53 W PFC-SSR flyback evaluation board with ICL8830 and HV CoolGaN™ transistor

High-frequency flyback IC for lighting applications

About this document

Scope and purpose

This document is an engineering report for the 53 W PFC-SSR flyback evaluation board (orderable part number: EVALICL8830GANTOBO1), which uses Infineon's ICL8830 single-stage PFC flyback controller, IGD70R200D2S 700 V CoolGaN™ Transistor and BSS126 600V N-channel depletion mode MOSFET.

This evaluation board can be used for on/off LED drivers or LED drivers with minimum dimming levels down to 0.1% and dim-to-off. Please refer to the performance section of this document for more information.

Intended audience

This document is intended for engineers interested in using ICL8830 as SSR high power factor (PF) flyback with CV output.

About this product family

Product family

Infineon's CoolGaN™ gallium nitride power solutions enable exceptionally high efficiency, switching speed, and power density in modern power conversion. By minimizing switching losses and enabling higher operating frequencies, CoolGaN™ helps reduce system size, improve thermal performance, and unlock new design headroom across both AC-DC and DC-DC stages. The portfolio is designed to address demanding performance targets while supporting robust, reliable operation in volume applications.

Target applications

- Adapters and fast chargers
- Server power supply units
- Telecom AC-DC power conversion
- Industrial SMPS
- Audio amplifiers solutions

Table of contents

1 Introduction

1.1 Infineon ICL88xx controller family for two-stage topologies

Two-stage topologies are growing in popularity because of the convenient scalability of power on the primary side as well as the features on the secondary side. High light quality, very low dimming levels, and complex systems with sensors and MCUs require a stable output voltage enabled by a constant voltage (CV) secondary-side regulated (SSR) topology. More stringent standards for flicker and total harmonic distortion (THD) as well as harmonics are also points in favor of a flyback SSR topology. The SSR configuration is suitable for on/off LED drivers and is the best solution for minimum dimming levels down to 0.1 percent and dim-to-off.

The main difference between SSR and primary-side regulation (PSR) flyback topology is that in the PSR system, the main channel secondary-side output voltage is indirectly measured through the primary auxiliary supply winding. This means the coupling between the main secondary and auxiliary windings does affect the regulation accuracy. In contrast, the SSR system directly measures the output, which makes the transformer design easier and less complicated.

If only 5% to 10% dimming is required and a larger output voltage tolerance (3% to 5%) is acceptable, then it might be possible to go for a PSR design, where the system costs are lower compared with the SSR solution. ICL8800, ICL8810 and ICL8820 devices can be used with all the features in the SSR system as well as the PSR topology. For more information about the PSR solution, see the Engineering Report of the PSR reference design.

ICL8800 is a family member, which is cost-optimized and can be perfectly used for on/off drivers and dimming down to 5%.

ICL8810 is a family member with the burst mode (BM) feature. This helps to control the output voltage quite accurately down to a very low output power level and dim-to-off operation.

ICL8820 is a family member with a BM and jitter feature. In addition to the BM, this IC offers a jitter function during DC operation. This helps to pass the EMI requirements for DC operation, required for the emergency lighting system.

ICL8830 is the latest family member of Infineon ICL88xx single-stage PFC flyback controllers. ICL8830 is tailored for high-frequency switching operation and capable to drive GaN transistor and Si MOSFET switching devices. It detects high frequency oscillation of the flyback switch drain voltage and provides the gate signal with a small delay for accurate and reliable quasi-resonant mode (QRM) operation to achieve high efficiency while providing a high power factor. The integrated BM feature allows designs with low standby and light-load power consumption even in high-switching-frequency designs. The controller is easy to design in and requires a minimum number of external components. ICL8830 does not support PSR topology.

1.2 Startup and feedback options

As a default setup, the evaluation board is assembled with an active startup circuit based on a BSS126 depletion-mode MOSFET on a very small adapter board. After the first start, the IC is then supplied from the auxiliary winding and the startup circuit is disabled. This setup offers the lowest standby losses.

If low standby consumption is not necessary as an option, the active startup circuit can be changed to a resistive startup. For resistive startup, the active startup daughterboard needs to be removed, and the main board must be modified as required; see Figure 2 and Section 6.1 for further information.

The evaluation board is equipped with two different regulation circuits, designed on two separate small plug-and-play boards. To operate the evaluation board, at least one of them must be connected to the main board.

The two feedback boards are designed to demonstrate the trade-off between cost and performance. Here the TL431 board offers the cheaper solution, and shows advantage in standby performance, while the opamp-based feedback board provides better regulation characteristics and improved harmonic performance.

1.3 THD/PF Optimization

For the best total harmonic distortion (THD) and power factor (PF) performance, the crossover frequency of the feedback loop should be in the range of 5 to 20 Hz. If the crossover frequency is too low, the feedback reaction will be extremely slow, making it unable to adapt for dynamic load changes (e.g., sudden load loss). At the same time, a lower crossover frequency improves THD. This creates a trade-off between feedback reaction and harmonic performance. However, if a faster load-jump-dependent loop is required, a fast path can be easily added to the existing feedback loop.

1.4 Flyback output overvoltage protection

For the flyback output overvoltage protection (OVP), it is necessary to say that it has a 10% tolerance across the entire production process and temperature range. This fact must be considered during the development phase. If the overvoltage level is too close to the normal operation voltage, it may lead to accidental triggering of the protection during fast load changes, especially at high input voltages. Here, the feedback loop is too slow to react to a sudden load loss, and it cannot control the output voltage within the very tight limit anymore. The converter will therefore move to hiccup oscillation. To avoid this, the OVP level must have a proper margin. If it is mandatory to improve regulation accuracy, there are a few options:

- Use a dynamic feedback or dynamic bleeder, which is active only when the voltage reaches a certain point. This adds some complexity and increases cost
- Increase the capacitance value of the output capacitor

2 Specifications

Table 1 lists the design specifications of the ICL8830 PFC-SSR flyback evaluation board.

Table 1 Design specifications

Specification	Symbol	Value	Unit
Maximum AC input voltage	VAC_{max}	90 to 277	V_{rms}
Rated operational AC input voltage	VAC_{rated}	100 to 264	V_{rms}
Rated operational AC input frequency	F_{line}	47 ~ 63	Hz
Secondary-side regulated CV output set-point	$V_{out,setpoint}$	66	V
Flyback output overvoltage protection set-point	$V_{out,OVP}$	75	V
Steady-state output load current	I_{out}	0 ~ 800	mA
Steady-state full-load output power	$P_{out,full}$	52.8	W
Minimum efficiency at $P_{out,full}$	$\eta_{min,at,Pout,full}$	91	%
Target minimum switching frequency at $P_{out,full}$	$f_{sw,min,at,Pout,full}$	200	kHz
Standard compliance			
Harmonics	–	EN 61000-3-2 Class C	–
EMI	–	EN55015	–
Board dimensions			
Main board	L x W	169 x 27	mm
Plug-in TL431 feedback board	L x W	36.5 x 27	mm
Plug-in opamp feedback board	L x W	38.5 x 27	mm
Startup daughterboard	L x W	15 x 11.5	mm

