

14 W, 15 V and 5 V SMPS reference board with CoolSET™ ICE5AR3995BZ-1

REF_5AR3995BZ-1_14W1

About this document

Scope and purpose

This document describes a universal input 14 W, 15 V and 5 V offline non-isolated flyback converter using the CoolSET™ 5th Generation Fixed Frequency Plus ICE5AR3995BZ-1 switching controller from Infineon, which offers high efficiency, low standby power with selectable entry and exit standby power options, wide V_{CC} operating range with fast startup, and various protection modes for a highly reliable system.

This reference board is designed to evaluate the performance of CoolSET™ ICE5AR3995BZ-1 switching controller for optimized efficiency, thermal performance, and EMI.

Intended audience

This document is intended for power supply design/application engineers, students, etc. who wish to design low-cost and highly reliable systems for offline SMPS either auxiliary power supplies for white goods, PCs, servers, and TVs, or enclosed adapters for gaming consoles.

CoolSET™

Infineon's CoolSET™ AC-DC integrated power stages in 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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ICE5AR3995BZ-1**

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1 Introduction

This document describes a 14 W, 15 V and 5 V reference board designed in a Fixed Frequency non-isolated flyback converter topology with primary-side feedback (FB) using the CoolSET™ 5th Generation Fixed Frequency Plus ICE5AR3995BZ-1 switching controller.

The reference board is operated in discontinuous conduction mode (DCM) and is running at 100 kHz fixed switching frequency. The frequency reduction with soft gate driving and frequency jittering offers lower EMI and better efficiency between light load and 50 percent load. The selectable active burst mode (ABM) power enables ultra-low power consumption.

In addition, numerous adjustable protection functions have been implemented in the ICE5AR3995BZ-1 switching controller to protect the system and customize the IC for the chosen application. In case of failure modes, such as V_{CC} overvoltage (OV)/undervoltage (UV), open control loop or overload, overtemperature, and V_{CC} short-to-GND, the device enters protection mode.

By cycle-by-cycle peak current limitation (PCL), the dimensions of the transformer and the current rating of the secondary diode can both be optimized. In this way, a cost-effective solution can easily be achieved.

Target applications of ICE5AR3995BZ-1 switching controller are either auxiliary power supplies for white goods, PCs, servers, and TVs, or enclosed adapters for gaming consoles.

This document describes the list of features, power-supply specifications, schematics, bill of materials (BOM), and transformer construction of the REF_5AR3995BZ-1_14W1 reference board. Typical operating characteristics such as performance curves and oscilloscope waveforms are shown at the end of the document.

14 W, 15 V and 5 V SMPS reference board with CoolSET™ ICE5AR3995BZ-1

REF_5AR3995BZ-1_14W1

Reference board

2 Reference board



Figure 1 REF_5AR3995BZ-1_14W1

2.1 Reference board specifications

Table 1 Reference board specifications

Description	Symbol	Min.	Typ.	Max.	Unit	Notes/conditions
Input						
Voltage	V_{IN}	85	–	300	V AC	Two wires (no P.E.)
Frequency	f_{LINE}	47	50/60	64	Hz	–
No-load input power	P_{stby_NL}	–	–	100	mW	230 V AC
Output						
Output voltage 1	V_{OUT1}	–	15	–	V	±5 percent
Output current 1	I_{OUT1}	–	–	830	mA	–
Output voltage ripple 1	$V_{RIPPLE1}$	–	–	150	mV	–
Output voltage 2	V_{OUT2}	–	5	–	V	±5 percent
Output current 2	I_{OUT2}	–	–	400	mA	–
Output voltage ripple 2	$V_{RIPPLE2}$	–	–	75	mV	–
Output power	P_{OUT_Nom}	–	14.45	–	W	–
Overcurrent protection (+15 V)	I_{OCP}	–	–	1250	mA	Full load on 5 V

14 W, 15 V and 5 V SMPS reference board with CoolSET™ ICE5AR3995BZ-1



REF_5AR3995BZ-1_14W1

Reference board

Description	Symbol	Min.	Typ.	Max.	Unit	Notes/conditions
Efficiency						
Average efficiency	η_{avg}	-	83	-	%	115 V AC/230 V AC
Environmental						
Conducted EMI	-	6			dB	Margin, CISPR 22 Class-B
Surge immunity						
Differential mode	-	±2			kV	EN 61000-4-5
Dimension						
PCB	-	110 x 66 x 27			mm	L x W x H

Note: This reference board is designed for dual-output with cross-regulated loop FB. It may not regulate properly if loading is only applied to single output. If you want to evaluate for single-output (e.g., 15 V only) conditions, the following changes are necessary on the board.

