

44 W, 12 V SMPS Evaluation Board with CoolSET™ ICE5AR0680AG-1 and other variants

EVAL_5AR0680AG-1_44W1

About this document

Scope and purpose

This document contains an engineering report that describes a universal input, 44 W 12 V offline flyback converter using the latest CoolSET™ 5th Generation Fixed-Frequency (FF) Plus ICE5AR0680AG-1 AC-DC integrated power stage. This document also provides recommendations on component changes for users who wish to evaluate the IC feature and functionality of ICE5BR4780AG-1, ICE5BR3995AG-1, ICE5GR1680AG-1 and ICE5GR2280AG-1 on the EVAL_5AR0680AG-1_44W1 Evaluation Board.

Intended audience

This document is intended for power supply design/application engineers who wish to design low-cost and high-reliability systems for offline SMPS, either auxiliary power supply of white goods, PC, server and TV or enclosed adapter, for gaming consoles.

CoolSET™

Infineon's CoolSET™ AC-DC integrated power stages in a fixed-frequency switching scheme offers increased robustness and outstanding performance. This family offers superior energy efficiency, comprehensive protective features, and reduced system costs and is ideally suited for auxiliary power supply applications in a wide variety of potential applications such as:

- [SMPS](#)
- [Home appliances](#)
- [Server](#)
- [Telecom](#)

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1 Introduction

This document describes a 44 W 12 V evaluation board designed in a fixed-frequency flyback converter topology using the CoolSET™ 5th Generation Fixed-Frequency Plus ICE5AR0680AG-1 switching controller. The ICE5AR0680AG-1 device offers high efficiency, low standby power with selectable entry and exit standby power option, wide V_{CC} operating range with fast startup, robust line protection with input overvoltage protection (OVP) and various modes of protections for a high-reliability system.

The evaluation board is operated in continuous conduction mode (CCM) and runs at a 100 kHz fixed switching frequency to optimize low line full-load efficiency. The frequency reduction with soft gate driving and frequency jittering offers lower EMI and better efficiency between light load to 50% load. The selectable Active Burst Mode power enables ultra-low power consumption.

In addition, numerous adjustable protection functions have been implemented in ICE5AR0680AG-1 to protect the system and customize the IC for the chosen application. In case of failure modes, like line overvoltage, V_{CC} overvoltage and undervoltage, open control-loop or overload, overtemperature, and V_{CC} short-to-ground, the device enters a protection mode. By cycle-by-cycle peak current limitation (PCL), the dimension of the transformer and current rating of the secondary diode can both be optimized. In this way, a cost-effective solution can be easily achieved.

Target applications of ICE5AR0680AG-1 are either auxiliary power supply of white goods, PC, server and TV, or enclosed adapter for gaming consoles.

This document contains the list of features, power supply specifications, schematics, bill of materials (BOM), and transformer construction. Typical operating characteristics such as performance curves and scope waveforms are shown. At the end of the document, suggestions on component changes are provided for users who wish to evaluate the IC feature and functionality of ICE5BR4780AG-1, ICE5BR3995AG-1, ICE5GR1680AG-1 and ICE5GR2280AG-1 on the EVAL_5AR0680AG-1_44W1 Evaluation Board.

44 W, 12 V SMPS Evaluation Board with CoolSET™ ICE5AR0680AG-1 and other variants

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Evaluation board

2 Evaluation board

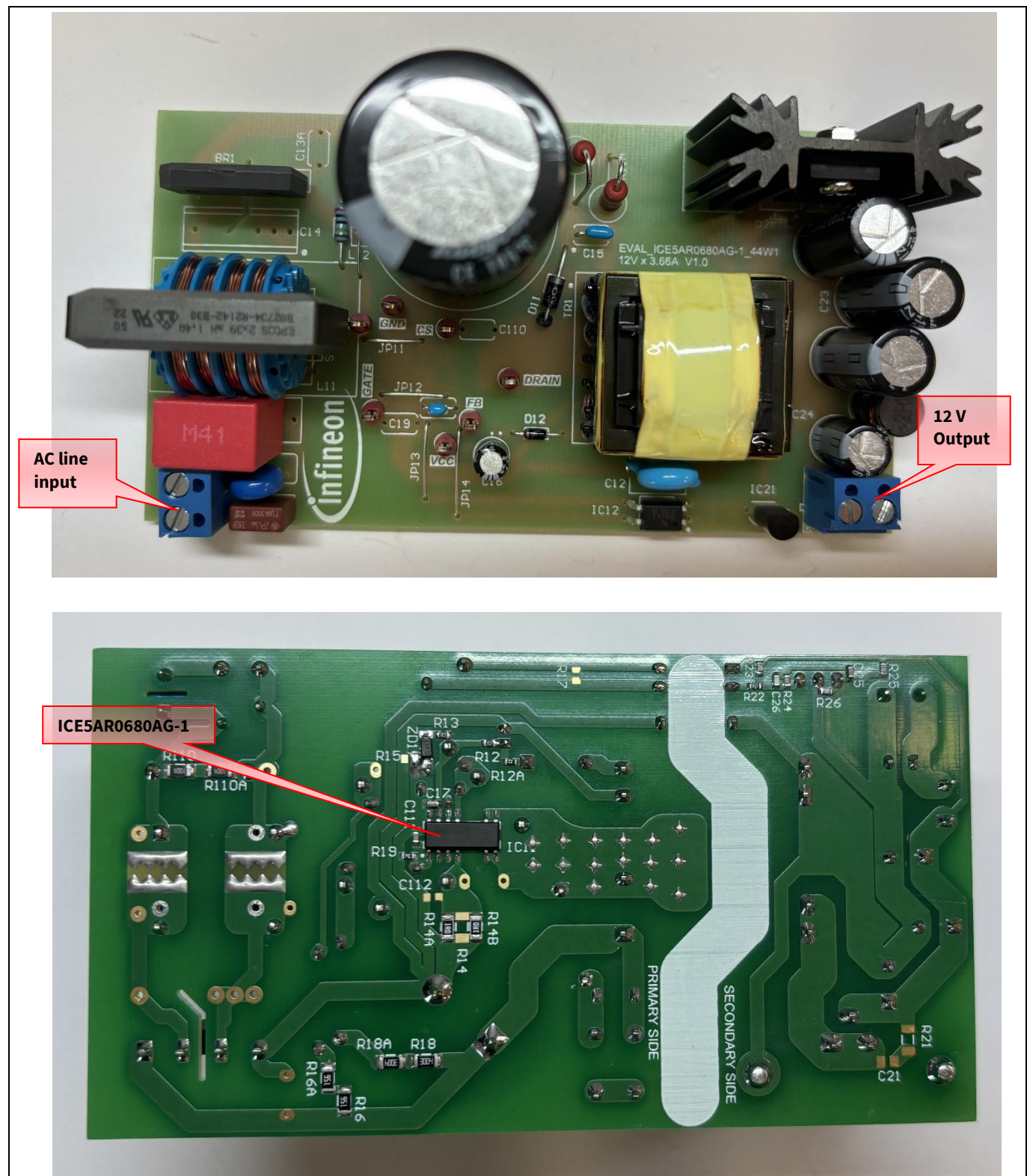


Figure 1 EVAL_5AR0680AG-1_44W1

44 W, 12 V SMPS Evaluation Board with CoolSET™ ICE5AR0680AG-1 and other variants



EVAL_5AR0680AG-1_44W1

Evaluation board specifications

3 Evaluation board specifications

Table 1 EVAL_5AR0680AG-1_44W1 specifications

Input voltage and frequency	85 V AC (60 Hz) ~ 300 V AC (50 Hz)
Output voltage, current, and power	12 V x 3.66 A = 44 W
Dynamic load response (12 V load change from 10% to 100%, slew rate at 0.4 A/μs, 100 Hz)	±3% of nominal output voltage
Output ripple voltage (full load, 85 V AC ~ 300 V AC)	12 V _{ripple_p-p} < 100 mV
Active mode four point average efficiency (25%, 50%, 75%, 100% load)	> 87% at 115 V AC and 230 V AC
No-load power consumption	< 100 mW at 230 V AC
Conducted emissions (EN55022 class B)	Pass with 8 dB margin for 115 V AC and 6 dB margin 230 V AC
ESD immunity (EN61000-4-2)	Level 4 for contact discharge and Level 3 for air discharge (±8 kV for both contact and air discharge)
Surge immunity (EN61000-4-5)	Installation class 4 (±2 kV for line to line and ±4 kV for line to earth)
Form factor case size (L x W x H)	(115 x 65 x 40) mm ³

4 Circuit diagram

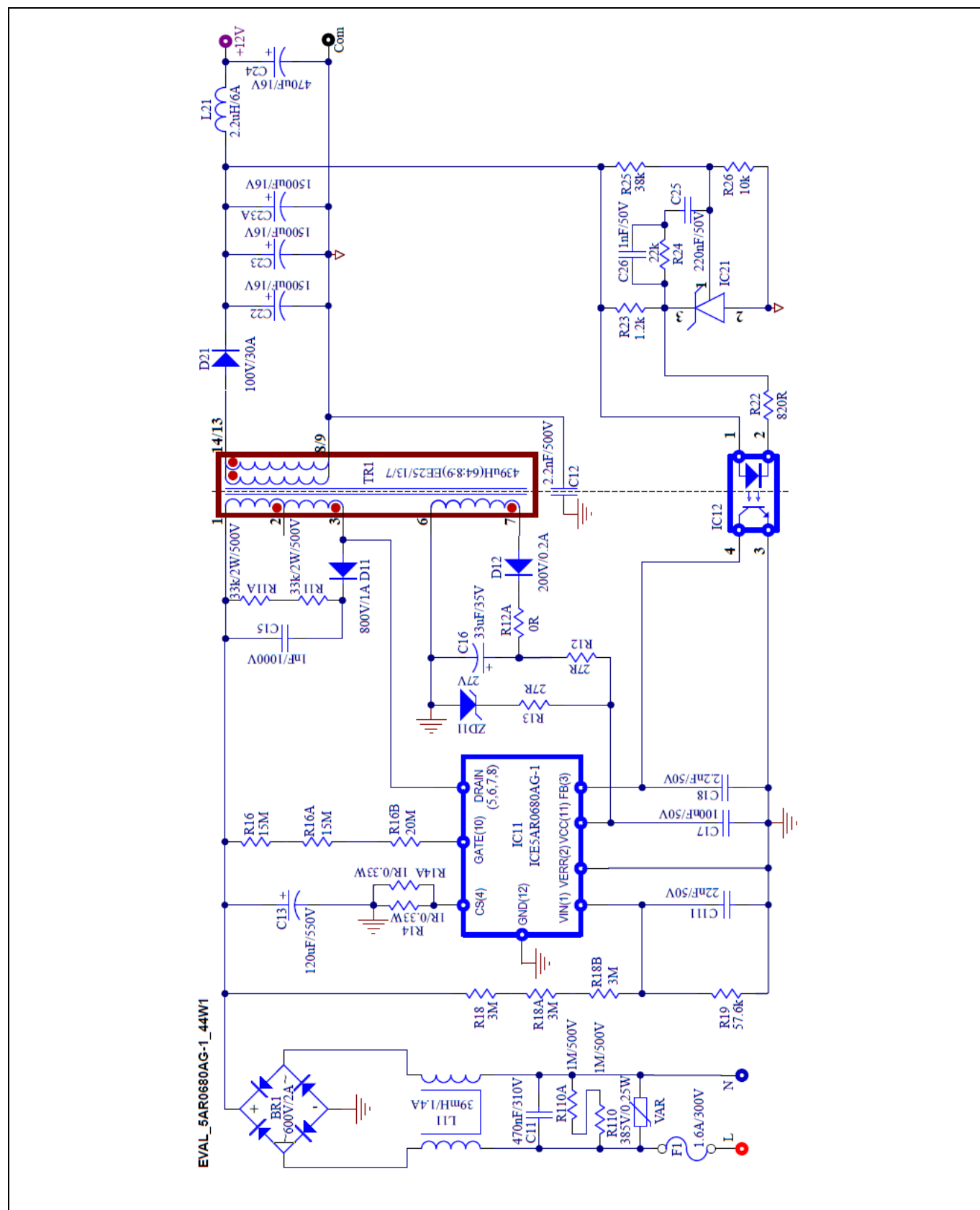


Figure 2 Schematic of EVAL_5AR0680AG-1_44W1

5 Circuit description

5.1 Line input

The AC line input side comprises the input fuse (F1) as overcurrent protection. The choke (L11), X-capacitor (C11), and Y-capacitor (C12) act as EMI suppressors. Optional spark gap devices SA1, SA2, and varistor VAR can absorb high-voltage stress during lightning surge test. A rectified DC voltage (120~424 V DC) is obtained through the bridge rectifier (BR1) together with the bulk capacitor (C13).

5.2 Startup

To achieve fast and safe startup, the ICE5AR0680AG-1 switching controller is implemented with a startup resistor and V_{CC} short-to-GND protection. When V_{VCC} reaches the turn-on voltage threshold of 16 V, the IC begins a soft start.

The soft start implemented in ICE5AR0680BZS-1 is a digital time-based function. The preset soft-start time is 12 ms with four steps. If not limited by other functions, the peak voltage on the CS pin will increase in increments from 0.3 V to 0.8 V. After the IC turn-on, the V_{CC} voltage is supplied by the auxiliary windings of the transformer. V_{CC} short-to-GND protection is implemented during the startup time.

5.3 Integrated CoolMOS™ with frequency reduction controller

The ICE5AR0680AG-1 switching controller comprises a CoolMOS™ superjunction MOSFET and frequency reduction control, which enables better efficiency between light-load and 50% load conditions. This integrated solution greatly simplifies the circuit layout and reduces the cost of PCB manufacturing.

The latest CoolSET™ switching controller can be operated in either discontinuous conduction mode (DCM) or CCM with frequency reduction mode. This reference board is designed to operate in CCM to increase the efficiency under low-line full-load conditions. When the system is operating at maximum power, the controller will switch at the fixed frequency of f_{OSC4} (100 kHz). To achieve a better efficiency between light-load and medium-load, frequency reduction is implemented; the reduction curve is shown in [Figure 2](#). VCS is clamped by the current limitation threshold or by the PWM opamp while the switching frequency is reduced. After maximum frequency reduction, the minimum switching frequency is f_{OSC4_MIN} (43 kHz).