3 Connections

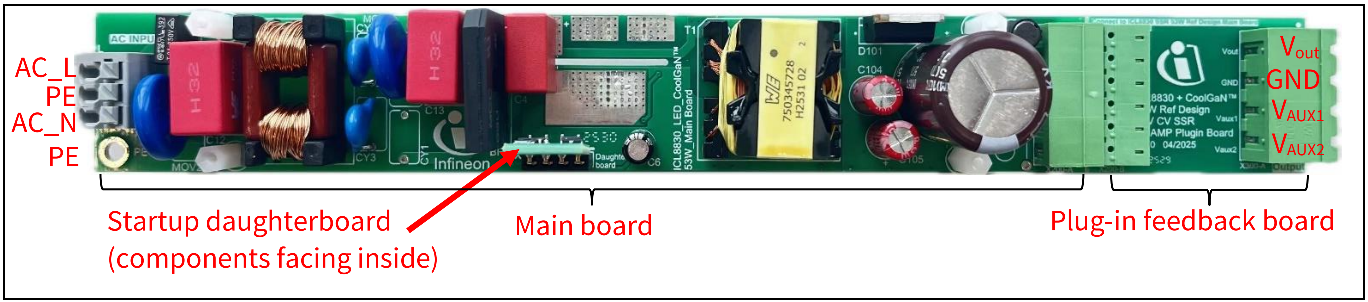


Figure 1 Top side with connections

4 Schematics

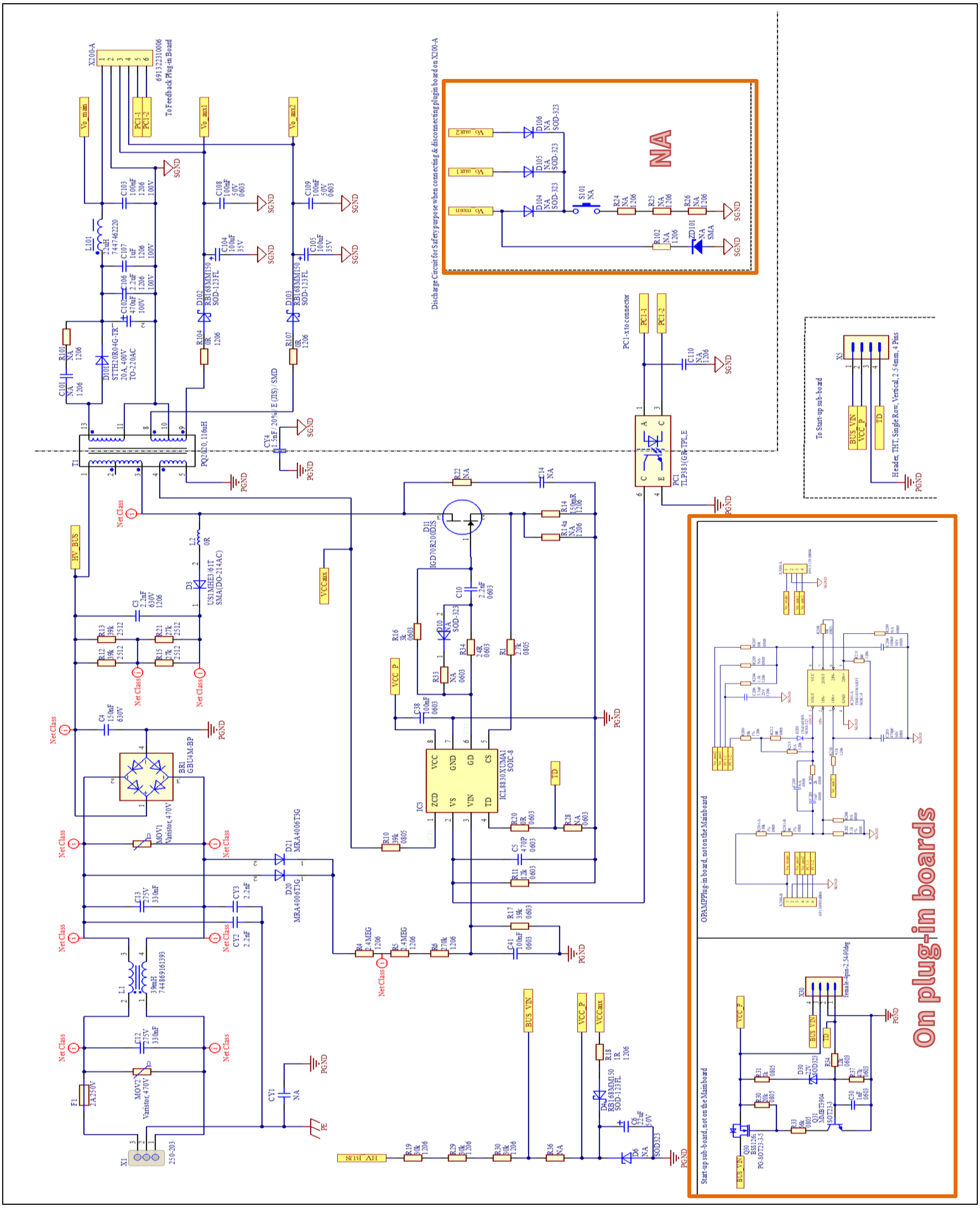


Figure 2 Schematic of the ICL8830 PFC-SSR flyback evaluation board

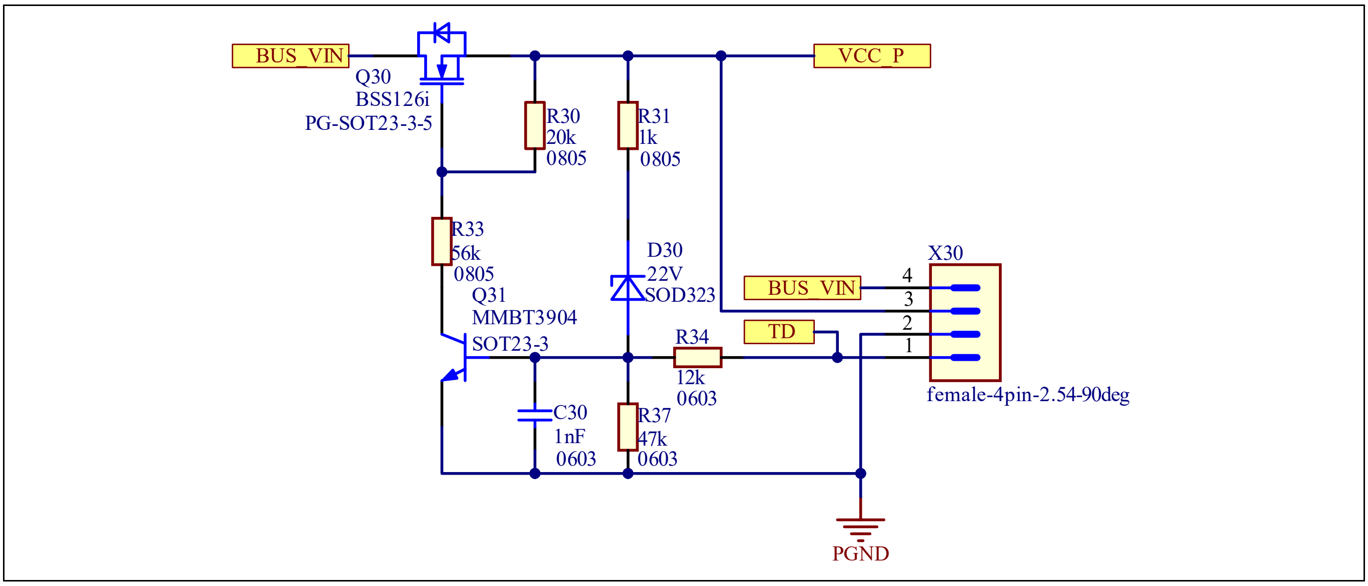


Figure 3 Schematic of the daughterboard with active startup circuit

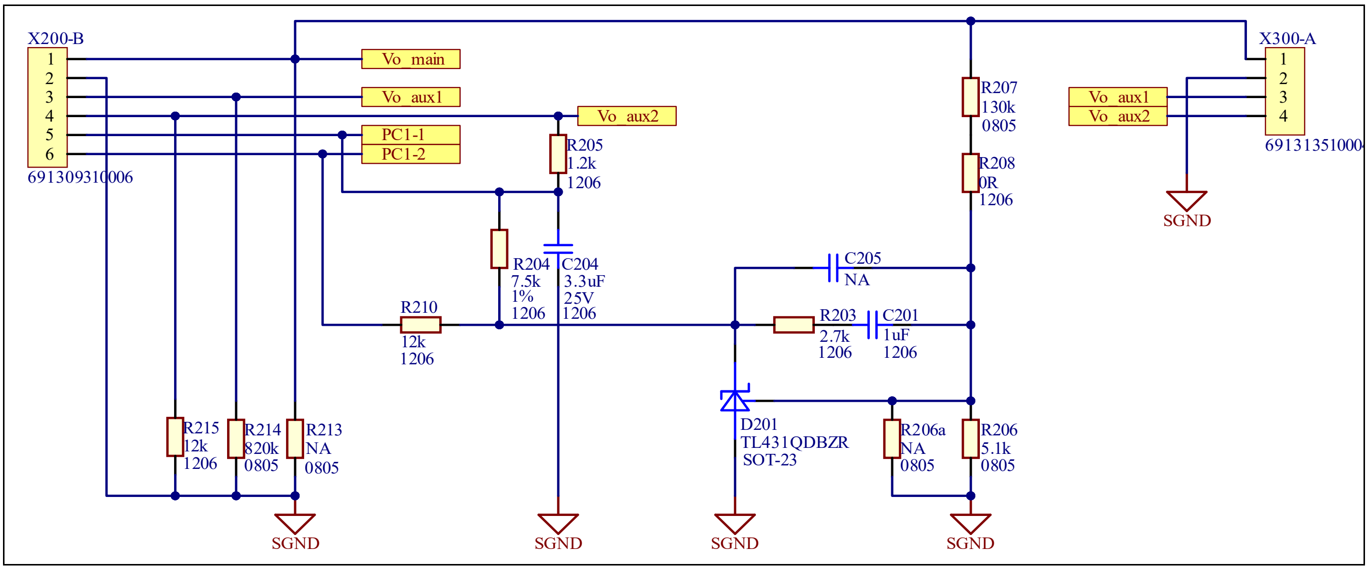


Figure 4 Schematic of the plug-in board with TL431 feedback loop circuit

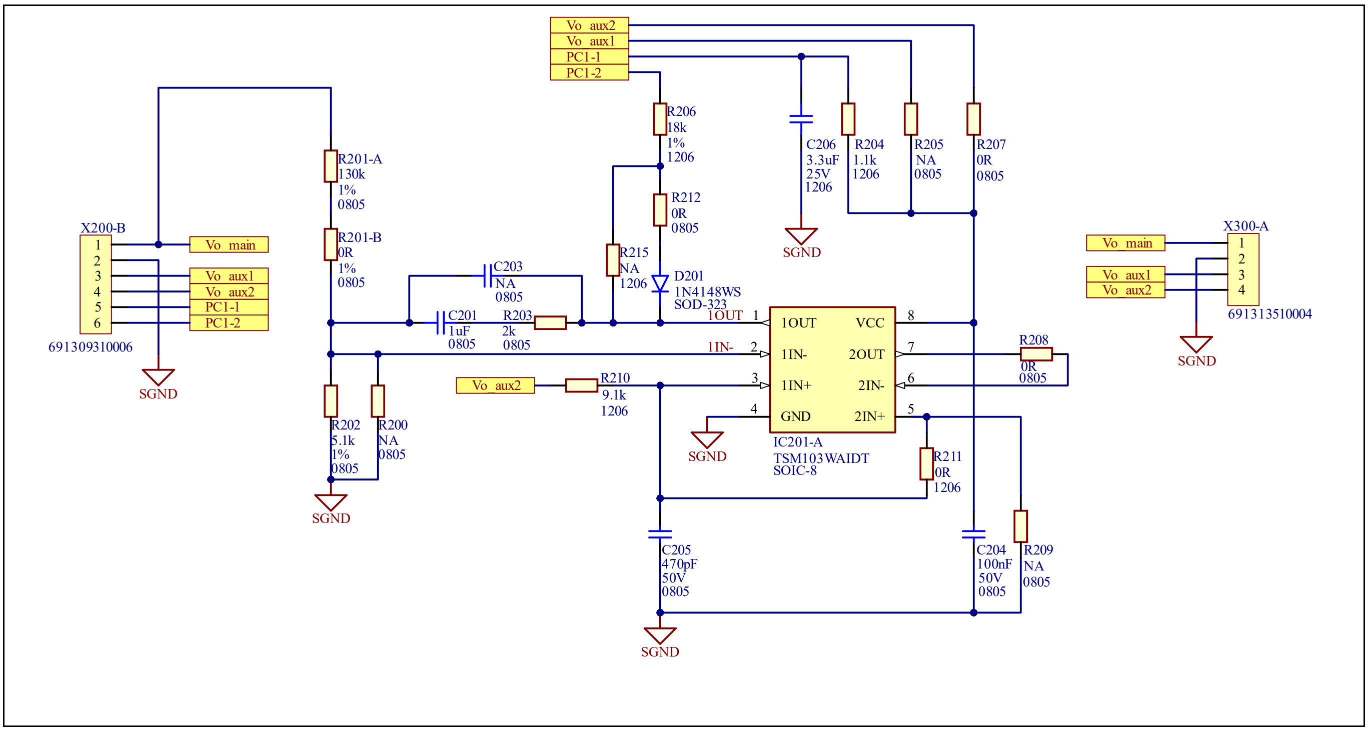


Figure 5 **Schematic of the plug-in board with the opamp feedback loop circuit**

5 Layouts

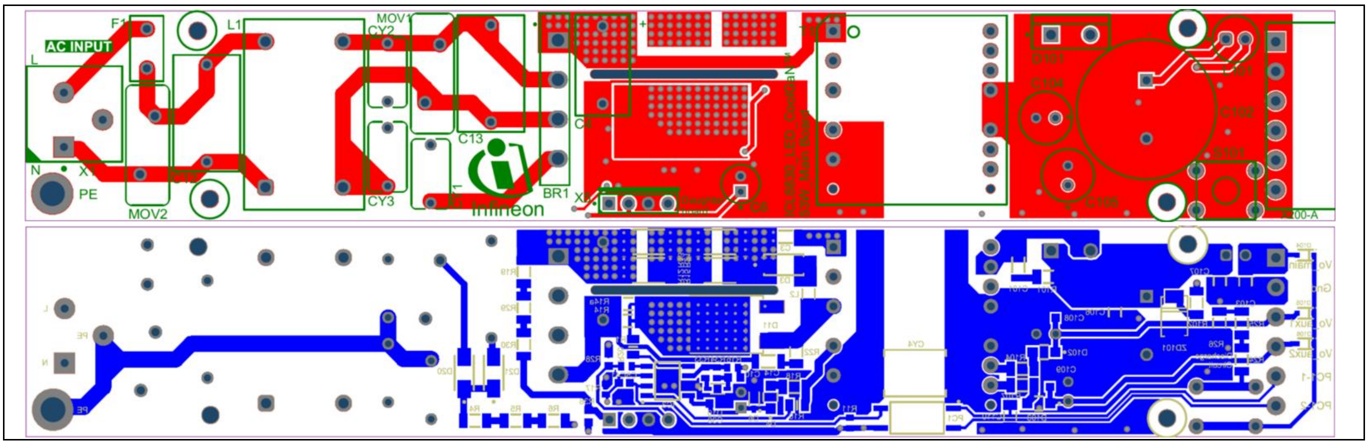


Figure 6 Layout of the top and bottom sides for the main board

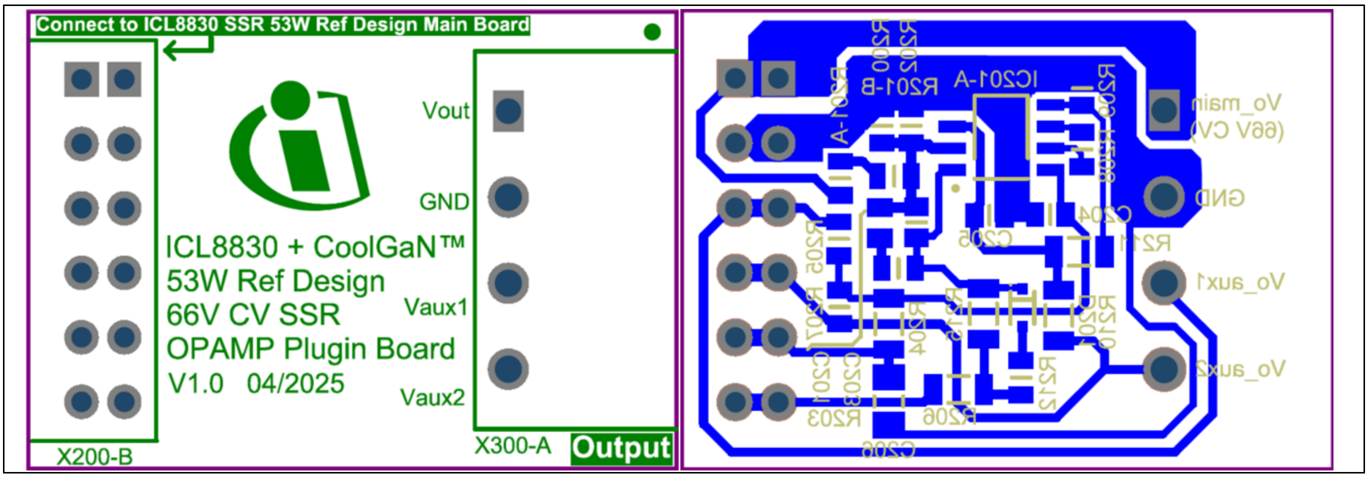


Figure 7 Layout of the opamp plug-in board

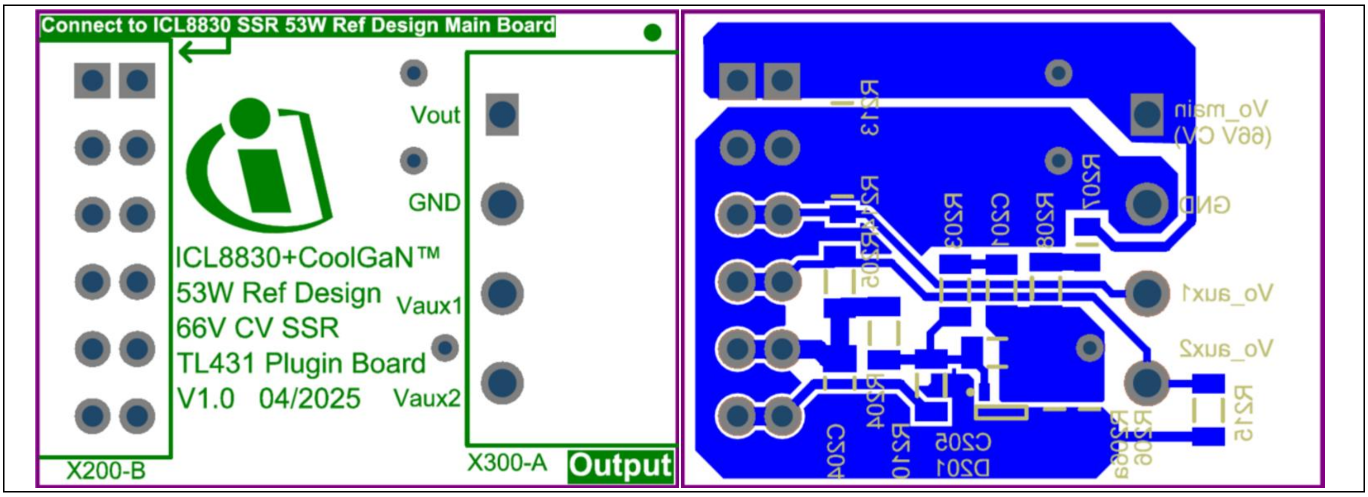


Figure 8 Layout of the TL431 plug-in board

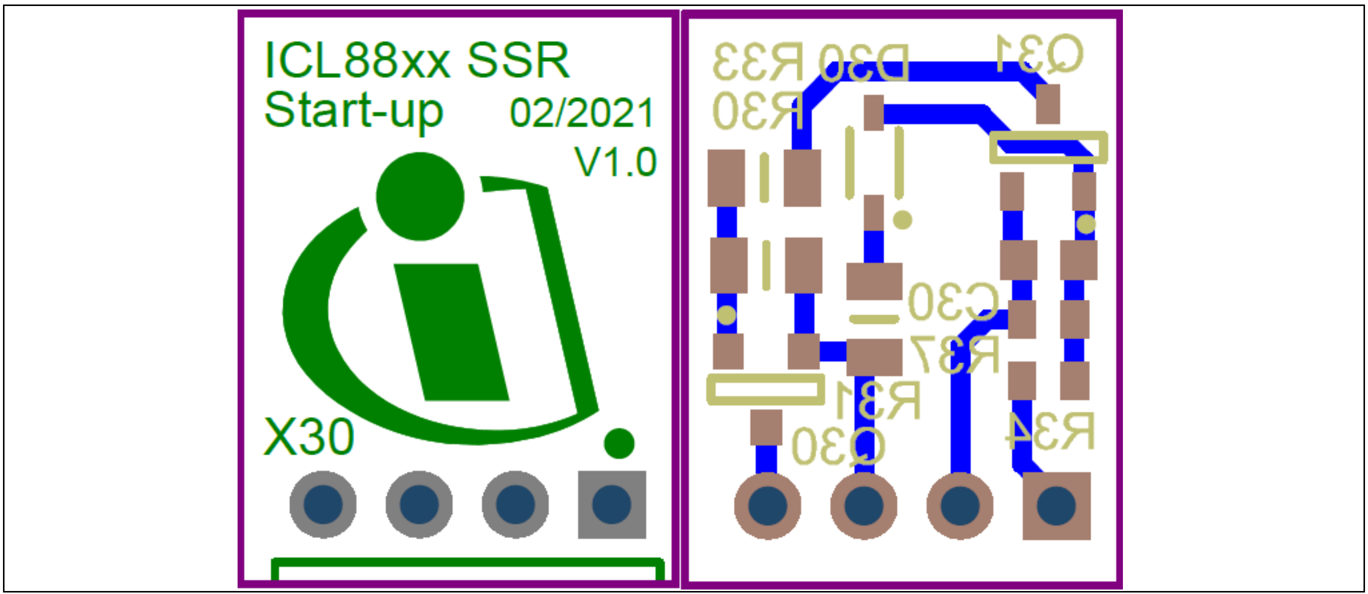


Figure 9 Layout of the active startup board

6 Board combinations

6.1 Startup options

As described earlier, this evaluation board offers two options for startup.

The resistive circuit is cost-effective but introduces constant power losses, which varies depending on the input voltage. It is perfect for on/off drivers and dimmable drivers without standby requirements.

The active startup circuit enables faster charging of the V_{CC} capacitor. The key advantage is the controllable resistive path, where the power losses are only present during startup, or when the V_{CC} gets too low. This option is most suitable where standby losses matter.

If testing without the active startup daughterboard, do the following:

1. Increase the startup resistors to approximately 200 kΩ
2. Populate R36 with 0 Ω and R28 with 68 kΩ
3. Populate D6 with a 22 V Zener
4. Unplug the active startup daughterboard

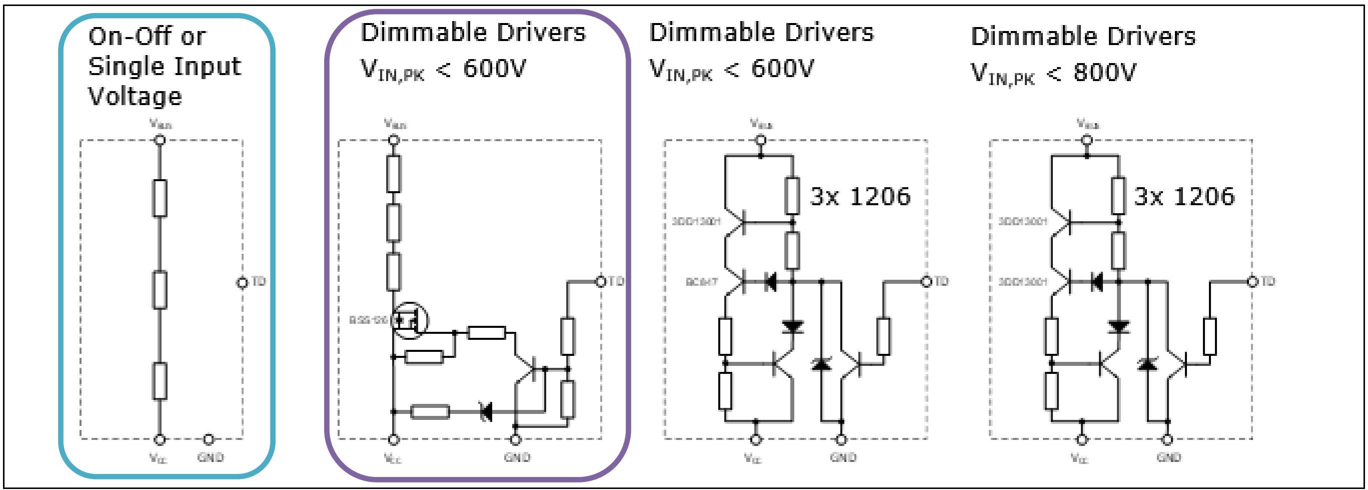


Figure 10 A selection of startup options

6.2 SSR circuit

Here, again, two options are offered.

The TL431 circuit features a simpler structure, resulting in a lower standby power consumption.

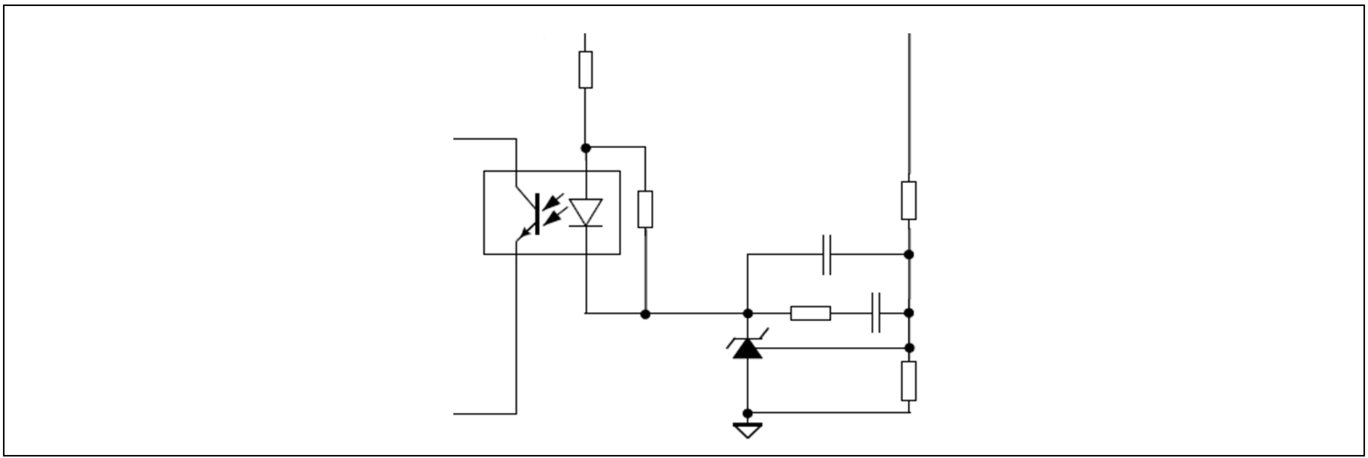


Figure 11 TL431 circuit

On the other hand, the opamp with an integrated voltage reference has better output regulation and harmonic performance, and the system peak efficiency is slightly superior to that of the TL431 circuit.

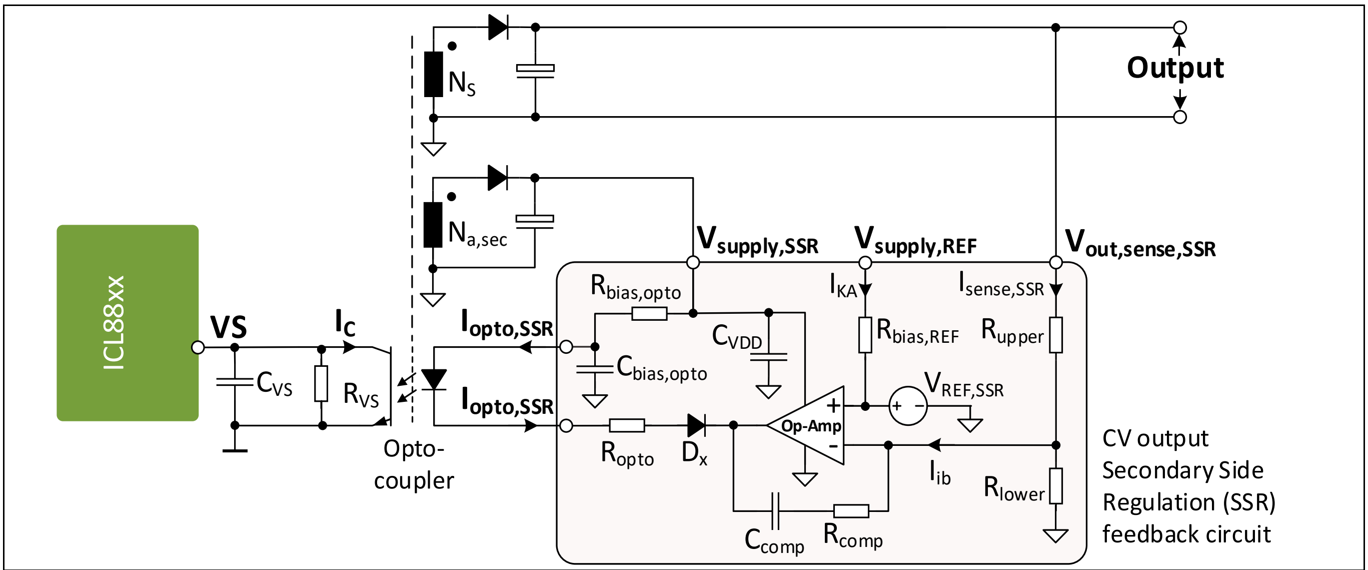


Figure 12 Opamp circuit

Both circuits have their advantages and disadvantages, and there is no general answer to which circuit is the best. It always depends on the input and output specifications, PCB space constraints, focus on cost or performance, and availability of components.

For test purposes, both boards can be used as plug-and-play.