1. Remove D101, L101, C102, C103, R102, R103, R104, and C104 to disable 5 V output.
2. Change R11 to 30 kΩ and R153 to 220 kΩ for full regulation FB at 15 V output.

Because the board (especially the transformer) is designed for dual-output with optimized cross regulation, single-output efficiency might not be optimized. It is only for IC functional evaluation under single-output condition.

3 Circuit description

3.1 Input filtering

The AC line input side comprises the input fuse (F1) as overcurrent protection. The common-mode choke (CMC) (L1) and X-capacitor (CX1) act as EMI suppressors. Optional spark-gap devices (SA1, SA2) and varistor (Z1) can absorb the high voltage (HV) stress during lightning surge testing. A rectified DC voltage is obtained through the bridge rectifier (BR1) together with the bulk capacitor (C1).

3.2 Startup

To achieve fast and safe startup, the ICE5AR3995BZ-1 switching controller is implemented with a high-resistance startup resistor and V_{CC} short-to-GND protection. When V_{VCC} reaches the turn-on voltage threshold V_{CC_ON} , the IC begins with a soft start.

The soft start implemented in ICE5AR3995BZ-1 is a digital time-based function. The preset soft-start time is around 12 ms with four steps. If not limited by other functions, the peak voltage on the CS pin will increase incrementally to V_{CS_N} . 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.

3.3 Integrated CoolMOS™ MOSFET with frequency reduction control

The integrated highly efficient CoolMOS™ superjunction MOSFET and the frequency reduction control enable better efficiency from light load to full 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 continuous conduction mode (CCM) with frequency reduction mode. This reference board is designed to operate in DCM. When the system is operating at maximum load condition, the controller switches at the fixed frequency of 100 kHz. To achieve better efficiency between light load and medium load, frequency reduction is implemented; the reduction curve is shown in [Figure 2](#). V_{CS} is clamped by the current limitation threshold or by the PWM opamp while the switching frequency is reduced. After the maximum frequency reduction, the minimum switching frequency is f_{OSC4_MIN} (43 kHz).

