XDPL8220 - Digital PFC+Flyback Combo Controller IC

CSV File Parameter Description for 50W Reference Design

XDP™ digital power

About this document

Scope and purpose

This document describes the parameters which are defined in the CSV file for XDPL8220 digital controller.

Intended audience

This document is intended for anyone who intends to design a high-performance dual-stage (PFC+Flyback) AC/DC-DC converter for LED lighting based on the digital controller XDPL8220.

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1 Introduction

This application note describes the available parameters and their use for XDPL8220. XDPL8220 is a configurable digital platform product. It can be configured to meet a wide range of application requirements. This is enabled by changing the application related parameters. These are constants used by the application firmware which is programmed in the IC controller and can be adapted to the respective LED-driver requirements on the different boards. The parameters are defined in the provided CSV file by Infineon. The procedure to change the parameters is done through the .dpVision tool.

Note: *The predefined parameters used in this description are intended for the 50W universal input reference board.*

2 Parameter Handling / Recommendations

After finishing calculations of the hardware components according to the design guide, the user has to determine the configuration for the XDPL8220. This is achieved by entering the hardware configuration and the customer's requirements into the .dp vision tool. Based on this data, the .dp vision tool will automatically calculate all relevant parameters. The tool allows the user to test the ICs with the parameters and finally to burn the parameters into the ICs.

A complete list of available parameters in XDPL8220 can be found in the XDPL8220 Target Datasheet (see **[1]**). Detailed information on using the .dp vision tool is available in the Application Note for the XDPL8220 reference design (see **[2]**) and in the .dp vision User Guide (see **[3]**).

The following subsections describe a few examples on how to set up an XDPL8220 configuration file. Additionally, the process of testing and burning parameters is described.

2.1 Design Parameters

The parameters are defined with the default values in the CSV file. This is provided by Infineon and available under http://www.infineon.com/cms/en/product/promopages/digital-power to be downloaded. After opening an existing configuration CSV file, it is necessary to enter the appropriate values calculated previously in the design parameters box table. Available parameters are presented in the following subsections.

Note: *.dpVision will check the plausibility of the parameters values which are input by the user. If any value violates the limits, the value will turn red and a warning will appear. The limits may also be dependent on other user inputs.*

2.1.1 Output Set-Points

The most prominent feature of the XDPL8220 is that the controller can regulate the output at Constant Current (CC), Constant Voltage (CV) and Limited Power (LP) mode. To configure the CC, CV and LP mode, three parameters are necessary as following:

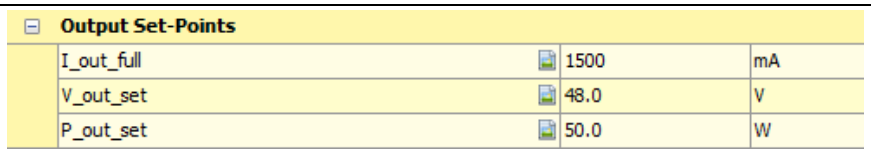


Figure 1 Output Set-Points Parameters

The parameters are described in the following table with correspondent figure:

Table 1 Output Set-Points Parameters

Parameter	Description	Unit
I_out_full	In the CC mode: non dimmed (100%) regulated output current value In the CV and LP mode: maximum output current value	mA
V_out_set	In the CV mode: regulated output voltage value In the CC and LP mode: maximum output voltage value	V
P_out_set	Maximum limited output power value	W

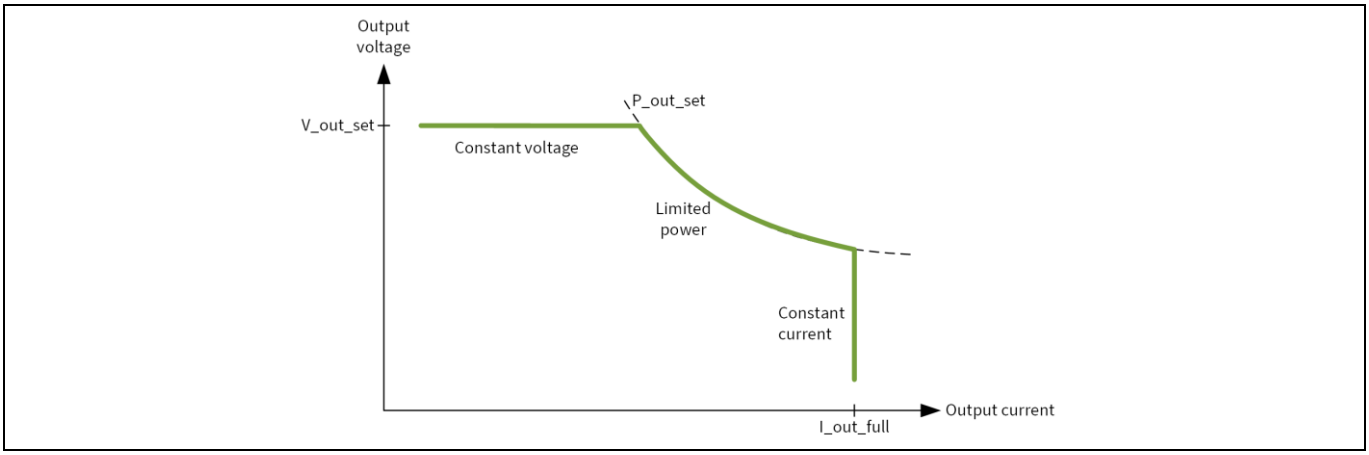


Figure 2 XDPL8220 Constant Current/Constant Voltage/Limited Power Mode

2.1.2 Hardware Configurations

Hardware configurations represent the core board component values that are assembled on the respective application board. The parameters should be entered in the fields accordingly as following:

Hardware Configuration		
L_p	3.1	mH
N_p_by_N_s	3.910	
N_p_by_N_a	4.940	
I_p_max	1.30	A
R_CS_FB	0.800	Ohm
R_ZCD_FB_1	68.00	kOhm
R_ZCD_FB_2	3.90	kOhm
R_VS_1	9960.0	kOhm
R_VS_2	52.3	kOhm
R_HV	100	kOhm

Figure 3 Hardware Configuration parameters

The parameters are described in the **Table 2** and **Figure 4**:

Table 2 Hardware Configuration Parameters

Parameter	Description	Unit
Lp	Flyback transformer primary inductance	mH
N_p/N_s	Flyback transformer turns ratio of primary to secondary windings	-
N_p/N_a	Flyback transformer turns ratio of primary to auxiliary windings	-
I_p_max	Flyback maximum primary peak current value	A
R_CS_FB	Flyback current sense resistor value	Ω
R_ZCD_FB_1	Flyback ZCD divider upper resistor value	k Ω
R_ZCD_FB_2	Flyback ZCD divider lower resistor value	k Ω
R_VS_1	PFC Bus Voltage Sense divider upper resistor value	k Ω
R_VS_2	PFC Bus Voltage Sense divider lower resistor value	k Ω
R_HV	HV resistor value for startup cell current limitation and AC/DC input voltage sensing	k Ω