Attention: ***Make sure that the output capacitor is discharged, and the AC mains voltage is turned off before changing the feedback board. To make the process easier, the footprint of a discharge circuit is already added on the main PCB. After assembling it, the output capacitor can be safely discharged by the push of a button.***

7 Performance

7.1 Performance with opamp plugin board

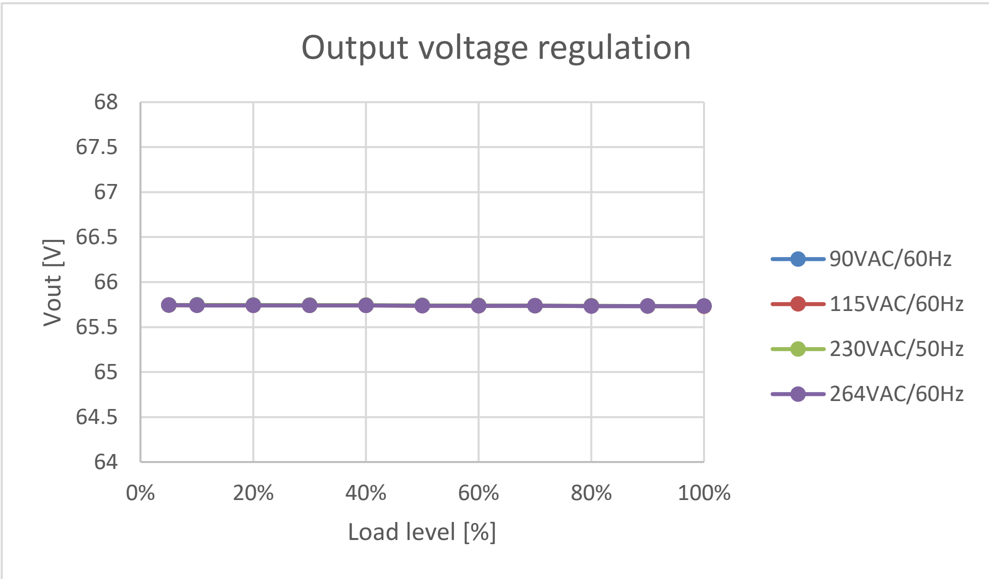


Figure 13 **V_{out} regulation**

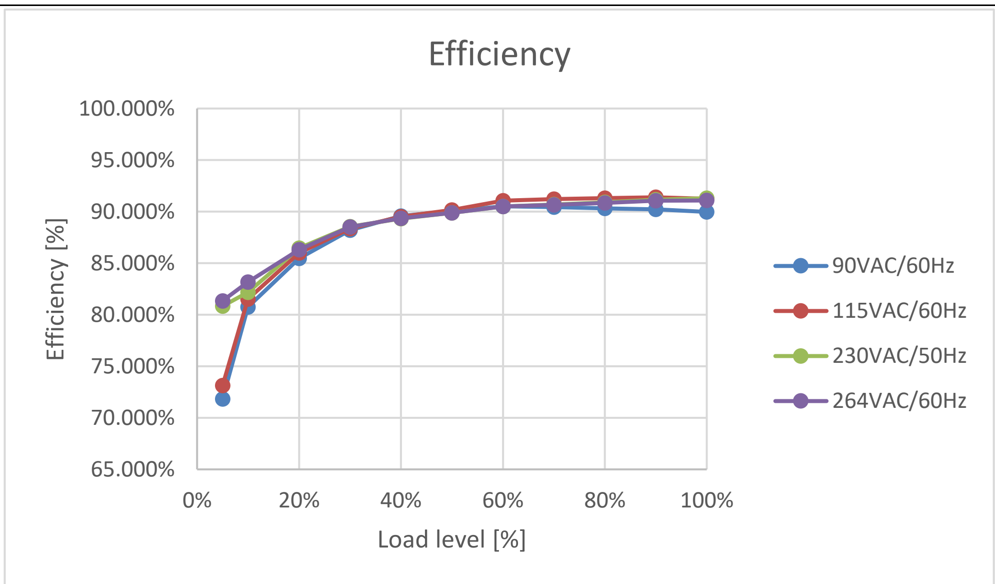


Figure 14 **Efficiency**

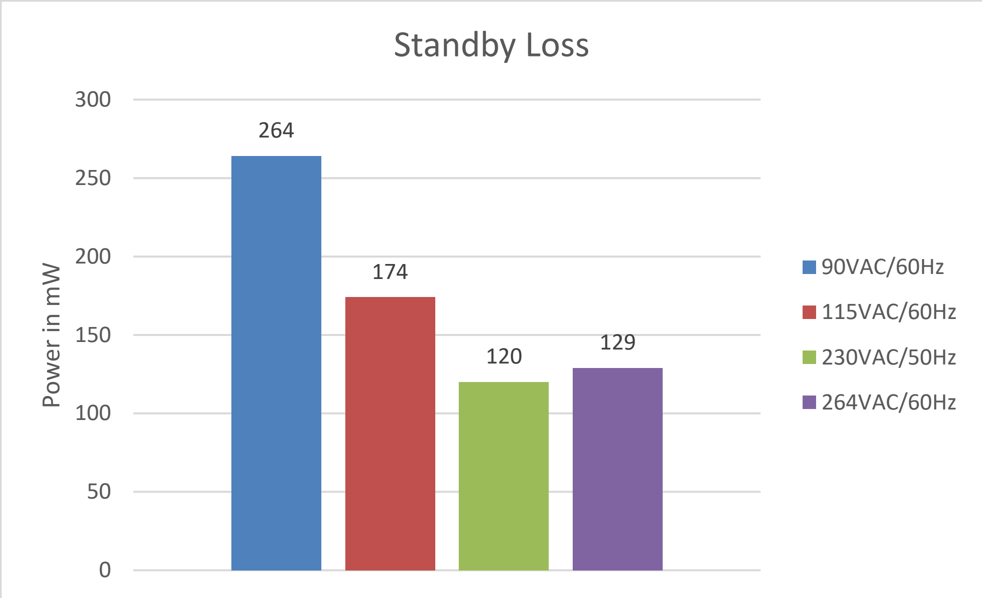


Figure 15 **No-load input power**

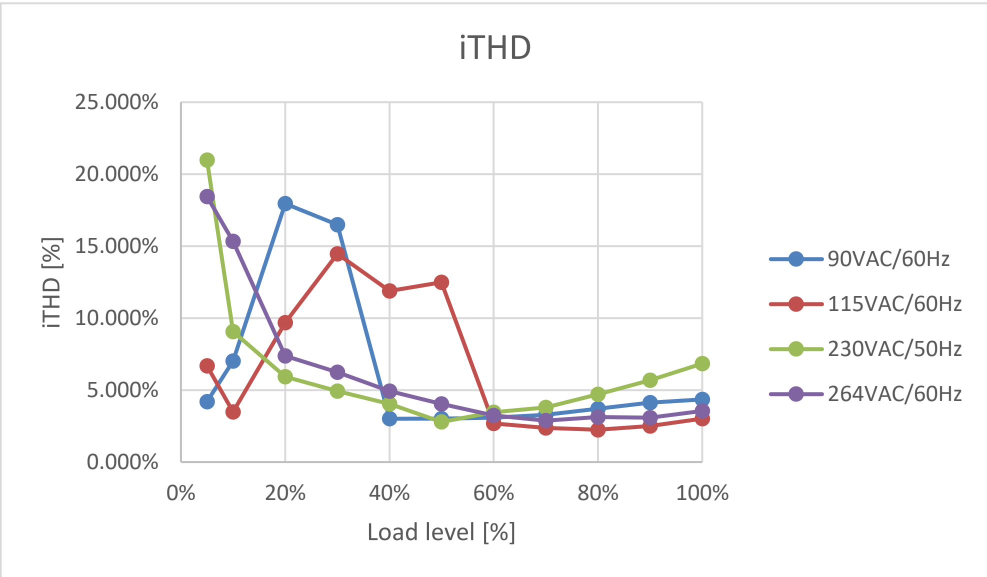


Figure 16 **THD measurement**

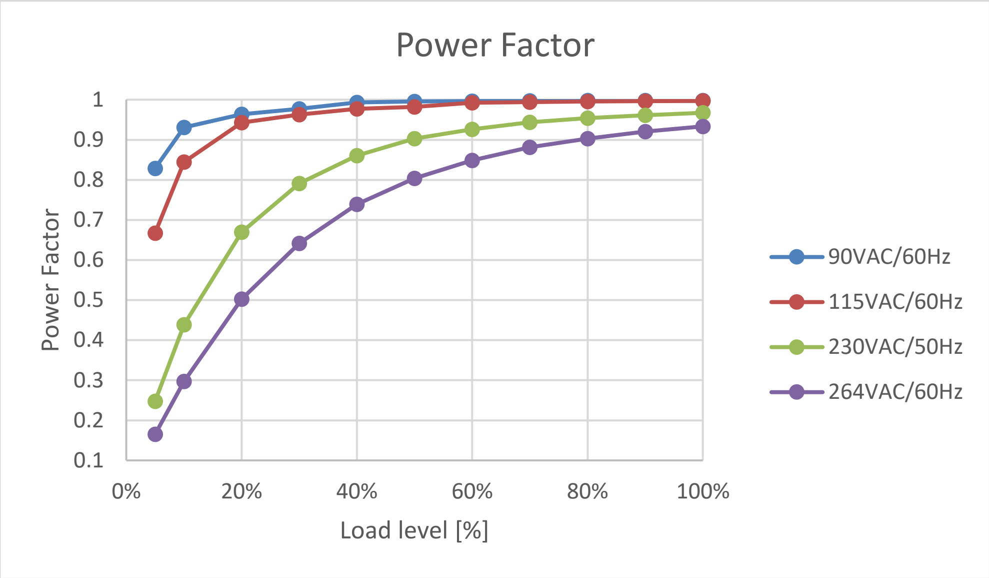


Figure 17 PF measurement

7.2 Performance with TL431 plugin board

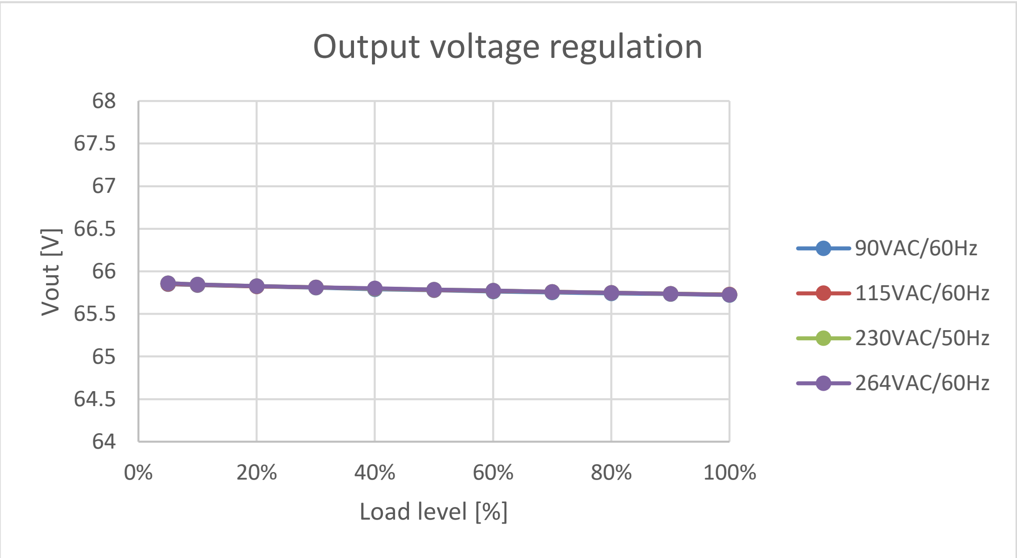


Figure 18 V_{out} regulation

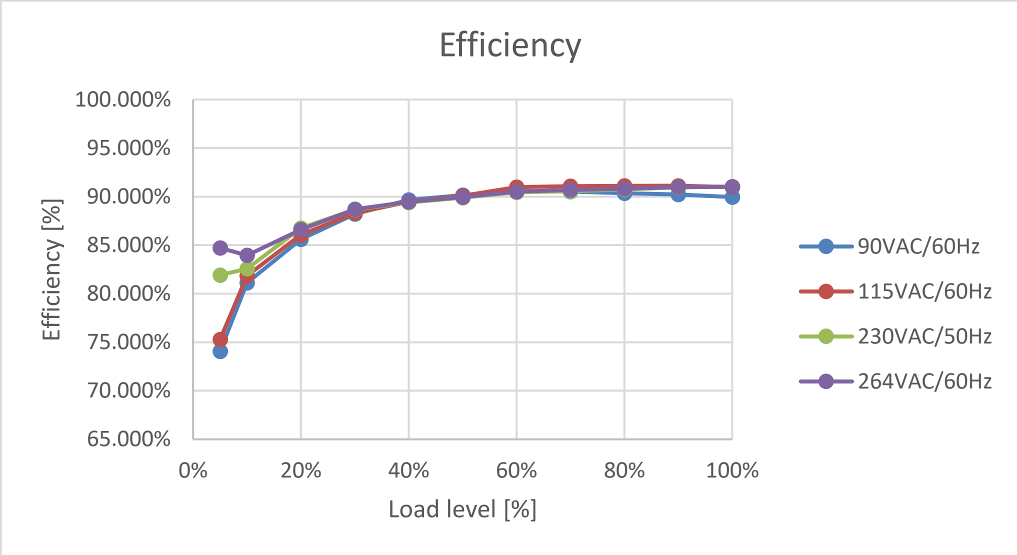


Figure 19 **Efficiency**

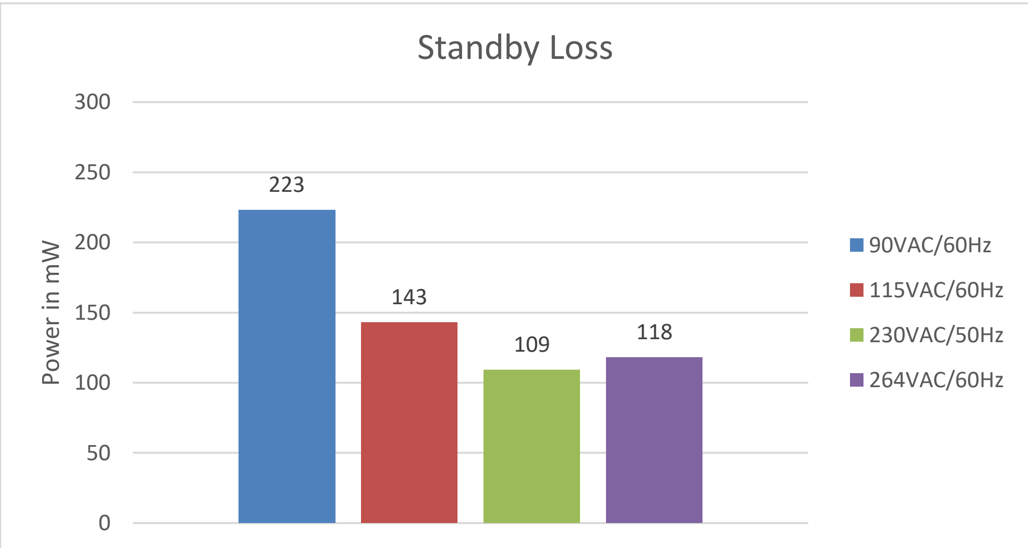


Figure 20 **No-load input power**

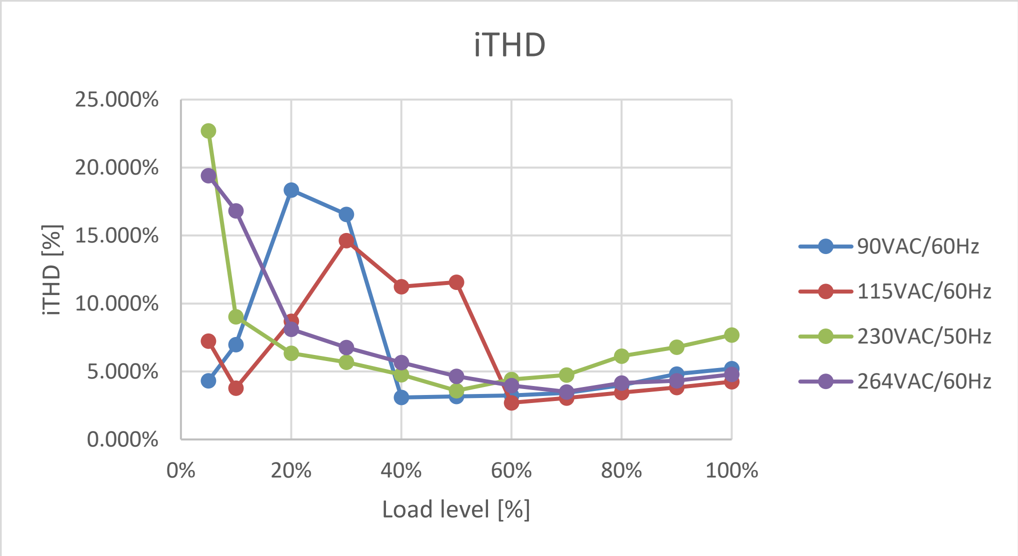


Figure 21 **THD measurement**

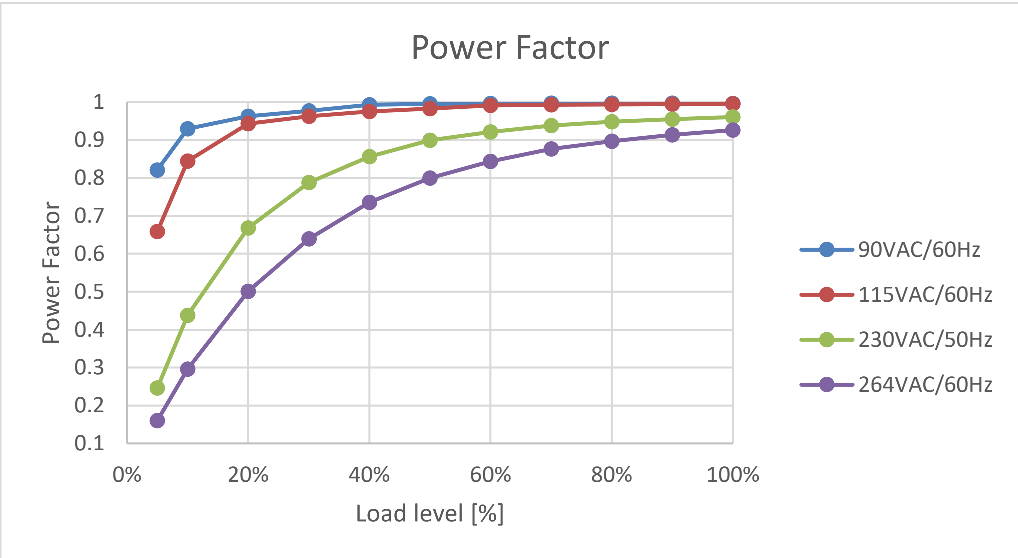


Figure 22 **PF measurement**

8 Key waveforms

8.1 Startup

This section shows the startup behavior of the converter at various input voltage and load conditions, when equipped with the default active startup circuit board and connected to the opamp plug-in board.

The selection of the V_{CC} pull-up resistors and V_{CC} capacitor ensures that the startup time is less than 300 ms in the worst-case scenario. This is crucial for meeting Energy Star time-to-light requirement of 500 ms.

To save energy and make the design in easier, the gate voltage is reduced (7 V typ.) during startup.