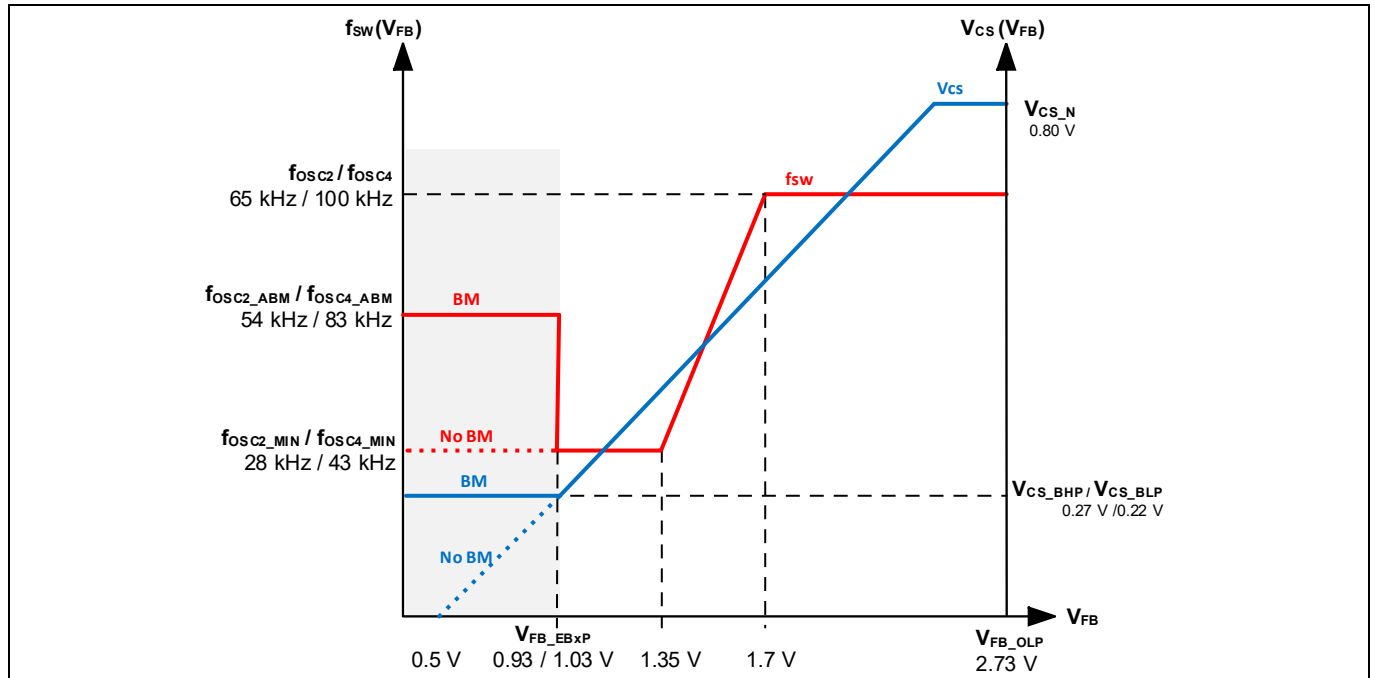


Figure 3 Frequency reduction curve

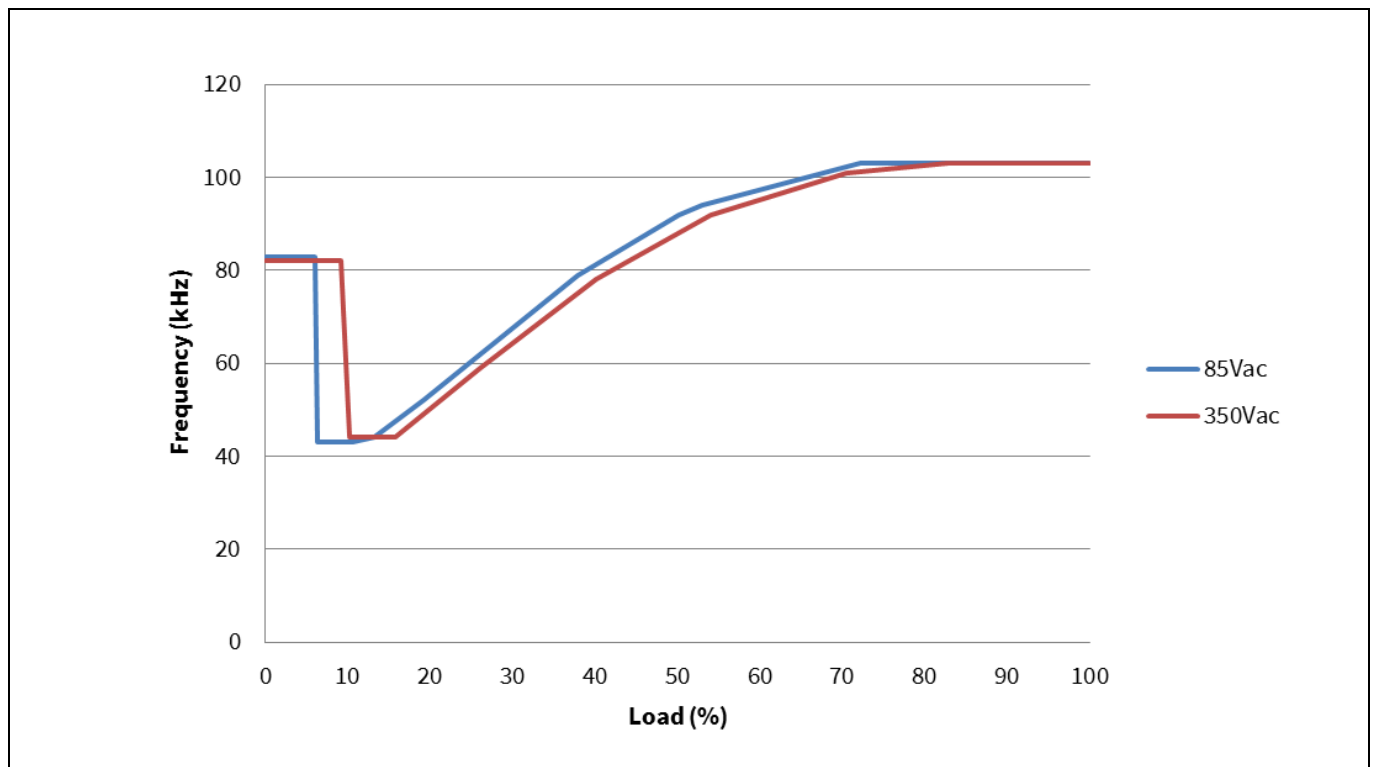


Figure 4 Frequency reduction curve of EVAL_5AR0680AG-1_44W1

The measured frequency reduction curve of EVAL_5AR0680AG-1_44W1 is shown in [Figure 4](#).

5.4 Frequency jittering

ICE5AR0680AG-1 has the frequency jittering feature to reduce the EMI noise. The jitter frequency is internally set at 100 kHz (± 4 kHz) and the jitter period is 4 ms.

5.5 RCD clamper circuit

A clamper network (R11, R11A, C15, and D11) dissipates the energy of the leakage inductance and suppresses ringing on the SMPS transformer.

5.6 Output stage

There is a single output on the secondary side, 12 V. The power is coupled out via a Schottky diode (D21). The capacitors (C22, C23, and C23A) provide energy buffering followed by the L-C filters (L21-C24) to reduce the output ripple and prevent interference between the SMPS switching frequency and line frequency considerably. Storage capacitors (C22, C23, and C23A) are designed to have an internal resistance (ESR) as low as possible to minimize the output voltage ripple caused by the triangular current.

5.7 Feedback loop

For feedback, the output is sensed by the voltage divider of R26 and R25, and compared to the IC21 (TL431) internal reference voltage. The capacitors and resistor (C25, C26, and R24) form the compensation network. The output voltage of IC21 (TL431) is converted to the current signal via the optocoupler (IC12) and two resistors (R22 and R23) for regulation control.

5.8 Active burst mode (ABM)

The ABM entry and exit power can be selected from three options, including no ABM. This reference board is set to option 3; details are shown in the product datasheet [\[1\]](#).

Under light-load conditions, the SMPS enters ABM operation. At this stage, the controller is always active but keeps V_{VCC} above the switch-off threshold. During ABM, the efficiency increases significantly; at the same time, it supports low ripple on V_{out} and fast response on load jump.

To enter ABM operation, two conditions apply:

- The FB voltage must be lower than the threshold of V_{FB_EBXP}
- A certain blanking time ($t_{FB_BEB} = 36 \text{ ms}$) is required

Once all these conditions are fulfilled, the ABM flip-flop is set and the controller enters ABM operation. This dual condition determines entering the ABM operation and prevents mis-triggering of ABM so that the controller enters ABM operation only when the output power is really low during the preset blanking time.

During ABM, the switching frequency is reduced to 83 kHz for level 2 and 3 selections and 43 kHz for level 1 (no ABM) to improve the efficiency during standby power measurement. The maximum current sense (CS) voltage is reduced from V_{CS_N} to V_{CS_BXP} to reduce the conduction loss and audible noise. During ABM operation, the FB voltage changes like a sawtooth between $V_{FB_Bon_ISO}$ and $V_{FB_Boff_ISO}$.

The FB voltage immediately increases if there is a high load jump, as observed by one comparator. As the current limit is 27/33% during ABM operation, a certain load is required so that the FB voltage can exceed V_{FB_LB} (2.73 V). After leaving ABM, the maximum current can be provided to stabilize V_{out} .

6 Protection features

Protection is one of the major factors in determining whether the system is safe and robust. Therefore, sufficient protection is necessary. ICE5AR0680BZS-1 provides comprehensive protection features to ensure that the system is operating safely. This includes V_{CC} overvoltage protection (OVP) and undervoltage protection (UVP), overload protection, overtemperature protection (controller junction), and V_{CC} short-to-GND protection. When those faults are detected, the system will enter protection mode. Once the fault is removed, the system resumes normal operation. The following table lists the protections and failure conditions.

Table 2 Protection function of ICE5AR0680AG-1

Protection functions	Normal mode	Burst mode		Protection mode
		Burst ON	Burst OFF	
Line overvoltage	√	√	√	Non-switch auto restart
V_{CC} overvoltage	√	√	Not applicable	Odd cycle skip auto restart
V_{CC} undervoltage	√	√	√	Auto restart
Overload/open loop	√	Not applicable	Not applicable	Odd cycle skip auto restart
Overtemperature	√	√	√	Non-switch auto restart
V_{CC} short-to-GND	√	√	√	No startup

7 PCB layout

7.1 Top side

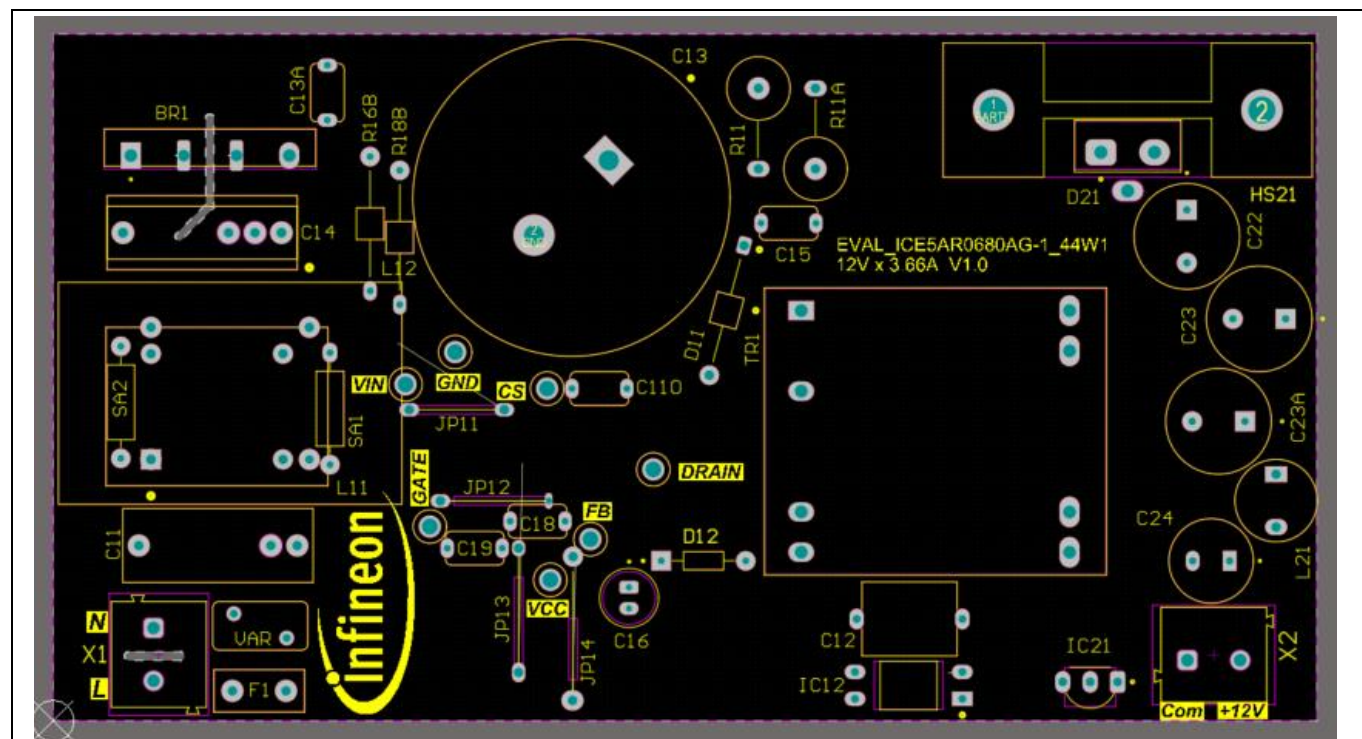


Figure 5 Top-side component legend

7.2 Bottom side

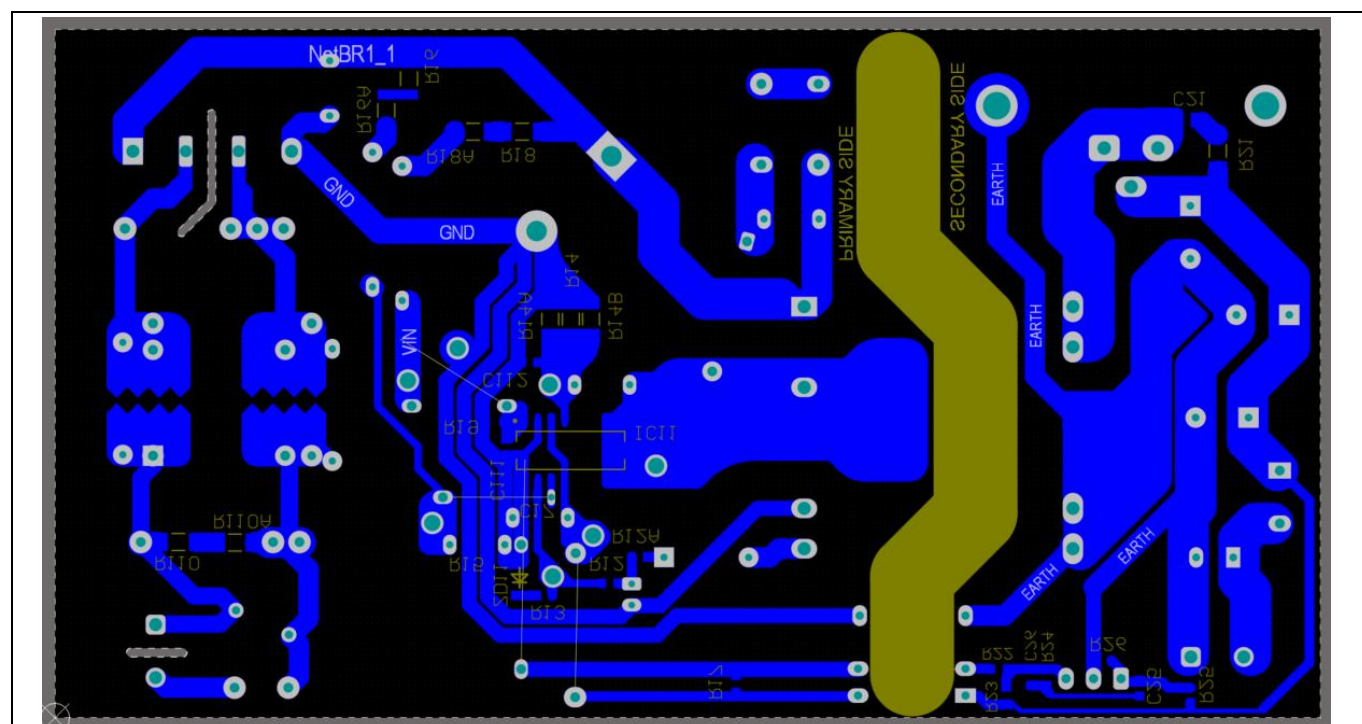


Figure 6 Bottom-side copper and component legend

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Bill of materials

8 Bill of materials

Table 3 Bill of material

No.	Designator	Description	Part Number	Manufacturer	Quantity
1	BR1	600V/2A	D2SB60A	Shindengen	1
2	C11	470nF/310V	890324024005	Würth Elektronik	1
3	C12	2.2nF/500V	DE1E3RA222MA4BQ	Murata	1
4	C13	120uF/550V	600MXH120MEFCSN25X45	Rubycon	1
5	C15	1nF/1000V	RDER73A102K2K1H03	Murata	1
6	C16	33uF/35V	50PX33MEFC5X11	Rubycon	1
7	C17	100nF/50V	GRM188R71H104KA93D	Murata	1
8	C18	2.2nF/50V	RDE5C1H222J0K1H03B	Murata	1
9	C26	1nF/50V	GRM1885C1H102GA01D	Murata	1
10	C22, C23, C23A	1500uF/16V	16ZLH1500MEFC10X20	Rubycon	3
11	C24	470uF/16V	16ZLH470MEFC8X11.5	Rubycon	1
12	C25	220nF/50V	GRM188R71H224KAC4D	Murata	1
13	C111	22nF/50V	GCM188R71H223KA37D	Murata	1
14	D11	800V/1A	UF4006	–	1
15	D12	200V/0.2A	1N485B	–	1
16	D21	100V/30A	VF30100SG	Vishay	1
17	F1	1.6A/300V	36911600000	LittleFuse	1
18	FB @ Pin 1 & 3 of TR1 and D11 anode	Ferrite bead	B64290P0035X038	Epcos	3
19	HS21	Heatsink	513002B02500G	Boyd Laconia, LLC	1
20	IC11	5AR0680AG-1	ICE5AR0680AG-1	Infineon	1
21	IC12	Optocoupler	SFH617A-3	–	1
22	IC21	Shunt Regulator	TL431BVLPG	–	1
23	JP11, JP12, JP13, JP14	Jumper		–	4
24	L11	39mH/1.4A	B82734R2142B030	Epcos	1
25	L21	2.2uH/6A	744772022	Würth Elektronik	1
26	R11, R11A	33k/2W/500V	PR02000203302JR500	Vishay	2
27	R12, R13	27R	0603 RESISTOR	–	2

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Bill of materials

No.	Designator	Description	Part Number	Manufacturer	Quantity
28	R12A	0R	0603 RESISTOR	–	1
29	R14A, R14B	1R/0.33W	ERJ8BQF1R0V	Panasonic Electronic Components	2
30	R16, R16A	15M	1206 RESISTOR	–	2
31	R16B	20M,0.125W(Axial leaded)	RK1/4DCT52R2005F	KOA Speer Electronics Inc	1
32	R18, R18A	3M	1206 RESISTOR	–	2
33	R18B	3M, 0.125W(Axial Leaded)	CF18JT3M00	Stackpole Electronics Inc	1
34	R19	57.6k	ERA-3AEB57R6V	Panasonic Electronic Components	1
35	R22	820R	0603 RESISTOR	–	1
36	R23	1.2k	0603 RESISTOR	–	1
37	R24	22k	0603 RESISTOR	–	1
38	R25	38k	0603 RESISTOR	–	1
39	R26	10k	0603 RESISTOR	–	1
40	R110, R110A	1M/500V	1206 RESISTOR	–	2
41	TR1	439uH(64:8:9)EE25 /13/7	750343606(R0.2)	Würth Elektronik	1
42	Test point for VIN, VERR, FB, VCC, CS, DRAIN, GATE and GND	Test Point	5010	Keystone Electronics Corp	7
43	VAR	385V/0.25W	B72207S0381K101	Epcos	1
44	X1&X2	Connector	691101710002	Würth Elektronik	1
45	ZD11	27V(SOD123)	MMSZ5254B-7-F	DIODES INC	1

Transformer construction

Core and material: EE25/13/7(EF25), TP4A (TDG)

Primary inductance: $L_p=439\ \mu\text{H}$ ($\pm 10\%$), measured between pin 1 and pin 3

Manufacturer and part number: Würth Elektronik Midcom (750343606 R02)