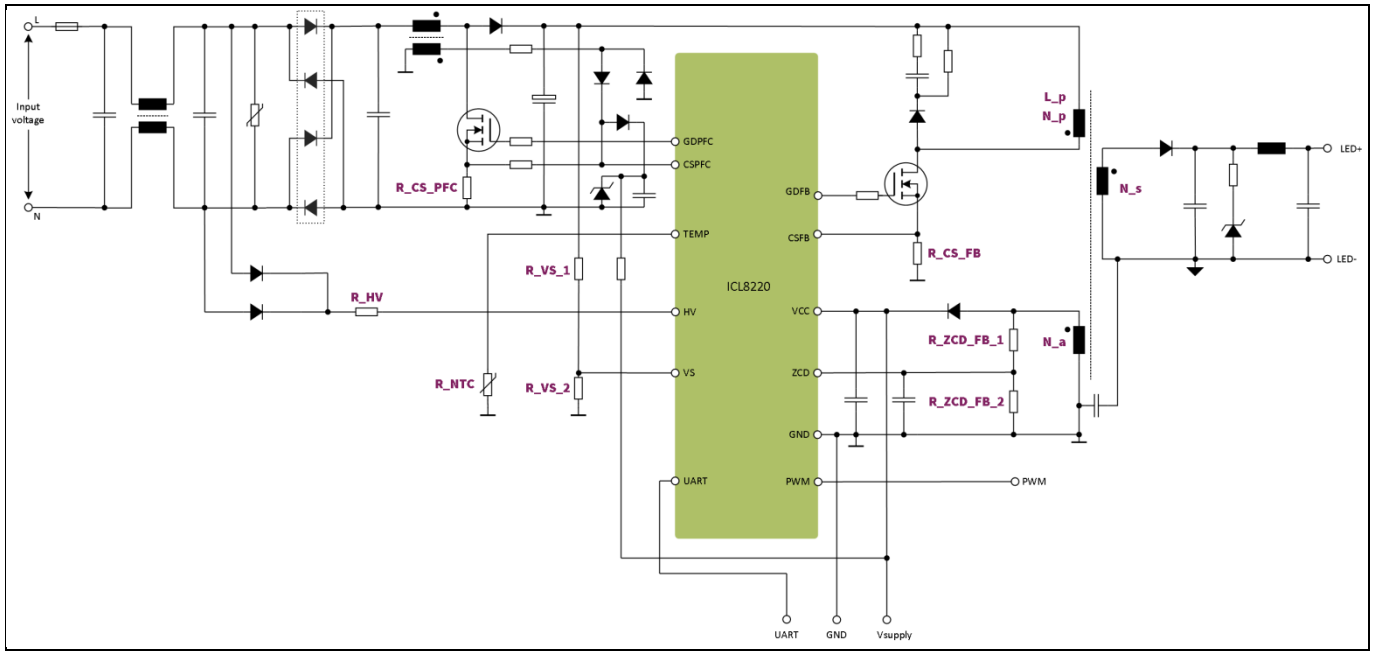
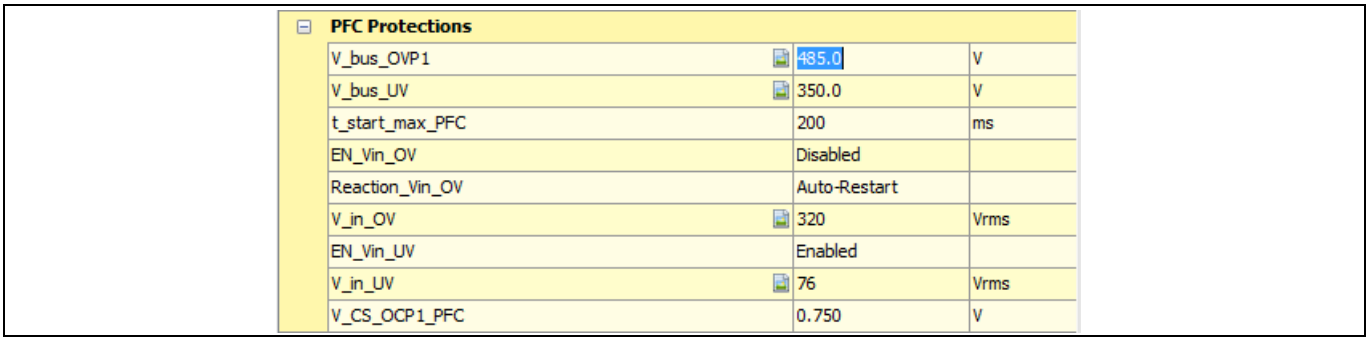


Figure 4 XDPL8220 typical application schematic

2.1.3 PFC Protection

PFC protection parameters are necessary for customers to define individually according to their own application requirements in order to protect the PFC core components on the application board.



PFC Protections		
V_bus_OVP1	485.0	V
V_bus_UV	350.0	V
t_start_max_PFC	200	ms
EN_Vin_OV	Disabled	
Reaction_Vin_OV	Auto-Restart	
V_in_OV	320	Vrms
EN_Vin_UV	Enabled	
V_in_UV	76	Vrms
V_CS_OCP1_PFC	0.750	V

Figure 5 PFC Protection Parameters

The parameters are described in the following table with correspondent figure:

Table 3 PFC Protection Parameters

Parameter	Description	Unit
V_bus_OVP1	Bus Over-Voltage detection level 1 threshold value. PFC will stop working if the detection threshold is reached continuously for the blanking time t_blank_vbus_OVP1. Flyback will continue working.	V
V_bus_UV	Bus Under-Voltage detection threshold value.	V

	The controller will be in the auto-restart mode if the detection threshold is reached continuously for the blanking time t_blank_vbus_UV	
t_start_max_PFC	Maximum PFC soft start time to settle the bus voltage at startup. If the defined bus voltage is not reached within this time, the controller will enter the auto-restart mode.	ms
Reaction_Vin_OV	Controller reaction to the input over-voltage detection "Auto-Restart Mode": Controller will be in the auto-restart mode "Latch-Mode": Controller will be in the latch mode	--
EN_Vin_OV	To enable the input over-voltage protection feature. "Disabled": Controller will not enter protection mode and keep on operating. "Enabled": Controller will enter protection mode and react with corresponding defined behavior.	--
V_in_OV	Input over-voltage detection threshold value	Vrms
EN_Vin_UV	To enable the input under-voltage protection feature. "Disabled": Controller will not enter protection mode and keep on operating. "Enabled": Controller will enter protection mode and react with auto-restart behavior.	--
V_in_UV	Input under-voltage detection threshold value	Vrms
V_CS_OCP1_PFC	Maximum voltage at the PFC current sense resistor to trigger the over-current protection level 1	V