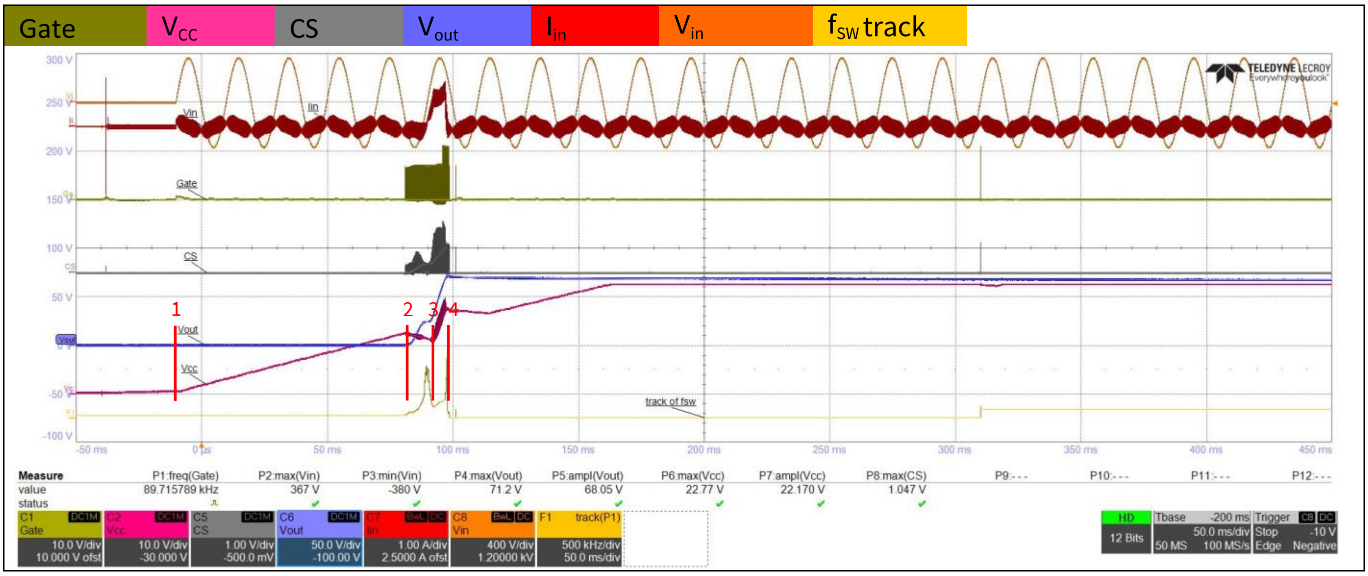


Figure 23 Startup at 264 Vac/no load

Table 2 Self-supply during startup referring to Figure 23

Section	Explanation
1	Start of the AC input voltage and start of the V_{CC} capacitor charging
2	Start of the IC, supply only from the V_{CC} capacitor
3	Auxiliary winding delivering power to the V_{CC} capacitor
4	Normal operation with self-supply

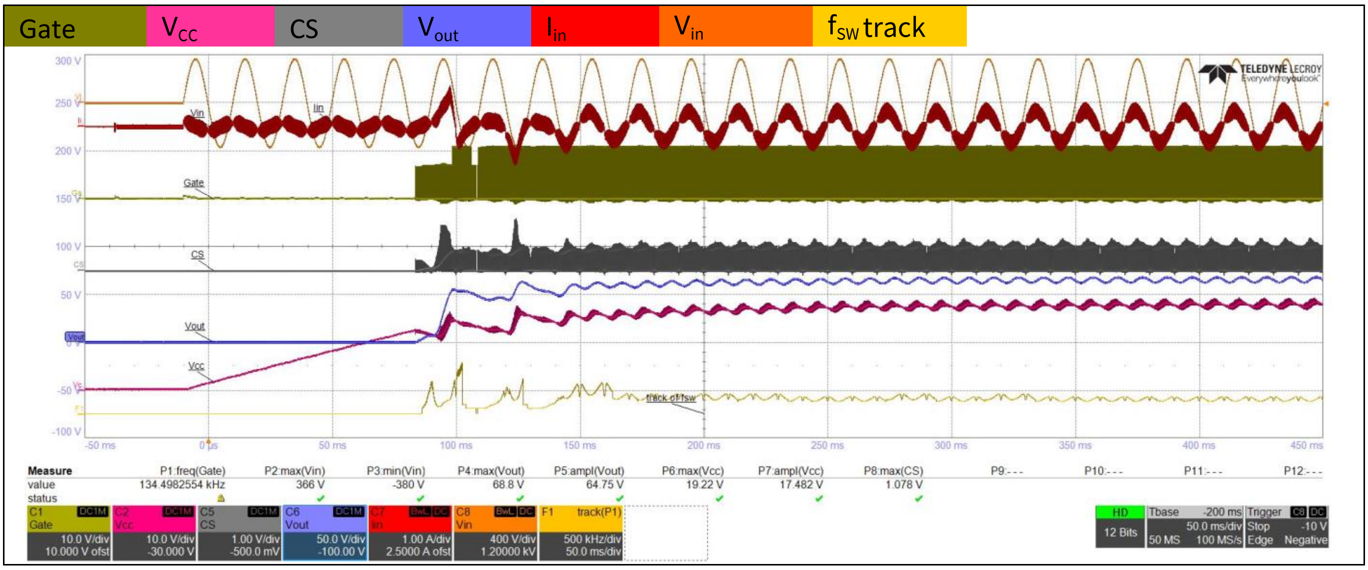


Figure 24 Startup at 264 Vac/full load

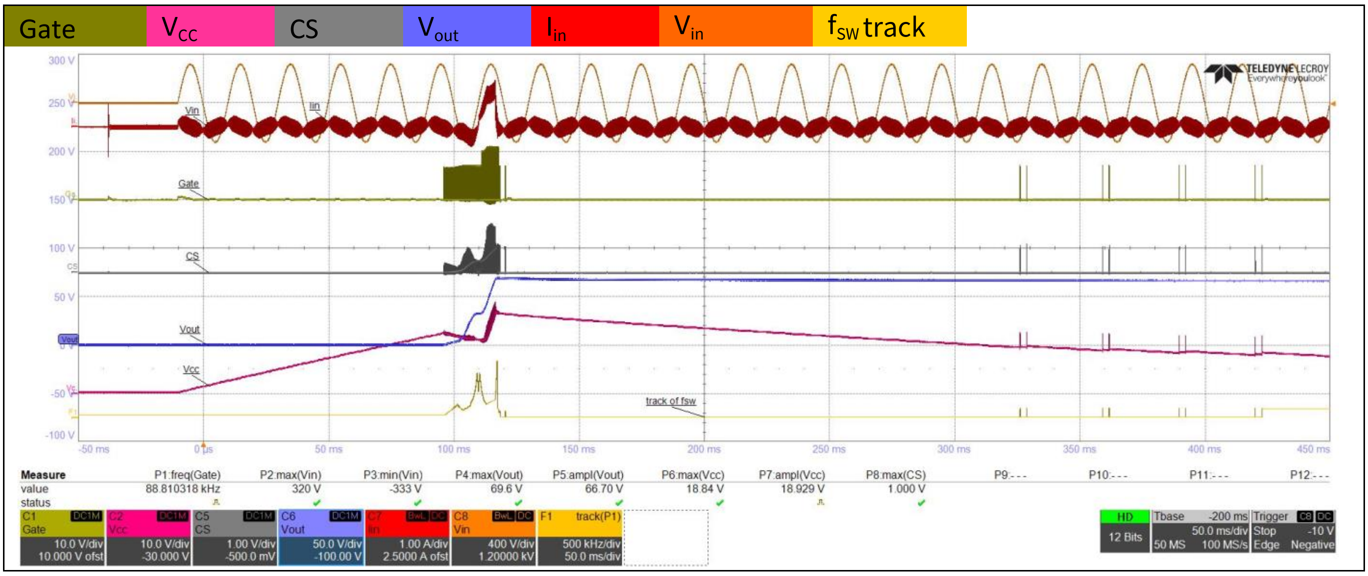


Figure 25 Startup at 230 Vac/no load

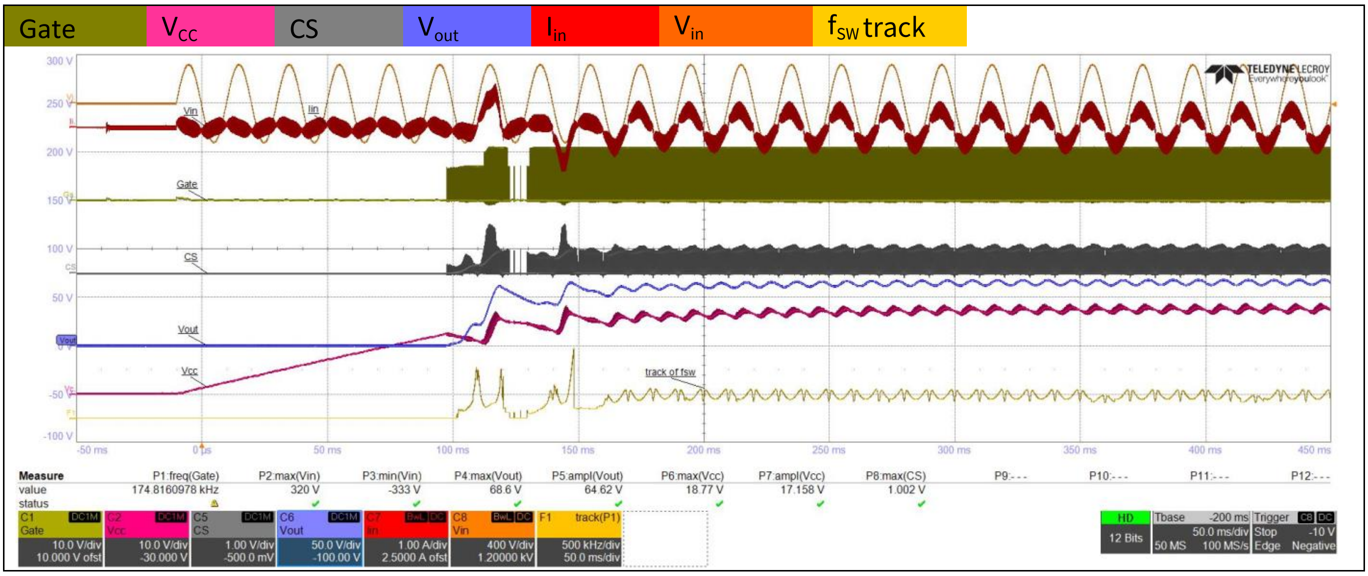


Figure 26 Startup at 230 Vac/full load

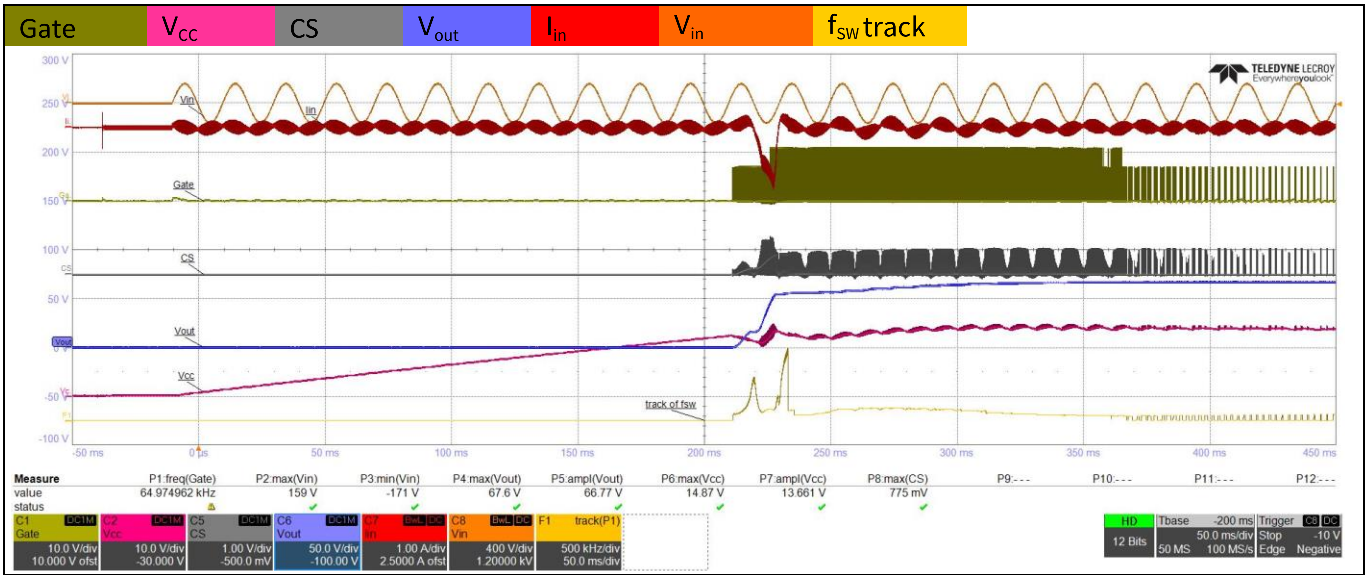


Figure 27 Startup at 115 Vac/no load

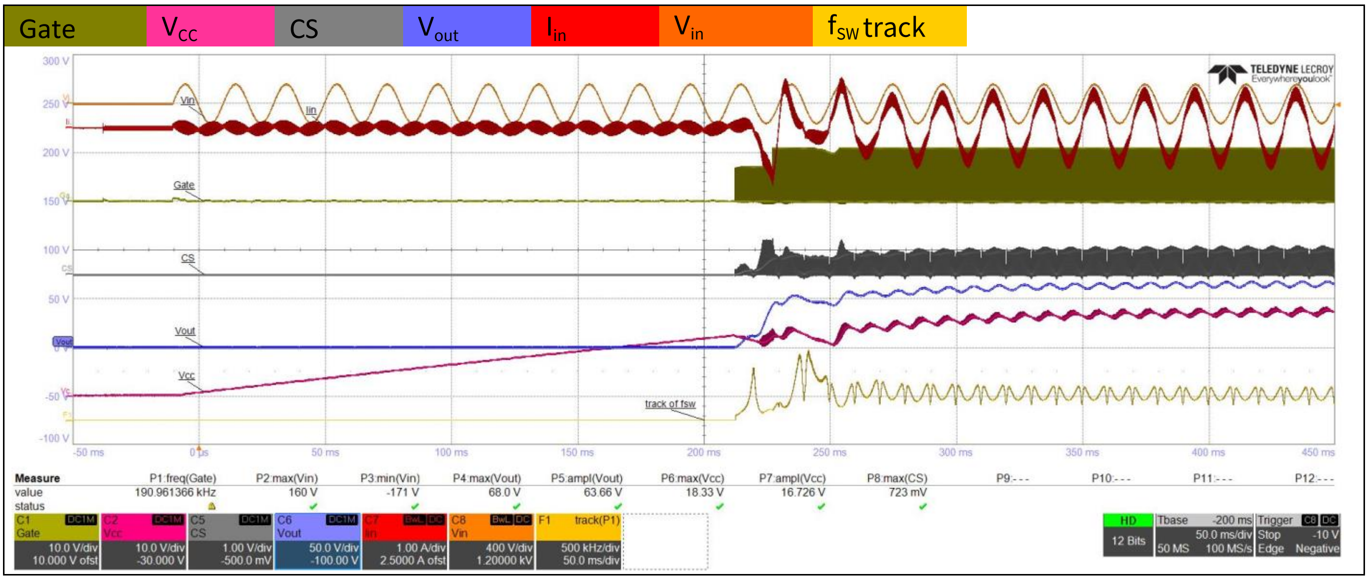


Figure 28 Startup at 115 Vac/full load

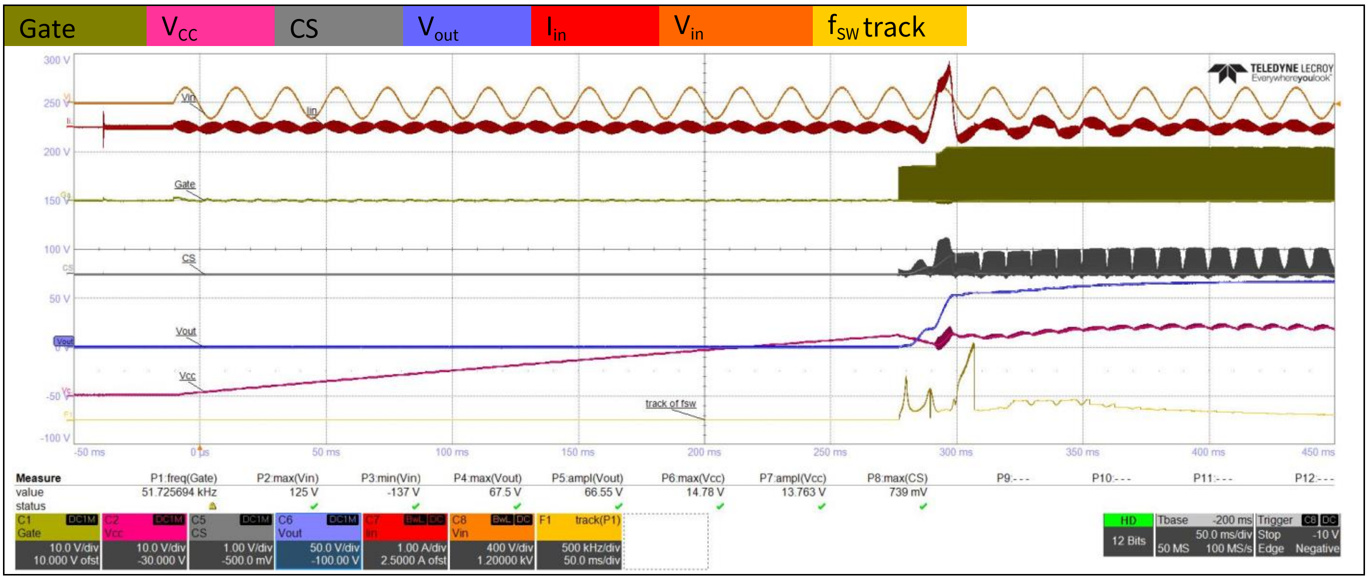


Figure 29 Startup at 90 Vac/no load, delay due to V_{in} pin averaging

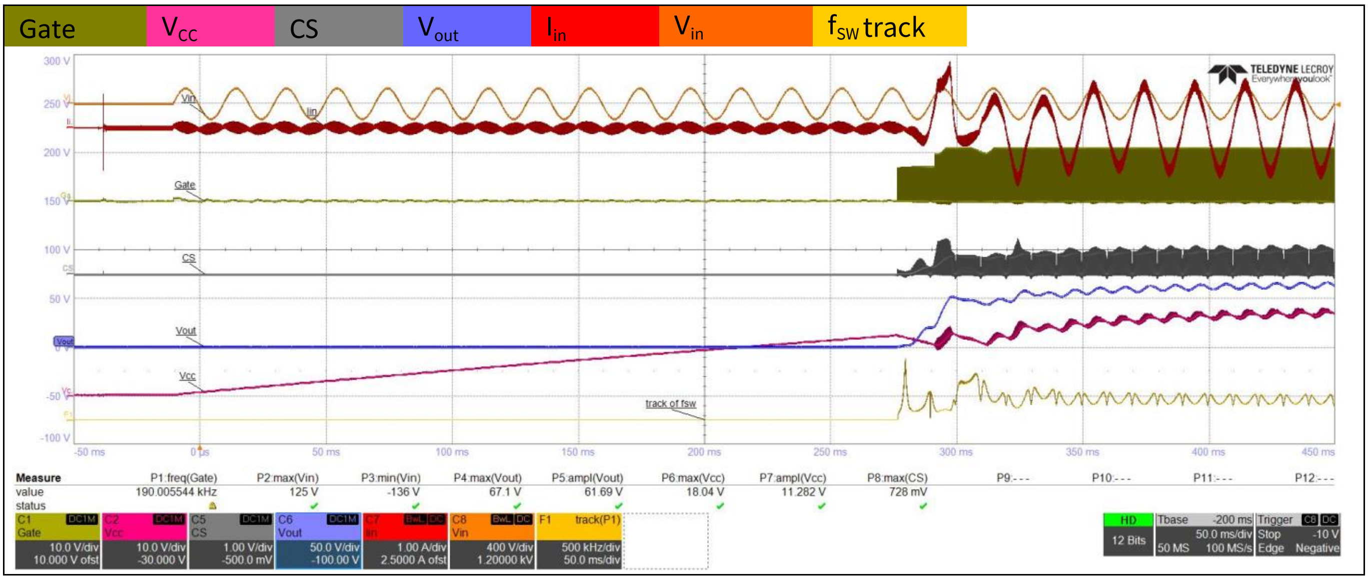


Figure 30 Startup at 90 Vac/full load, delay due to V_{in} pin averaging

Because the input voltage is internally averaged, it may result in delayed startups close to the brown-in voltage.

