XDPL8221 limited power mode

XDP™ digital power

About this document

Scope and purpose

This document explains the Limited Power (LP) mode of XDPL8221, and the dimming operation in LP mode.

Intended audience

This document is intended for anyone designing high-performance dual-stage digital Power Factor Correction (PFC) + flyback converters for LED lighting based on the XDPL8221 digital controller.

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1 XDPL8221 operating window

The XDPL8221 includes three control schemes for a Constant Current (CC), Constant Voltage (CV) or LP output. Depending on the parameterization, the operating window of an offline AC-DC LED driver using the XDPL8221 generally looks as shown in **Figure 1**.

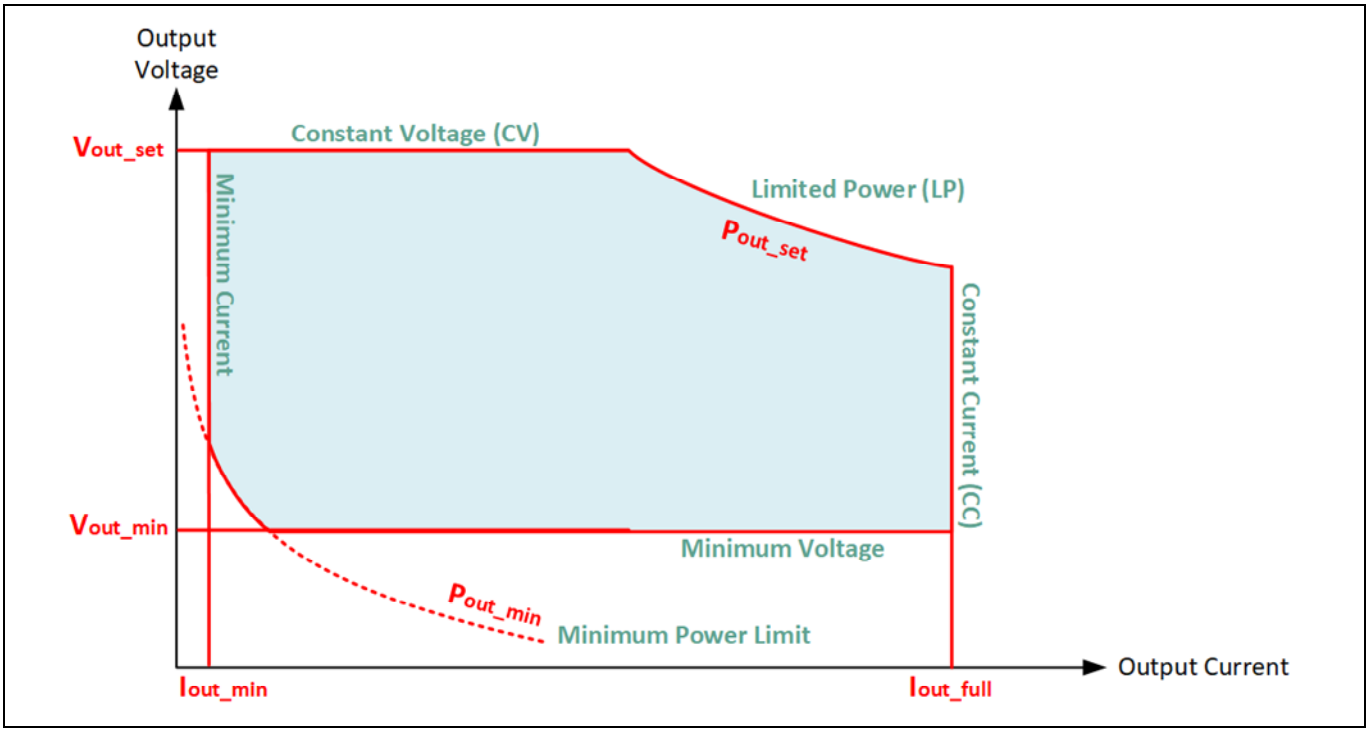

Figure 1 Operating window of an LED driver using XDPL8221

The configurable parameters of the XDPL8221 that define the operating window are shown in **Table 1**.