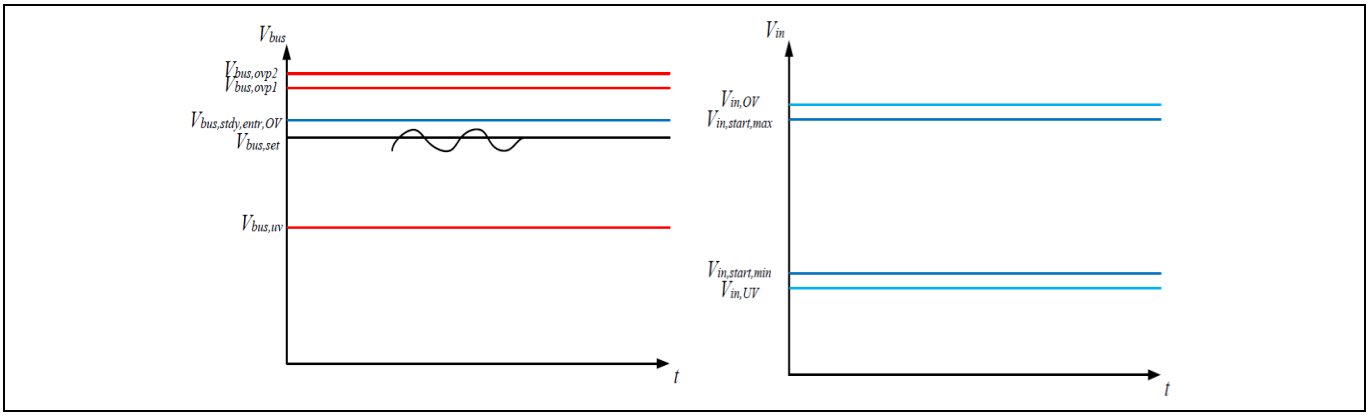
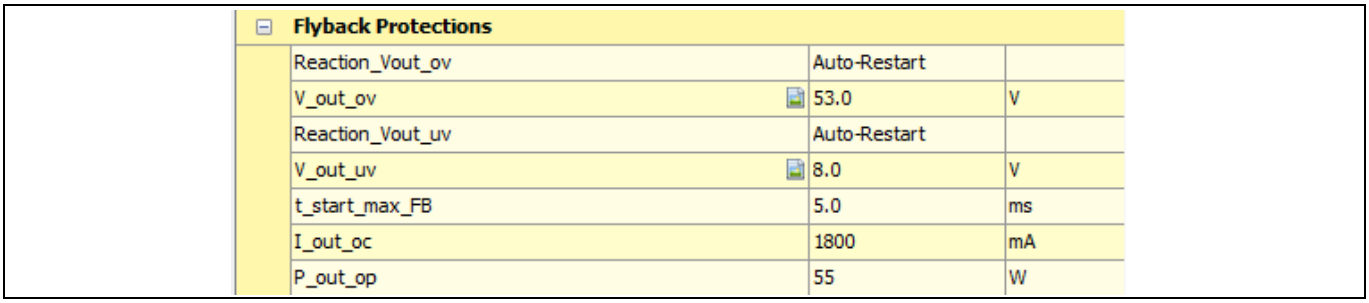


Figure 6 PFC Protection Parameters

2.1.4 Flyback Protection

Flyback protection parameters are necessary to define individually to the own application requirements in order to protect the Flyback core components on the application board.



Flyback Protections		
Reaction_Vout_ov	Auto-Restart	
V_out_ov	53.0	V
Reaction_Vout_uv	Auto-Restart	
V_out_uv	8.0	V
t_start_max_FB	5.0	ms
I_out_oc	1800	mA
P_out_op	55	W

Figure 7 Flyback Protection Parameters

The parameters are described in the following table with correspondent figure:

Table 4 Flyback Protection Parameters

Parameter	Description	Unit
V_out_OV	Output over-voltage detection threshold If the output over-voltage detection threshold is reached for the blanking time, controller will enter the defined protection mode.	V
Reaction_Vout_OV	Controller reaction to the output over-voltage detection after blanking time "Fast Auto-Restart": Controller will enter the fast auto-restart mode "Auto-Restart": Controller will enter the auto-restart mode "Latch-Mode": Controller will enter the latch mode	--
V_out_UV	Output under-voltage detection threshold value If the output under-voltage detection threshold is reached for the blanking time, controller will enter the defined protection mode.	V
Reaction_Vout_UV	Controller reaction to the output under-voltage detection after blanking time "Auto-Restart": Controller will enter the auto-restart mode "Latch-Mode": Controller will enter the latch mode	--
t_start_max_FB	Maximum Flyback startup time in order to detect an output short at startup	ms
I_out_OC	Output over-current detection threshold value If the output over-current detection threshold is reached for the blanking time, controller will enter the defined protection mode.	A
P_out_OP	Output over-power detection threshold value If the output over-power detection threshold is reached for the blanking time, controller will enter the defined protection mode.	W

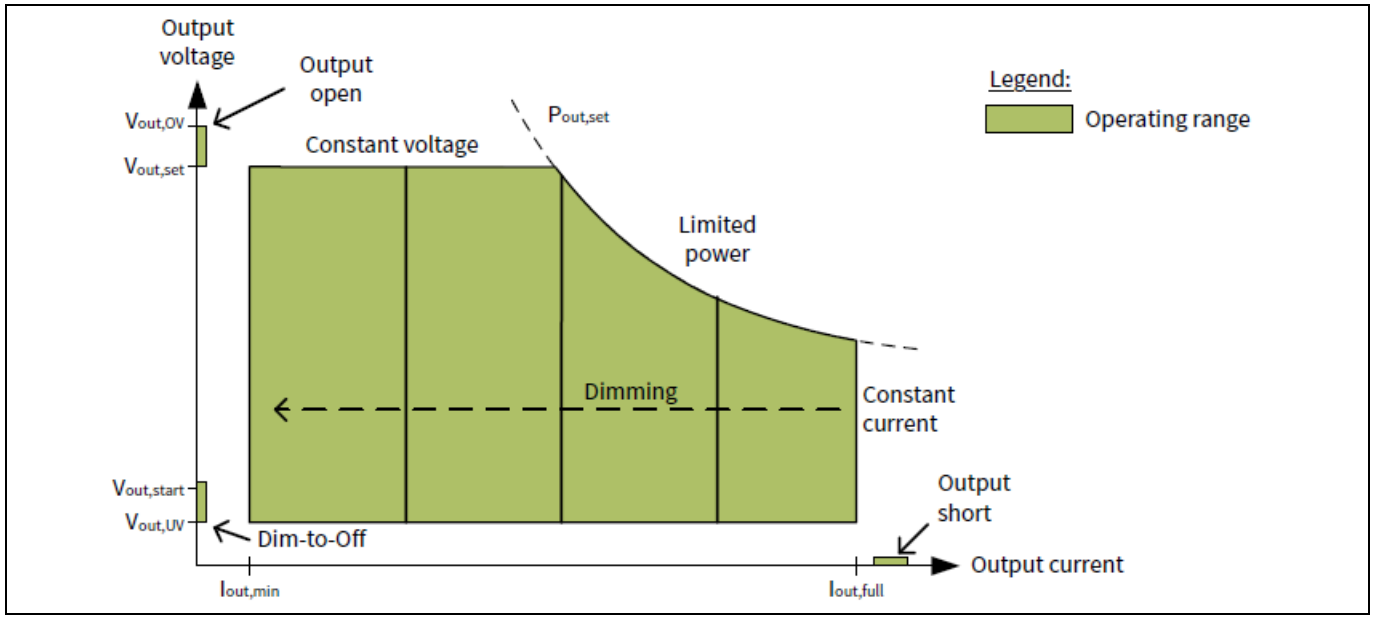


Figure 8 Flyback Protection Parameters

2.1.5 General Protection

General protection parameters set the different global protection features.

