PT4105 versus AX2002

It's stated in many CPF posts that the functionalities of PT4105 and AX2002 in principle are identical but AX2002 is superior. This seems not to be valid under all circumstances.

I did some tests of Kennan_II (blue board with PT4105) against Kennan_III (green board with AX2002). The findings support that Kennan_III is superior for output currents above about 1000 mA. But it provides much less efficient dimming capabilities than Kennan_II and needs significantly higher 'headroom' (voltage difference V_{IN} to V_f)

This may have three reasons as far as I can imagine:
– Layout of Kennan_III is not optimized with respect to rf currents
– Recommended application circuitries have some differences
– AX2002 itself has poorer analog dimming features than PT4105

1. Layout of Kennan_III is not optimized with respect to rf currents

Kennan_II with PT4105 (blue board with orthogonal alignment of components) has a pretty good layout: There are not too thin traces carrying rf-currents. Ground (= V_{SS} = In–) is connected by seven vias to the broad outer ring on the bottom layer.

Kennan III with AX2002 (green board) shows a bad (but nice locking) layout: The outer ring on the bottom layer is connected to ground (= V_{SS} = In–) by only one via and additionally in series with a R000 bridge (this could be replaced by a diode to realize polarity protection). This would not matter in case there would be broad traces on the top layer too, but there aren't. There's only a very thin unclosed ring around the board, at some places less than 0,5mm broad. This long thin trace carries all the rf-chopped currents! Additionally both blocking capacitors are very small too and don't block to the same point: The thin GND-trace acts as a voltage devider!

The consequence of this poor layout is:
– Rf ripple at the LED is high
– Function is unstable and tends to "flicker" especially at low input voltages
– CE-pin does not work properly due to superposed rf ripple voltage
– Minor efficiency

It is possible to modify the layout by hand (much to do!):
– Replace input capacitor by 22µ 16V and output capacitor by 47µ 6V3
– Solder a thick wire around the top side of the board and/or make many connections from top to bottom rings.

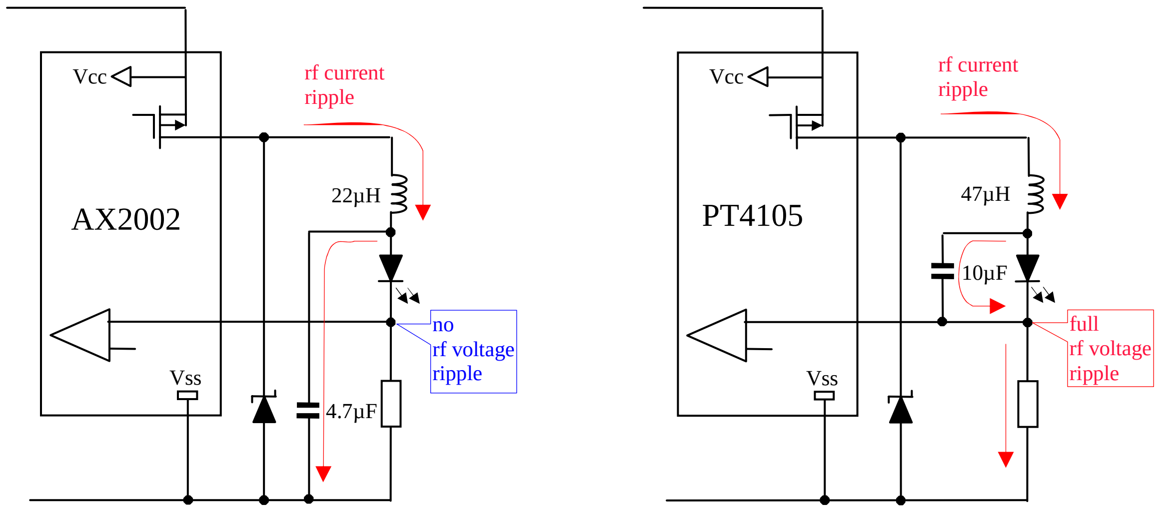
These modifications achieve stable function and increase efficiency too. But nevertheless the efficiency is significantly lower than that of the older Kennan with PT4105 at least for output currents up to 700 mA. The original board achieves 38% efficiency for 30 mA output current to a single LED at 9V input voltage. The modification improves this to 43% – still bad!

2. Recommended application circuitries have some differences

There are two main differences:
a) The inductors have different values. The reason for that is, that magnetic saturation should be avoided or the stored energy is limited ($E = \frac{1}{2} I^2 L$). PT4105 is recommended up to 700mA with 47µH and restricted to 1000mA while AX2002 allows about one and a half times these values and is recommended for 22µH. But this shouldn't be any problem,

because Kennan_I and Kennan_II (PT4105) were delivered in various versions either with 22µH or with 47µH. Both worked well, even at low output currents.
Nevertheless I tested Kennan AX2002 with R_{SENSE} = R330 with original coil and with 120µH. This improved efficiency at 9V/30mA slightly to 53%. But this is still poor with respect to Kennan PT4105 achieving more than 80% at 9V/30mA. Unfortunately increasing the inductivity (and wire resistor too) decreases the efficiency at max. output current for R330 (700mA). So increasing the inductivity is no solution!

b) The output capacitors are connected differently: For AX2002 it's connected from out+ to supply- but for PT4105 from out+ to out-. Consequently the FB pin of PT4105 sees the full rf ripple, but AX2002 does not.
I tried out both methods vice versa, all combinations work comparably, this doesn't matter.