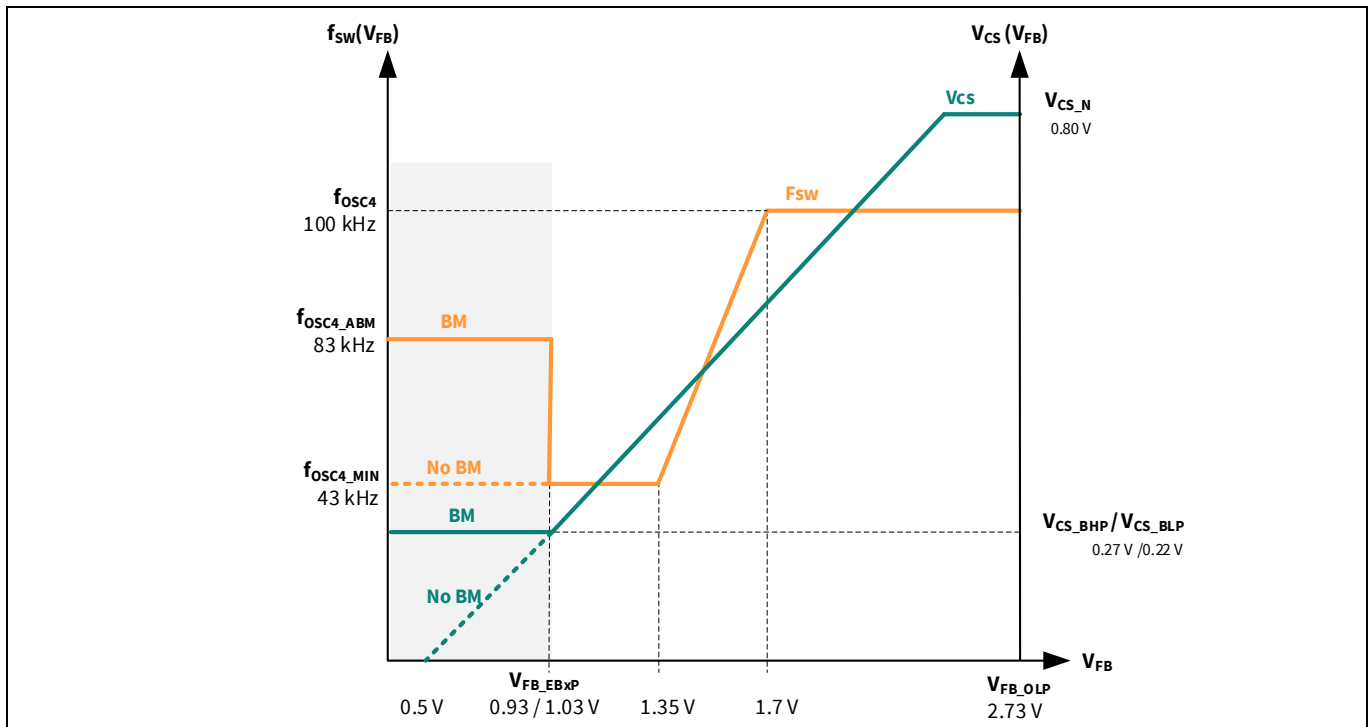


Figure 2 Frequency reduction curve

3.4 Frequency jittering

ICE5AR3995BZ-1 has a frequency jittering feature to reduce the EMI noise. The jitter frequency is internally set at 100 kHz (± 4 percent) and the jitter period is 4 ms.

3.5 RCD clamper circuit

A clamper network (R4, C2, and D1) dissipates the energy of the leakage inductance and suppresses the ringing on the SMPS transformer. This is a dissipative circuit; therefore, R4 and C2 need to be fine-tuned depending on the voltage derating factor and efficiency requirement.

3.6 Output stage

There are two outputs in this converter, +15 V and +5 V. The power is coupled out via the Schottky diodes (D151 and D101). The capacitors (C152 and C102) provide energy buffering followed by the L-C filters (L151-C153 and L101-C103) to reduce the output voltage ripple and prevent interference between SMPS switching frequency and line frequency. Storage capacitors (C152 and C102) are selected to have a low ESR to minimize the output voltage ripple.

3.7 Feedback loop

The output voltage is sensed by the voltage divider (R11, R103, and R153), and compared to the internal reference voltage of ICE5AR3995BZ-1 switching controller via the VERR pin, which is connected to the input of an integrated error amplifier internally. By connecting this pin, achieves a non-isolated application. The comparison voltage is converted to the current signal via the IC internal integrated error amplifier to the FB pin for regulation control.

3.8 Active burst mode (ABM)

The ABM entry and exit power (three levels) can be selected in ICE5AR3995BZ-1 switching controller. Details are illustrated in the product datasheet [1]. At light-load condition, the SMPS enters ABM mode. At this stage, the controller is always active but the V_{VCC} must be kept above V_{VCC_OFF} . During ABM, the efficiency increases significantly; at the same time it supports low ripple on V_{OUT} and fast response on load-jump condition.

To enter into ABM, two conditions apply:

- The FB voltage must be lower than the threshold of V_{FB_EBXP}
- A certain blanking time must have elapsed ($t_{FB_BEB} = 36$ ms).

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

During ABM, the maximum CS voltage is reduced from V_{CS_N} to V_{CS_BXP} to reduce the conduction loss and the audible noise. In burst mode, the FB voltage is changing like a sawtooth between $V_{FB_Bon_NISO}$ and $V_{FB_Boff_NISO}$.