Table 1 Operating window parameters

Parameter	Description	Unit
I_{out_full}	In CC mode: non-dimmed (100 percent) regulated output current value In CV and LP mode: maximum output current value	mA
V_{out_set}	In CV mode: regulated output voltage value In CC and LP mode: maximum output voltage value	V
P_{out_set}	Maximum limited output power value	W
I_{out_min}	Minimum output dimmed current in CC mode	mA
V_{out_min}	Minimum output voltage	V

The minimum output power depends on other parameters and can be derived from the formula below:

$$P_{out\_min} = \frac{1}{2} * L_{P\_FB} * I^2_{p\_pk\_min} * \frac{N_{ABM\_FB}}{t_{burst\_FB}}$$

Table 2 Minimum output power related variables

Parameter	Symbol	Unit
Flyback transformer primary main inductance	L_{p_FB}	mH
Flyback minimum primary peak current	$I_{p\_pk\_min}$	A
Number of pulses in Active Burst Mode (ABM)	N_{ABM_FB}	–
Burst frequency in ABM	f_{burst_FB}	Hz

To set the minimum output current, the minimum output voltage must be taken into account so that it can be reached with the LED load in lowest dimming:

$$I_{out\_min} \geq \frac{P_{out\_min}}{V_{out\_min}}$$

For more explanations of the operating window definition, please refer to the XDPL8221 Design Guide [2].

2 XDPL8221 CC mode

As shown in **Figure 2**, in the case of LED_a as load, the forward voltage V_f determines the output voltage of the driver. The XDPL8221 operates in CC mode and drives a constant output current I_{out_full} to the load in the non-dimmed operation, as long as the following condition is fulfilled:

$$V_{f\_max} * I_{out\_full} \leq P_{out\_set}$$

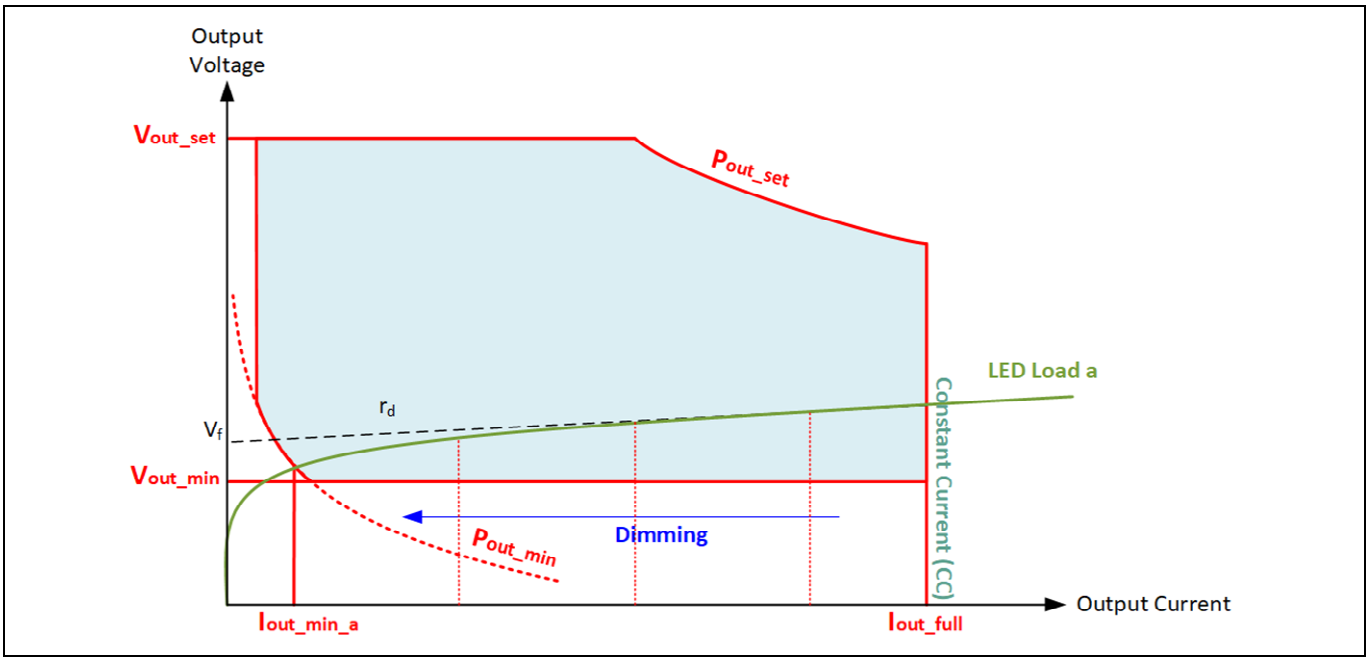

Figure 2 XDPL8221 CC mode

In the dimming operation, the output current of the LED driver stays constant and varies according to the dimming level between I_{out_full} and $I_{out\_min\_a}$. This can be visualized by moving the vertical red dotted line left and right.

3 XDPL8221 LP mode

As shown in **Figure 2**, in the case of LED_b with a higher forward voltage as load, the high output voltage V_f and configured current I_{out_full} will exceed the defined power limit P_{out_set}:

$$V_{f\_max} * I_{out\_full} > P_{out\_set}$$

The XDPL8221 operates in LP mode to ensure that the power limit of the components is not exceeded.

In LP mode, XDPL8221 maintains the constant output current control but reduces the output current automatically to such a level, I_{out_max}, that the power limitation works:

$$V_{f\_max} * I_{out\_max} \leq P_{out\_set}$$

In this way, the light output remains uninterrupted.

