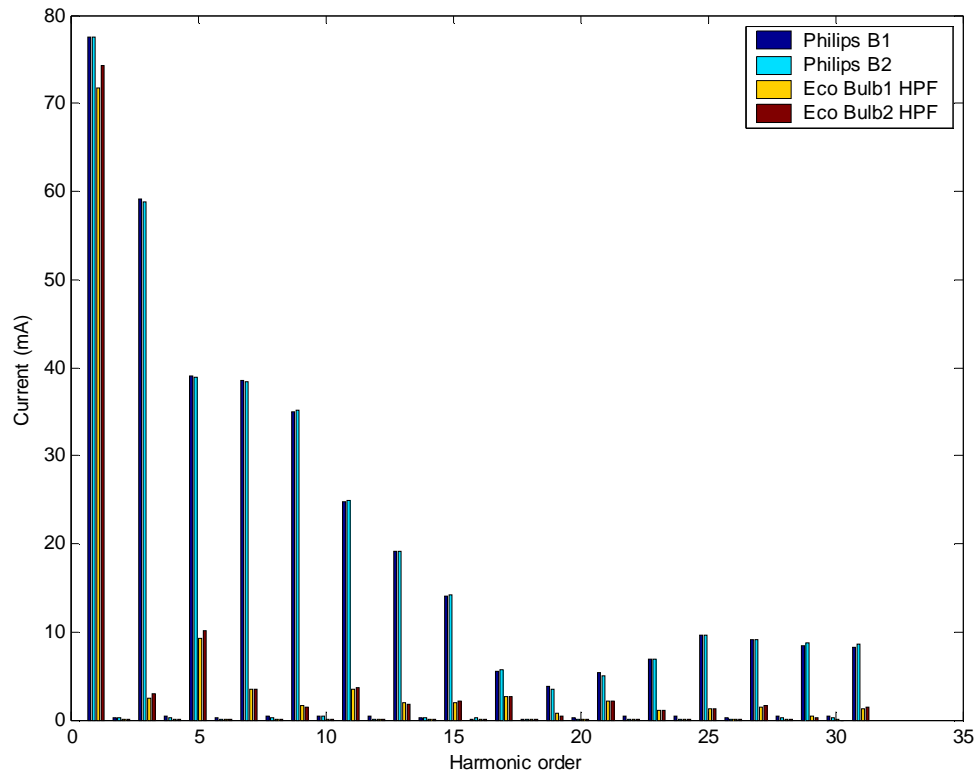


Figure 2. Comparison of Harmonic Current Components for sample CFLs

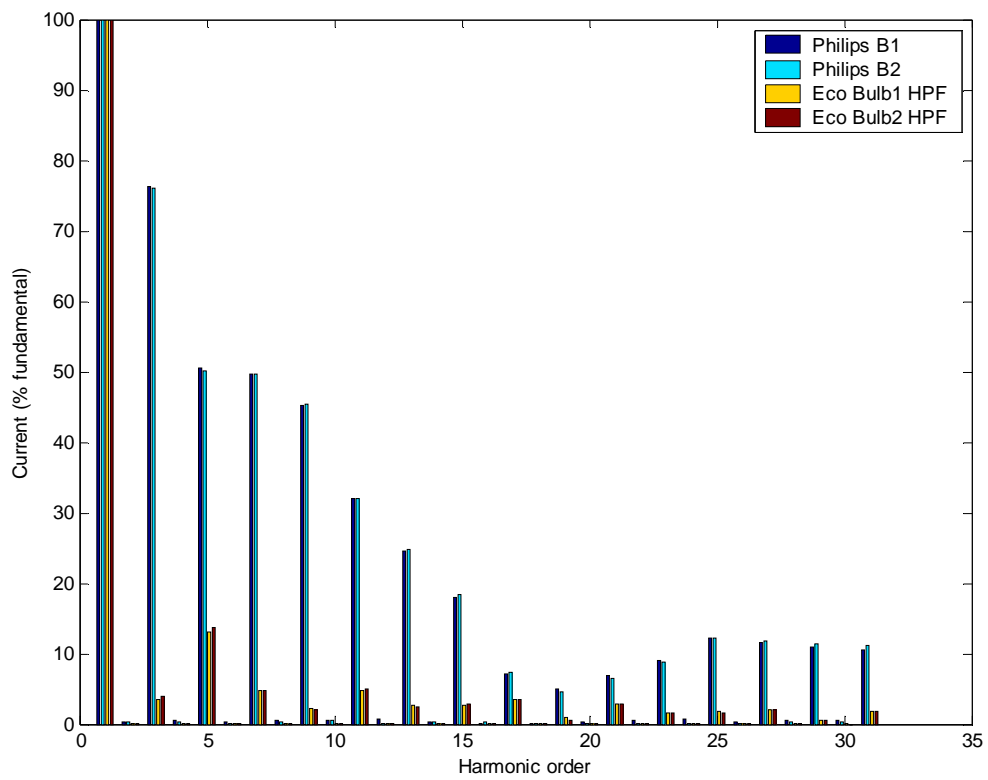


Figure 3. Comparison of Harmonic Current Components as percentage of fundamental for sample CFLs

3.0 Discussion

The latest joint Australia/New Zealand standard for harmonic emission from equipment which draws less than 16 Amp per phase is AS/NZS 61000.3.2:2003. The CFL bulbs are type C equipment. Note that for type C equipment with input power of less than or equal to 25 Watts Table 3 of the standard is used (which has the title: Limits for Class D equipment).