The FB voltage immediately increases if there is a sudden increment in output load, as observed by one comparator. When the FB voltage can exceed V_{FB_LB} , it leaves ABM and the PCL threshold voltage will return to V_{CS_N} immediately to stabilize V_{OUT} .

4 Protection features

Protection is one of the major factors in determining whether the system is safe and robust. Therefore, sufficient protection is necessary. ICE5AR3995BZ-1 provides a comprehensive protection features to ensure the system is operating safely. Protections include V_{CC} OV and UV, overload, overtemperature (controller junction), and V_{CC} short-to-GND. When those faults are detected, the system will enter protection mode until the fault is removed, and then resume normal operation. The following table lists the protections and failure conditions.

Table 2 Protection features of ICE5AR3995BZ-1 switching controller

Protection function	Failure condition	Protection mode
V_{CC} OV	$V_{VCC} > V_{VCC_OVP}$	Extended cycle skip auto-restart
V_{CC} UV	$V_{VCC} < V_{VCCoff}$	Auto-restart
Overload	$V_{FB} > V_{FB_OLP}$ and lasts for $t_{FB_OLP_B}$	Extended cycle skip auto-restart
Overtemperature	$T_J > 140^{\circ}\text{C}$ (40°C hysteresis)	Non-switch auto-restart
V_{CC} short-to-GND ($V_{VCC} = 0\text{ V}$, $R_{StartUp} = 50\text{ M}\Omega$ and $V_{DRAIN} = 90\text{ V}$)	$V_{VCC} < V_{CC_SCP}$, $I_{VCC_Charge1} \approx -0.2\text{ mA}$	Cannot start up