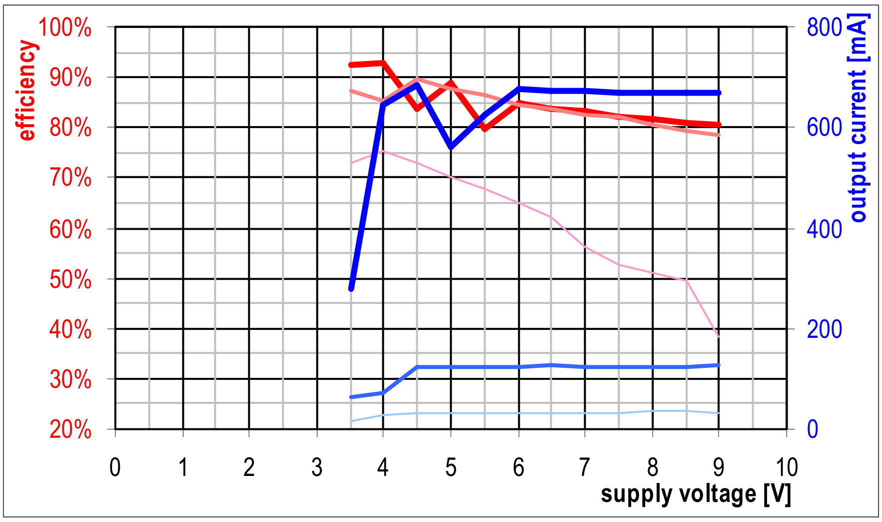


3. AX2002 itself has poorer analog dimming features than PT4105

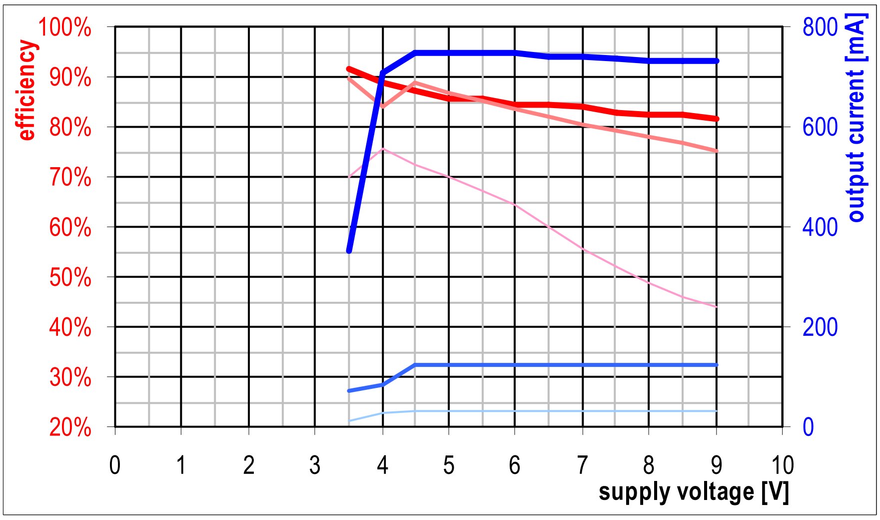
PT4105E reduces its own supply current to max. 100µA when no output current is required (feedback pin is at or above reference voltage). AX2002 still sinks up to 5mA under such conditions.
The datasheet of AX2002 refers to applications also for 20mA output current. With a load of one LED this equals about 50mW output power. When you drive this circuitry with 10V, the standby power dissipation of the IC is up to 50mW too, that means the efficiency is below 50% and additional losses are necessary for switching the output current nevertheless. I measured about 38% efficiency at 9V for output 30mA with the unmodified Kennan_III board and about 43% when modified (ceramic capacitors) and 53% with 120µH. With PT4105 I get more than 80% under same conditions.

Conclusion

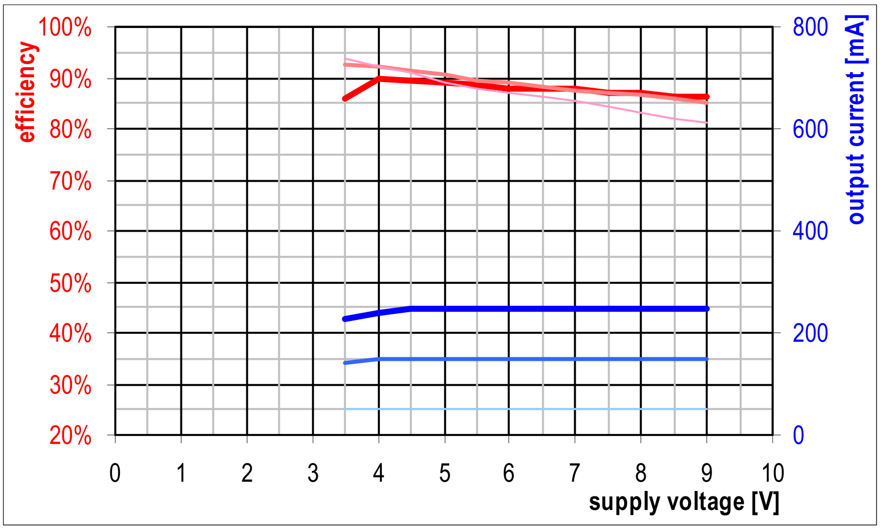
AX2002 has more power, that's true. But it needs more headroom (higher voltage) than PT4105 and with dimmed output the AX2002 is quite inefficient. And apart of the ICs, the layout of Kennan_III is poor with respect to that of Kennan_II.
More isn't always better...



Original Kennan_III with AX2002 but R330 instead of R220 and connection from FB pin to R330 cut and reconnected via 3k6 allowing analog dimming. At input voltages below about 5V the function was unstable and the LED flickered randomly.



Kennan_III (AX2002) modified for medium currents:
R330, 3k6, C_{IN} 22µ, C_{OUT} 47µ, reinforced ground trace, multiple connections to the bottom ring.



Kennan_II with PT4105 modified for low currents.