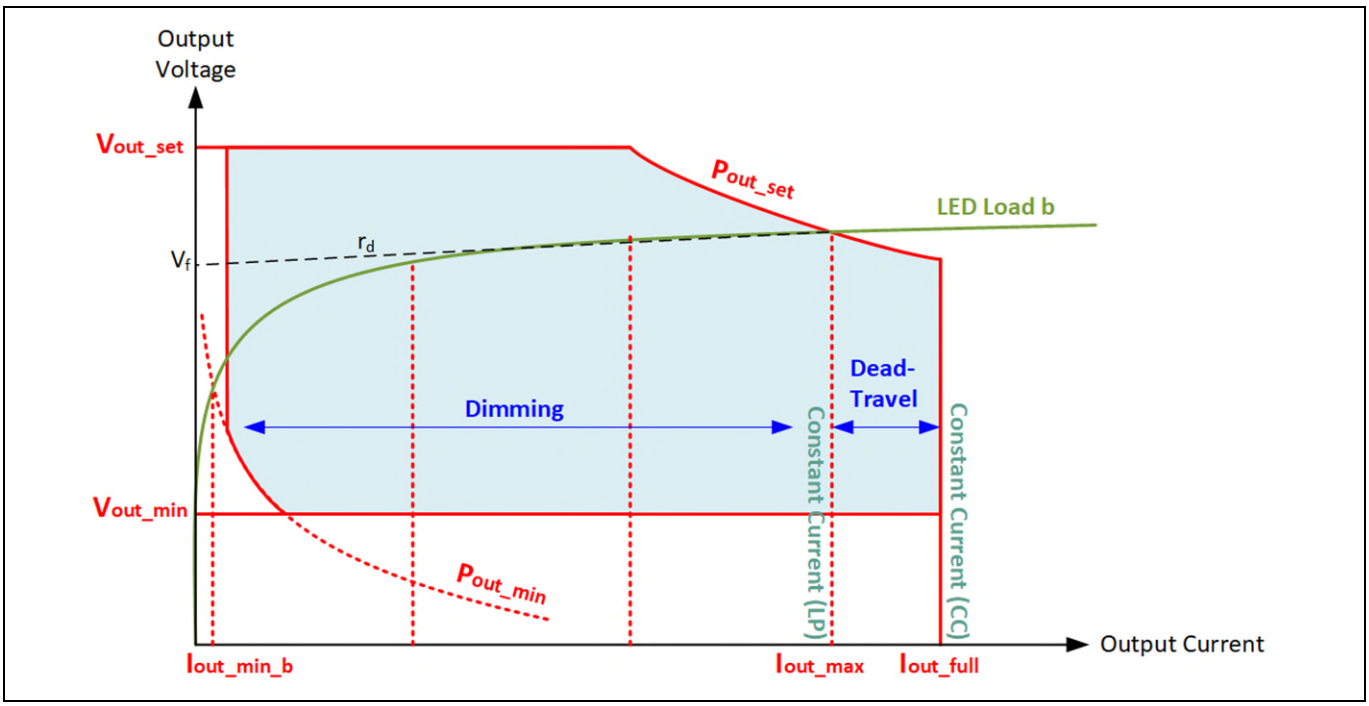

Figure 3 XDPL8221 LP mode

In the non-dimmed LP operation, the LED driver delivers a constant output current I_{out_max}, which is smaller than the configured I_{out_full}:

$$I_{out\_max} \leq I_{out\_full}$$

For the dimming operation in LP mode, there are two different options:

- LP mode dimming is disabled

  The configured maximum LED driver current I_{out_full} is mapped to the maximum dimming level (100 percent). As the current I_{out_full} cannot be delivered due to the LP mode, the dimmer will experience a dead travel, which means the upper dimmer has no impact: therefore as the dimming level decreases from 100 percent, the output current first remains unchanged at I_{out_max} until CC mode is reached. At that point, the driver output current varies between I_{out_max} and $I_{out\_min\_b}$ according to the dimming level, as shown in **Figure 3**.

- LP mode dimming is enabled

  The maximum output current I_{out_max} in LP mode is mapped to the maximum dimming level (100 percent). The output current varies between I_{out_max} and $I_{out\_min\_b}$ according to the dimming level. The dimmer will not experience dead travel in this case.

Note: The parameters for the dimming operation in LP mode can be configured. Please refer to the XDPL8221 CSV file description [3].

LP mode dimming is shown in **Figure 4**.