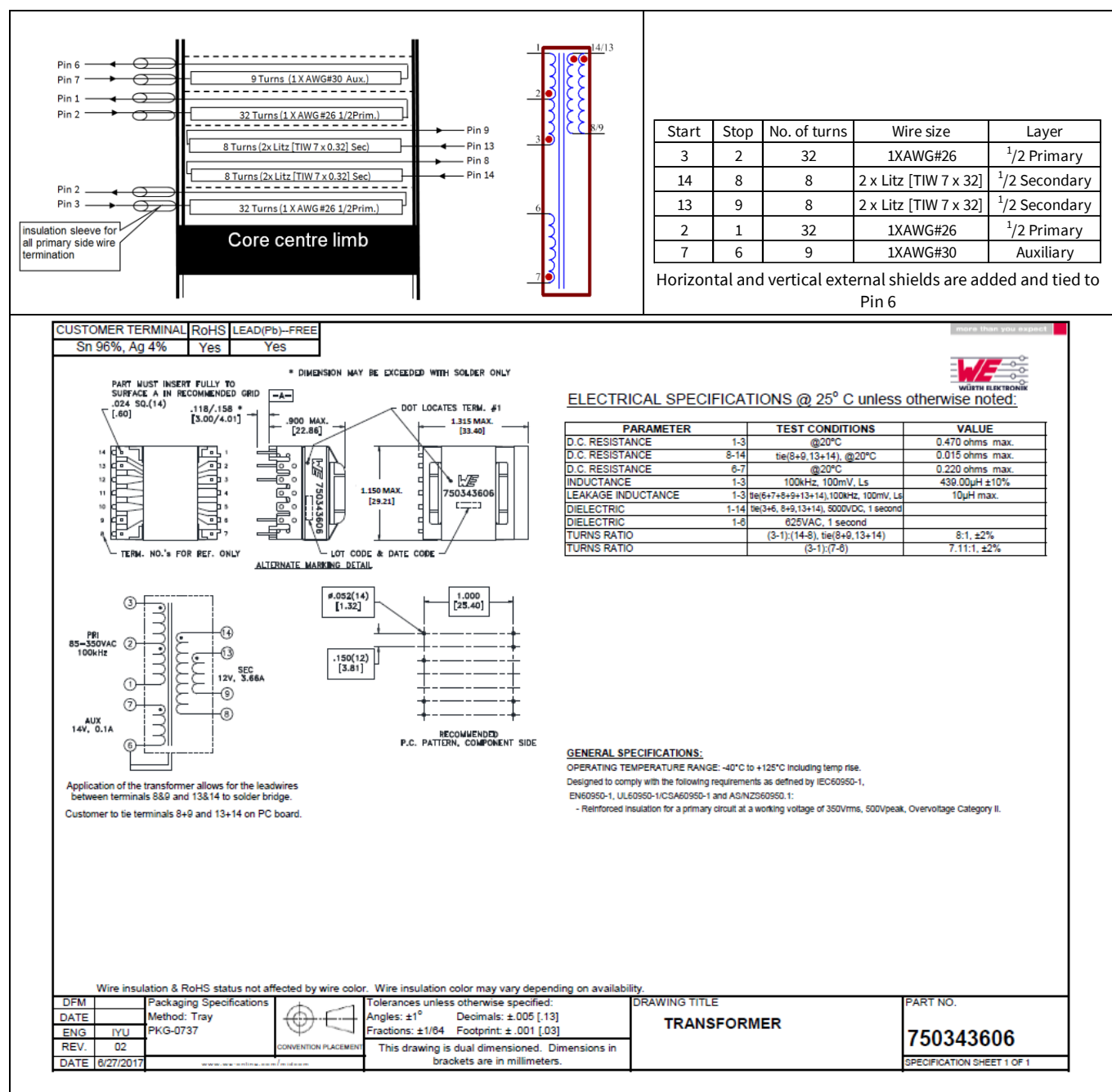


Figure 7 **Transformer structure**

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Test results

10 Test results

10.1 Efficiency, regulation, and output ripple

Table 4 Efficiency, regulation, and output ripple

Input (V AC/Hz)	P _{in} (W)	V ₁₂ (V _{DC})	I ₁₂ (A)	V _{12RPP} (mV)	P _{out} (W)	η (%)	Average η (%)	OLP P _{in} (W)	OLP I _{out12V} (A)
85 V AC/60 Hz	0.03984	12.05	0.000	50				61.1	4.28
	12.79	12.05	0.91672	14	11.04	86.33	85.59		
	25.6	12.04	1.83186	16	22.05	86.15			
	38.65	12.03	2.74743	23	33.05	85.50			
	52.14	12.02	3.6605	29	44.00	84.38			
115 V AC/60 Hz	0.04544	12.05	0.000	52				69.7	4.91
	12.71	12.05	0.91692	14	11.05	86.91	86.82		
	25.33	12.04	1.83201	16	22.05	87.07			
	37.98	12.03	2.74751	20	33.05	87.01			
	50.98	12.02	3.6608	27	44.00	86.30			
230 V AC/50 Hz	0.08295	12.05	0.000	55				76.0	5.53
	12.80	12.05	0.91691	14	11.05	86.30	87.32		
	25.21	12.04	1.8321	16	22.05	87.50			
	37.62	12.03	2.74759	20	33.05	87.85			
	50.23	12.02	3.6609	25	44.00	87.61			
265 V AC/50 Hz	0.10055	12.05	0.000	57				75.8	5.53
	12.87	12.05	0.91687	13	11.05	85.83	87.12		
	25.26	12.04	1.83205	15	22.05	87.30			
	37.75	12.03	2.74766	20	33.05	87.55			
	50.12	12.02	3.6609	24	44.01	87.80			
300 V AC/50 Hz	0.12711	12.05	0.000	58				78.4	5.69
	12.97	12.05	0.91686	13	11.04	85.15	86.47		
	25.52	12.04	1.83203	15	22.05	86.42			
	38.01	12.03	2.74758	20	33.05	86.96			
	50.39	12.02	3.6608	23	44.00	87.32			

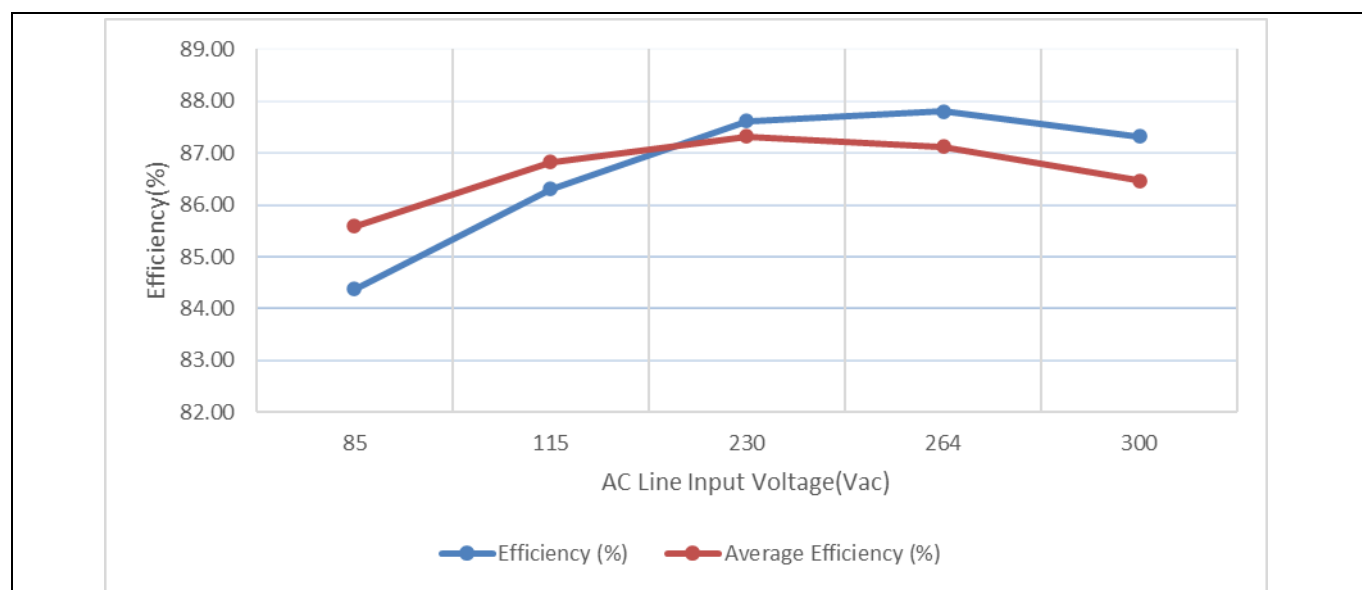


Figure 8 Efficiency vs. AC line input voltage

10.2 Standby power

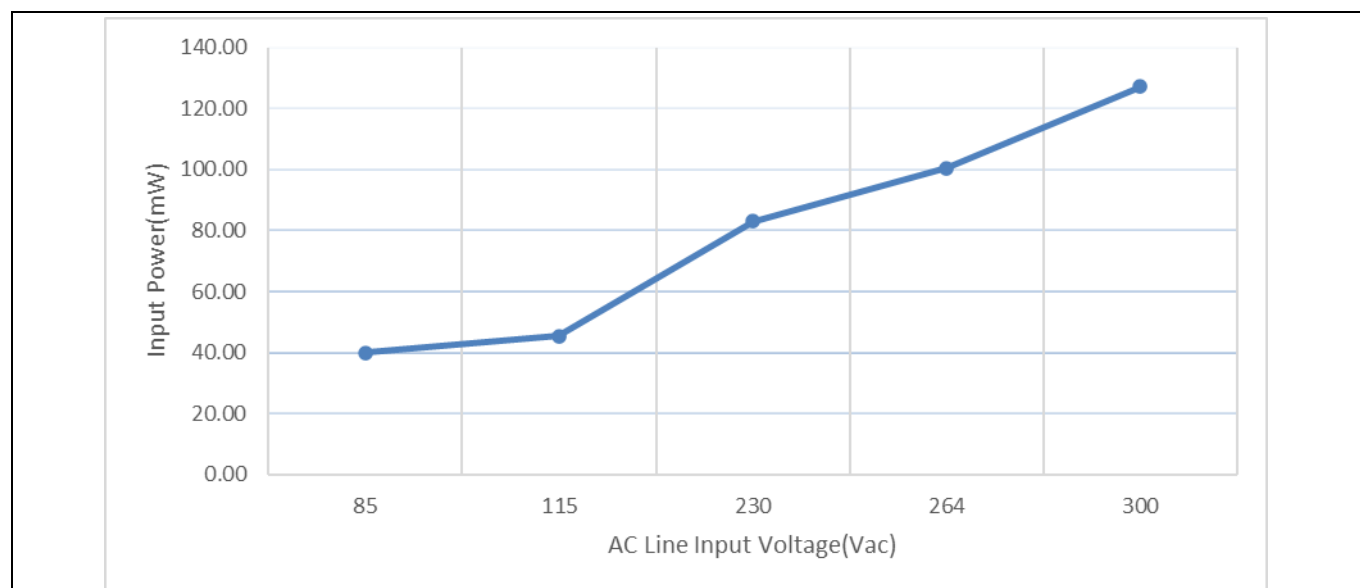


Figure 9 Standby power at no load vs. AC line input voltage (measured by Yokogawa WT210 power meter - integration mode)

10.3 Line regulation

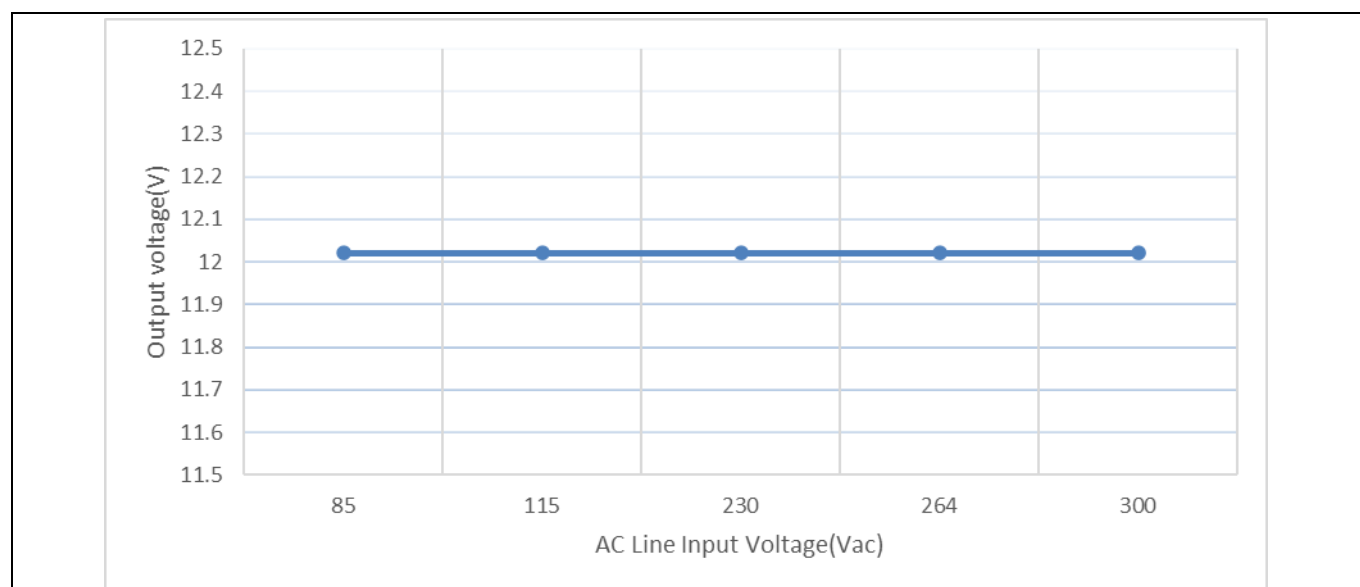


Figure 10 Line regulation V_{out} at full load vs. AC line input voltage

10.4 Load regulation

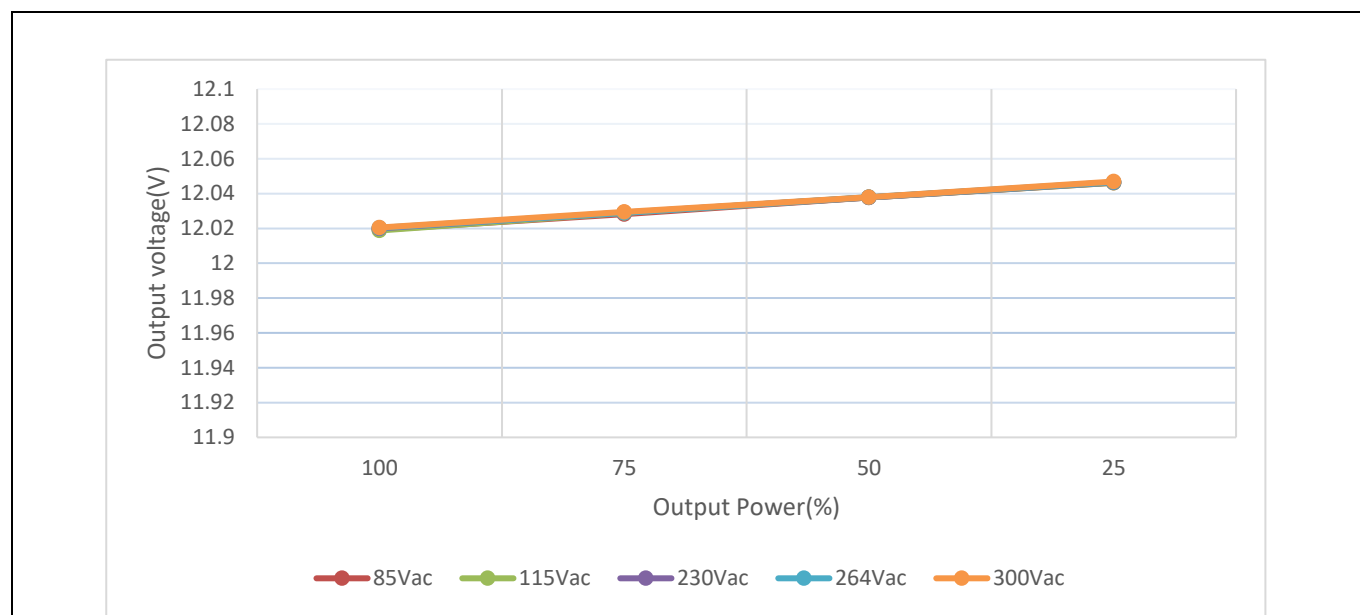


Figure 11 Load regulation V_{out} vs. output power

10.5 Maximum input power

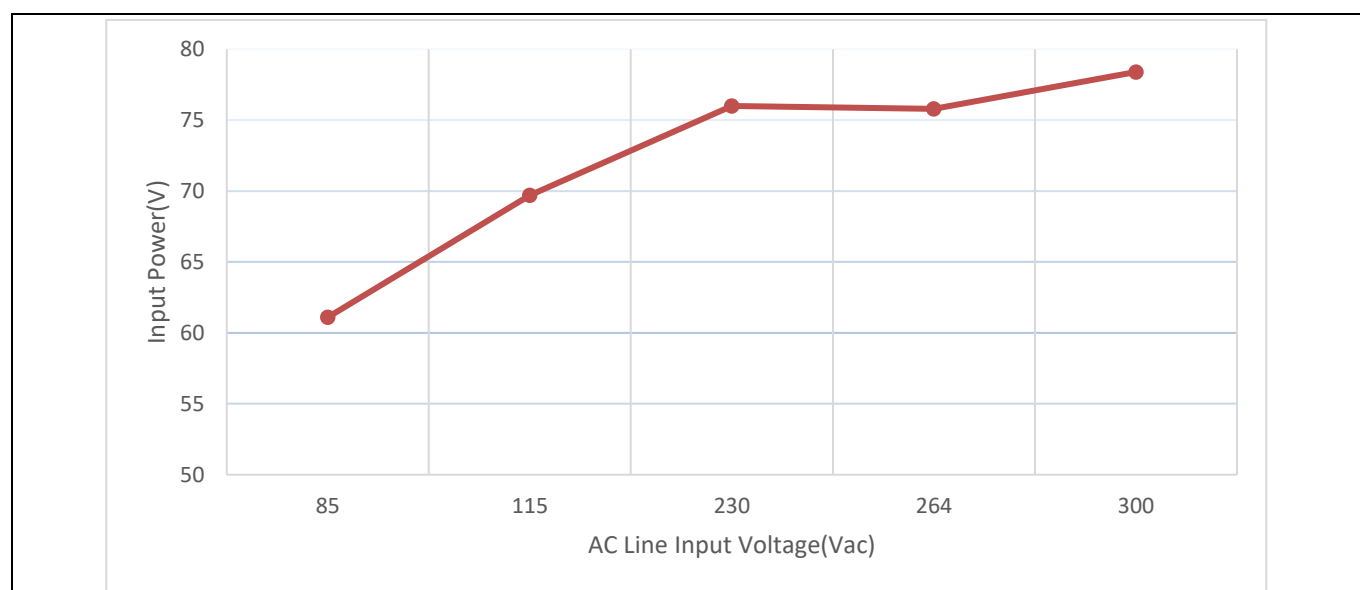


Figure 12 Maximum input power (before overload protection) vs. AC line input voltage

10.6 ESD immunity (EN61000-4-2)

Pass EN61000-4-2 Level 4 for contact discharge and Level 3 for air discharge (± 8 kV for both contact and air discharge).