8.2 Steady state

This section shows the switching waveforms during steady-state operation, when equipped with the opamp plug-in board.

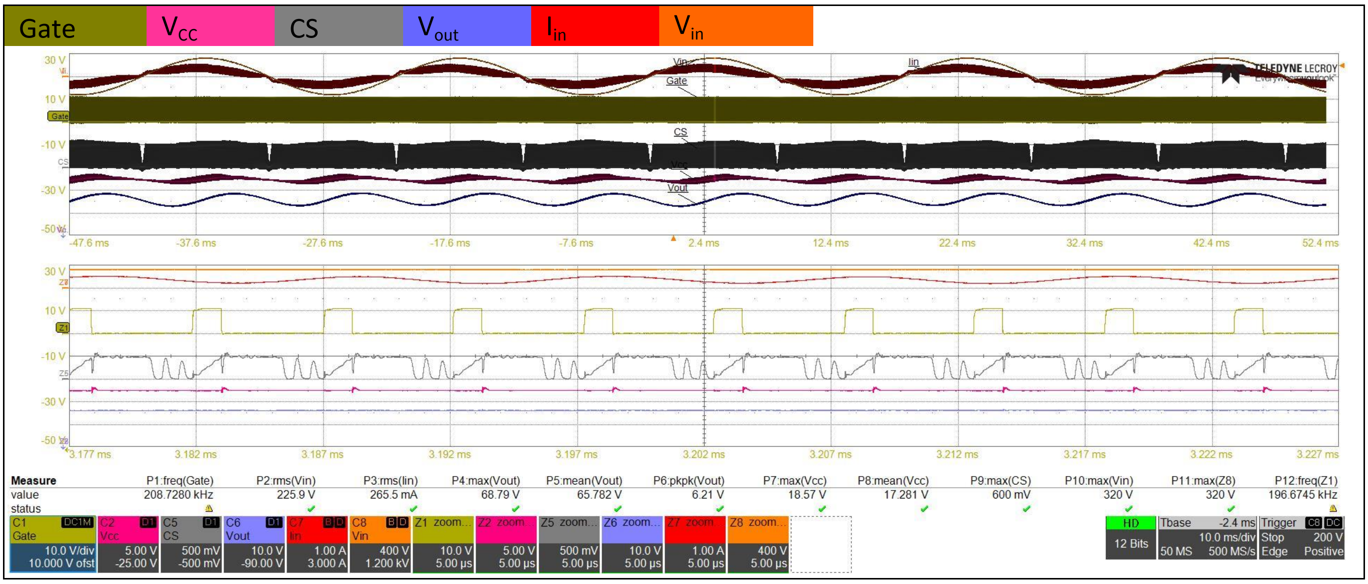


Figure 31 230 Vac 3rd-valley operation (Iout = 0.8 A, V_{out} ripple pk-pk 6.21 V, fsw = 196.67 kHz at line voltage peak region)

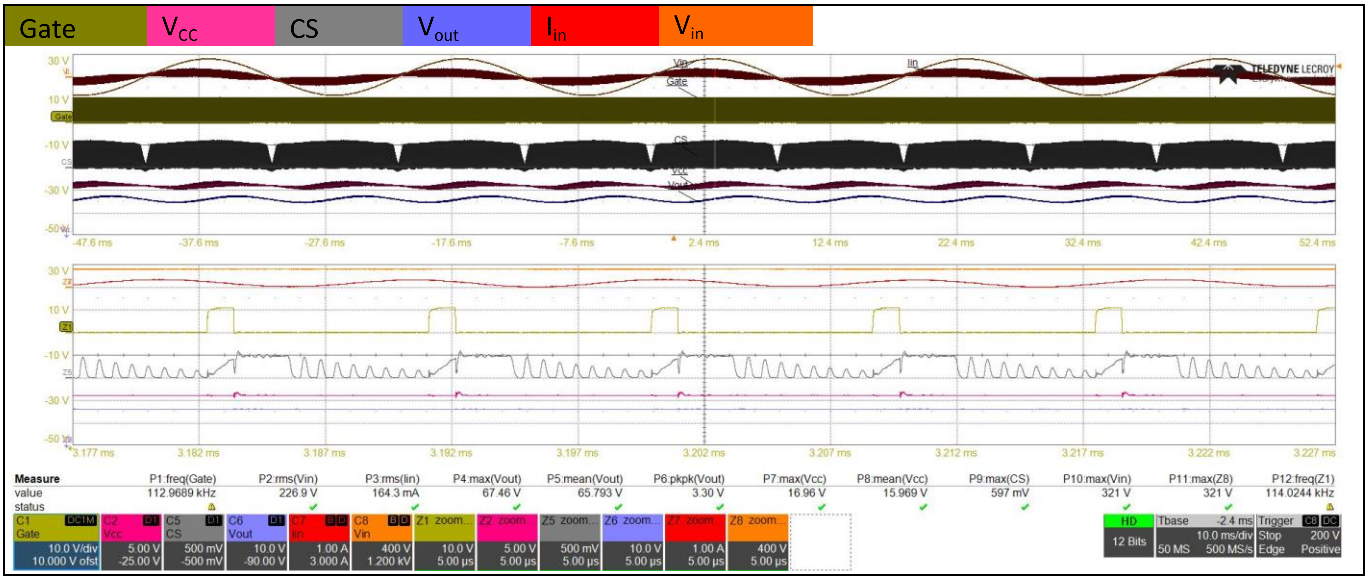


Figure 32 230 Vac 9th-valley operation (Iout = 0.4 A, V_{out} ripple pk-pk 3.3 V, fsw = 114.02 kHz at line voltage peak region)

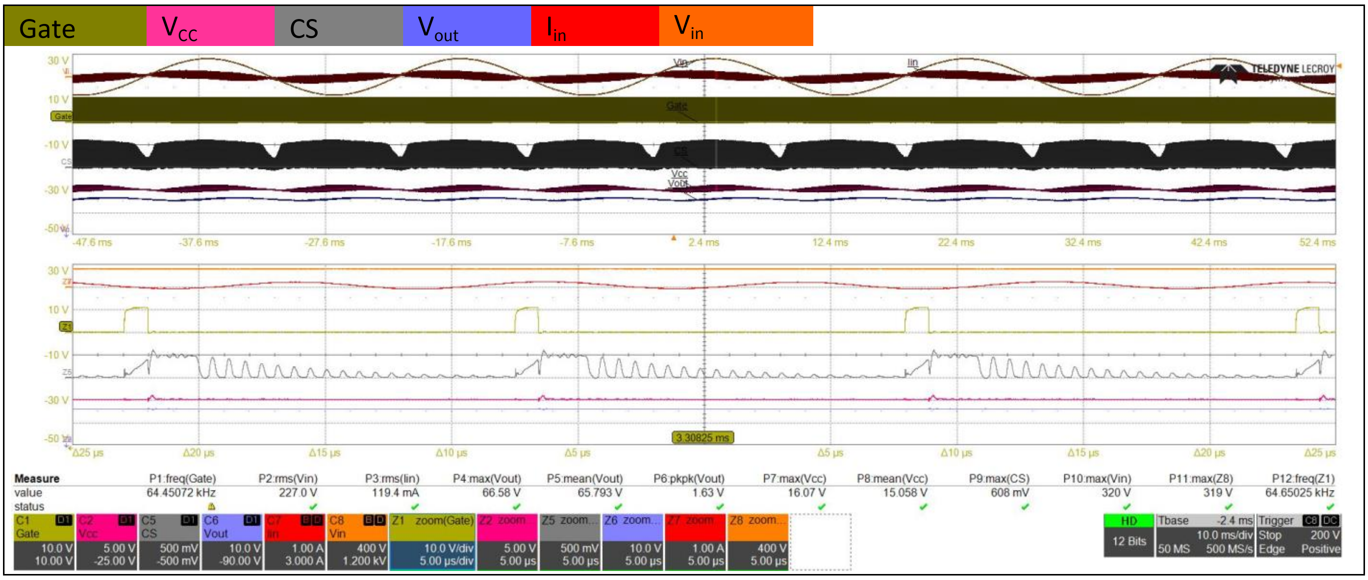


Figure 33 230 Vac 20th-valley operation (Iout = 0.16 A, V_{out} ripple pk-pk 1.63 V, fsw = 64.65 kHz at line voltage peak region)

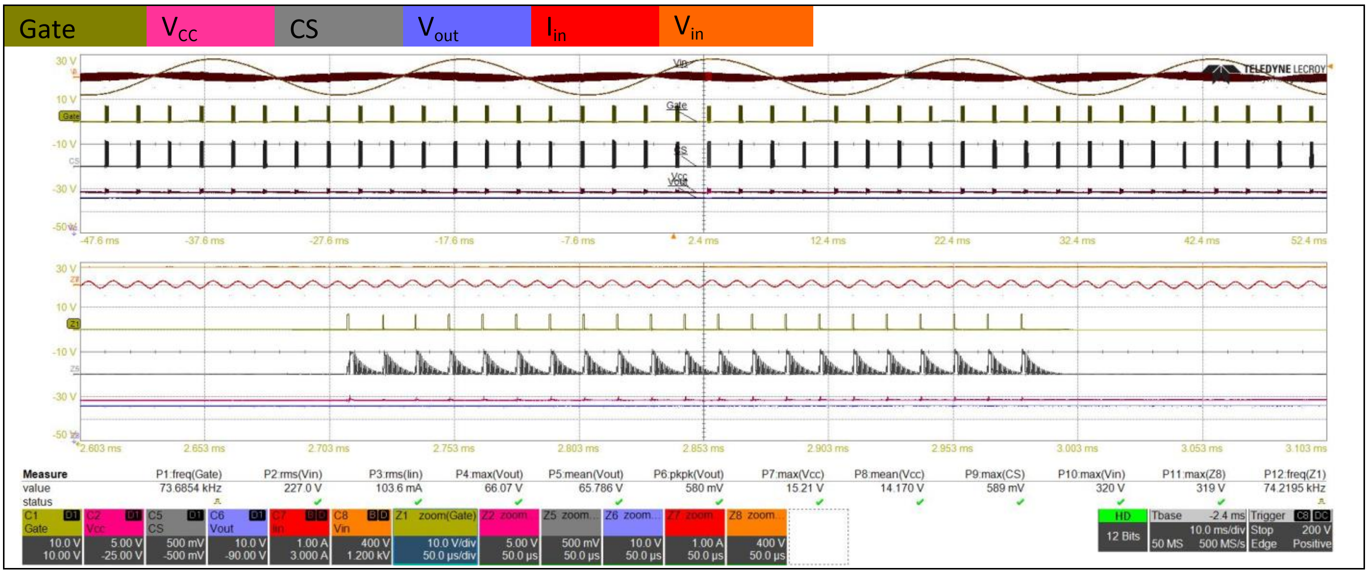


Figure 34 230 Vac burst-mode operation (Iout = 0.01 A, V_{out} ripple pk-pk 0.58 V)

8.3 Burst mode

The oscilloscope screenshots in this section offer an insight into the very smooth and nearly ripple-free BM operation of ICL8830.

To save energy and make the design in easier, the gate voltage is reduced in BM (7 V typ.). Furthermore, the BM has a very smooth entry and exit. This gradual change of modes is shown in the following images.

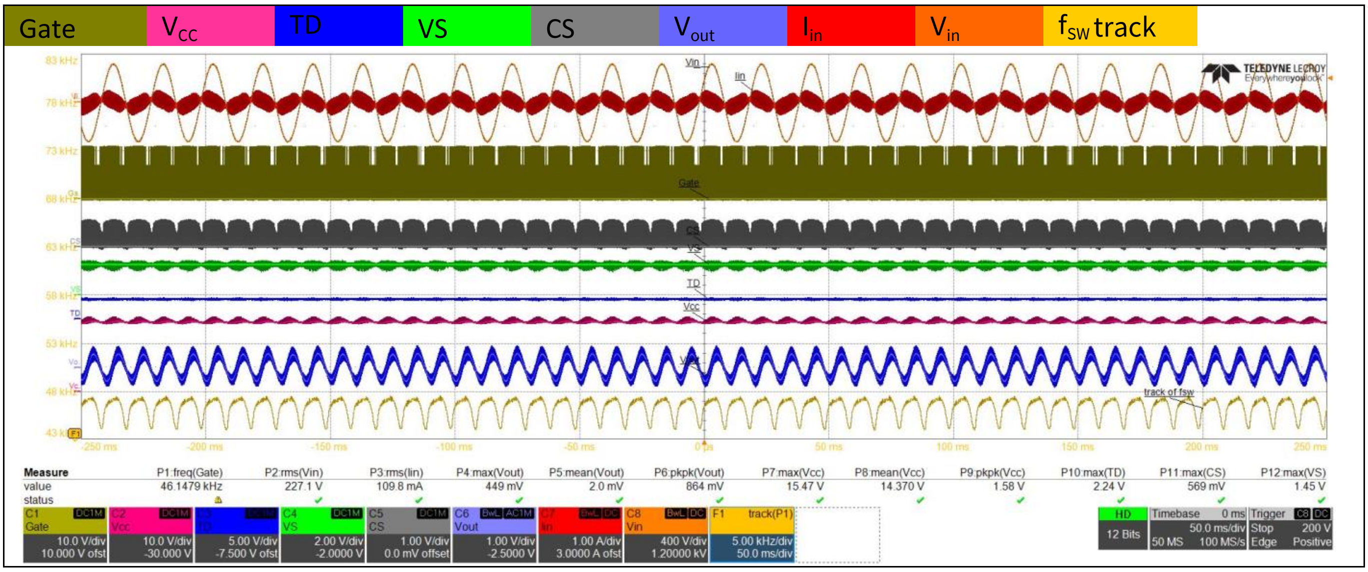


Figure 35 Operating point between BM and normal operation, smooth BM entry (864 mV pk-pk at V_{out})

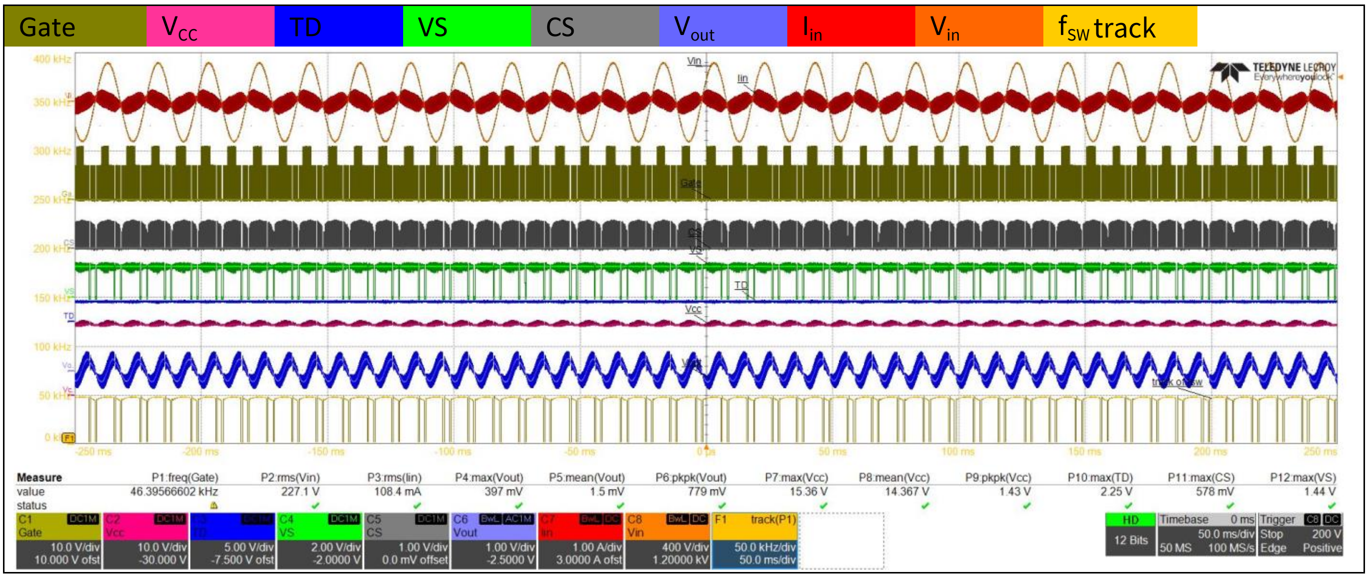


Figure 36 Operating point with partial IC sleep (779 mV pk-pk at V_{out})

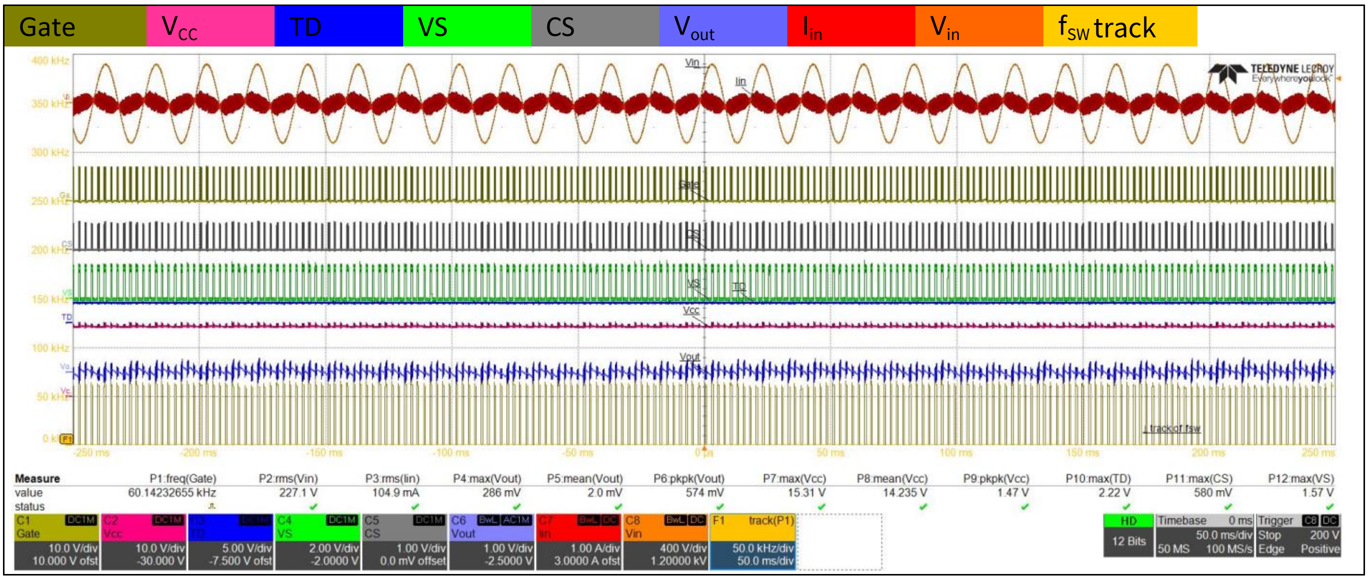


Figure 37 Operating point fully in BM (574 mV pk-pk at V_{out})