14 W, 15 V and 5 V SMPS reference board with CoolSET™ ICE5AR3995BZ-1

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Schematic

5 Schematic

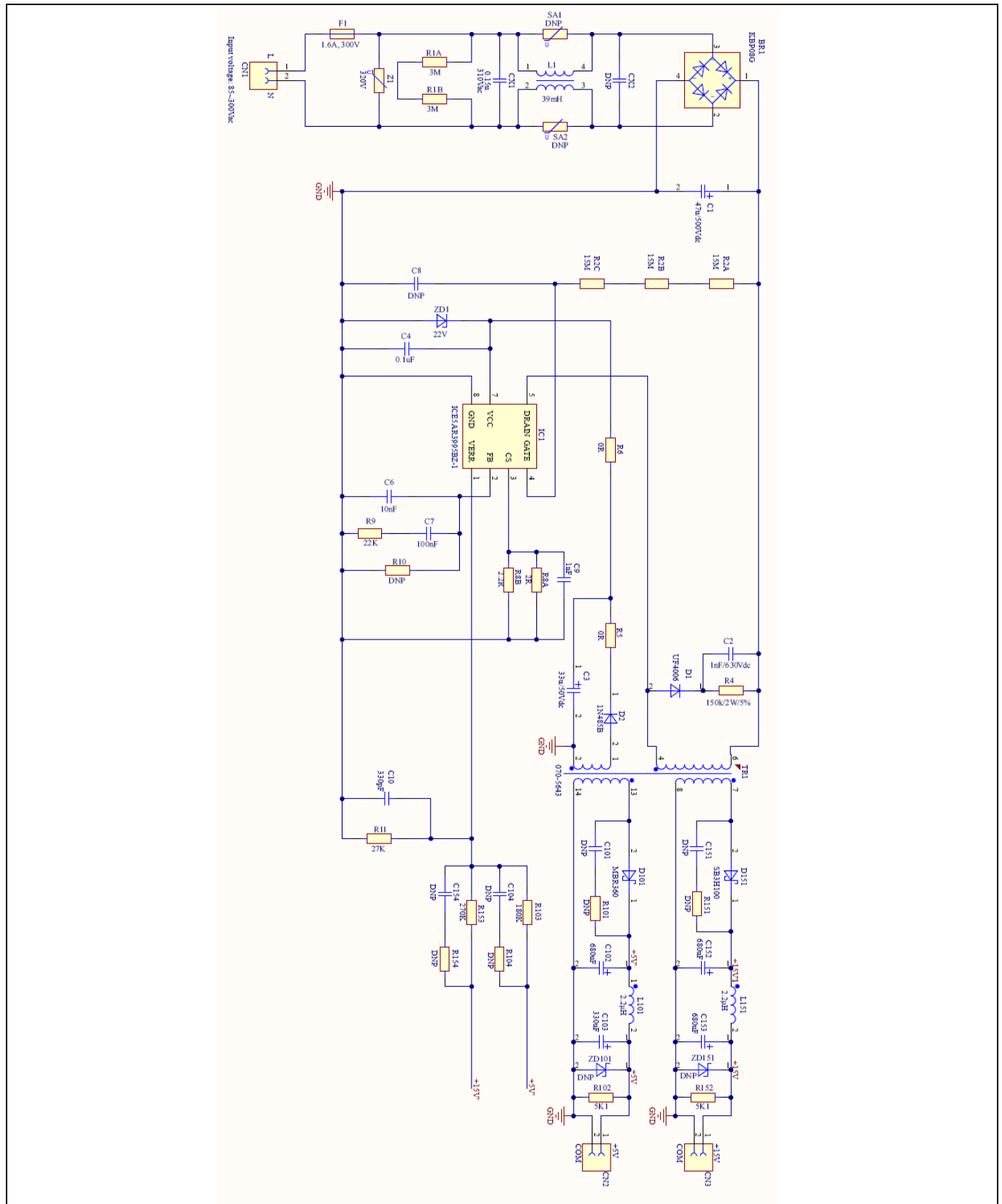


Figure 3 REF_5AR3995BZ-1_14W1

14 W, 15 V and 5 V SMPS reference board with CoolSET™ ICE5AR3995BZ-1

REF_5AR3995BZ-1_14W1

PCB layout

6 PCB layout

6.1 Top side

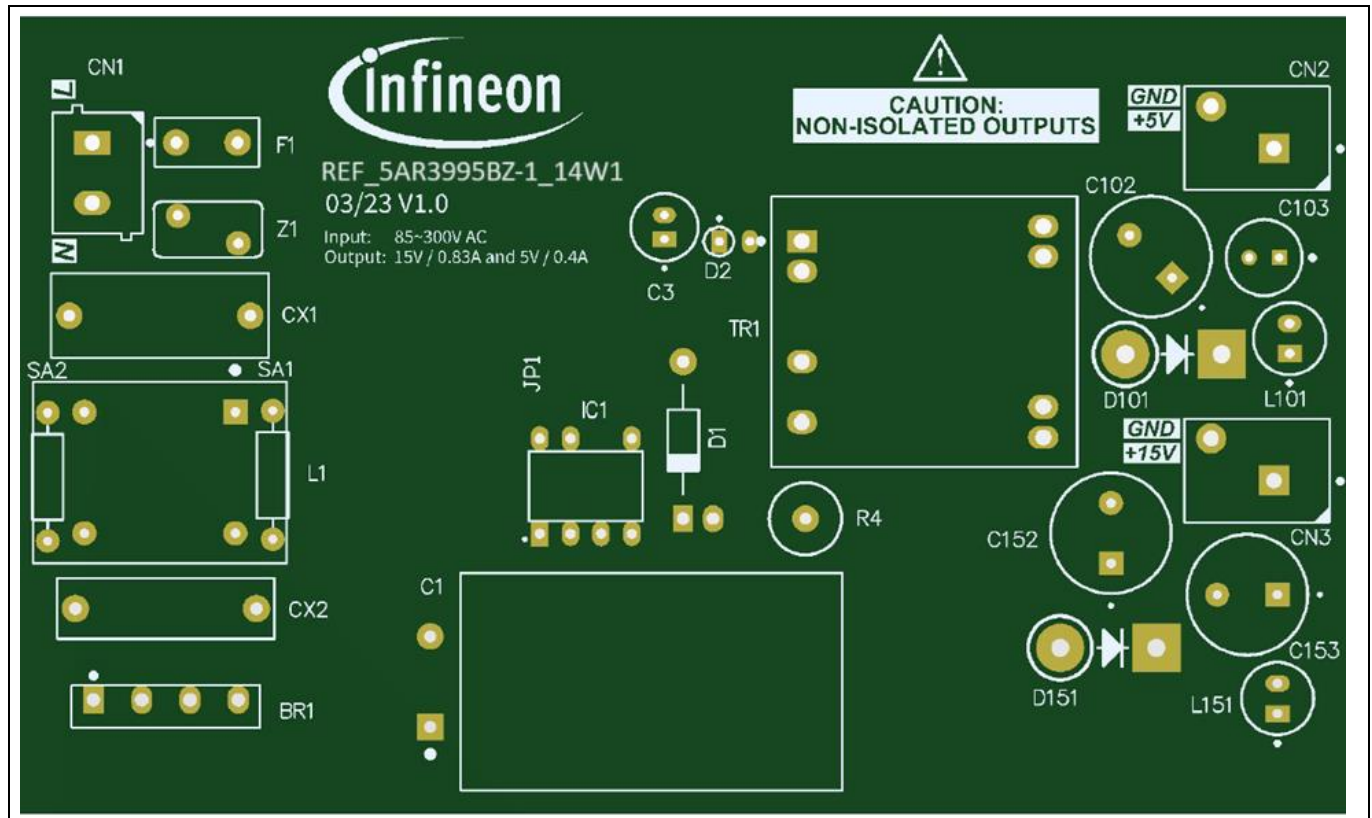


Figure 4 Top-side component legend

**14 W, 15 V and 5 V SMPS reference board with CoolSET™
ICE5AR3995BZ-1**

REF_5AR3995BZ-1_14W1

PCB layout

6.2 Bottom side

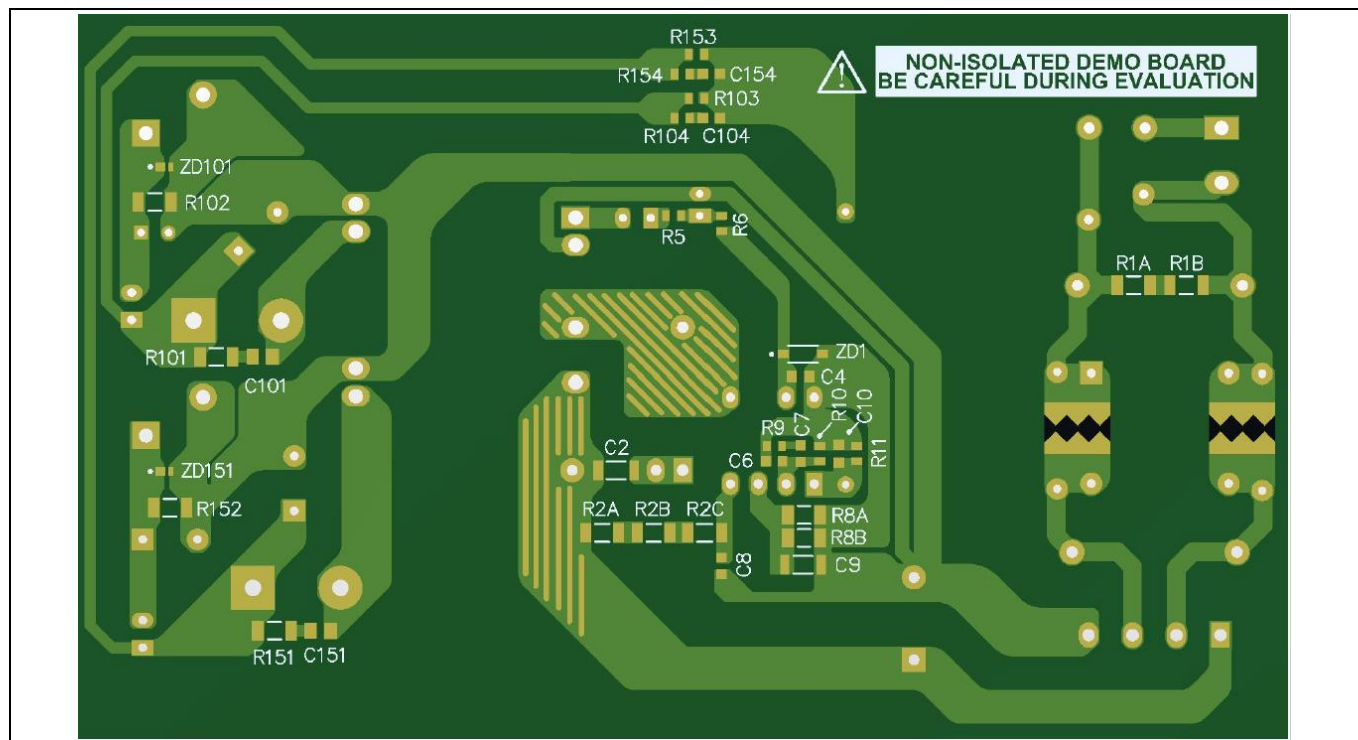


Figure 5 Bottom-side component legend