General Protections		
t_AR	1.00	s
t_AR_fast	0.050	s
N_AR_max	10	
Debug_Mode	Disabled	

Figure 9 General Protection Parameters

The parameters are described in the following table with correspondent figure:

Table 5 General Protection Parameters

Parameter	Description	Unit
t_AR	Auto-restart time defines the time duration in the controller protection mode auto-restart. It starts at the moment that controller stops operation till the next restart.	s
t_AR_fast	Fast-auto-restart time defines the time duration in the controller protection mode fast-auto-restart. It starts at the moment that controller stops operation till the next restart.	s
N_AR_max	Maximum number of restarts in case of any limited number of restarts for any protection. After this number of restarts, the controller will latch.	--
Debug_Mode	Debug mode switches all protections to stop mode. "Disabled": Controller will enter corresponding defined mode in case of protection. "Enabled": Controller will enter stop mode in case of any protection.	--

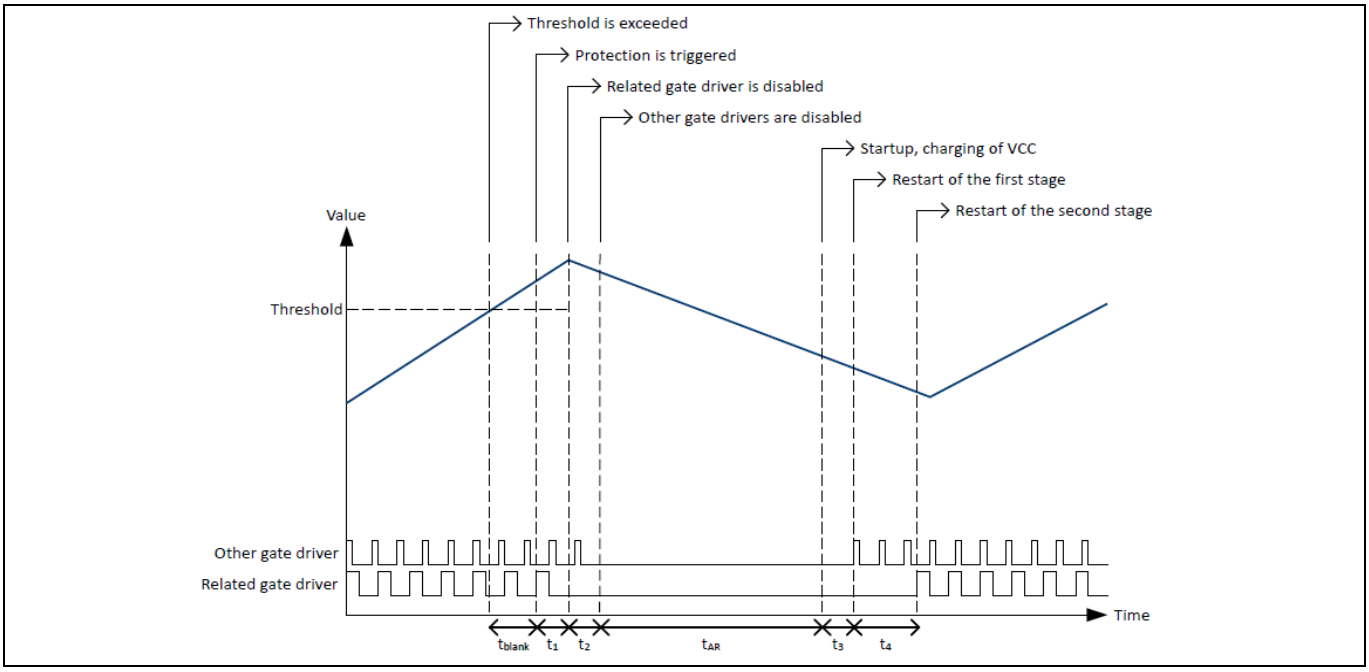


Figure 10 General Protection Parameters

2.1.6 Adaptive Temperature Protection

This section allows the user to set the value and reaction for temperature protection. It is necessary to enter the values of temperature thresholds that define the device's behavior regarding operating temperature conditions. In addition to the conventional temperature protection, the XDPL8220 also features an advanced adaptive temperature protection. The parameters of this feature are given and described in **Figure 11, Table 6**, **Figure 12** and **Figure 13**.

Adaptive Temperature Protection		
Reaction_Tint_ot	Auto-Restart	
Reaction_Text_ot	Auto-Restart	
R_NTC_critical	1657	ohm
R_NTC_hot	2293	ohm
T_critical	110	degC
T_hot	100	degC
I_out_step	5	mA
I_out_red	200	mA

Figure 11 Adaptive Temperature Protections Parameters

The parameters are described in the following table with correspondent figure:

Table 6 Adaptive Temperature Protections Parameters

Parameter	Description	Unit
T_critical	Defines the over-temperature detection threshold value. If this value is reached, controller will reacts with defined protection mode.	°C
Reaction_Tint_OT	If the controller internal temperature sensor detects an over-temperature case, controller will react with: "Auto-Restart Mode": Controller will stop operation and go into the auto-restart mode.	--

	"Latch Mode": Controller will stop operation and go into the latch mode.	
Reaction_Text_OT	If an externally connected NTC reaches the defined resistor value due to the temperature change, it will be detected by the controller at the connected pin. In this case, controller will react with: "Auto-Restart Mode": Controller will stop operation and go into the auto-restart mode. "Latch Mode": Controller will stop operation and go into the latch mode.	--
T_hot	Defines the temperature threshold, which will activate the thermal management by reducing output current	°C
R_NTC_critical	Value of the externally connected NTC resistor at over-temperature threshold T_critical which activates the protection	Ω
R_NTC_hot	Value of the externally connected NTC resistor at temperature threshold T_hot which activates the thermal management	Ω
I_out_step	Thermal management: output current step change	A
I_out_red	Thermal management: lowest output current value which can be reached while reducing current	A