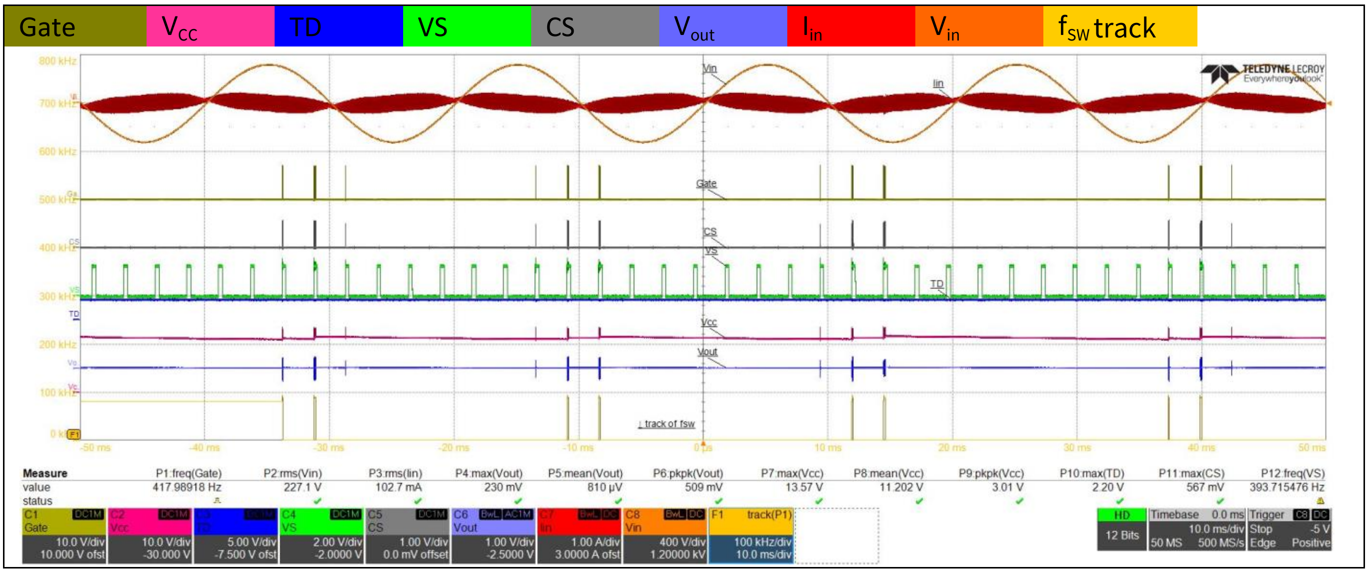


Figure 38 **Operating point in standby mode (509 mV pk-pk at V_{out})**

8.4 V_{CC} maintenance mode

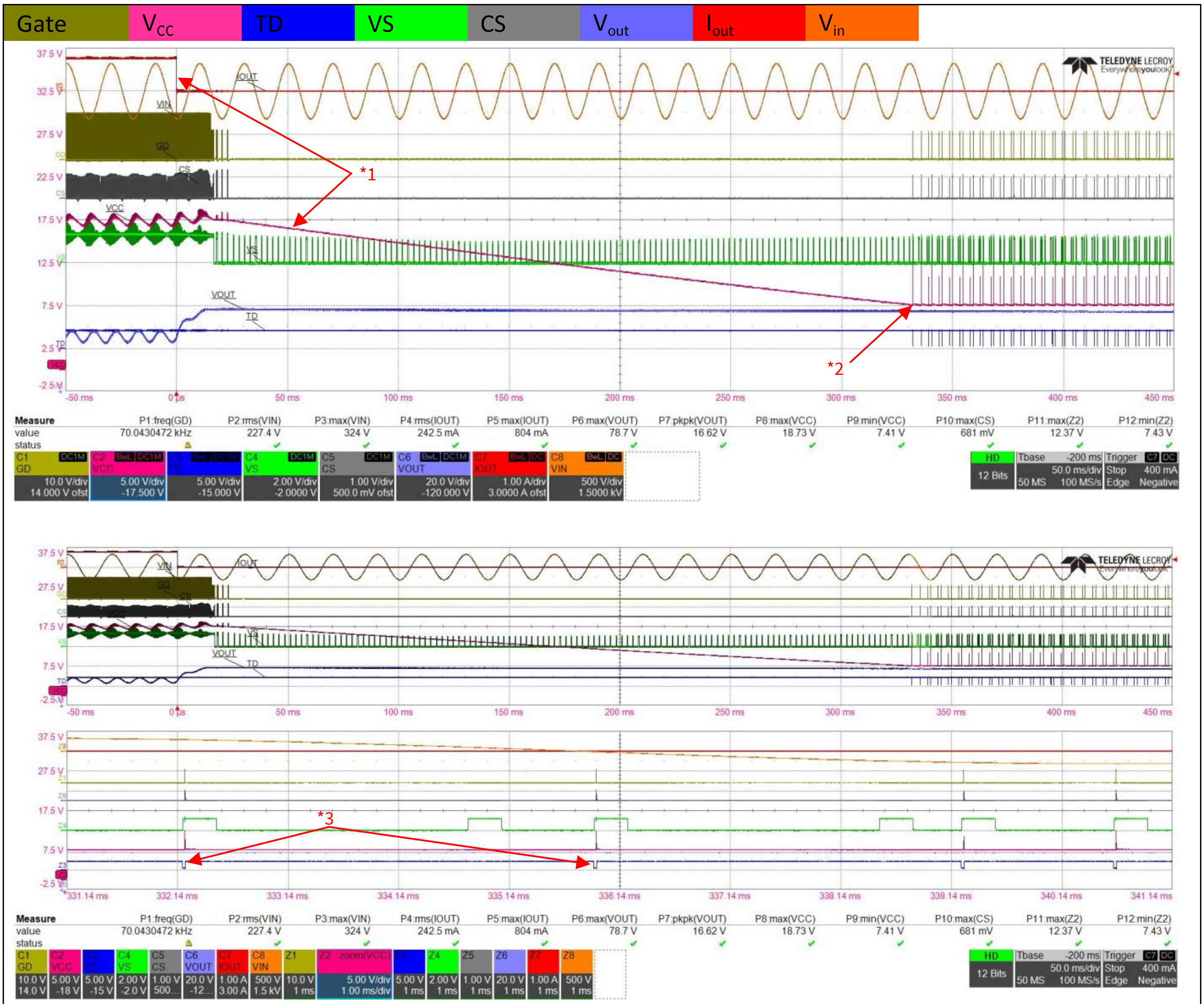
Because this IC only generates pulses when the feedback requires it, after a load drop, the flyback output OVP might be triggered. In this case, it will be a long time until the next pulses are generated (this is highly dependent on the system and the size of the V_{CC} capacitor). In BM, during the IC sleep, the VS pin voltage is zero. To check the power demand, the VS pin gets pulled up after the wakeup of the IC. If no pulse is needed, the IC falls back to sleep again. This will happen every 200 Hz.

If the V_{CC} voltage gets too low, there are mechanisms to keep the IC operational:

- In addition to the BM wakeup according to the control loop, a higher-priority V_{CC} wakeup threshold may trigger a burst start if V_{CC} drops as low as $V_{VCCwake}$. The controller continues with the burst until V_{CC} increases up to $V_{VCCburst}$ again (this behavior can be seen in Figure 39)
- In parallel, the TD pin lowers its voltage to allow an external startup circuit to charge the V_{CC} capacitor until $V_{VCCburst}$ is reached

This BM control allows tight output regulation and reduces the standby power, because no unnecessary pulses are generated. In addition, it allows the use of a small V_{CC} capacitor.

This V_{CC} maintenance mode is designed to have minimal impact on the output voltage. Furthermore, the coupling and the fact that in this case the auxiliary winding has the highest power demand should help with minimizing the impact on the output voltage. This behavior can also help to keep the microcontroller functional, as shown in Figure 39.



*1: A load jump event triggers the flyback output OVP protection, and Vcc drops accordingly.

*2: When Vcc drops to $V_{VCCwake}$ (7.6 V typ.), the controller continues the burst pulsing until Vcc = $V_{VCCburst}$ (8.1 V typ.).

*3: The TD pin internal pull-down when Vcc drops to $V_{VCCwake}$, to allow an external startup circuit to charge Vcc to $V_{VCCburst}$.

Figure 39 V_{CC} maintenance mode if V_{CC} drops too low, with minimum impact on output; VS signal shows wakeup and TD pin internal pull-down

Attention: ***The Vcc wakeup burst control mechanism is intended to work with the Vcc voltage supply via the ZCD winding. In case of the Vcc voltage is supplied via a winding voltage, which follows a certain ratio of the primary bus voltage, you must ensure that the Vcc voltage during burst mode is always higher than $V_{VCCburst\ maximum}$ value (9.1 V maximum) by a sufficient margin, especially when the input voltage is low and close to brownout level, so that the Vcc wakeup burst mechanism can be avoided, to achieve a good output regulation.***

8.5 Flyback output OVP

The flyback output OVP features industry-leading precision. The IC senses the current flowing into the ZCD pin. This current is internally multiplied with a fixed factor. The resulting current is injected into the CS pin during the off time of the primary power switch.

This multifunctional use of the OCP1 threshold achieves an 8% IC accuracy over the whole temperature range and production variations.

Offering an accurate and cycle-by-cycle-based fast OVP can save cost and eases the design of SELV LED drivers.

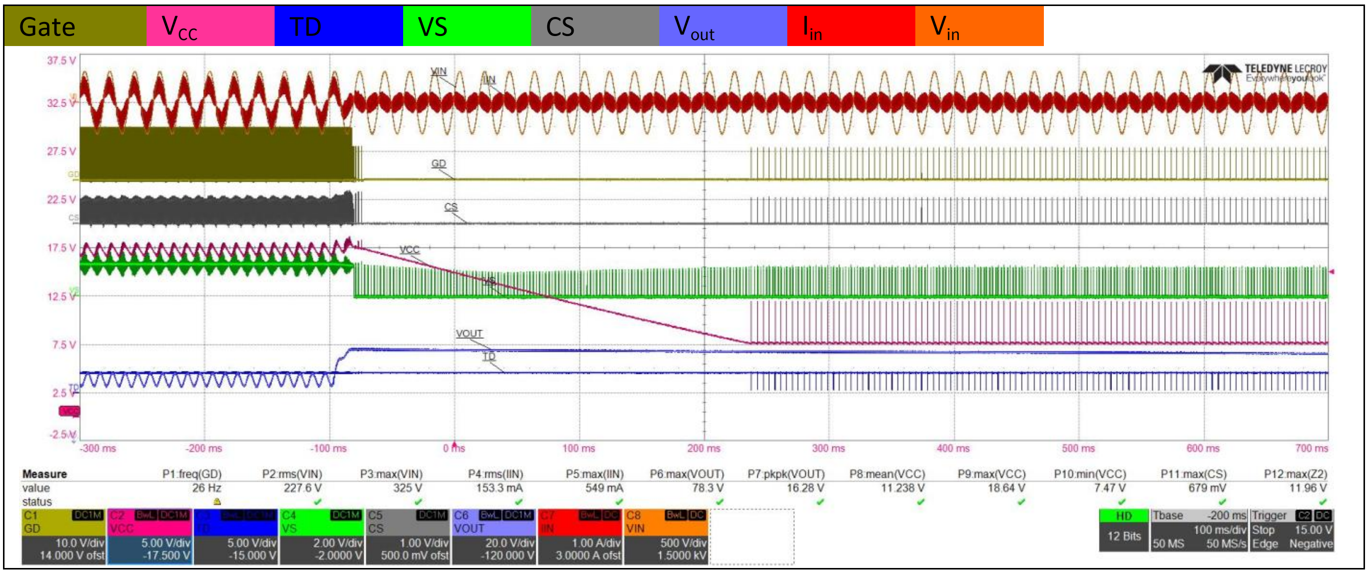


Figure 40 **Flyback output OVP at 78.3 V after sudden output open condition following BM entry at 230 Vac**

9 Thermal images

Table 3 Thermally measured components

SP1	CMC (core or winding)
SP2	Diode bridge
SP3	CoolGaN™ transistor case (bottom view) or thermal pad (top view)
SP4	Transformer (core or winding)
SP5	Output rectifier diode (case)
SP6	Snubber diode (bottom view) or thermal pad (top view)
SP7	Single-stage PFC flyback controller

Measurements:	
SP1	35.7°C
SP2	62.7°C
SP3	73.3°C
SP4	74.5°C
SP5	36.7°C
SP6	95.1°C
SP7	64.5°C
Parameters:	
Background temp.	24.2°C
Emissivity	0.95

Note:
230 Vac, 50 Hz, full load;
with opamp board connected;
bottom side

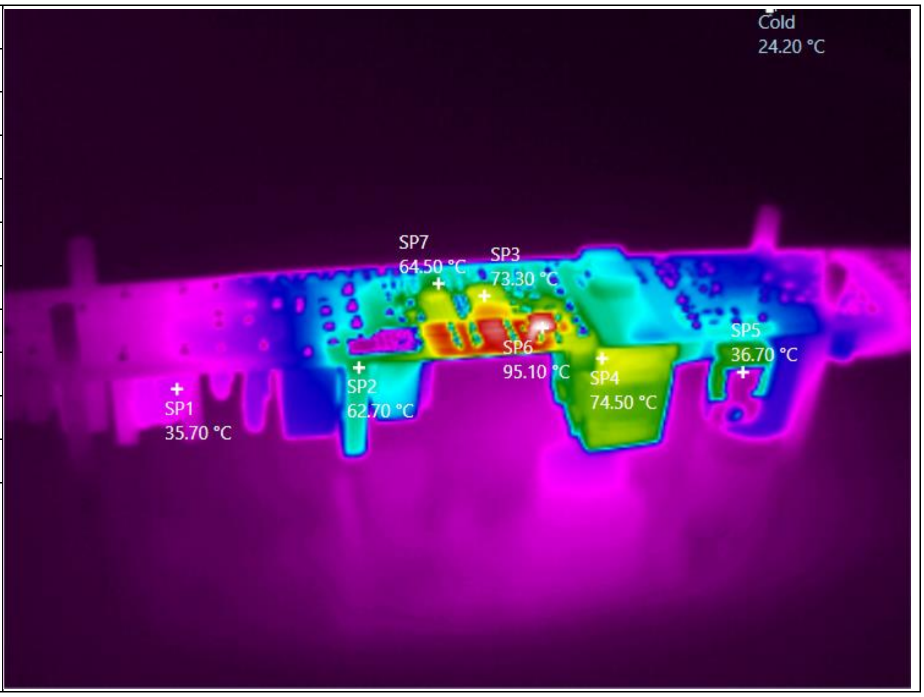


Figure 41 Thermal image – bottom side at 230 Vac, 50 Hz

Measurements:	
SP1	33.7°C
SP2	59.5°C
SP3	63.2°C
SP4	75.3°C
SP5	35.9°C
SP6	82.0°C
SP7	NA
Parameters:	
Background temp.	24.1°C
Emissivity	0.95
Note: 230 Vac, 50 Hz, full load; with opamp board connected; top side	

Figure 42 Thermal image – top side at 230 Vac, 50 Hz

Measurements:	
SP1	53.7°C
SP2	69.1°C
SP3	68.5°C
SP4	63.9°C
SP5	40.2°C
SP6	94.8°C
SP7	60.2°C
Parameters:	
Background temp.	23.3°C
Emissivity	0.95
Note: 115 Vac, 60 Hz, full load; with opamp board connected; bottom side	

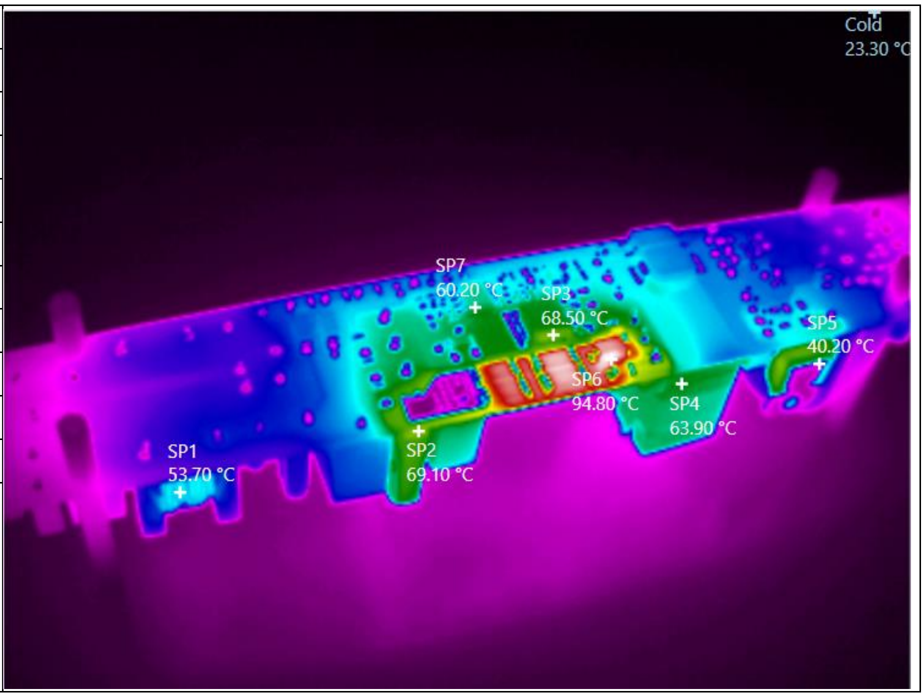


Figure 43 Thermal image – bottom side at 115 Vac, 60 Hz

Measurements:

SP1	55.2°C
SP2	67.3°C
SP3	56.0°C
SP4	66.1°C
SP5	39.0°C
SP6	80.1°C
SP7	NA

Parameters:

Background temp.	24.8°C
Emissivity	0.95

Note:
115 Vac, 60 Hz, full load;
with opamp board connected;
top side

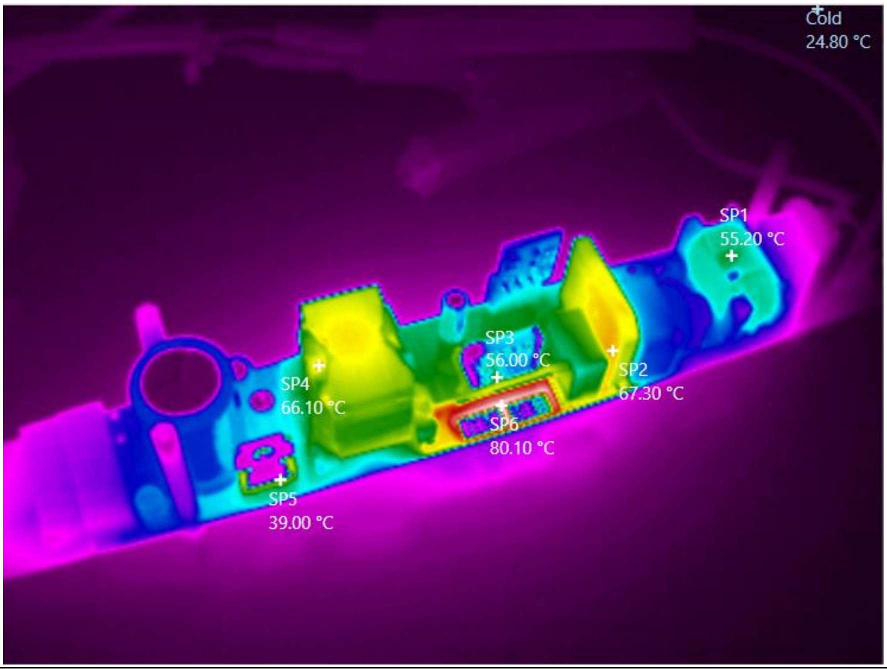


Figure 44 Thermal image – top side at 115 Vac, 60 Hz

10 Setup and measurement remarks

- AC source: Chroma 61604
- Load: BK 8601B in CC mode with V_{on} threshold of 25 V
- Power-up of the evaluation board must be done with the active startup board plugged in
- If testing without the active startup board:
  - Increase the start-up resistors to approximately 200 kΩ
  - Populate R36 with 0 Ω and R28 with 68 kΩ
  - Populate D6 with a 22 V Zener
- Because the feedback loops are optimized to deliver a good THD and PF, the crossover frequency of the loop is very low. This compromises the load-jump behavior and favors soft-dimming behavior. For dynamic load changes, an additional D-path in the feedback loop is required. This can usually consist of a resistor and a capacitor in parallel to the upper voltage divider resistor. However, non-linear feedback with diodes instead of a resistor is also possible. A circuit example is shown in Figure 45
- The fast-reacting flyback output OVP and the slow feedback loop may cause unwanted behavior, where the system is stuck in repetitive restarts. Here, the output voltage rises very fast to the OVP level (half-charged output capacitor, fast AC restart, etc.) and triggers the protection while the feedback loop had no time to react. This can occur for multiple reasons, such as a too-small output capacitor or when the output voltage setpoint is too close to the OVP level. Solutions include increasing the output capacitor, increasing the threshold for the OVP, lowering the setpoint, or changing the behavior of the load

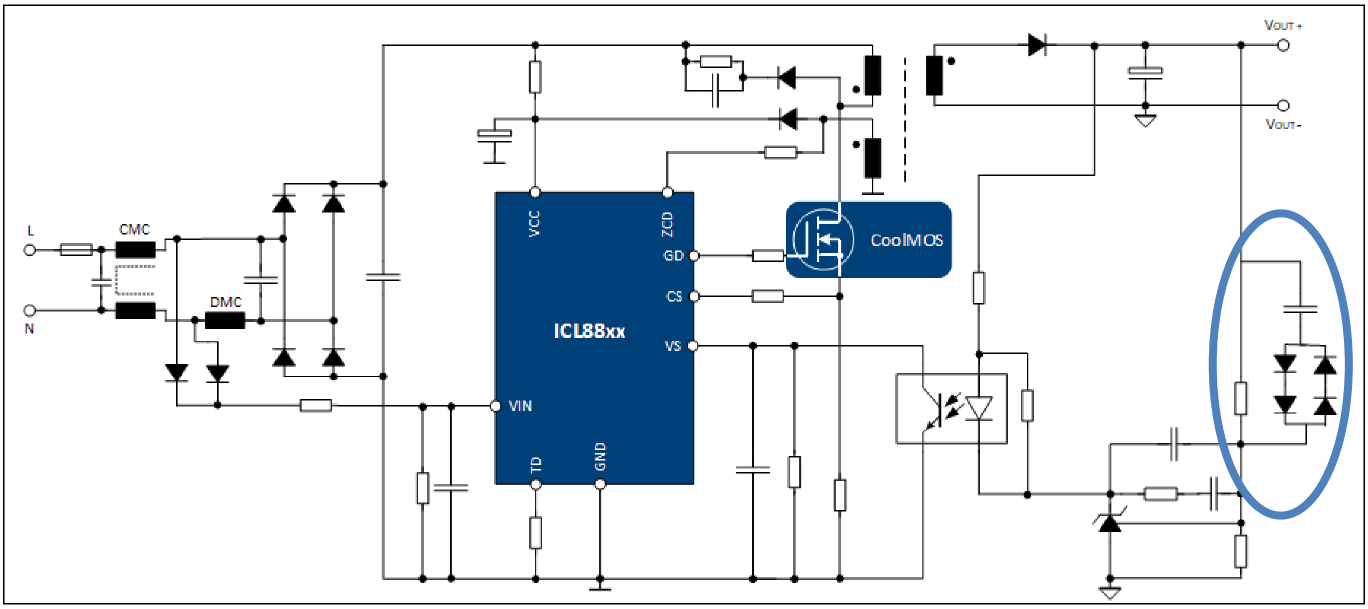


Figure 45 **Non-linear feedback circuit for highly dynamic loads without compromising THD and steady-state performance**

11 Harmonics

Because the ICL88xx family are primarily designed for lighting, they can easily pass the international harmonic standard.

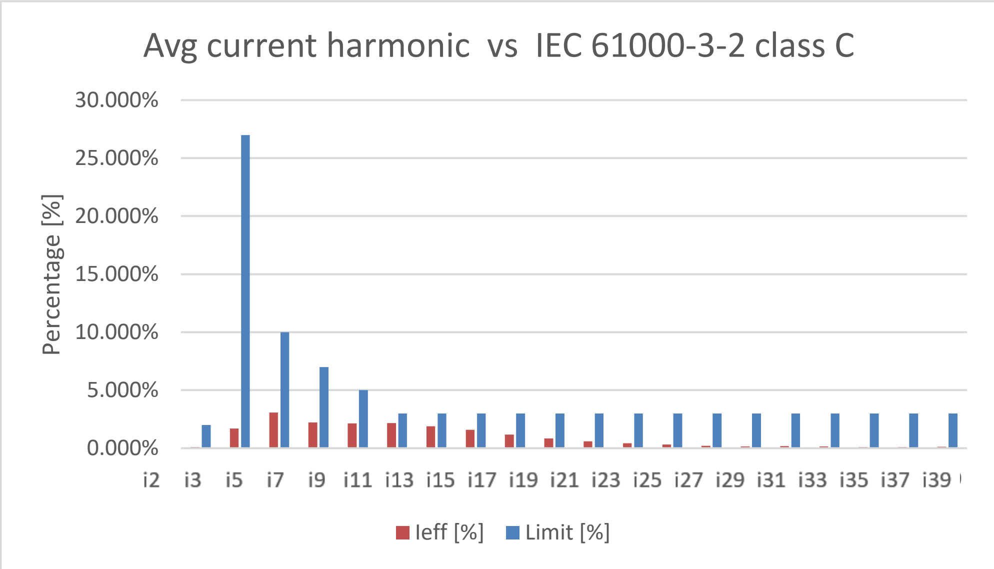


Figure 46 **Harmonics measurement at 230 Vac, 50 Hz and full load, with opamp board attached**

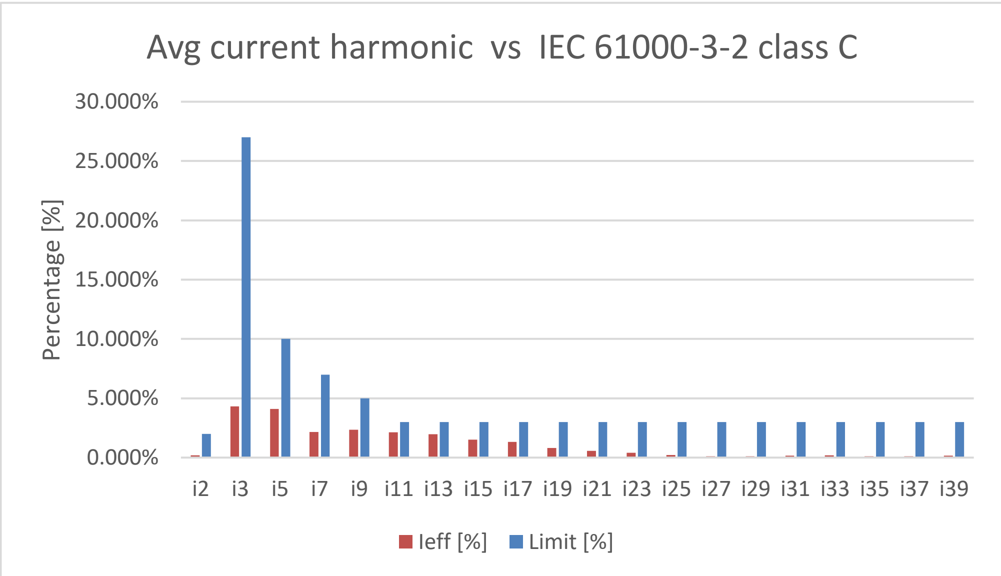


Figure 47 **Harmonics measurement at 230 Vac, 50 Hz and full load, with TL431 board attached**

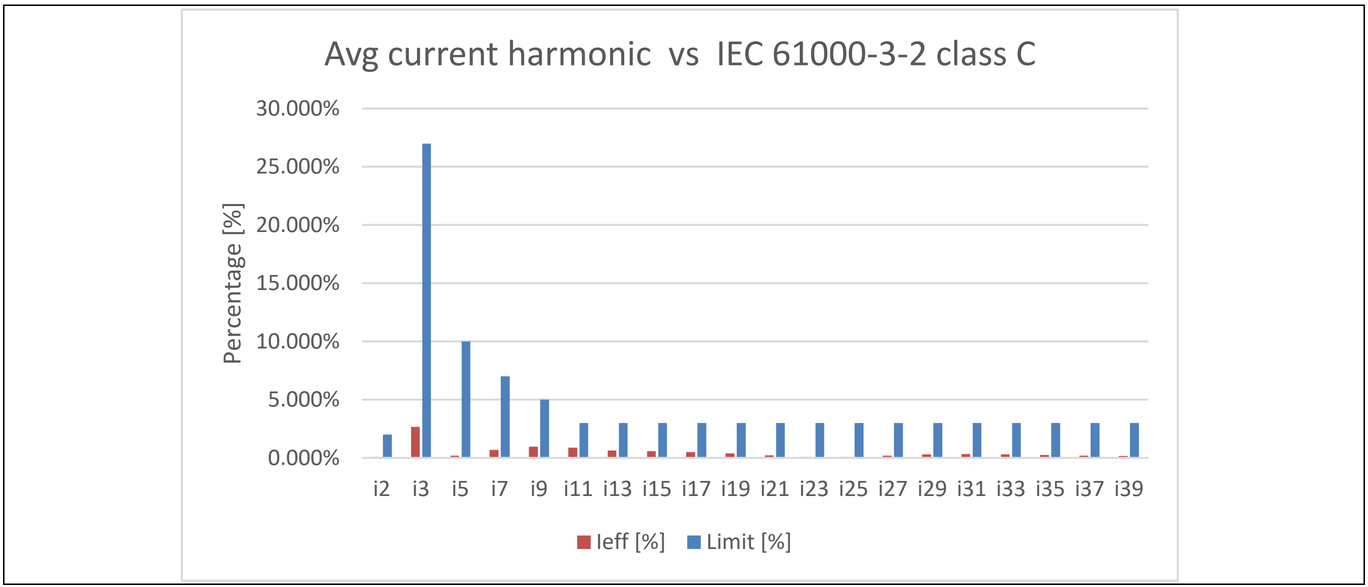


Figure 48 Harmonics measurement at 115 Vac, 60 Hz and full load, with opamp board attached

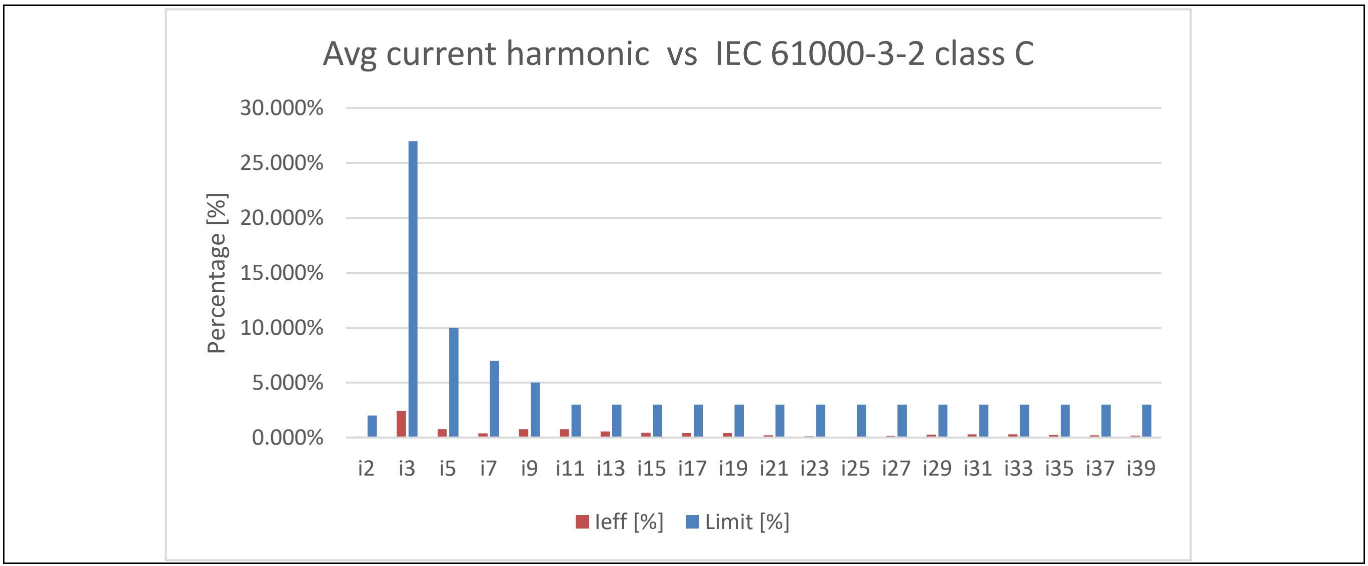


Figure 49 Harmonics measurement at 115 Vac, 60 Hz and full load, with TL431 board attached

12 EMI measurements

Under AC operating conditions, the PFC-SSR evaluation board fully complies with the EN 55015 electromagnetic interference (EMI) standard for conducted emission limits from 9 kHz to 30 MHz.