10.7 Surge immunity (EN61000-4-5)

Pass EN61000-4-5 Installation Class 4 (± 2 kV for line to line and ± 4 kV for line to earth).

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Test results

10.8 Conducted emissions (EN55022 Class-B)

The conducted EMI was measured by Schaffner (SMR4503) and followed the test standard of EN55022 (CISPR 22) Class-B. The evaluation board was set up at maximum load (44 W) with input voltage of 115 V AC and 230 V AC.

Pass conducted emissions EN55022 (CISPR 22) Class-B with 8 dB margin for low line (115 V AC) and 6 dB margin for high line (230 V AC).

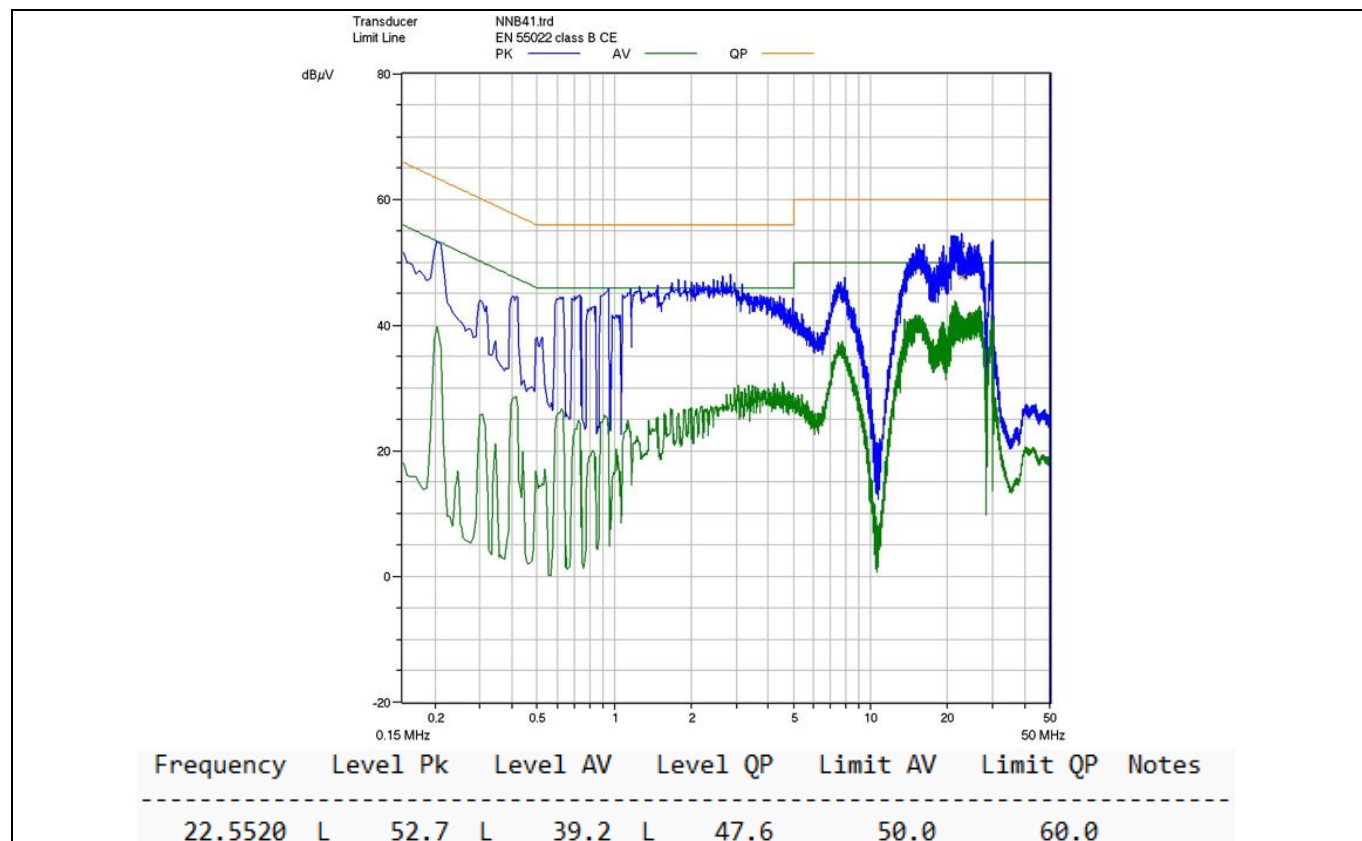


Figure 13 Conducted emissions (line) at 115 V AC and maximum load

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Test results

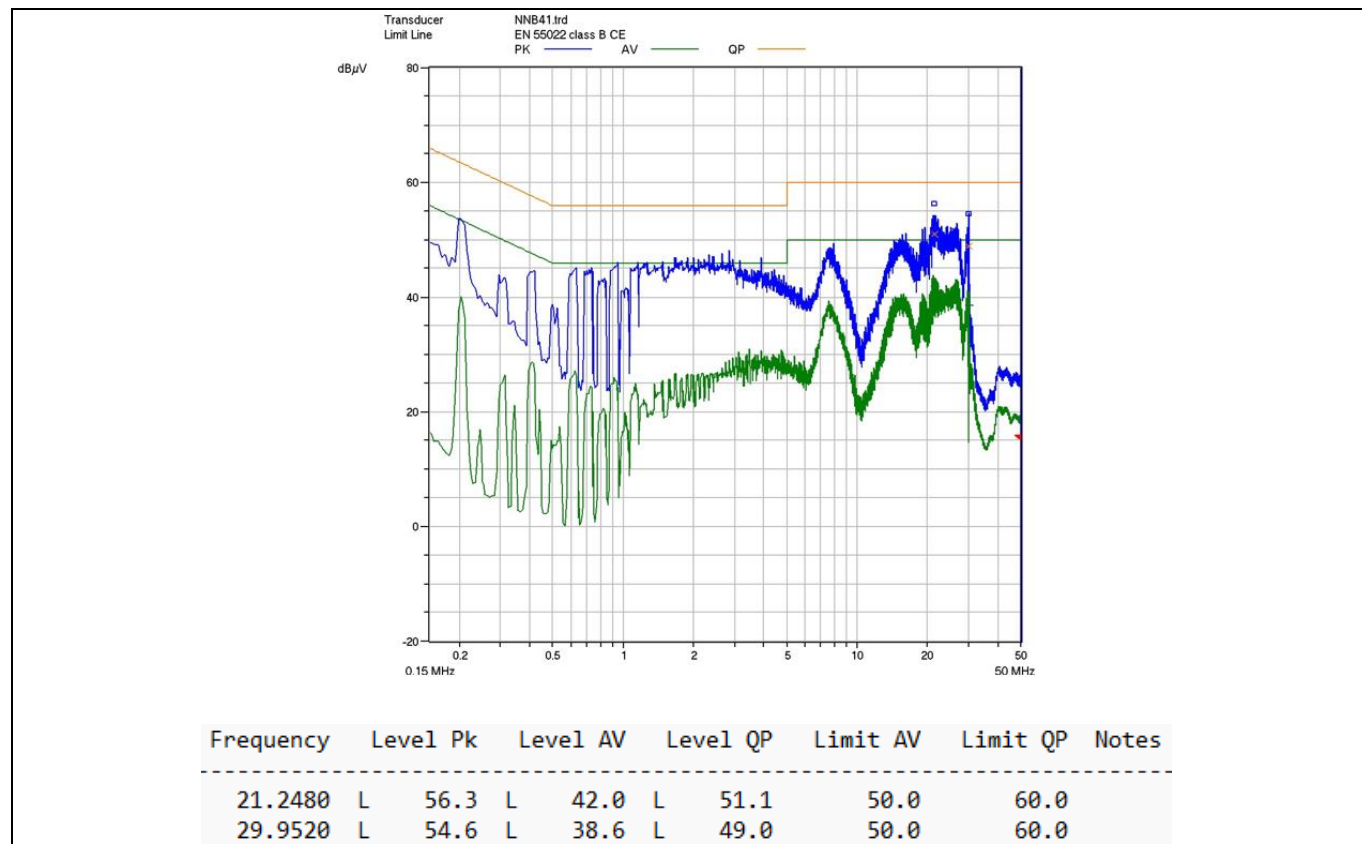


Figure 14 Conducted emissions (neutral) at 115 V AC and maximum load

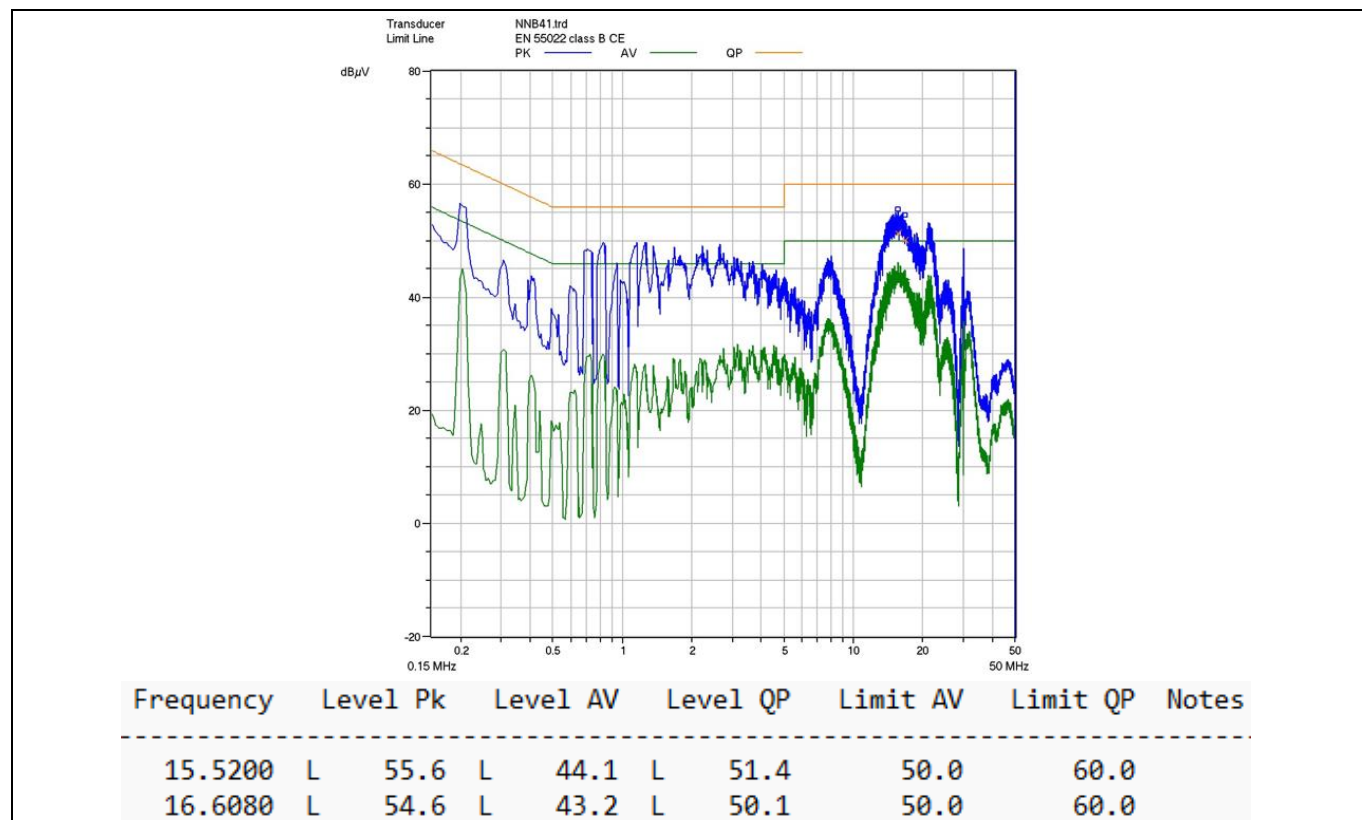


Figure 15 Conducted emissions (line) at 230 V AC and maximum load

Test results

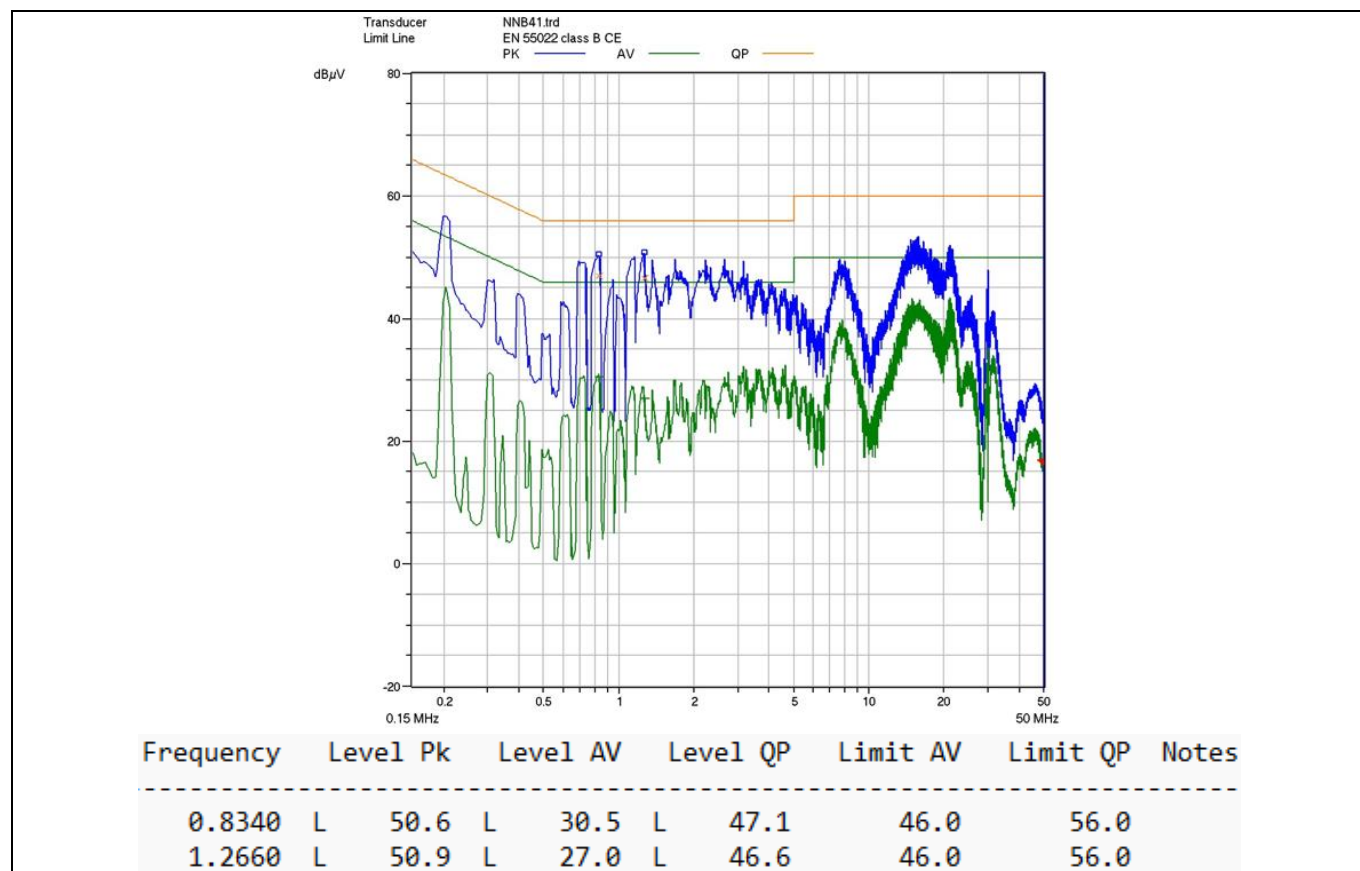


Figure 16 Conducted emissions (neutral) at 230 V AC and maximum load

10.9 Thermal measurement

The thermal test of the open frame evaluation board was done using an infrared thermography camera (FLIR-T62101) at ambient temperature 23°C. The measurements were taken after one hour running at full load.