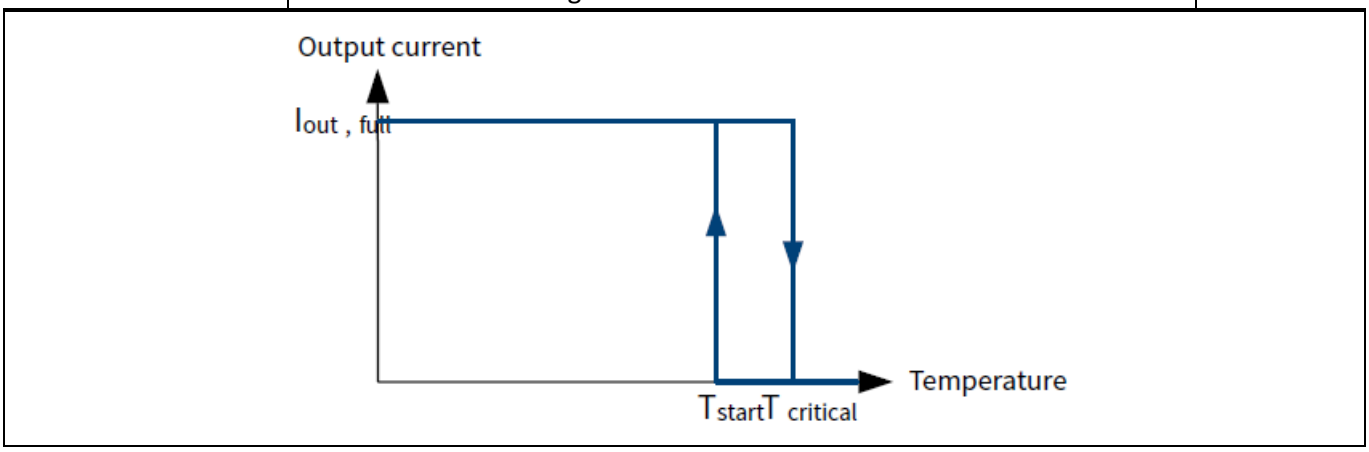


Figure 12 Over-Temperature Protections Parameters

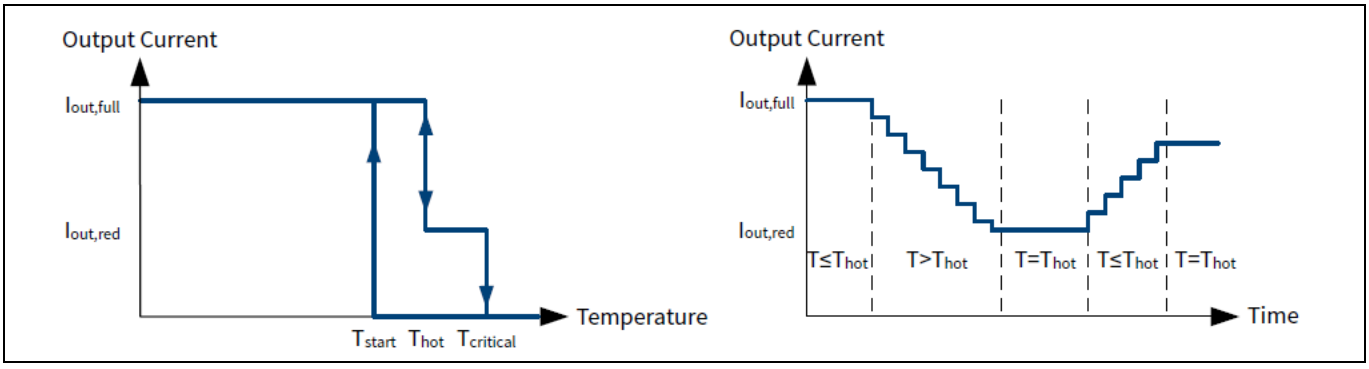


Figure 13 Adaptive Temperature Protections Parameters

2.1.7 Start Up and Shut Down

The parameters in this section define the startup and end conditions for both PFC and FB stages.

Startup and Shutdown		
V_bus_start_PFC	75.0	V
V_out_start	12.5	V

Figure 14 Start Up and Shut Down Parameters

The parameters are described in the following table with correspondent figure:

Table 7 Protection Parameters

Parameter	Description	Unit
V_out_start	Output voltage threshold value, after triggered, control loop is activated, start up is finished.	V
V_bus_start_PFC	Bus voltage threshold value. After it is reached, PFC startup begins.	V

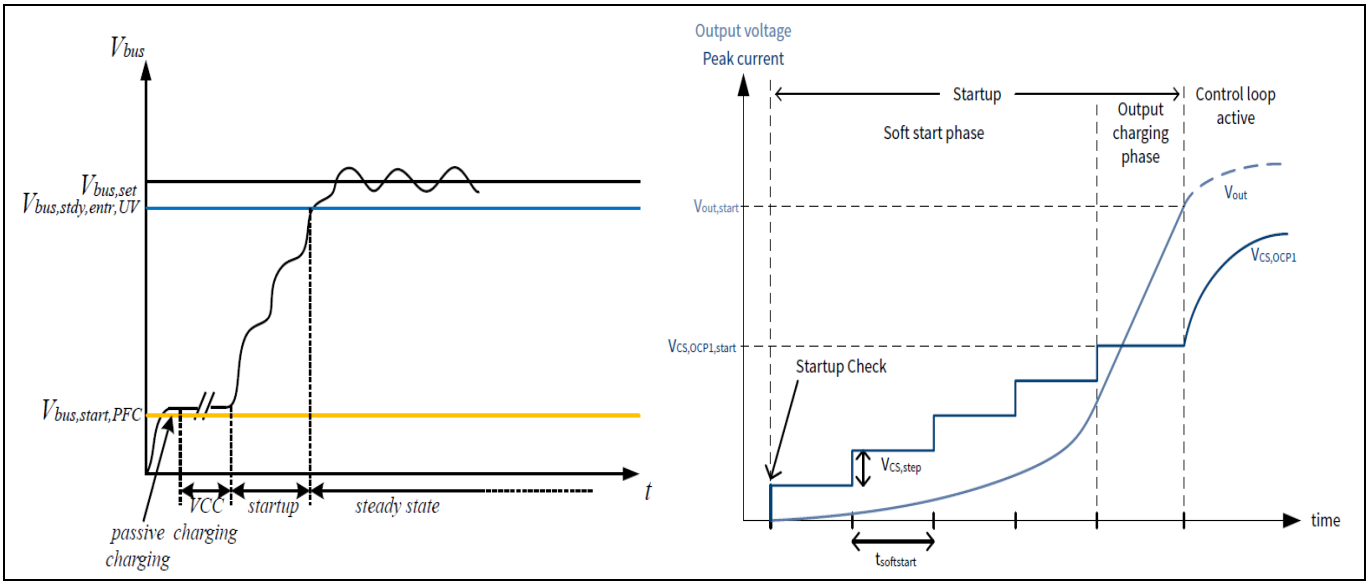


Figure 15 Start Up and Shut Down Parameters

2.1.8 PFC Control Loop

PFC control loop parameters determine the PFC operation behaviors.