Figure 50 115 Vac L line spectrum overview with opamp board attached

Figure 51 115 Vac N line spectrum overview with opamp board attached

Figure 52 230 Vac L line spectrum overview with opamp board attached

Figure 53 230 Vac N line spectrum overview with opamp board attached

Figure 54 115 Vac L line spectrum overview with TL431 board attached

Figure 55 115 Vac N line spectrum overview with TL431 board attached

Figure 56 230 Vac L line spectrum overview with TL431 board attached

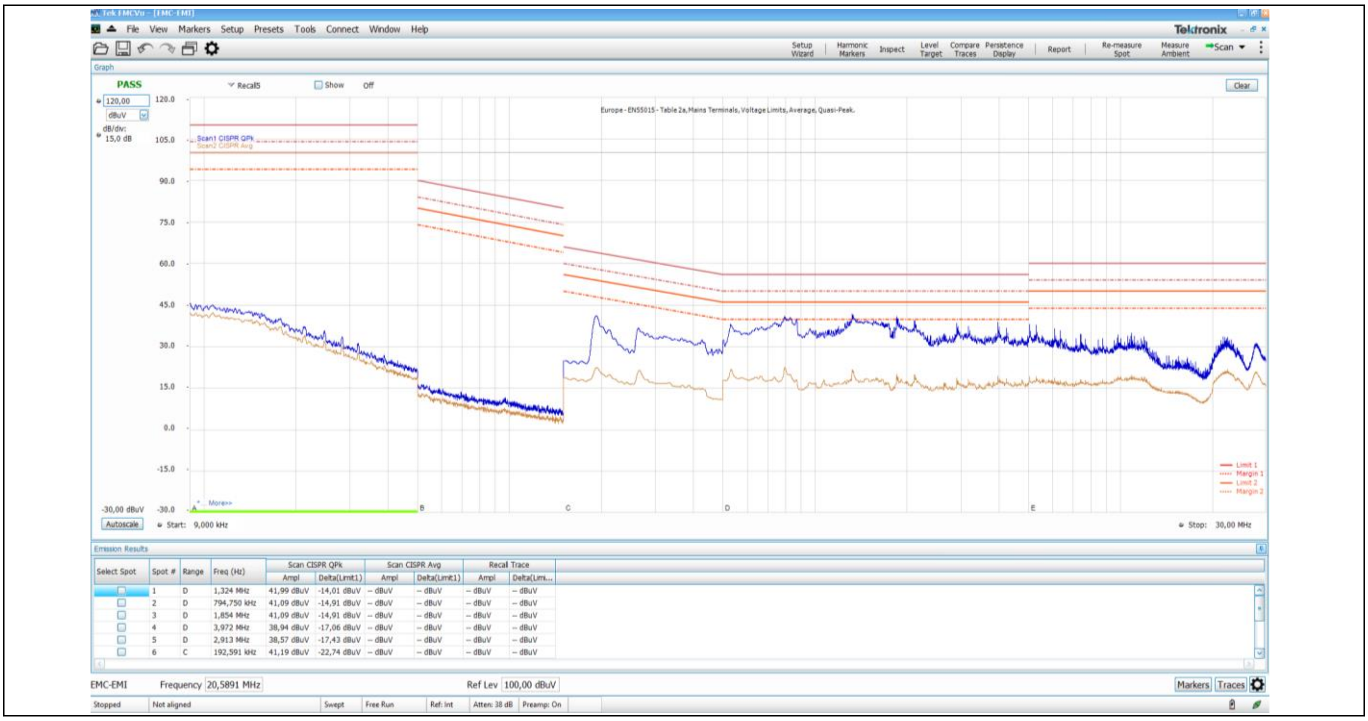
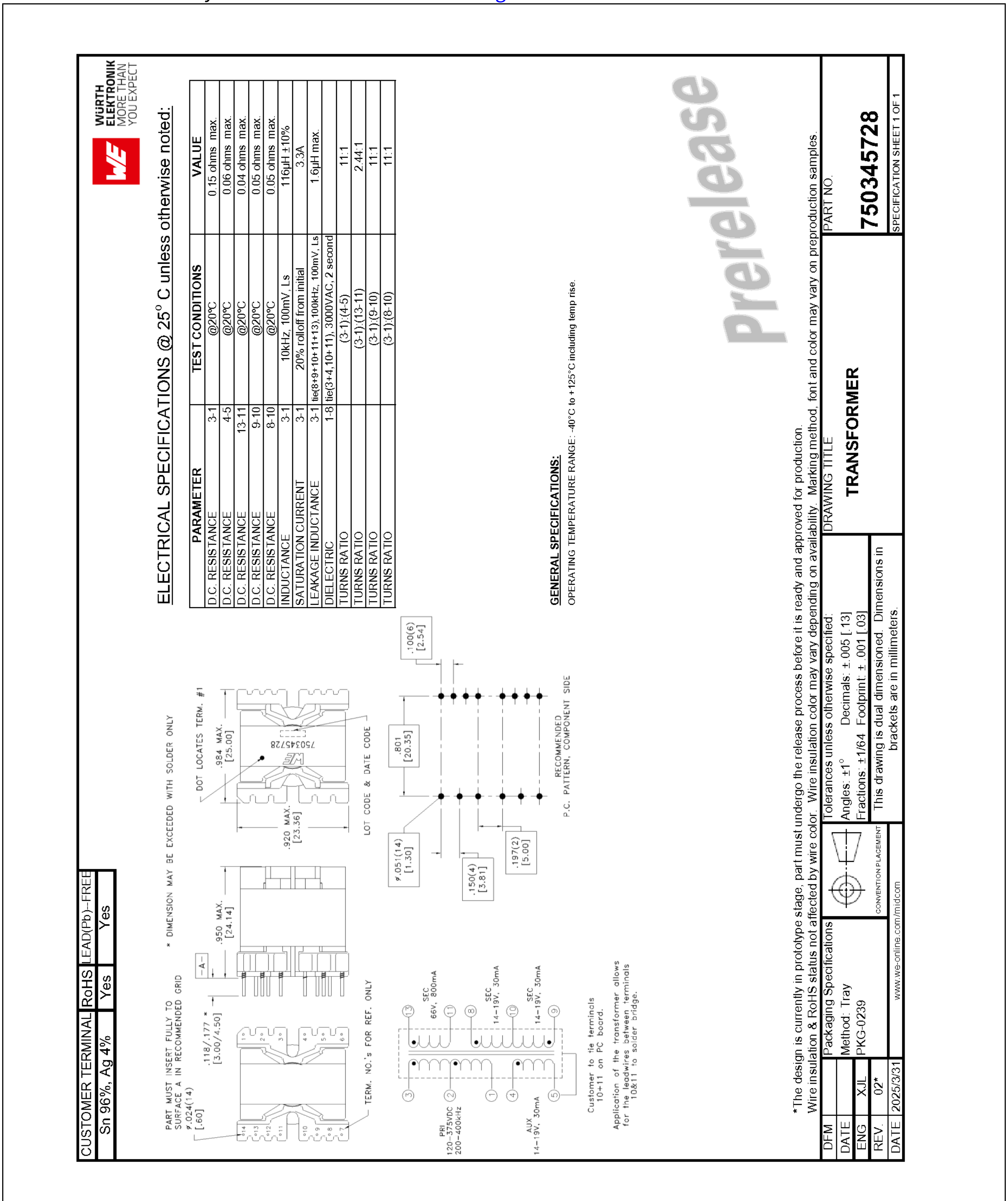


Figure 57 230 Vac N line spectrum overview with TL431 board attached

13 Magnetics

The datasheet of the flyback transformer is shown in Figure 58.



PARAMETER		TEST CONDITIONS	VALUE
D.C. RESISTANCE	3-1	@20°C	0.15 ohms max.
D.C. RESISTANCE	4-5	@20°C	0.06 ohms max.
D.C. RESISTANCE	13-11	@20°C	0.04 ohms max.
D.C. RESISTANCE	9-10	@20°C	0.05 ohms max.
D.C. RESISTANCE	8-10	@20°C	0.05 ohms max.
INDUCTANCE	3-1	10kHz, 100mV, Ls	116µH ±10%
SATURATION CURRENT	3-1	20% rolloff from initial	3.3A
LEAKAGE INDUCTANCE	3-1	tie(8+9+10+11+13),100kHz, 100mV, Ls	1.6µH max.
DIELECTRIC	1-8	tie(3+4,10+11), 3000VAC, 2 second	
TURNS RATIO		(3-1):(4-5)	11:1
TURNS RATIO		(3-1):(13-11)	2.44:1
TURNS RATIO		(3-1):(9-10)	11:1
TURNS RATIO		(3-1):(8-10)	11:1

Figure 58 Flyback transformer (T1) specifications

14 Bill of materials

Table 4 **Startup board**

Sl. No.	Quantity	Designator	Description	Manufacturer	Value
1	1	C30	Ceramic/1 nF/50 V/X7R/0603/10%	Murata	1 nF
2	1	D30	Zener diode/22 V/300 mW/ SOD323	Nexperia	BZX384-B22,115
3	1	**Q30**	**N-Channel/Depletion Mode/ 600 V/ 21 mA (Ta) /500 mW (Ta) /PG-SOT23**	**Infineon**	**BSS126H6327XTSA2**
4	1	Q31	TRANS/NPN/40V/0.2A/SOT23-3	Onsemi	MMBT3904LT1G
5	1	R30	RES 20k/150 V/0805/1%/125 mW	Yageo	20 k
6	1	R31	RES 1k/150 V/0805/1%/125 mW	Yageo	1 k
7	1	R33	RES 56k/150 V/0805/1%/125 mW	Yageo	56 k
8	1	R34	RES 12k/75 V/0603/1%/100 mW	Yageo	12 k
9	1	R37	RES 47k/75 V/0603/1%/100 mW	Yageo	47 k
10	1	X30	female/4-pin/2.54 mm/90°	CJ	A2541HWR-4P

Table 5 **Opamp board**

Sl. No.	Quantity	Designator	Description	Manufacturer	Value
1	1	C201	Ceramic/1uF/50V/X7R/0805/10%	Murata	1 uF
2	0	C203	Ceramic/0805	NA	NA
3	1	C204	Ceramic/0.1uF/50V/X7R/0805/10%	Yageo	0.1 uF
4	1	C205	Ceramic/470pF/50V/NP0/0805/5%	Yageo	470 pF
5	1	C206	Ceramic/3.3uF/25V/ X7R/1206/10%	TDK	3.3 uF
6	1	D201	Standard Diode/150°C/75V/150mA/ SOD323F	Onsemi	1N4148WS
7	1	IC201-A	Op-amp IC with reference voltage/ SOIC-8	ST	TSM103WAIDT
8	0	R200	RES/0805	NA	NA
9	1	R201-A	RES 130k/150 V/0805/1%/125 mW	UNI-ROYAL	130 k
10	1	R201-B	RES 0R/150 V/0805/1%/125 mW	UNI-ROYAL	0 R
11	1	R202	RES 5.1k/150 V/0805/1%/125 mW	UNI-ROYAL	5.1 k
12	1	R203	RES 2k/150 V/0805/1%/125 mW	UNI-ROYAL	2 k
13	1	R204	RES 1.1k/200 V/1206/1%/250 mW	UNI-ROYAL	1.1 k

Sl. No.	Quantity	Designator	Description	Manufacturer	Value
14	0	R205	RES/0805	NA	NA
15	1	R206	RES 18k/200 V/1206/1%/250 mW	UNI-ROYAL	18 k
16	1	R207	RES 0R/150V/0805/1%/125mW	UNI-ROYAL	0 R
17	1	R208	RES 0R/150V/0805/1%/125mW	UNI-ROYAL	0 R
18	0	R209	RES/0805	NA	NA
19	1	R210	RES 9.1k/200V/1206/1%/250mW	UNI-ROYAL	9.1 k
20	1	R211	RES 0R/200V/1206/1%/250mW	UNI-ROYAL	0 R
21	1	R212	RES 0R/150V/0805/1%/125mW	UNI-ROYAL	0 R
22	0	R215	RES/1206	NA	NA
23	1	X200-B	6 Pins Terminal Block Header/ Female Sockets/3.81mm/90° Right Angle/ Through Hole	Würth	691309310006
24	1	X300-A	4 Pins Terminal Block Header/Male Pins/5.08mm/90° Right Angle/ Through Hole	Würth	691313510004

Table 6 TL431 board

Sl. No.	Quantity	Designator	Description	Manufacturer	Value
1	1	C201	Ceramic/1uF/50V/X7R/1206/10%	Murata	1 uF
2	1	C204	Ceramic/3.3uF/25V/ X7R/1206/10%	TDK	3.3 uF
3	0	C205	Ceramic/1206	NA	NA
4	1	D201	Shunt Voltage Reference IC/ Adjustable/±0.5%/100 mA/ -40°C ~ 125°C/ SOT-23	Nexperia	TL431BQDBZR
5	1	R203	RES 2.7k/200V/1206/1%/250mW	UNI-ROYAL	2.7 k
6	1	R204	RES 7.5k/200V/1206/1%/250mW	UNI-ROYAL	7.5 k
7	1	R205	RES 1.2k/200V/1206/1%/250mW	UNI-ROYAL	1.2 k
8	1	R206	RES 5.1k/150V/0805/1%/125mW	UNI-ROYAL	5.1 k
9	0	R206a	RES/0805	NA	NA
10	1	R207	RES 130k/150V/0805/1%/125mW	UNI-ROYAL	130 k
11	1	R208	RES 0R/200V/1206/1%/250mW	UNI-ROYAL	0 R
12	1	R210	RES 12k/200V/1206/1%/250mW	UNI-ROYAL	12 k

Sl. No.	Quantity	Designator	Description	Manufacturer	Value
13	0	R213	RES/0805	NA	NA
14	1	R214	RES 820k/150 V/0805/1%/125 mW	UNI-ROYAL	820 k
15	1	R215	RES 12k/200 V/1206/1%/250 mW	UNI-ROYAL	12 k
16	1	X200-B	6 Pins Terminal Block Header/ Female Sockets/3.81mm/90° Right Angle/ Through Hole	Würth	691309310006
17	1	X300-A	4 Pins Terminal Block Header/Male Pins/5.08mm/90° Right Angle/ Through Hole	Würth	691313510004

Table 7 Main board

Sl. No.	Quantity	Designator	Description	Manufacturer	Value
1	1	BR1	Bridge Rectifiers/4 A/800 V	MCC	GBU4K-BP
2	1	C3	Ceramic/2.2 nF/630 V/C0G/1206/5%	Murata	2.2 nF
3	1	C4	Film/150 nF/275 VAC/X2/ P=10 mm/10%	Würth	890324023025
4	1	C5	Ceramic/470 pF/50 V/C0G/0603/5%	Murata	470 pF
5	1	C6	Aluminum/22 uF/50V/5x11 mm/20%	Panasonic	ECA1HHG220
6	1	C10	Ceramic/2.2 nF/50V/NP0/0603/5%	Yageo	2.2 nF
7	1	C12	Film/330 nF/275 VAC/X2/ P=12.5 mm/10%	Würth	890324024003
8	1	C13	Film/330 nF/275 VAC/X2/ P=12.5 mm/10%	Würth	890324024003
9	0	C14	Ceramic/1206	NA	NA
10	1	C38	Ceramic/100 nF/50 V/X7R/0603/10%	Yageo	100 nF
11	1	C41	Ceramic/100 nF/50V/X7R/0603/10%	Yageo	100 nF
12	0	C101	Ceramic/1206	NA	NA
13	1	C102	Aluminum/470 uF/100 V/ 18x25 mm/20%	Chemi-Con	EKY-101ELL471MM25S
14	1	C103	Ceramic/100 nF/100 V/ X7R/1206/10%	Yageo	100 nF
15	1	C104	Aluminum/100 uF/35 V/ 6.3x11 mm/20%	Würth	860020573008
16	1	C105	Aluminum/100 uF/35 V/ 6.3x11 mm/20%	Würth	860020573008

Sl. No.	Quantity	Designator	Description	Manufacturer	Value
17	1	C106	Ceramic/2.2 uF/100 V/X7R/1206/10%	Yageo	2.2 uF
18	1	C107	Ceramic/1 uF/100 V/X7R/1206/10%	Samsung	1 uF
19	1	C108	Ceramic/100 nF/50 V/X7R/0603/10%	Yageo	100 nF
20	1	C109	Ceramic/100 nF/50 V/X7R/0603/10%	Yageo	100 nF
21	0	C110	Ceramic/1206	NA	NA
22	0	CY1	Ceramic/P=7.5 mm	NA	NA
23	1	CY2	Ceramic/2.2 nF/X1, Y2/Z5U/P=7.5 mm/20%	TDK	CS80ZU2GA222MYVKA
24	1	CY3	Ceramic/2.2 nF/X1, Y2/Z5U/P=7.5 mm/20%	TDK	CS80ZU2GA222MYVKA
25	1	CY4	Ceramic/1.5 nF/X1, Y1/Nonstandard SMD/-40°C ~ 125°C/20%	Murata	DK1E3EA152M86RAH01
26	1	D3	Ultrafast Rectifier/1000 V/1 A/DO214AC	Vishay	US1MHE3_A/I
27	1	D4	Schottky Diode/150 V/1 A/SOD-123FL	ROHM	RB168MM150
28	0	D6	Zener diode/ SOD323	NA	NA
29	0	D10	Standard Diode/ SOD323	NA	NA
30	1	**D11**	**CoolGaN™ Transistor 700 V G5, 200 mΩ, DPAK**	**Infineon**	**IGD70R200D2S**
31	1	D20	Standard Diode /1000 V/1 A/DO214AC	Onsemi	MRA4007T3G
32	1	D21	Standard Diode /1000 V/1 A/DO214AC	Onsemi	MRA4007T3G
33	1	D101	Ultrafast Rectifier/400 V/20A/TO-220AC-2	ST	STTH20R04D
34	1	D102	Schottky Diode/150 V/1 A/SOD-123FL	ROHM	RB168MM150
35	1	D103	Schottky Diode/150 V/1 A/SOD-123FL	ROHM	RB168MM150
36	0	D104	Standard Diode/ SOD323	NA	NA
37	0	D105	Standard Diode/ SOD323	NA	NA
38	0	D106	Standard Diode/ SOD323	NA	NA
39	1	F1	FUSE/250 V/2 A	Littelfuse	39212000000
40	1	**IC3**	**High frequency, single-stage PFC flyback controller for constant voltage output**	**Infineon**	**ICL8830XUMA1**

Sl. No.	Quantity	Designator	Description	Manufacturer	Value
41	1	L1	39 mH@10 kHz / 2 Line Common Mode Choke / Through Hole / 850 mA / DCR 1.43 Ω	Würth	744869161393
42	1	L2	RES 0R/200 V/1206/1%/250 mW	UNI-ROYAL	0 R
43	1	L101	22 uH / Unshielded Drum Core / Wirewound Inductor /1.8 A / DCR 130 mΩ	Würth	7447462220
44	1	MOV1	Varistors/300 VAC/6 kA/125 J/ D=14 mm/ P=7.5 mm/10%	TDK	B72214S2301K101
45	1	MOV2	Varistors/300 VAC/6 kA/125J/ D=14 mm/ P=7.5 mm/10%	TDK	B72214S2301K101
46	1	PC1	Optoisolator/ 5000 Vrms/ 1 CH/ 6-SO, 4 Lead	Toshiba	TLP383(GR-TPL, E
47	1	R1	RES 2.7k/150 V/0805/1%/125 mW	UNI-ROYAL	2.7 k
48	1	R4	RES 2.4 MΩ/200 V/1206/1%/250 mW	UNI-ROYAL	2.4 MEG
49	1	R5	RES 2.4 MΩ/200 V/1206/1%/250 mW	UNI-ROYAL	2.4 MEG
50	1	R6	RES 270k/200 V/1206/1%/250 mW	UNI-ROYAL	270 k
51	1	R10	RES 39k/150 V/0805/1%/125 mW	UNI-ROYAL	39 k
52	1	R11	RES 12k/75 V/0603/1%/100 mW	UNI-ROYAL	12 k
53	1	R12	RES 39k/200 V/2512/1%/1 W	UNI-ROYAL	39 k
54	1	R13	RES 39k/200 V/2512/1%/1 W	UNI-ROYAL	39 k
55	1	R14	SHUNT RES/150 mΩ/1206/1%/ 100 ppm/1 W	Milliohm	150 mR
56	0	R14a	SHUNT RES/1206	NA	NA
57	1	R15	RES 27k/200 V/2512/1%/1 W	UNI-ROYAL	27 k
58	1	R16	RES 3k/75 V/0603/1%/100 mW	UNI-ROYAL	3 k
59	1	R17	RES 39k/75 V/0603/1%/100 mW	UNI-ROYAL	39 k
60	1	R18	RES 1R/200 V/1206/1%/250 mW	UNI-ROYAL	1 R
61	1	R19	RES 30k/200 V/1206/1%/250 mW	UNI-ROYAL	30 k
62	1	R20	RES 0R/75 V/0603/1%/100 mW	UNI-ROYAL	0 R
63	1	R21	RES 27k/200 V/2512/1%/1 W	UNI-ROYAL	27 k
64	0	R22	RES/1206	NA	NA
65	0	R24	RES/1206	NA	NA

Sl. No.	Quantity	Designator	Description	Manufacturer	Value
66	0	R25	RES/1206	NA	NA
67	0	R26	RES/1206	NA	NA
68	0	R28	RES/0603	NA	NA
69	1	R29	RES 30k/200 V/1206/1%/250 mW	UNI-ROYAL	30 k
70	1	R30	RES 30k/200 V/1206/1%/250 mW	UNI-ROYAL	30 k
71	0	R33	RES/0603	NA	NA
72	1	R34	RES 24R/75 V/0603/1%/100 mW	UNI-ROYAL	24 R
73	0	R36	RES/0603	NA	NA
74	0	R101	RES/1206	NA	NA
75	0	R102	RES/1206	NA	NA
76	1	R104	RES 0R/200 V/1206/1%/250 mW	UNI-ROYAL	0 R
77	1	R107	RES 0R/200 V/1206/1%/250 mW	UNI-ROYAL	0 R
78	0	S101	Tactile Switch	NA	NA
79	1	T1	Transformer, PQ2020, 116 uH	Würth	750345728
80	1	X1	Terminal Strip, 3 pol., Pitch 3.5 mm, THT	WAGO	250-203
81	1	X5	Header, THT, Single Row, Vertical, 2.54 mm, 4 Pins	CJ	A2541WV-4P
82	1	X200-A	6 Pins Terminal Block Header/Male Pins/3.81 mm/90° Right Angle/ Through Hole	Würth	691322310006
83	0	ZD101	Zener diode/ DO214AC	NA	NA

15 Related resources

- Product family – AC/DC LED driver ICs
- Developer Community – LED Driver ICs
- Datasheet – ICL8830
- Application note – ICL8830 high-frequency GaN controller for LED lighting

Revision history

Document revision	Date	Description of changes
V 1.0	2025-09-25	Initial release

Trademarks

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