14 W, 15 V and 5 V SMPS reference board with CoolSET™

ICE5AR3995BZ-1



REF_5AR3995BZ-1_14W1

Bill of materials

7 Bill of materials

Table 3 BOM

No.	Designator	Description	Manufacturer	Part number	Qty
1	F1	Time Lag Fuse, 300V, 1.6A	Littelfuse	36911600000	1
2	Z1	Varistor, 0.3 W/ 320 V	Panasonic	ERZE07A511	1
3	BR1	Bridge Diode 800V, 1.5A	Diodes Incorporated	KBP08G	1
4	CX1	CAP FILM 0.15UF 10% 310VAC RADIAL	EPCOS/TKD	B32932A3154K189	1
5	C1	CAP ALUM 47UF 500V RADIAL	Rubycon	500BXC47MEFC18X31.5	1
6	C2	CAP CER 1000PF 630V U2J 1206	Murata	GRM31A7U2J102JW31D	1
7	C3	CAP ALUM 33UF 20% 50V RADIAL	Rubycon	50PX33MEFC5X11	1
8	C4	CAP CER 0.1UF 50V X7R 0603	-	-	1
9	C6	CAP CER 10NF 50V X7R 0603	-	-	1
10	C7	CAP CER 100NF 50V X7R 0603	-	-	1
11	C9	CAP CER 1206 1NF 25V X7R 5%	-	-	1
12	C10	CAP CER 330PF 50V X7R 0603	-	-	1
13	C102	CAP ALUM 680UF 20% 10V RADIAL	Rubycon	10ZL680MEFC8X16	1
14	C103	CAP ALUM 330UF 20% 10V RADIAL	Rubycon	10ZLH330MEFC6.3X11	1
15	C152, C153	CAP ALUM 680UF 20% 25V RADIAL	Rubycon	25ZLS680MEFC10X16	2
16	ZD1	DIODE ZENER 27V 500MW 1206	Taiwan Semiconductor Corporation	BZS55B27 RXG	1
17	D1	DIODE GEN PURP 800V 1A DO204AL	Vishay	UF4006-E3/54	1
18	D2	DIODE GEN PURP 200V 200MA DO35	Onsemi	1N485B	1
19	D151	DIODE SCHOTTKY 150V 3A DO201AD	ST	STPS3150	1
20	D101	DIODE SCHOTTKY 60V 3A DO201AD	Onsemi	MBR360G	1