PFC Control Loop		
t_on_max_PFC	35.00	us
f_sw_max_PFC	120.00	kHz
N_valley_max_PFC	5	
V_bus_set	460.0	V
V_bus_steady_entry_OV	460.0	V
V_bus_steady_entry_UV	448.0	V

Figure 16 PFC Control Loop Parameters

The parameters are described in the following table with correspondent figure:

Table 8 PFC Control Loop Parameters

Parameter	Description	Unit
t_on_max_PFC	PFC maximum on-time limit	us
f_sw_max_PFC	PFC maximum switching frequency	kHz
N_valley_max_PFC	The maximum possible PFC switching valley	-
V_bus_set	Bus voltage set-point	V
V_bus_steady_entry_UV	Bus voltage steady state entry under-voltage threshold	V

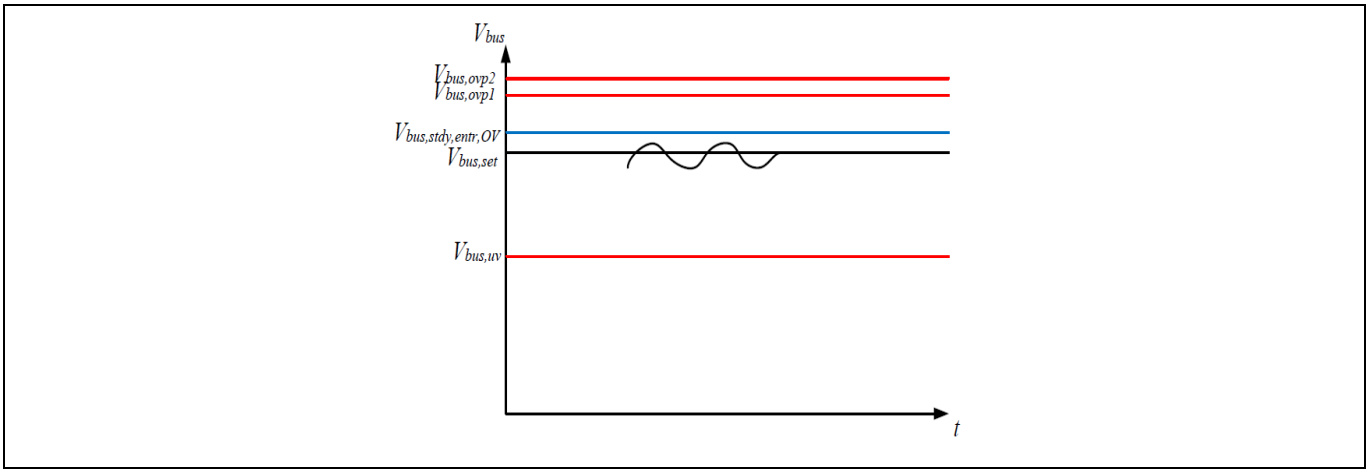


Figure 17 PFC Control Loop Parameters

2.1.9 Flyback Control Loop

Flyback control loop parameters determine the flyback behavior.

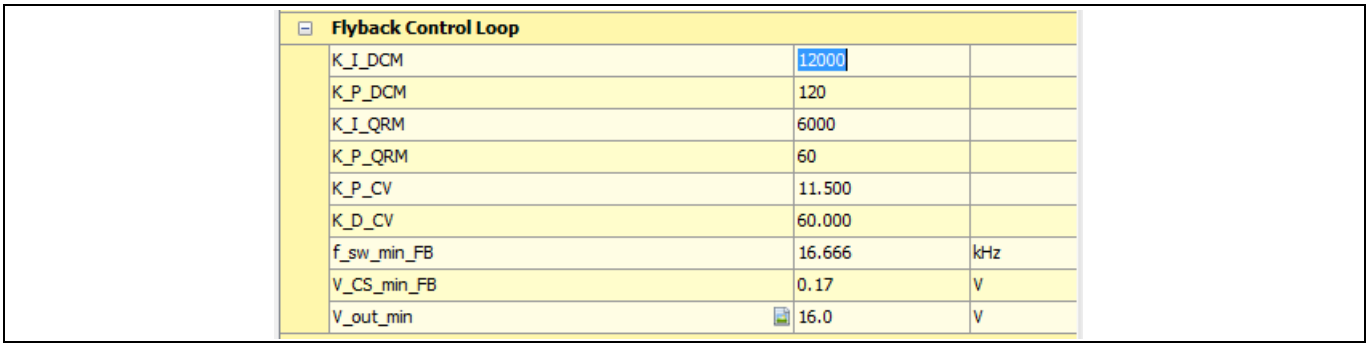


Figure 18 Flyback Control Loop Parameters

The parameters are described in the following table with correspondent figure:

Table 9 Flyback Control Loop Parameters

Parameter	Description	Unit
K_I_DCM	Integral gain of the control loop in DCM. Typically, a good value is typically 100*K_P_DCM	--
K_P_DCM	Proportional gain of the control loop in DCM	--
K_I_QRM	Integral gain of the control loop in QRM. Typically, a good value is typically 100*K_P_QRM	--

K_P_QRM	Proportional gain of the control loop in QRM	--
K_P_CV	Proportional gain for the CV mode	--
K_D_CV	Derivative gain for CV mode	--
f_sw_min_FB	Minimum switching frequency of Flyback converter	kHz
V_CS_min_FB	Minimum primary peak current converted to voltage at the shunt resistor. Decrease to achieve lower output current (a wider dimming range). Increase in case of instabilities due to ringing at the CSFB pin.	V
V_out_min	Minimum output voltage	V

2.1.10 Dimming

This section allows users to define the parameters related to the dimming function. If the feature is enabled, the XDPL8220 will measure the duty cycle at the PWM pin and change the output current accordingly (see **Figure 20**).

The human eye is subject to the logarithm of the light power (Weber-Fechner law). As a consequence, the quadratic dimming curve on the right of **Figure 20** creates a more equally dimming experience to the human eye. It is therefore recommended to be used in combination with, for example, 0 – 10 V wall dimmers. If the dimming voltage is provided by an external source (e.g. a microcontroller for DALI), the linear curve on the left of **Figure 20** can also be selected.

For applications in which no hard wall switch is available to turn off the light completely, the XDPL8220 provides a dim-to-off feature. If enabled, the XDPL8220 will turn off the output current if a duty cycle lower than D_DIM_off is sensed. The output current will be turned on again if the dimming voltage exceeds D_DIM_min again.

In some applications, the dimmer is supplied by the output of the driver (e.g. current-sink dimmer). This requires keeping a minimum output voltage to provide power to the dimmer. The XDPL8220 includes a feature which can maintain an output voltage of $V_{out,start}$ while the driver is in the dim-to-off state. The driver will recharge the output to this voltage level every certain ms.