Table 5 Hottest temperature of evaluation board

No.	Major component	85 V AC (°C)	300 V AC (°C)
1	IC11 (ICE5AR0680AG-1)	84	81
2	R14 (current sense resistor)	56	46
3	TR1 (transformer)	56	65
4	BR1 (bridge diode)	57	37
5	D11(clamper diode)	67	65
6	L11 (choke)	58	30
7	D21 (Secondary diode)	64	64
8	Ambient	23	23

44 W, 12 V SMPS Evaluation Board with CoolSET™ ICE5AR0680AG-1 and other variants

EVAL_5AR0680AG-1_44W1

Test results

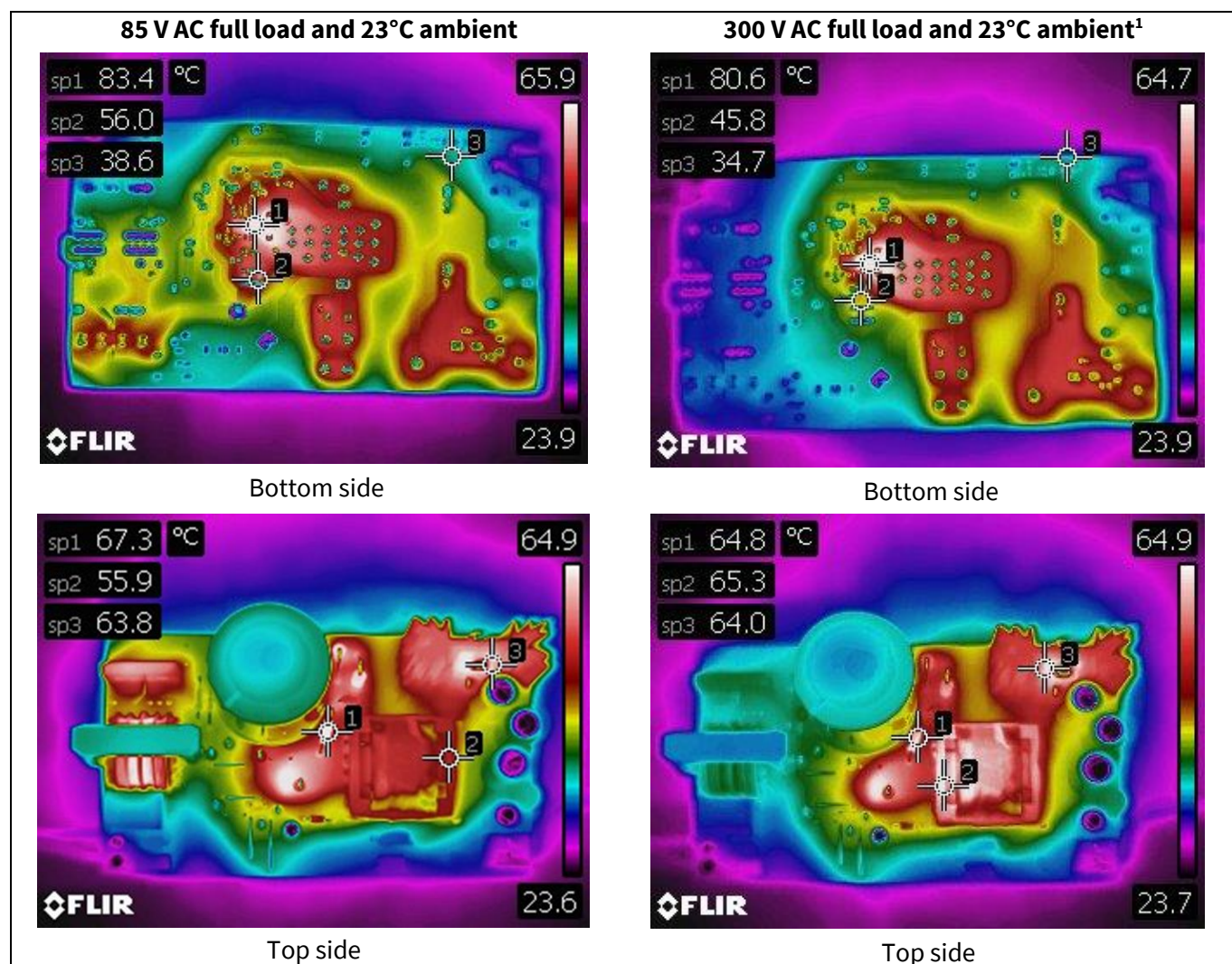


Figure 17 Infrared thermal image of EVAL_5AR0680AG-1_44W1

11 Waveforms and scope plots

All waveforms and scope plots were recorded with a TELEDYNE LECROY 606Zi oscilloscope.