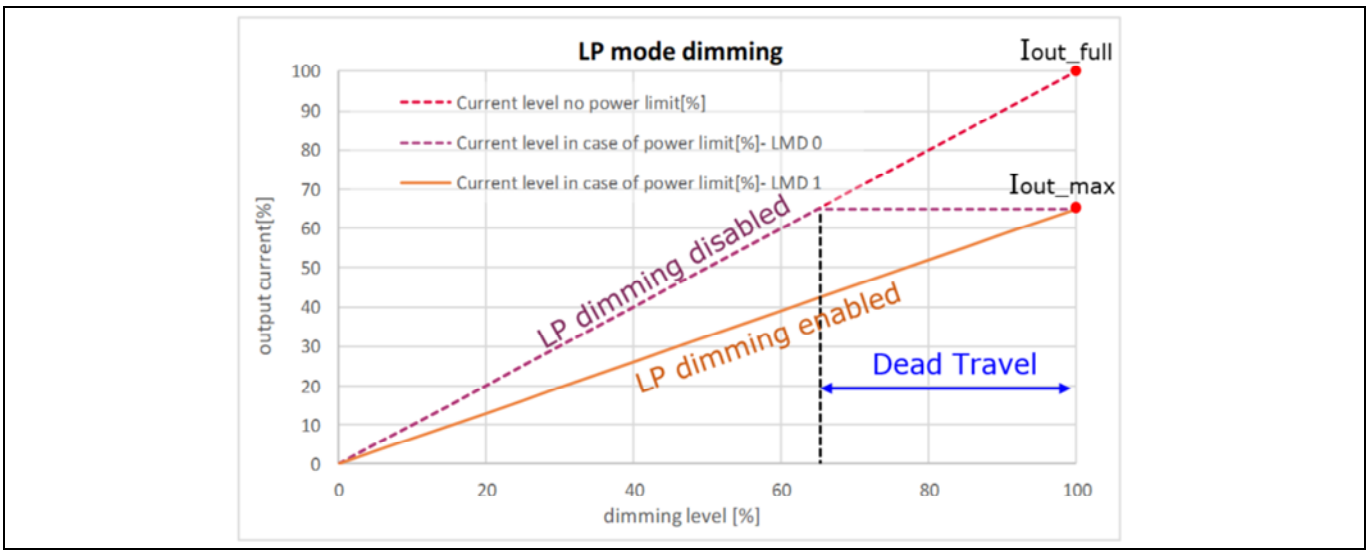

Figure 4 LP mode dimming

In the case that the LED load forward voltage decreases in the non-dimmed operation (e.g. due to environmental temperature variation), XDPL8221 will increase the output current, but the output power remains constant and limited. As the output voltage drops further, XDPL8221 leaves LP mode and the output power will also decrease. This is shown in **Figure 5**.

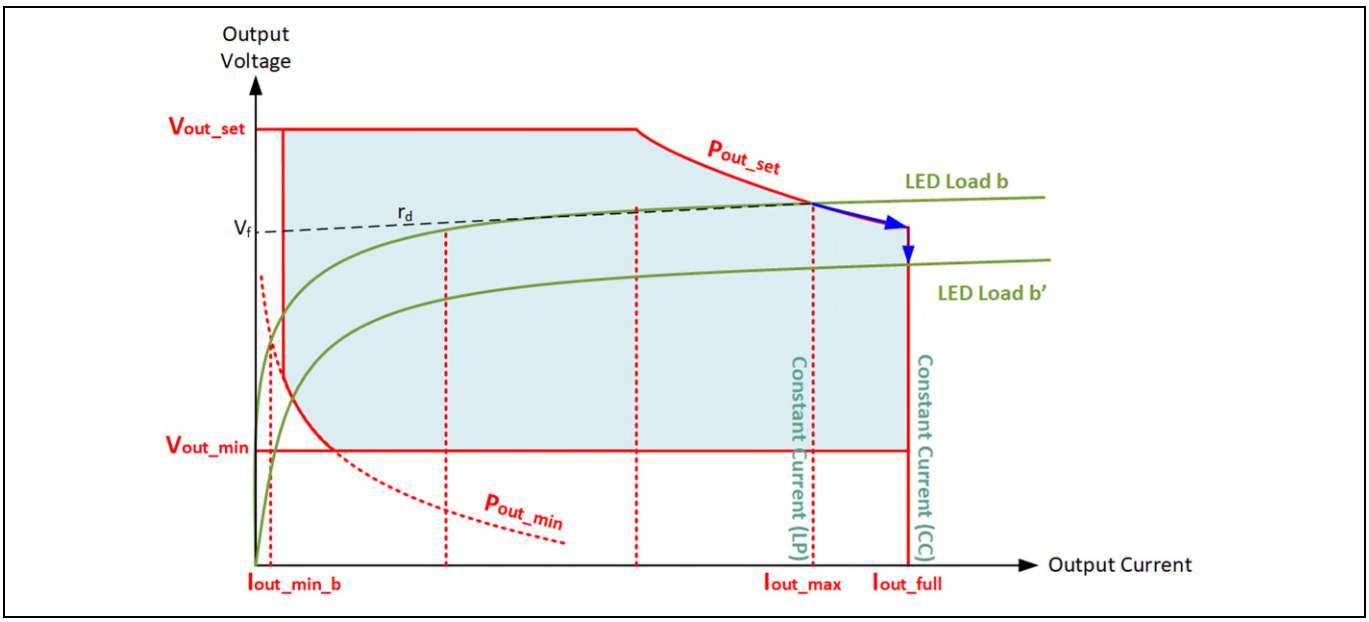

Figure 5 Leaving LP mode

[1] XDPL8221 Datasheet

[2] XDPL8221 Design Guide

[3] XDPL8221 50 W/100 W CSV file description

Revision history

Document version	Date of release	Description of changes
1.0	2019-01-01	First release

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