Note:*The Dim-to-Off feature with maintenance of output voltage requires an active bleeder circuit.*

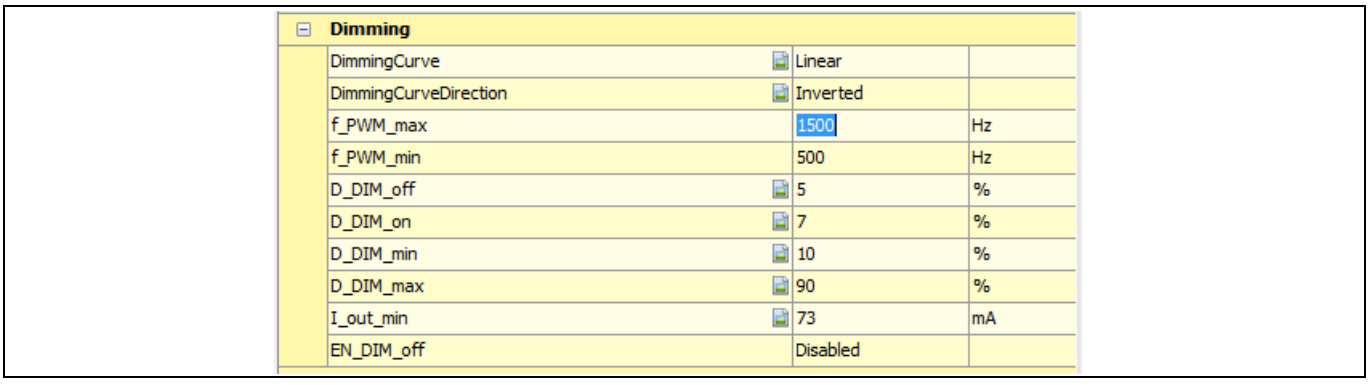


Figure 19 Dimming Parameters

The parameters are described in the following table with correspondent figure:

Table 10 Dimming Parameters

Parameter	Description	Unit
DimmingCurve	Dimming curve shape: “Linear”	--

	“Eye-Adapted”	
DimmingCurveDirection	Direction of the dimming curve “Normal” “Inverted”	--
EN_DIM_off	To enable the dim-to-off feature: Enabled: the dim-to-off feature is enabled. Disabled: the dim-to-off feature is disabled.	--
D_DIM_off	Threshold for the PWM dimming duty cycle which maps to Dim-to-Off	%
D_DIM_on	Threshold for the PWM dimming duty cycle which maps to Dim-to-On	%
D_DIM_min	Threshold for the PWM dimming duty cycle which maps to minimum current	%
D_DIM_max	Threshold for the PWM dimming duty cycle which maps to full current	%
I_out_min	Minimum output current in dimmed mode	mA
f_PWM_min	Minimum frequency of the dimming PWM signal	Hz
f_PWM_max	Maximum frequency of the dimming PWM signal	Hz

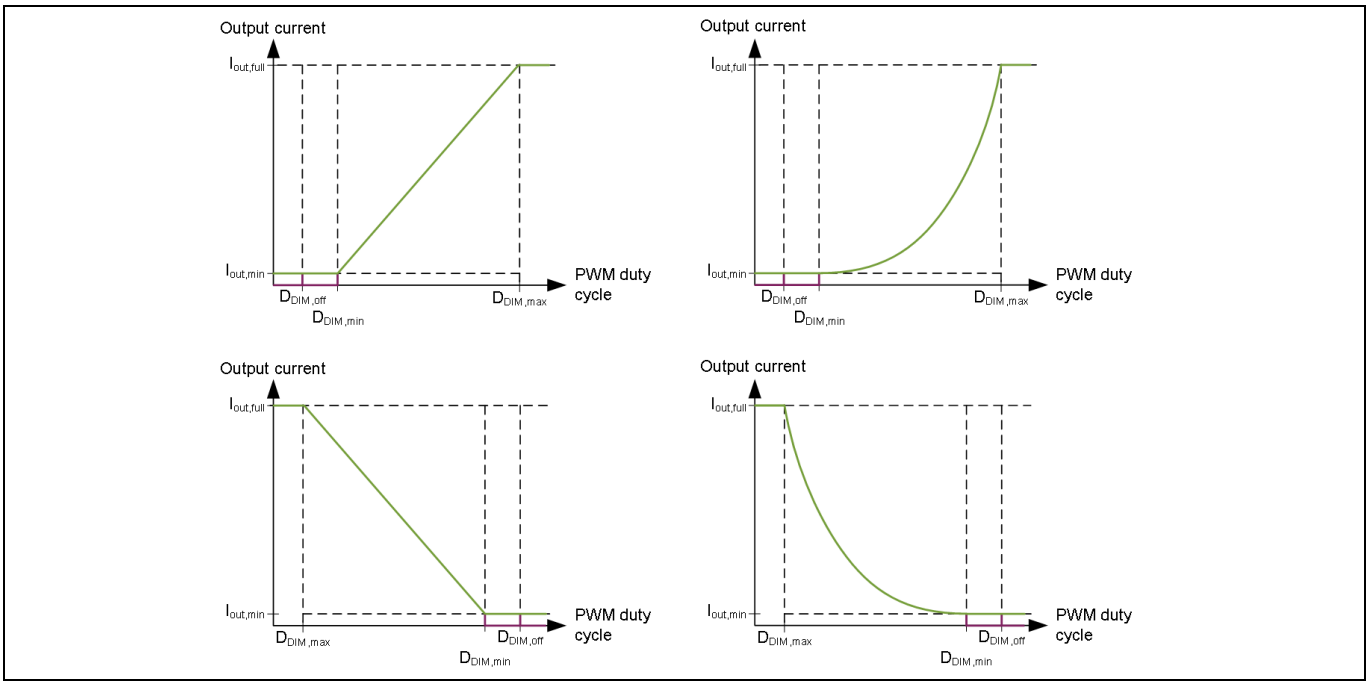


Figure 20 Dimming Parameters

2.1.11 Fine Tuning Parameters

The parameters in **Figure 21** and **Table 11** allow compensating the parasitic elements of the hardware. They enable better performance of the target application. For more information about how to calculate these parameters, please refer to the XDPL8220 design guide for the 50W reference board (see **[4]**).

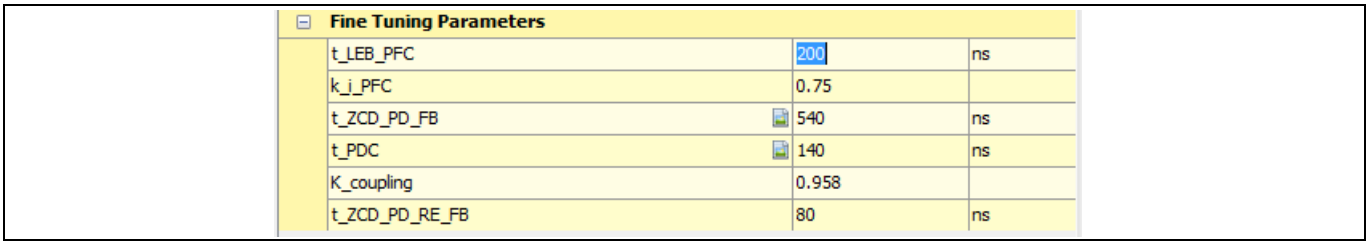


Figure 21 Fine Tuning Parameters

The parameters are described in the following table with correspondent figure:

Table 11 Fine Tuning Parameters

Parameter	Description	Unit
t_ZCD_PD_FB	Flyback Converter: Delay of the zero-crossing signal. Tune this parameter to achieve switching of the flyback at the valley of the auxiliary voltage. This value influences the accuracy of output current!	ns
K_coupling	Flyback Converter: Transformer coupling coefficient. Tune this parameter to eliminate any offset error between measured output current and the values set in this GUI.	--
t_PDC	Flyback Converter: Propagation delay compensation. Tune this parameter to eliminate any output current regulation error due to a variation of bus voltage.	ns
t_ZCD_PD_RE_FB	Flyback Converter: Rising edge delay of the zero-crossing signal. Tune this parameter to optimize the output current accuracy with respect to output voltage regulation.	ns
t_LEB_PFC	PFC Converter: Current sense leading edge blanking	ns
K_i_PFC	PFC Converter: THD optimization co-efficient	--

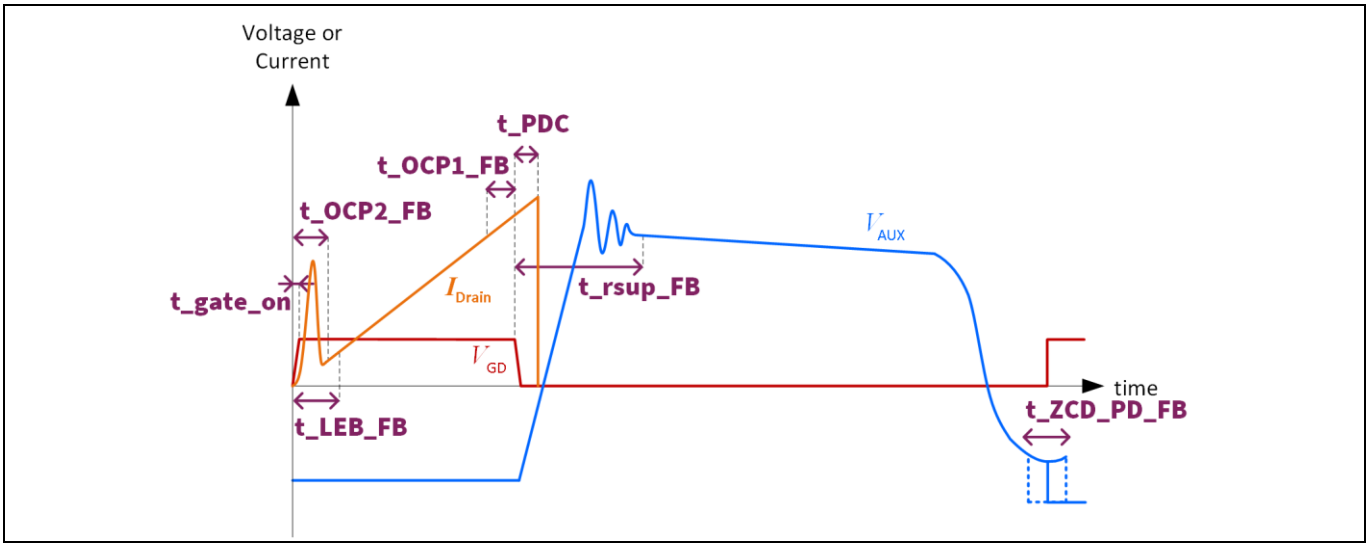


Figure 22 Fine Tuning Parameters

3 Default Parameter Values for 50W Reference Board

Following table gives the default parameter values for 50W Reference Board:

Table 12 Default Parameter Values for 50W Reference Board

Parameter	Value	Unit
Output Set-Points		
I_out_full	1500	mA
V_out_set	48	V
P_out_set	50	W
Hardware Configuration		
Lp	3.1	mH
N_p/N_s	3.91	--
N_p/N_a	4.94	--
I_p_max	1.3	A
R_CS_FB	0.8	Ω
R_ZCD_FB_1	68	k Ω
R_ZCD_FB_2	3.9	k Ω
R_VS_1	9960	k Ω
R_VS_2	52.3	k Ω
R_HV	99	k Ω
PFC Protection		
V_bus_OVP1	485	V
V_bus_UV	350	V
t_start_max_PFC	200	ms
Reaction_Vin_OV	Latch	--
EN_Vin_OV	Disabled	--
V_in_OV	320	Vrms
EN_Vin_UV	Enabled	--
V_in_UV	76	Vrms
V_CS_OCP1_PFC	0.75	V
Flyback Protection		
V_out_OV	53	V
Reaction_Vout_OV	Auto-Restart	--
Reaction_Vout_UV	Auto-Restart	--
V_out_UV	8	V
t_start_max_FB	5	ms
I_out_OC	1800	mA
P_out_OP	55	W

Parameter	Value	Unit
General Protection		
t_AR	1	s
t_AR_fast	0.15	s
N_AR_max	10	--
Debug_Mode	Disabled	--
Adaptive Temperature Protection		
T_critical	110	°C
Reaction_Tint_OT	Auto-Restart	--
Reaction_Text_OT	Auto-Restart	--
T_hot	100	°C
R_NTC_critical	1657	Ω
R_NTC_hot	2293	Ω
I_out_step	5	mA
I_out_red	200	mA
Start Up & Shut Down		
V_out_start	12.5	V
V_bus_start_PFC	75	V
PFC Control Loop		
t_on_max_PFC	35	us
f_sw_max_PFC	120	kHz
N_valley_max_PFC	5	--
V_bus_set	460	V
V_bus_steady_entry_UV	448	V
Flyback Control Loop		
K_I_DCM	12000	--
K_P_DCM	120	--
K_I_QRM	6000	--
K_P_QRM	60	--
K_P_CV	11500	--
K_D_CV	60000	--
f_sw_min_FB	16.666	kHz
t_on_max_FB	10	us
V_CS_min_FB	0.17	V
V_out_min	16	V

Parameter	Value	Unit
Dimming		
DimmingCurve	Linear	--
DimmingCurveDirection	Inverted	--
EN_DIM_off	Disabled	--
D_DIM_off	5	%
D_DIM_on	7	%
D_DIM_min	10	%
D_DIM_max	90	%
I_out_min	73	mA
f_PWM_min	500	Hz
f_PWM_max	1500	Hz

Fine Tuning Parameters		
t_ZCD_PD_FB	540	ns
K_coupling	0.958	--
t_PDC	140	ns
t_ZCD_PD_RE_FB	80	ns
t_LEB_PFC	200	ns
K_i_PFC	0.75	--

4 References

[1] XDPL8220 Datasheet

[2] XDPL8220 Reference Board Description 50W

[3] .dp vision – Basic Mode User Manual

[4] XDPL8220 Design Guide

Revision History

Major changes since the last revision

Page or Reference	Description of change	Revision	Date
All	Initial version	1.0	2016-07-01
All	Update according to the FW_0.5.4	1.1	2016-10-25
All	Update according to the FW_1.0.0	1.2	2016-11-29

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