11.1 Startup at low/high AC line input voltage with maximum load

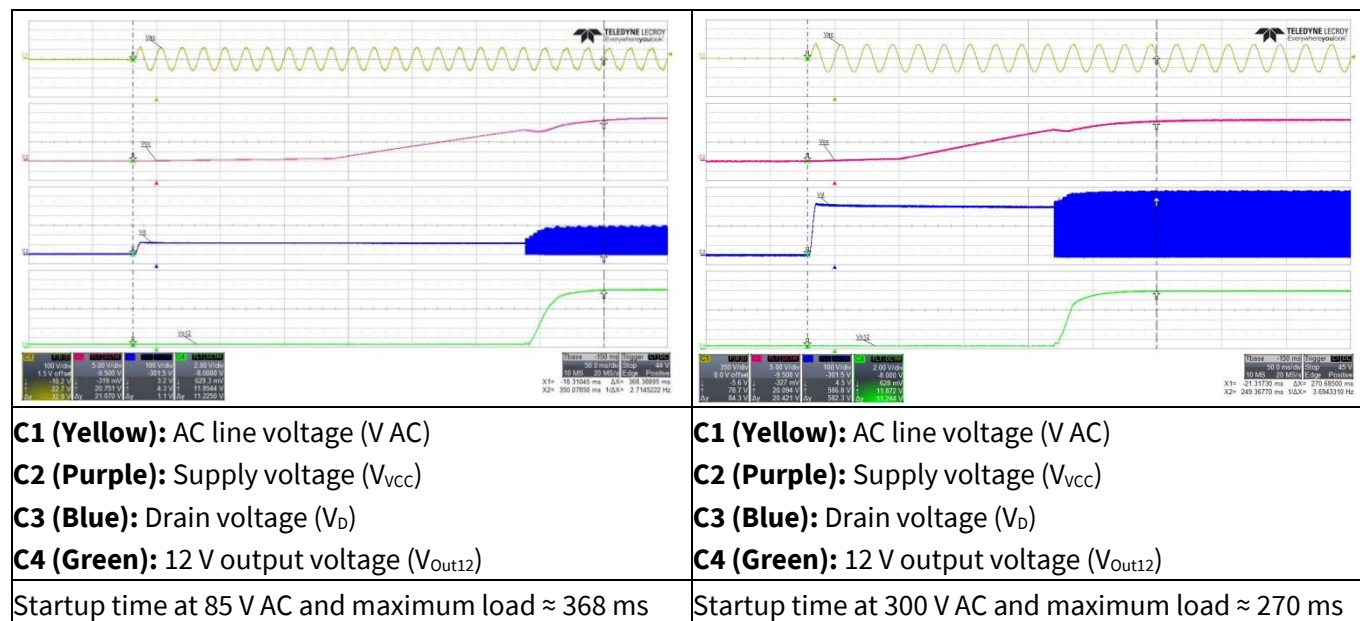


Figure 18 Startup

11.2 Soft start

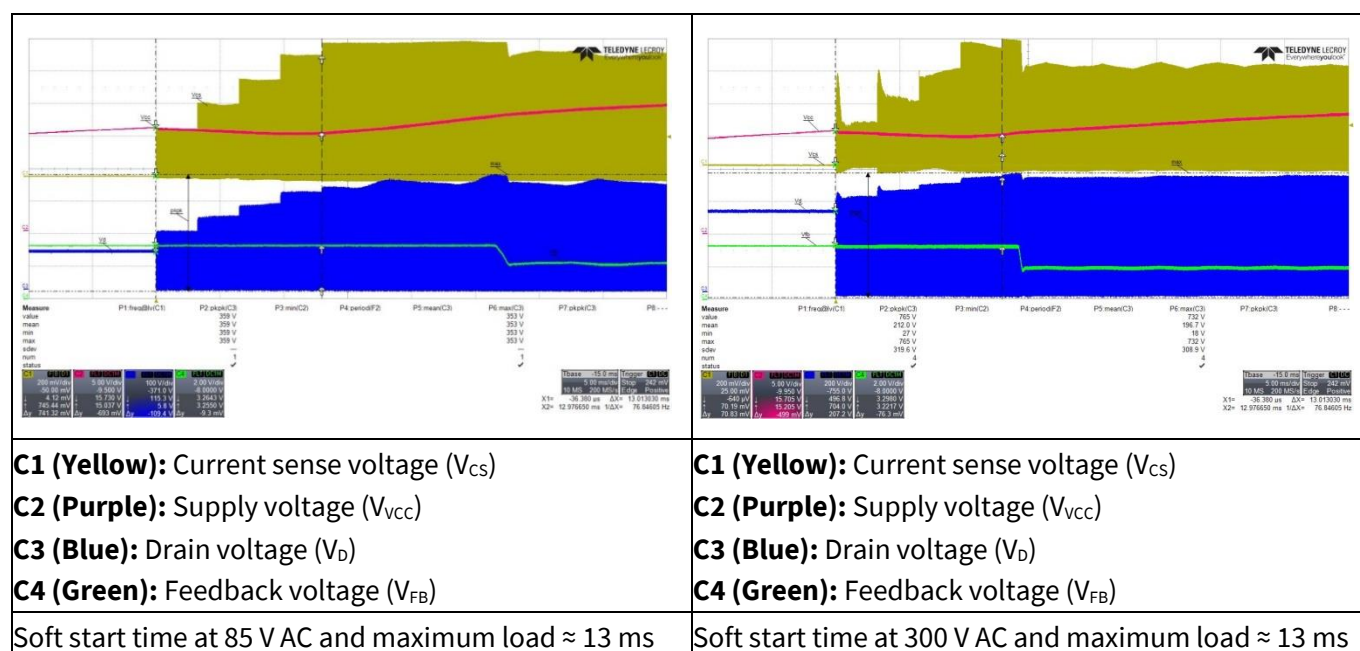


Figure 19 Soft start

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Waveforms and scope plots

11.3 Drain and current sense voltage at maximum load

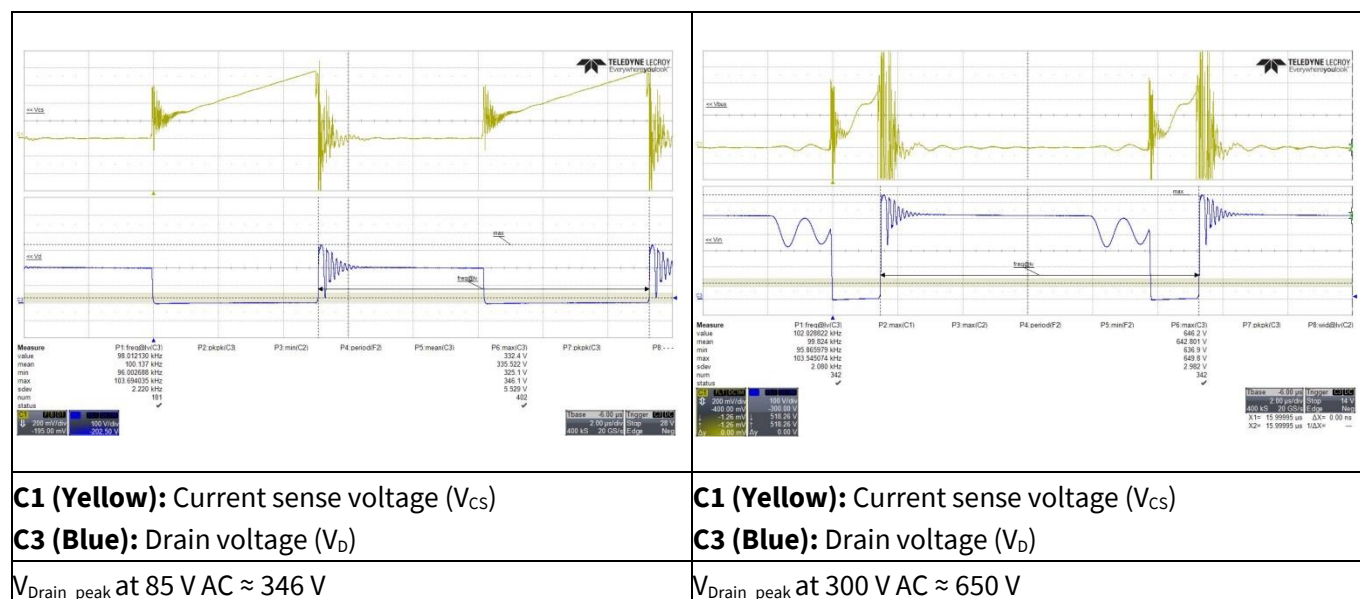


Figure 20 Drain and current sense voltage at maximum load

11.4 Frequency jittering

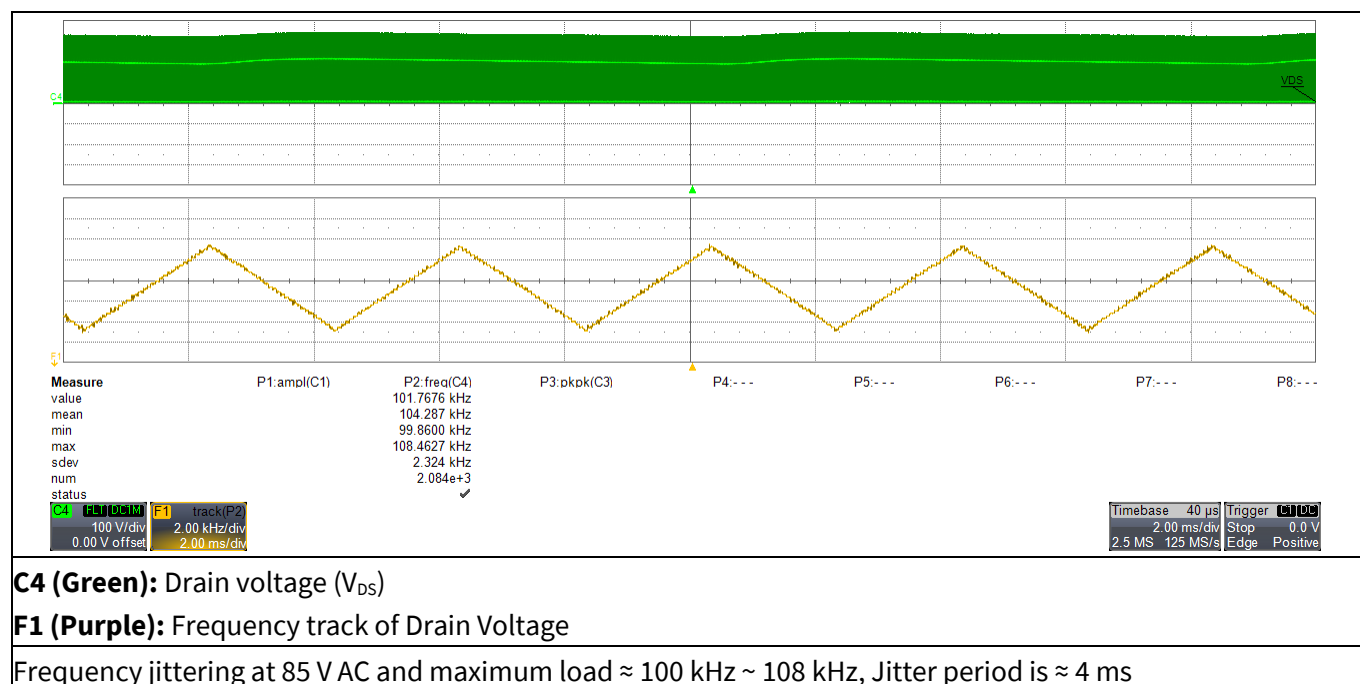


Figure 21 Frequency jittering

11.5 Load transient response (dynamic load from 10% to 100%)

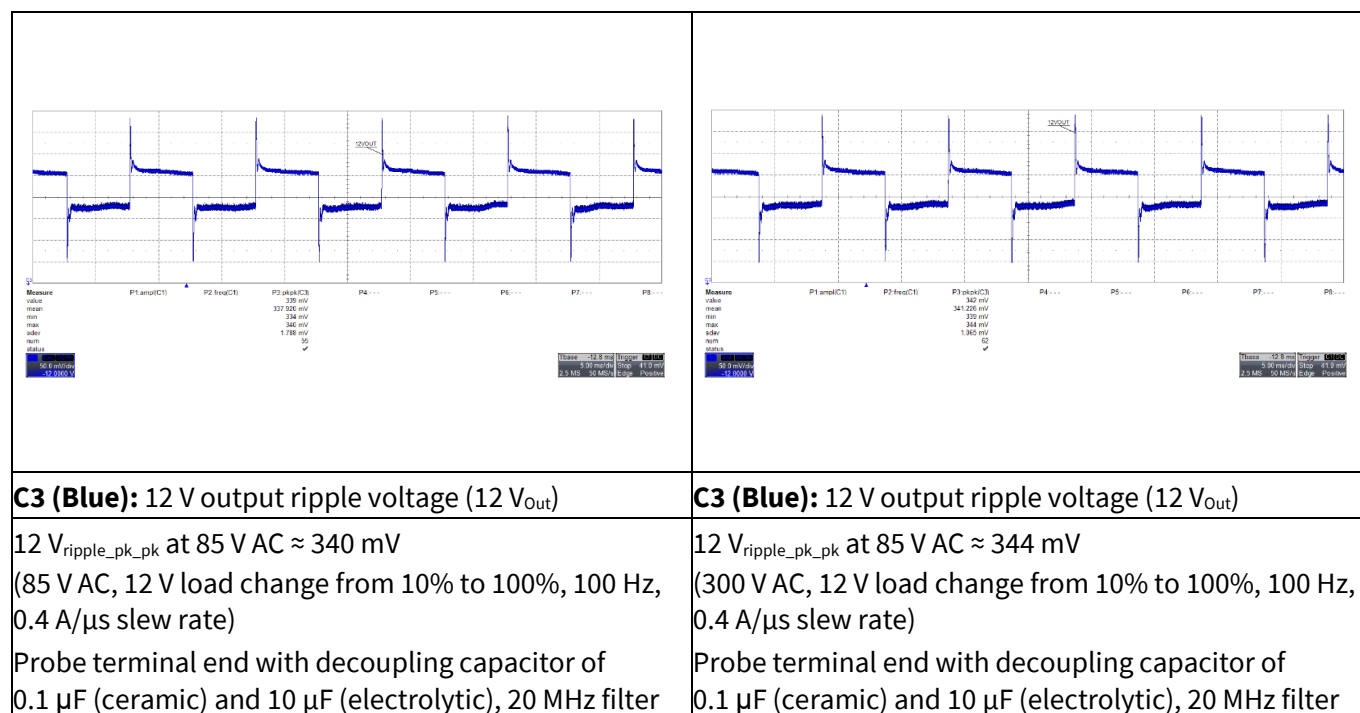


Figure 22 Load transient response

11.6 Output ripple voltage at maximum load

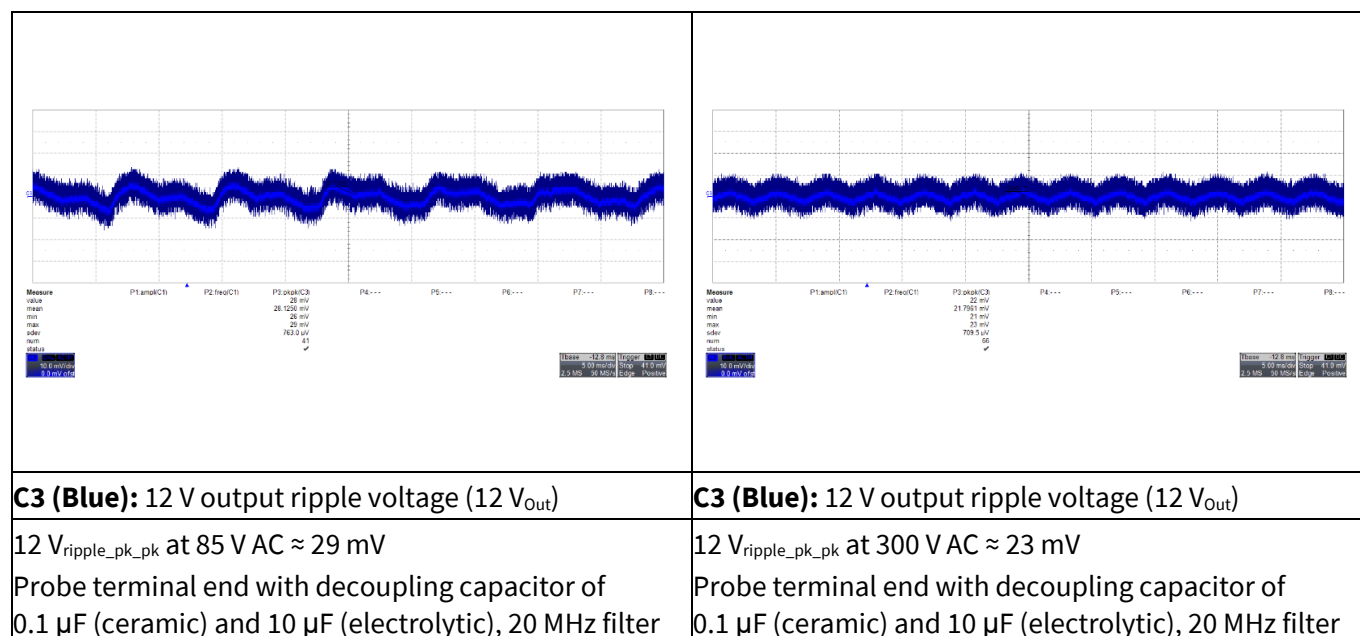


Figure 23 Output ripple voltage at maximum load

44 W, 12 V SMPS Evaluation Board with CoolSET™ ICE5AR0680AG-1 and other variants

EVAL_5AR0680AG-1_44W1

Waveforms and scope plots

11.7 Output ripple voltage at active burst mode 1 W load

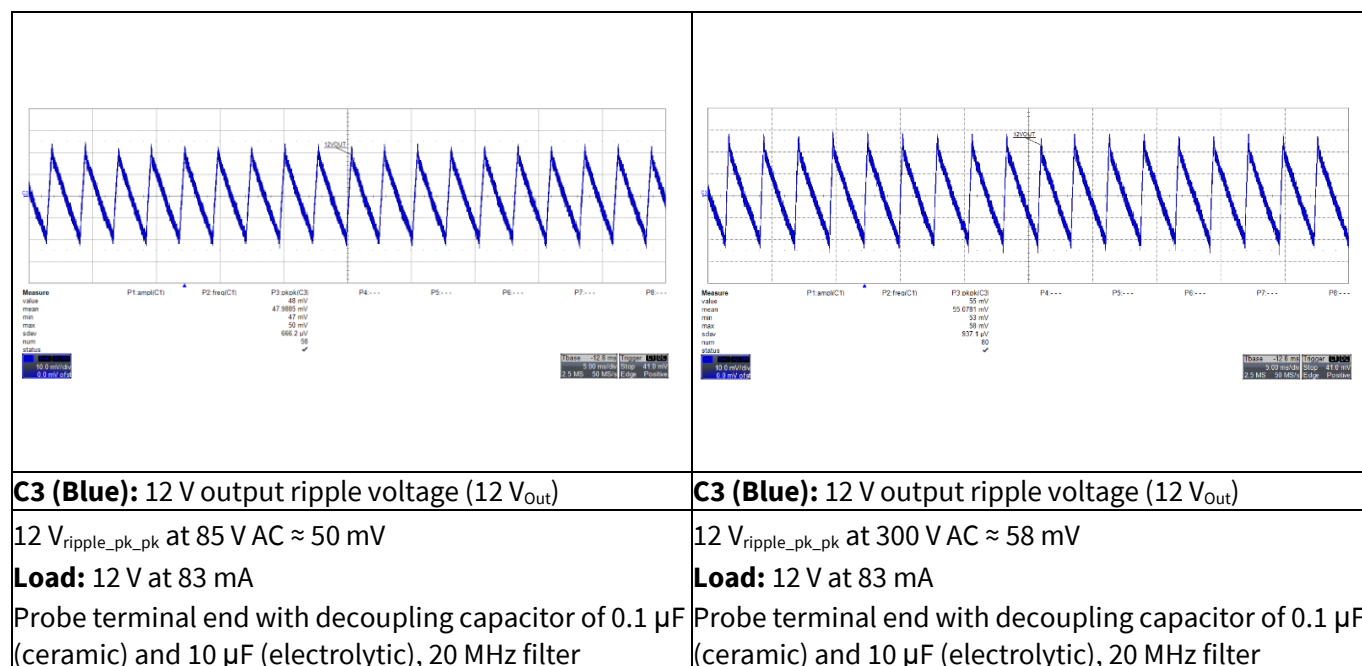


Figure 24 Output ripple voltage at burst mode 1 W load

11.8 Entering active burst mode

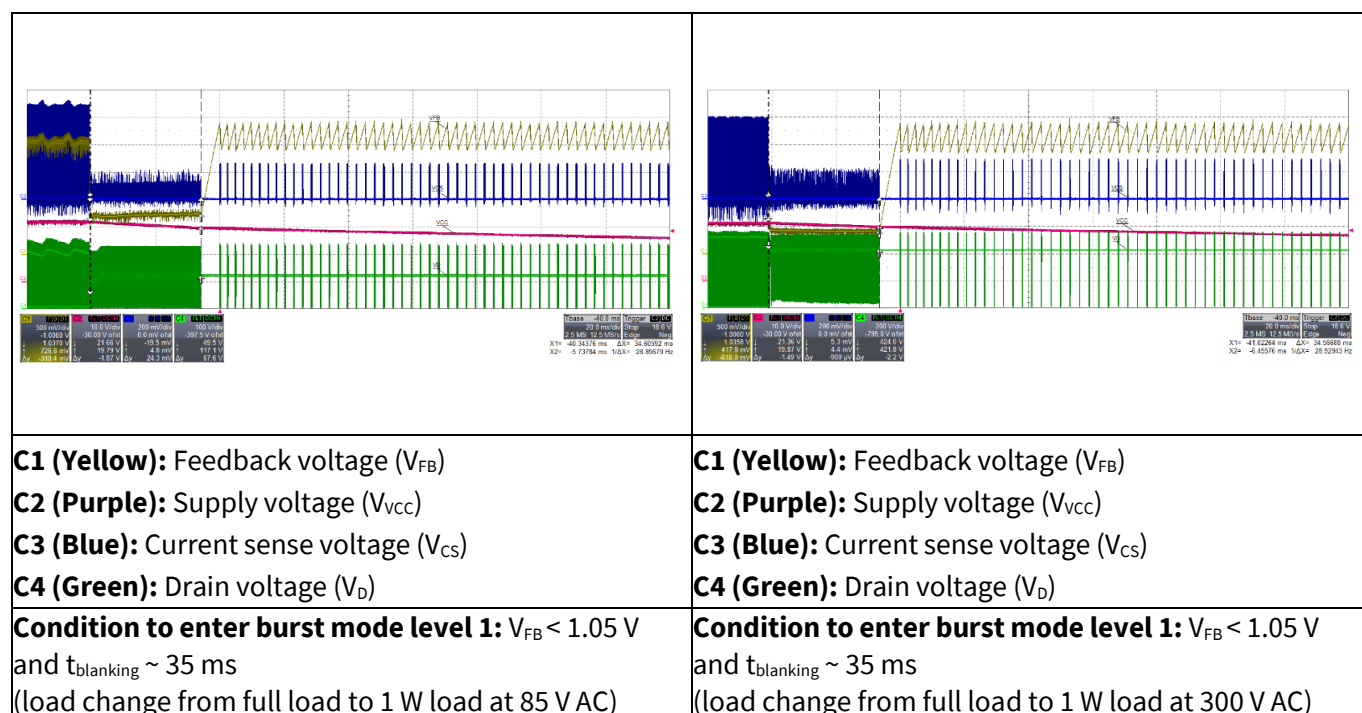


Figure 25 Entering active burst mode

11.9 During active burst mode

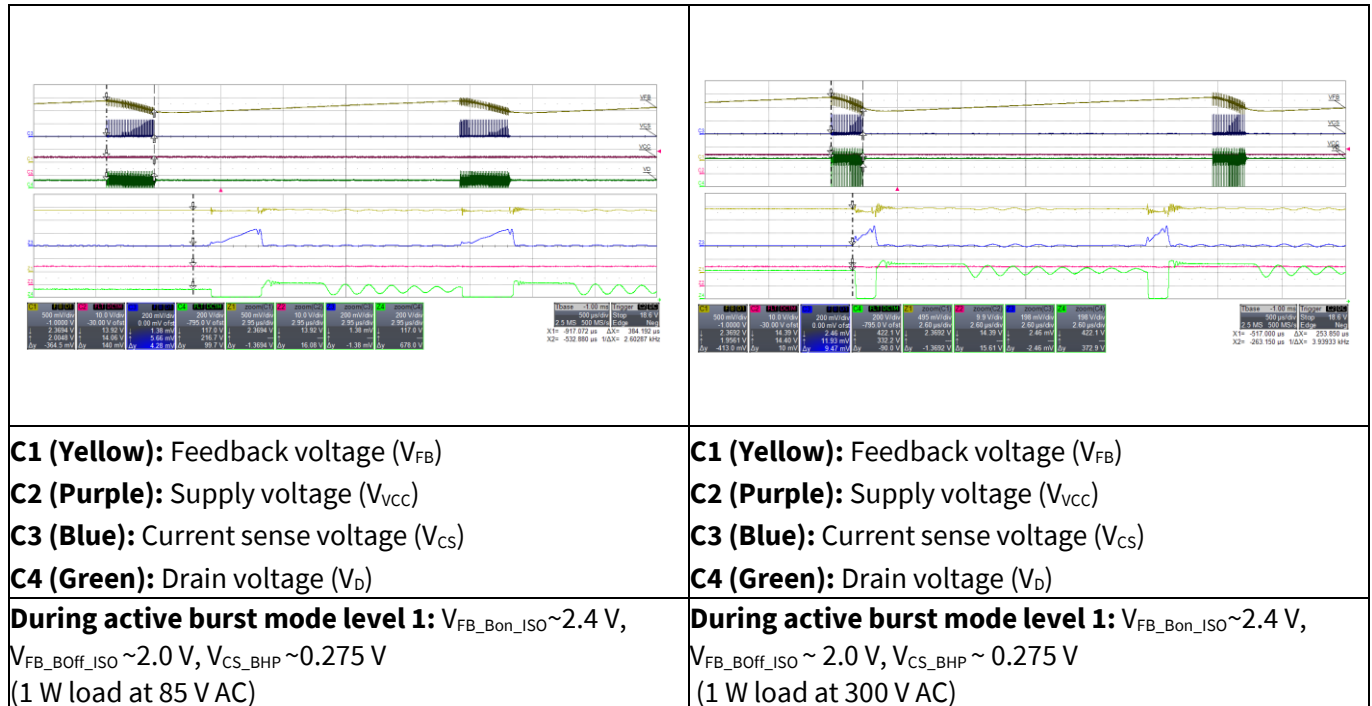


Figure 26 During active burst mode

11.10 Leaving active burst mode

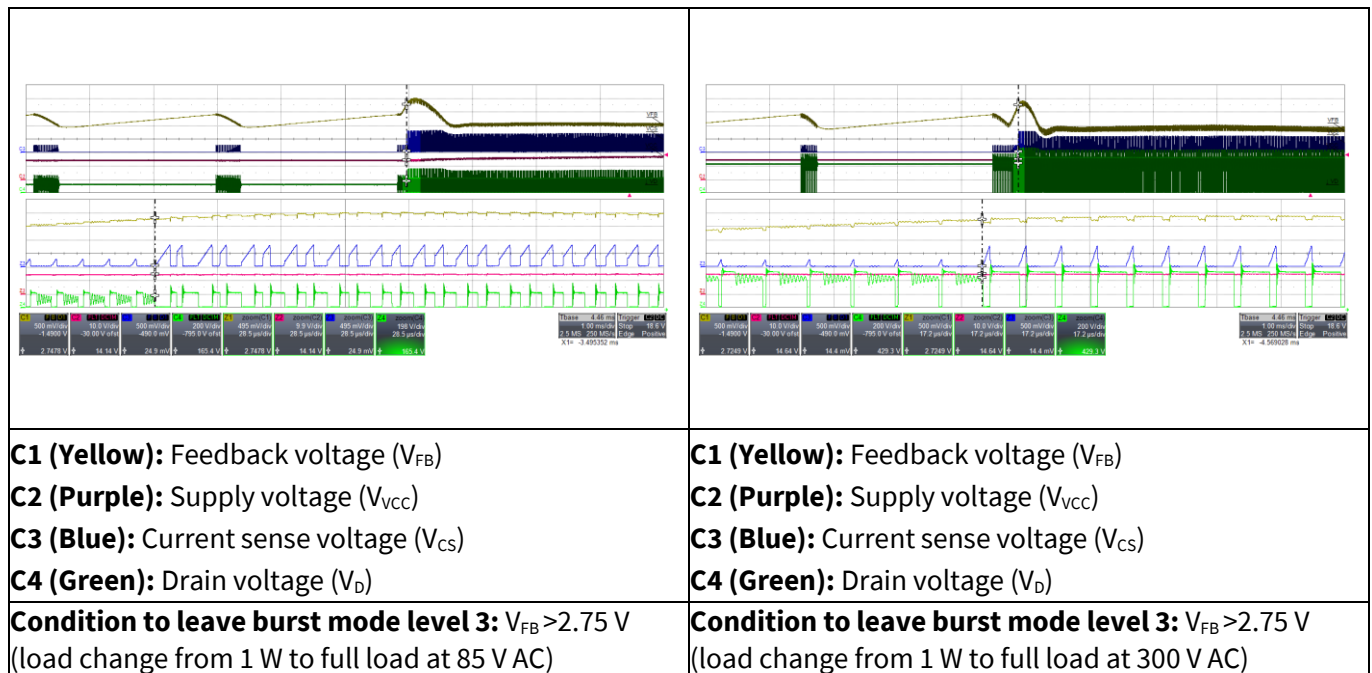


Figure 27 Leaving active burst mode

11.11 Line overvoltage protection (Non-switch auto restart)

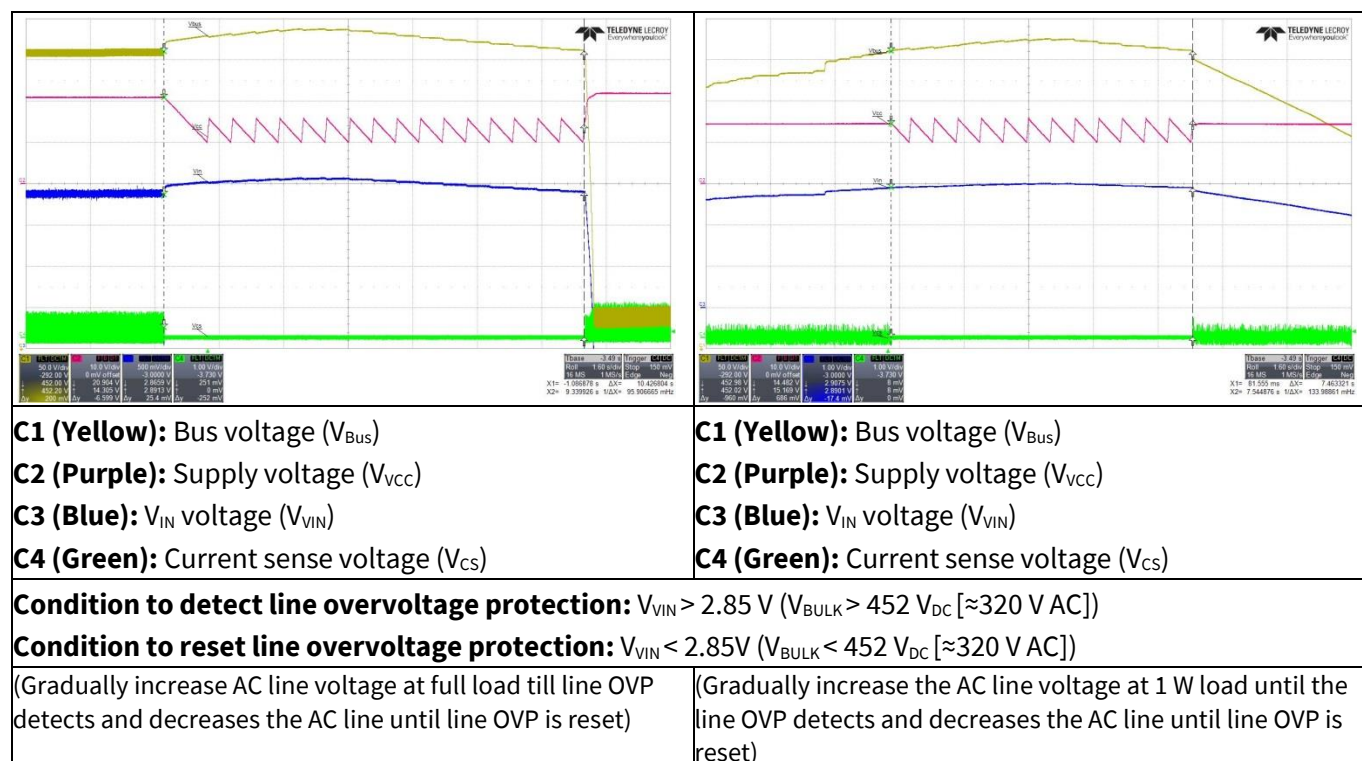


Figure 28 Line overvoltage protection at 320 V AC

11.12 V_{CC} overvoltage protection (Odd skip auto restart)