Active input power ≤ 25 W

Discharge lighting equipment having an active input power smaller than or equal to 25 W shall comply with one of the following two sets of requirements:

- the harmonic currents shall not exceed the power-related limits of Table 3, column 2, or:
- the third harmonic current, expressed as a percentage of the fundamental current, shall not exceed 86 % and the fifth shall not exceed 61 %; moreover, the waveform of the input current shall be such that it begins to flow before or at 60° , has its last peak (if there are several peaks per half period) before or at 65° and does not stop flowing before 90° , where the zero crossing of the fundamental supply voltage is assumed to be at 0° .

If the discharge lighting equipment has a built-in dimming device, measurement is made only in the full load condition.

Table 3. Limits for Class D equipment

Harmonic Order n	Maximum permissible harmonic current per watt (mA/mW)	Maximum permissible harmonic current (A)
3	3.4	2.3
5	1.9	1.14
7	1.0	0.77
9	0.5	0.40
11	0.35	0.33
$13 \leq n \leq 39$ odd harmonic only	$3.85/n$	See Standard

It is clear that the Philips Tornado CFL can not comply with either of the two sets of requirements. Note that the comparison in Figure 4 uses the rated power not the actual. If the actual power is used, these limits reduce. The variation between the two Eco Bulb samples is greater than that of the Philips bulbs. This is most clearly seen in variation in the fundamental component (see Figure 2), and the size of the discrepancy is significant. The harmonic performance of the high power-factor Eco Bulb is dramatically better than the earlier Eco Bulbs and also dramatically better than the Philips Tornado CFL.

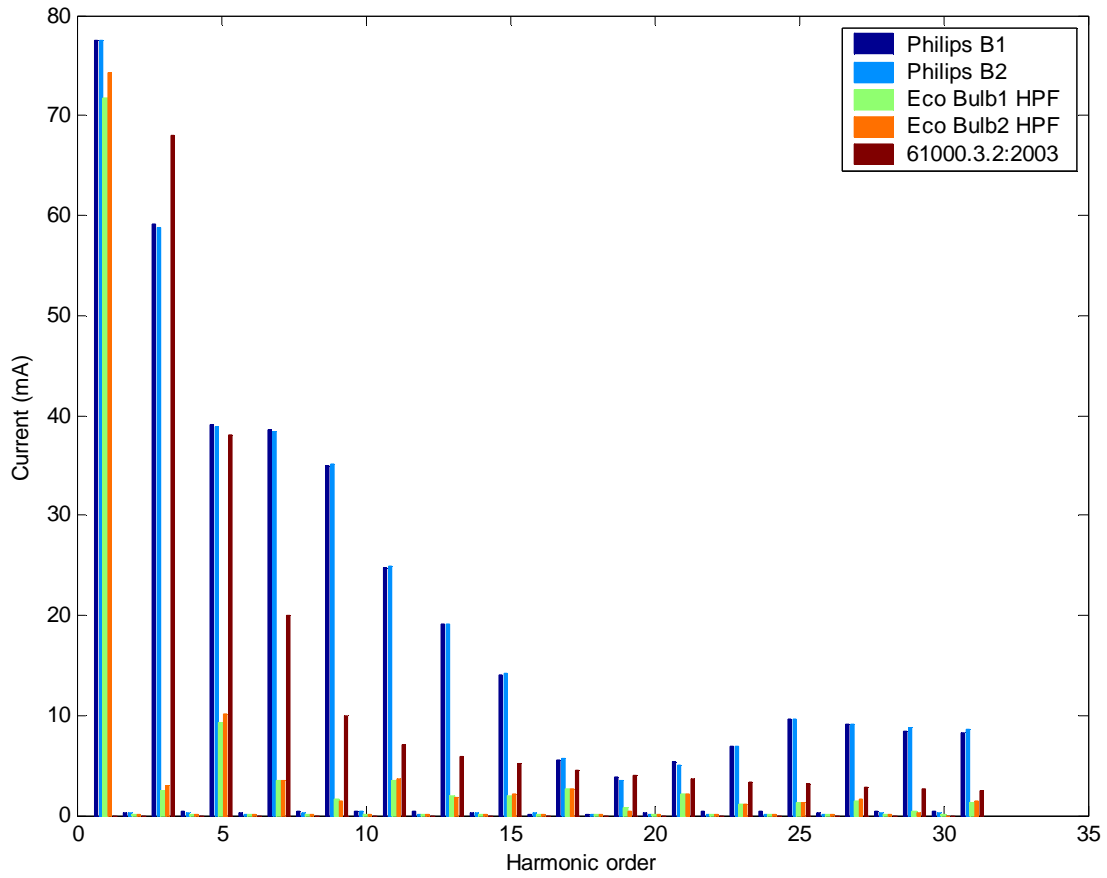


Figure 4. Comparison with limits of Table 3 (assuming the CFL power matched its rated power).