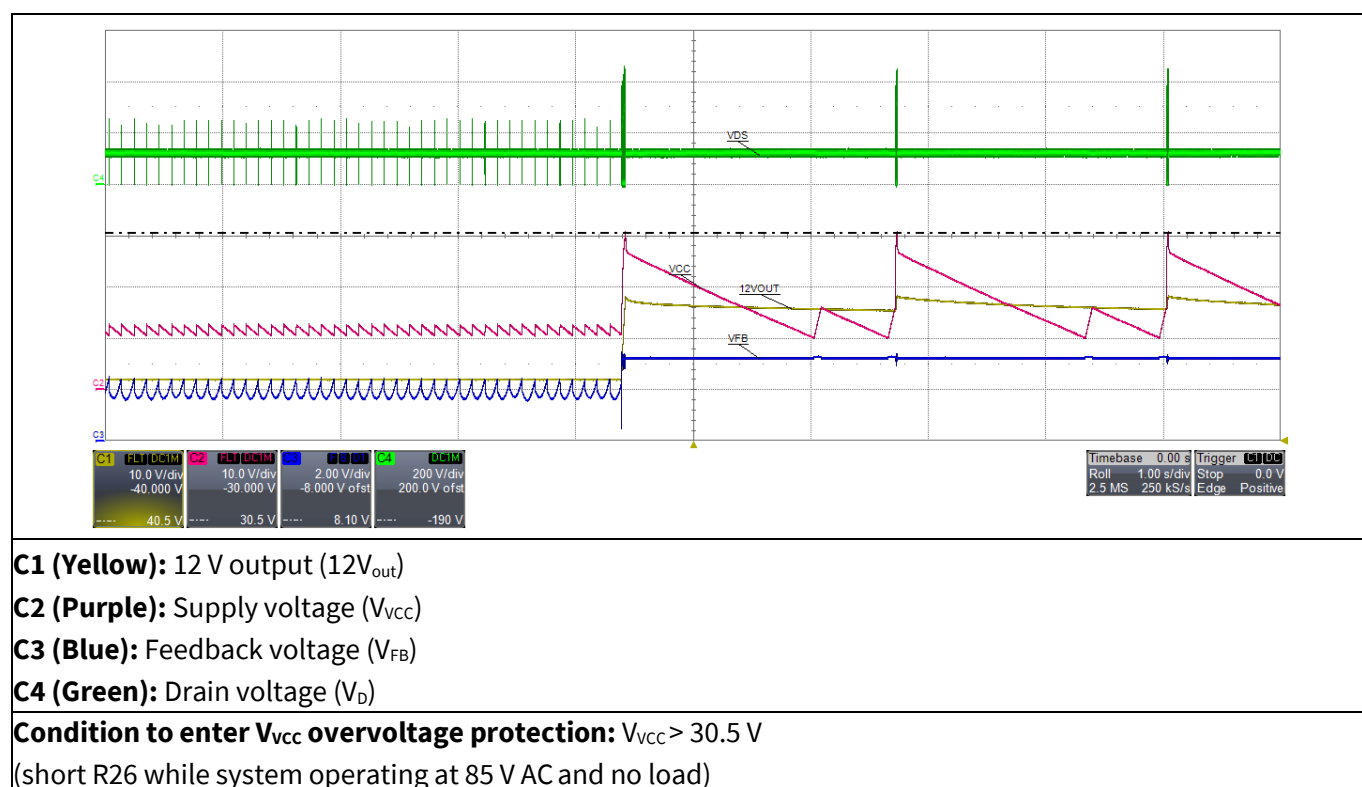
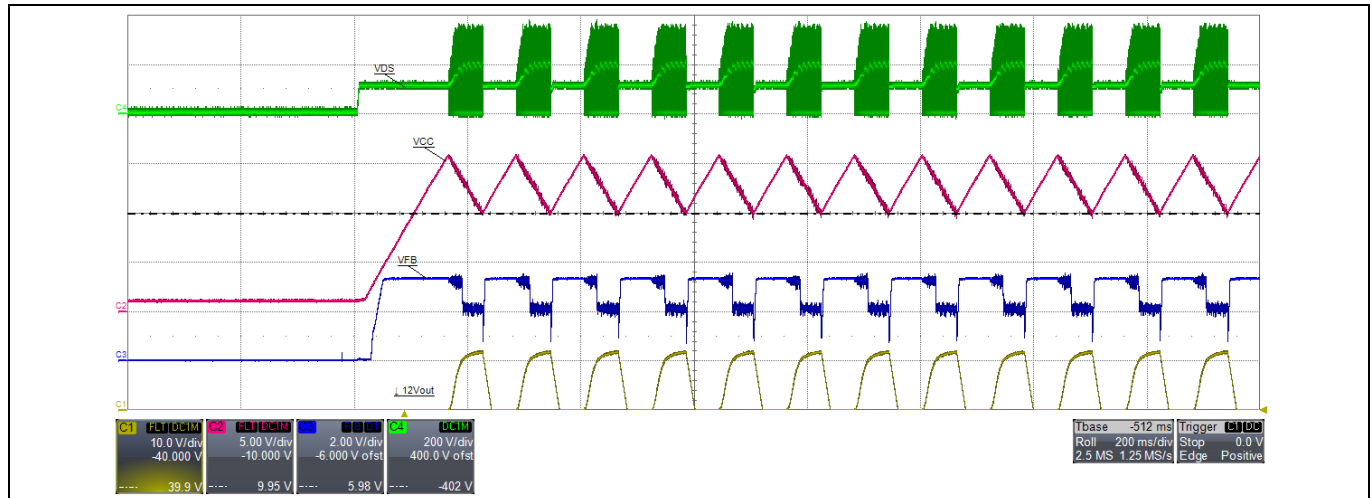


Figure 29 V_{CC} overvoltage protection

11.13 V_{CC} undervoltage protection (Auto restart)



C1 (Yellow): 12 V output ($12V_{out}$)

C2 (Purple): Supply voltage (V_{CC})

C3 (Blue): Feedback voltage (V_{FB})

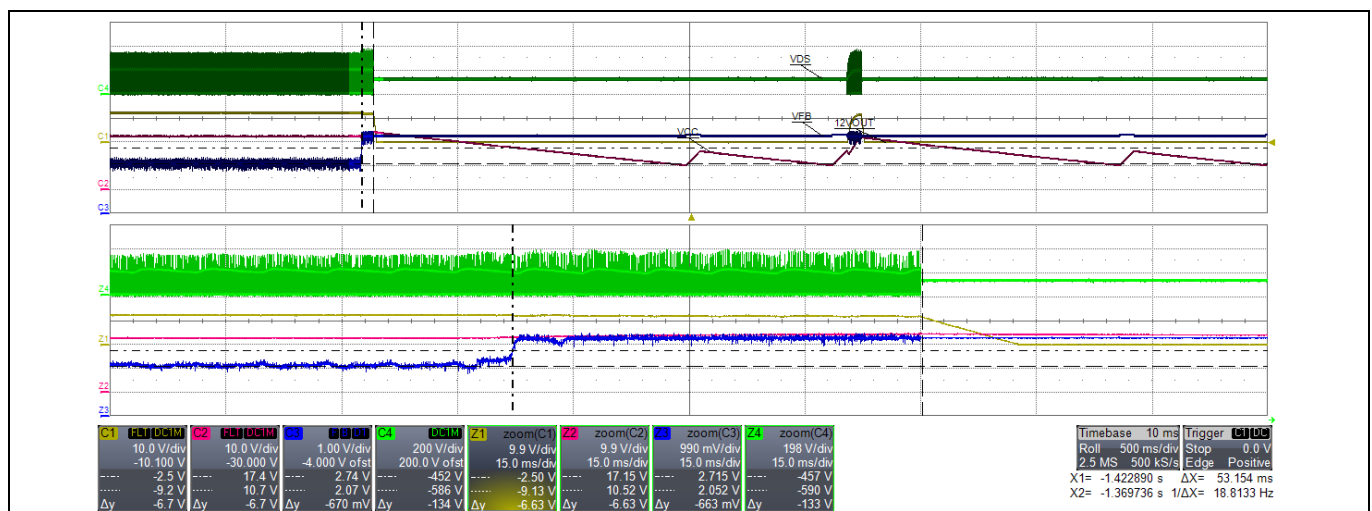
C4 (Green): Drain voltage (V_D)

Condition to enter V_{CC} undervoltage protection: $V_{CC} < 10$ V

(Remove R12A and power on the system with full load at 85 V AC)

Figure 30 V_{CC} under voltage protection

11.14 Overload protection (Odd skip auto restart)



C1 (Yellow): 12 V output ($12V_{out}$)

C2 (Purple): Supply voltage (V_{CC})

C3 (Blue): Feedback voltage (V_{FB})

C4 (Green): Drain voltage (V_D)

Condition to enter overload protection: $V_{FB} > 2.75$ V & last for 54 ms blanking time

(load change from full to 4.3 A load at 85 V AC)

Figure 31 Overload protection

11.15 V_{CC} short-to-GND protection

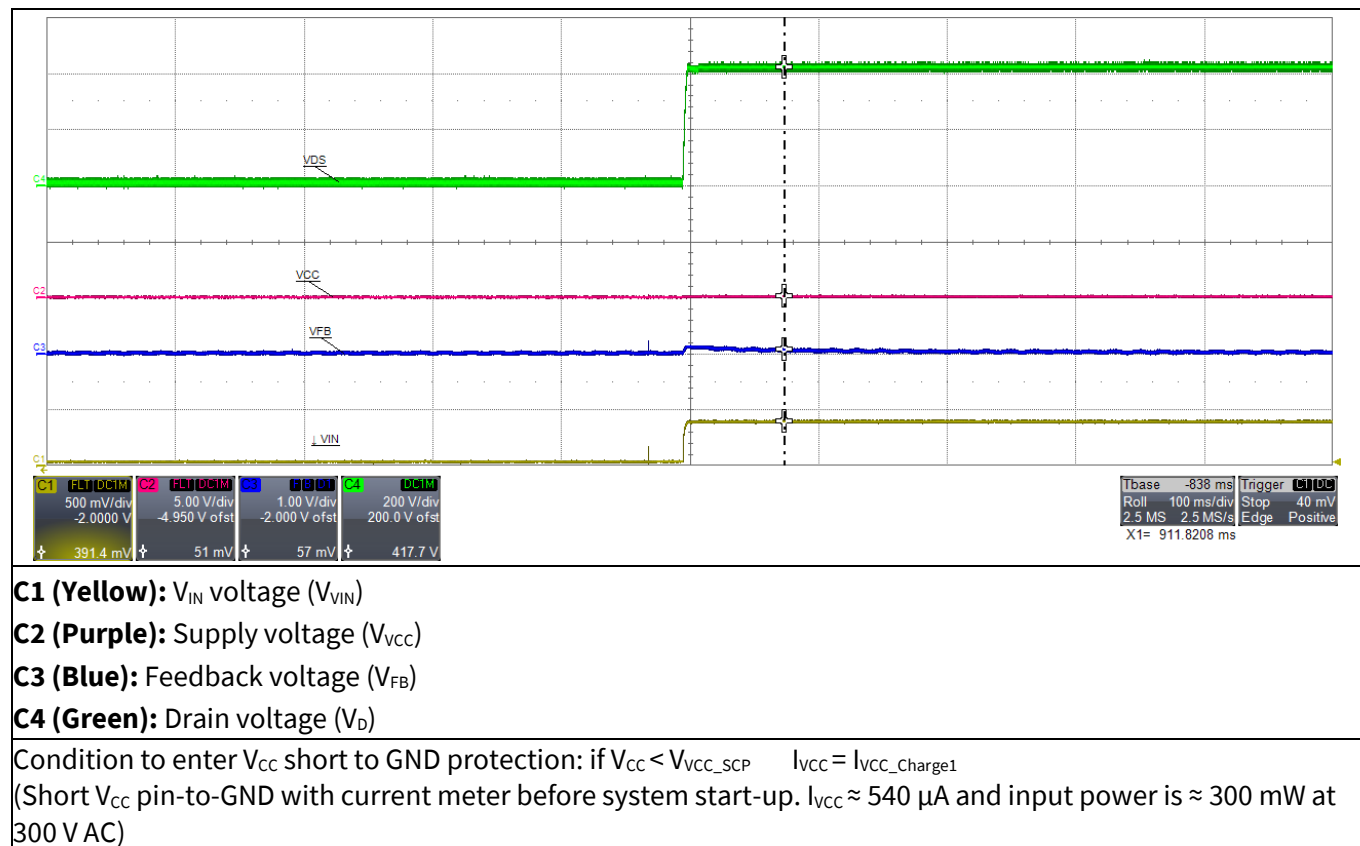


Figure 32 V_{CC} short-to-GND protection

44 W, 12 V SMPS Evaluation Board with CoolSET™ ICE5AR0680AG-1 and other variants

EVAL_5AR0680AG-1_44W1

350 V AC operating voltage

12 350 V AC operating voltage

To operate up to 350 V AC and line OVP at 370 V AC, make the following changes in the evaluation board.

Table 6 Changes for 350 V AC line voltage

No.	Designator	Description	Part Number	Quantity
1	C11	330 nF/350V AC	-	1
2	F1	1.6 A/350 V AC	0697W1600-05	1
3	L11	39 mH/1.4A/350 V AC	-	1
4	R19	50.5k	PAT0603E50R5BST5	1

12.1 Line overvoltage protection at 370 V AC (Non-switch auto restart)

The oscillogram below shows line overvoltage protection at 370 V AC.

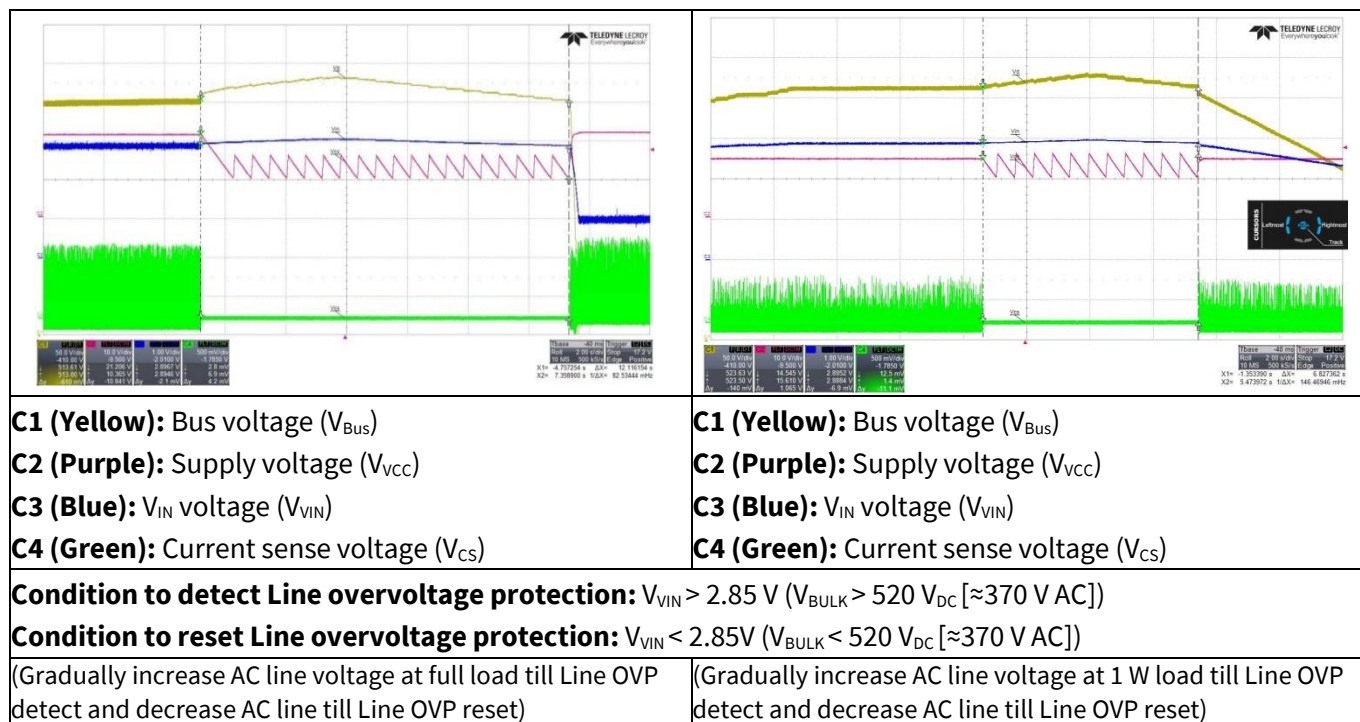


Figure 33 Line overvoltage protection at 370 V AC

44 W, 12 V SMPS Evaluation Board with CoolSET™ ICE5AR0680AG-1 and other variants

EVAL_5AR0680AG-1_44W1

350 V AC operating voltage

12.2 Drain and current sense voltage at 350 V AC and maximum load

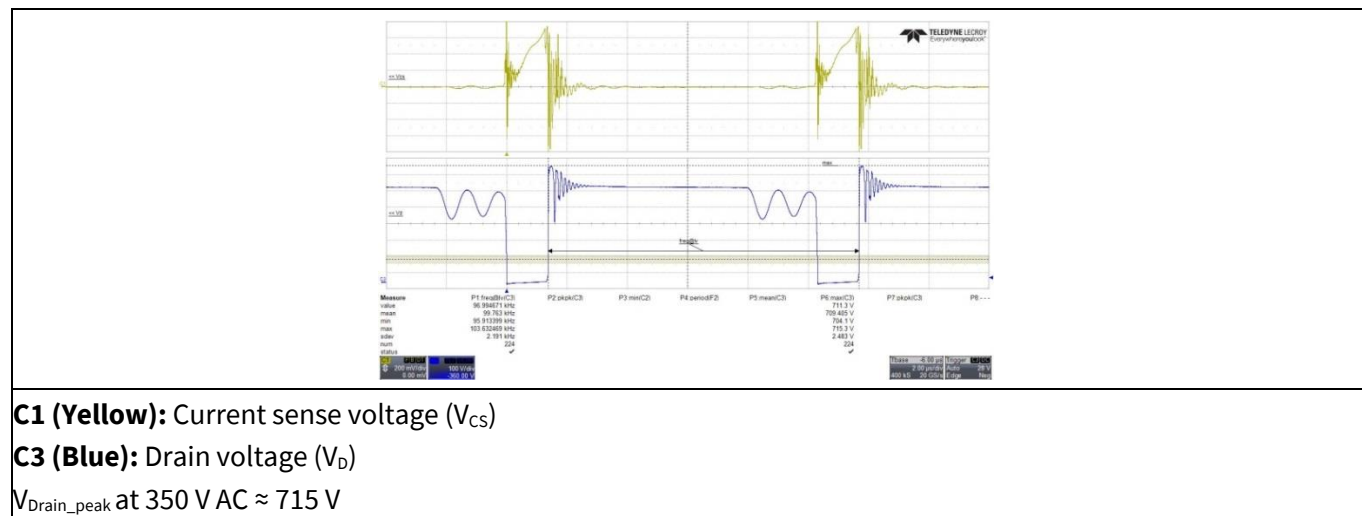


Figure 34 Drain and current sense voltage at 350 V AC and maximum load

44 W, 12 V SMPS Evaluation Board with CoolSET™ ICE5AR0680AG-1 and other variants

EVAL_5AR0680AG-1_44W1

Component change for evaluation of other variants

13 Component change for evaluation of other variants

Customers can evaluate IC features and functionality of other variants (ICE5BR4780AG-1, ICE5BR3995AG-1, ICE5GR1680AG-1 and ICE5GR2280AG-1) on EVAL_5AR0680AG-1_44W1 by changing the transformer and components such as the current sense resistance and output capacitance.

13.1 Transformer designs for other variants

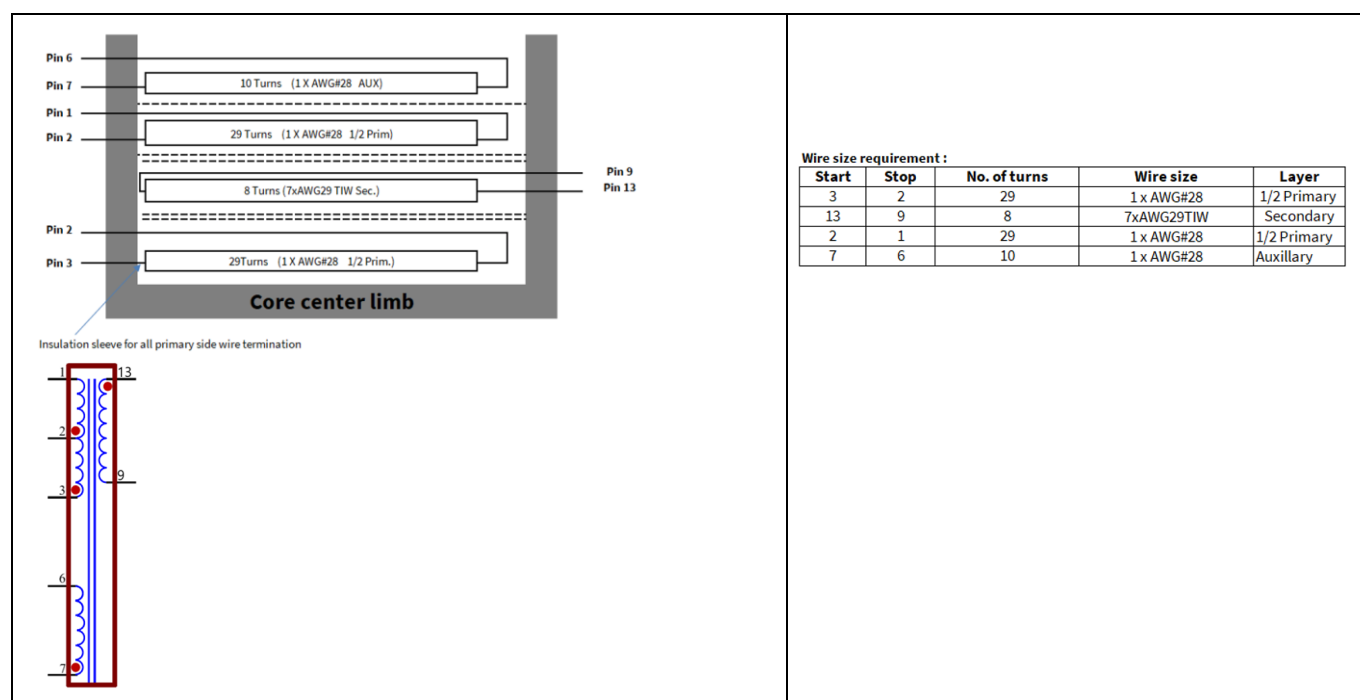
13.1.1 Transformer for ICE5BR4780AG-1 and ICE5BR3995AG-1

Core and material: EE25/13/7(EF25), TP4A (TDG)

Bobbin: 070-5644 (14 pin, THT, horizontal version)

Primary inductance: $L_p=910 \mu\text{H}$ ($\pm 5\%$), measured between pin 1 and pin 3

Manufacturer and part number: Würth Elektronik Midcom (750345764)



44 W, 12 V SMPS Evaluation Board with CoolSET™ ICE5AR0680AG-1 and other variants

EVAL_5AR0680AG-1_44W1

Component change for evaluation of other variants

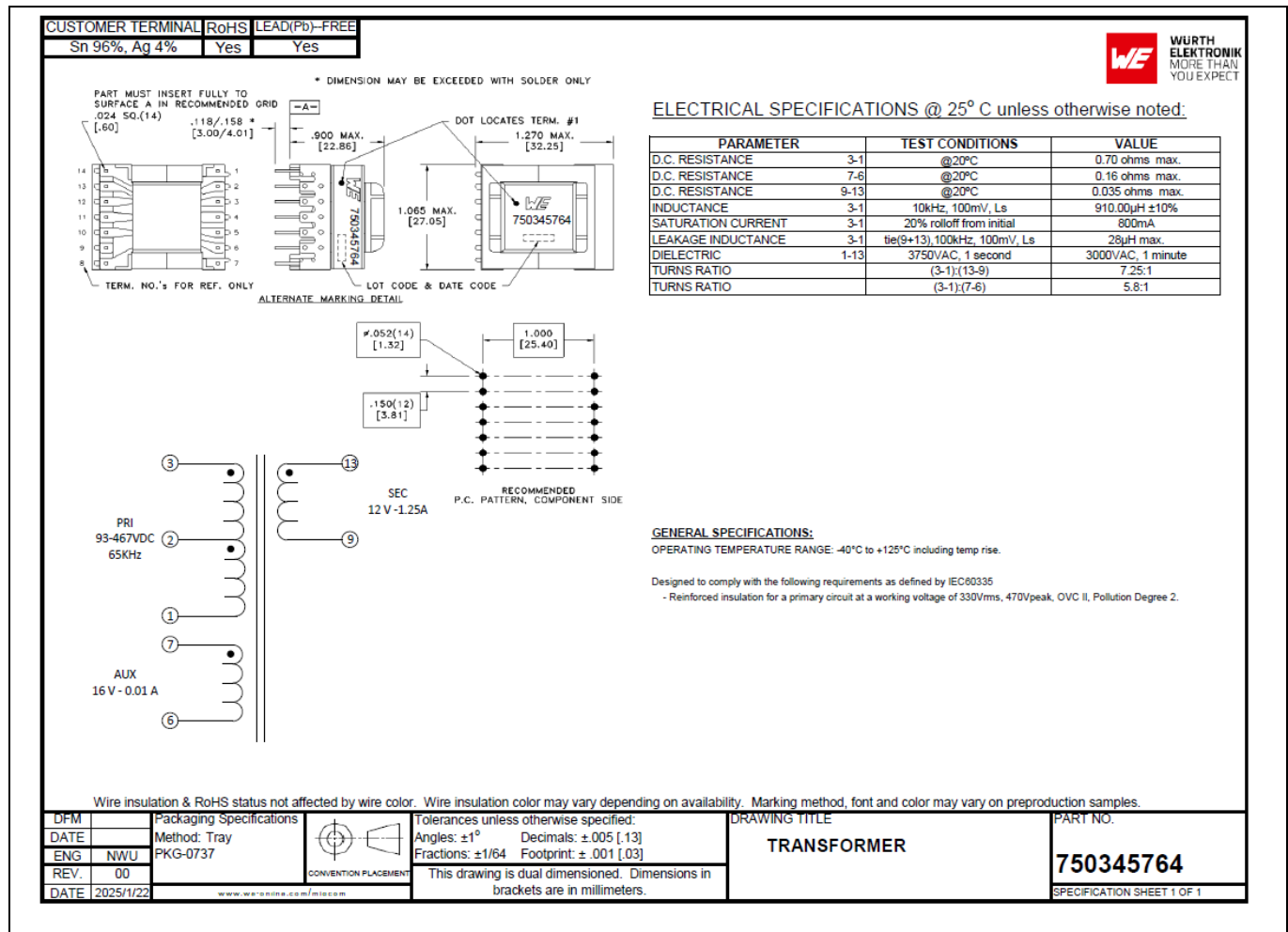


Figure 35 Transformer structure for ICE5BR4780AG-1 and ICE5BR3995AG-1

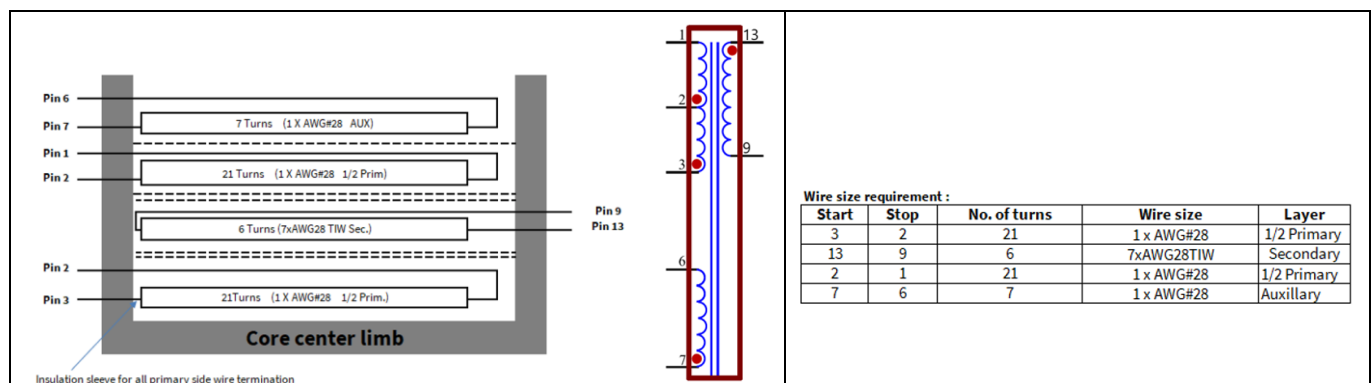
13.1.2 Transformer for ICE5GR1680AG-1 and ICE5GR2280AG-1

Core and material: EE25/13/7(EF25), TP4A (TDG)

Bobbin: 070-5644 (14 pin, THT, horizontal version)

Primary inductance: $L_p = 470 \mu H$ (±5%), measured between pin 1 and pin 3

Manufacturer and part number: Würth Elektronik Midcom (750345765)



44 W, 12 V SMPS Evaluation Board with CoolSET™ ICE5AR0680AG-1 and other variants

EVAL_5AR0680AG-1_44W1

Component change for evaluation of other variants

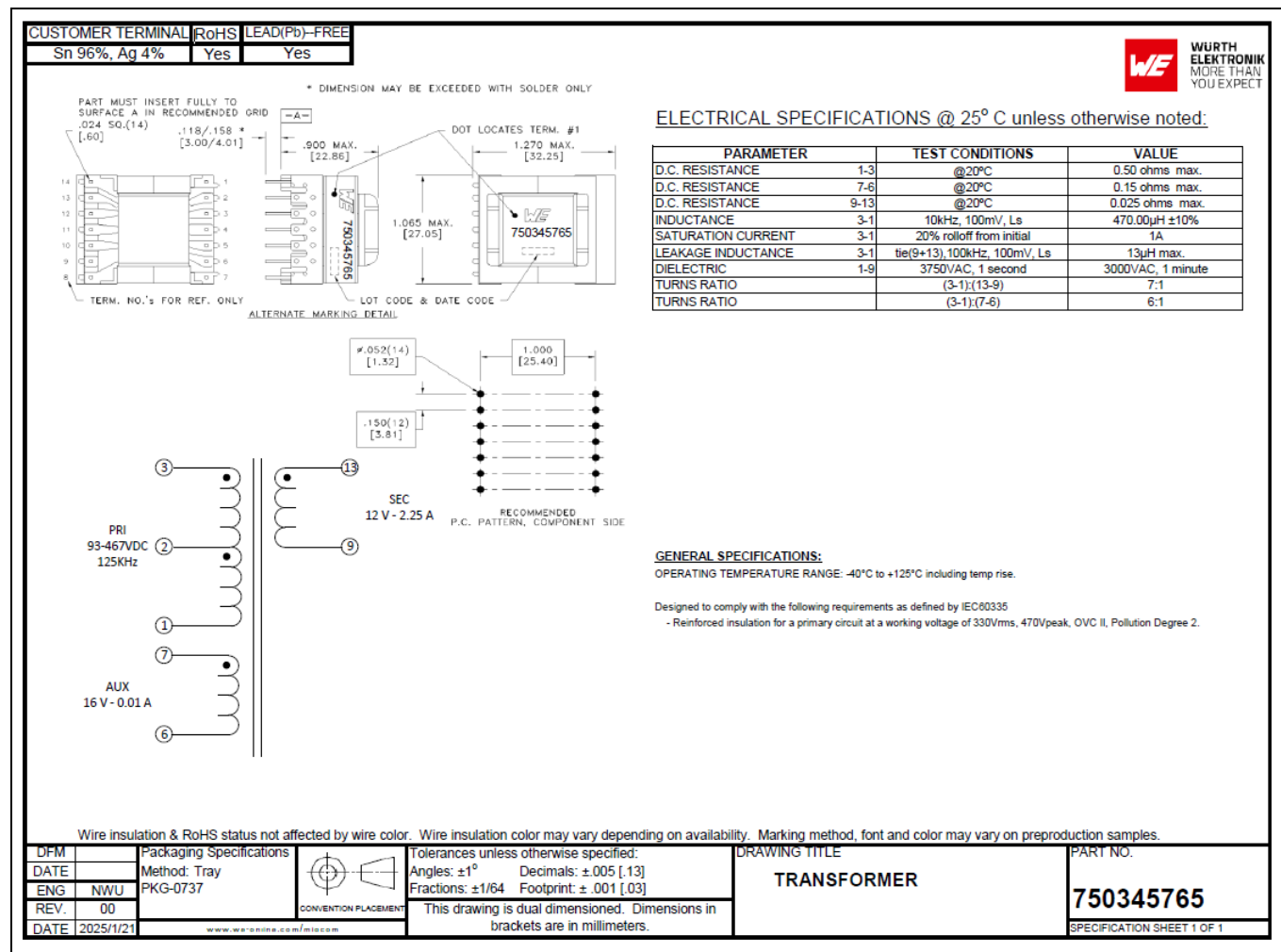


Figure 36 Transformer structure for ICE5GR1680AG-1 and ICE5GR2280AG-1

13.2 Change of current sense resistance and output capacitance

Table 7 Current sense resistance and output capacitance value

	ICE5BR4780AG-1_15W	ICE5BR3995AG-1_15W	ICE5GR2280AG-1_22W	ICE5GR1680AG-1_27W
Current sense resistance R14//R14A//R14B (Ω) (1%, 0.25W)	1	1	0.87	0.78
Output capacitance (C22//C23//C23A)(µF)	1000	1000	1500	1500

References

- [1] Infineon Technologies AG: *ICE5xRxxxxAG-1 datasheet*; [Available online](#)
- [2] Infineon Technologies AG: *CoolSET™ 5th Generation Fixed Frequency Plus flyback design guide*; [Available online](#)
- [3] Infineon Technologies AG: *CoolSET™ 5th Generation Fixed Frequency Plus calculation tool for flyback*; [Available online](#)

44 W, 12 V SMPS Evaluation Board with CoolSET™ ICE5AR0680AG-1 and other variants



EVAL_5AR0680AG-1_44W1

Revision history

Revision history

Document revision	Date	Description of changes
V 1.0	2025-06-25	Initial release

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