14 W, 15 V and 5 V SMPS reference board with CoolSET™

ICE5AR3995BZ-1



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Bill of materials

No.	Designator	Description	Manufacturer	Part number	Qty
21	IC1	Fixed frequency 950 V CoolSET™	Infineon	ICE5AR3995BZ-1	1
22	L1	CMC 39mH 700MA 2LN TH	EPCOS/TDK	B82732R2701B030	1
23	L101, L151	FIXED IND 2.2UH 6.3A 20 MOHM TH	Würth Elektronik	7447462022	2
24	R1A, R1B	RES 3M OHM 1% 1/4W 1206	Yageo	RC1206FR-073RL	2
25	R2A, R2B, R2C	RES 15M OHM 5% 1/4W 1206	Yageo	RC1206JR-0715ML	3
26	R4	RES 150K OHM 5% 2W AXIAL	Yageo	FMP200JR-52-150K	1
27	R5, R6	RES 0 OHM JUMPER 1/10W 0603	-	-	2
28	R8A	RES 2 OHM 1% 1/4W 1206	-	-	1
29	R8B	RES 2.2 OHM 1% 1/4W 1206	-	-	1
30	R9	RES 22K OHM 1% 1/10W 0603	-	-	1
31	R11	RES 27K OHM 1% 1/10W 0603	-	-	1
32	R103	RES 180K OHM 1% 1/10W 0603	-	-	1
33	R153	RES 270K OHM 1% 1/10W 0603	-	-	1
34	R102, R152	RES 5.1K OHM 5% 1/4W 1206	-	-	2
35	TR1	Transformer, EE20_H, rev 00	Würth Elektronik	750343698	1
36	CN1	Terminal Blocks WR-TBL 300VAC 15A 2P Straight	Würth Elektronik	691102710002	1
37	CN2, CN3	Terminal Blocks WR-TBL 2POS 3.5mm 6A 300V	Würth Elektronik	691412120002B	2
38	JP1	Jumper	-	-	1
39	PCB	110 mm x 66 mm (L x W), single layer, 2 oz., FR-4	-	-	1

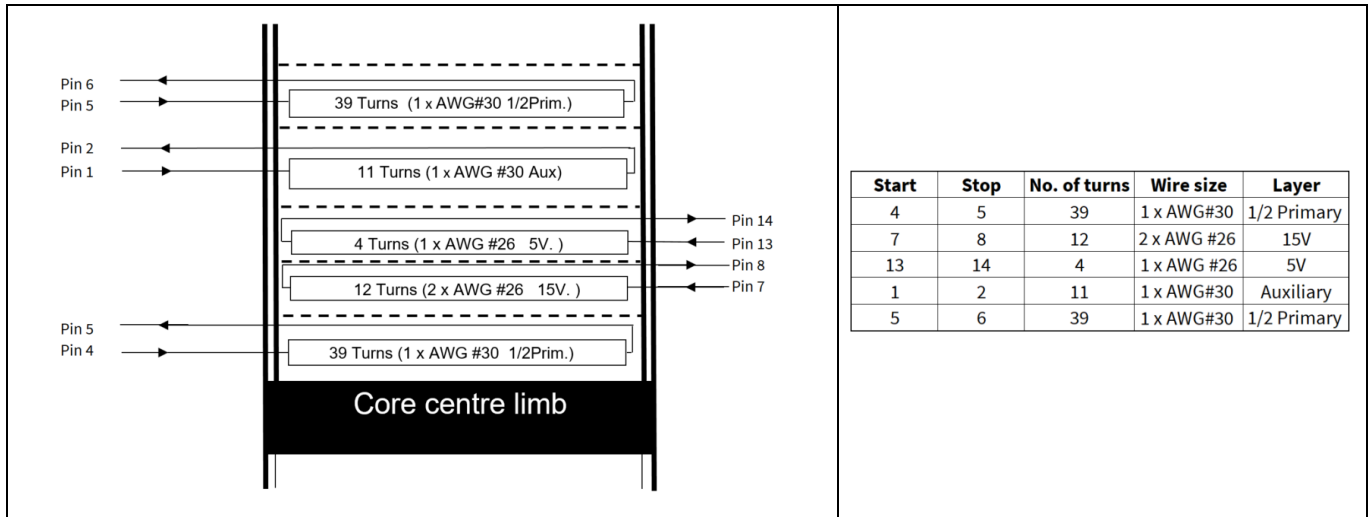
14 W, 15 V and 5 V SMPS reference board with CoolSET™ ICE5AR3995BZ-1

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Transformer construction

8 Transformer construction

- **Core and materials:** EE20/10/6, TP4A (TDG)
- **Bobbin:** 070-5643 (14-pin, THT, horizontal version)
- **Primary inductance:** $L_p = 550 \mu\text{H}$ (± 10 percent), measured between pin 4 and pin 6
- **Manufacturer and part number:** Würth Elektronik (750343698)



CUSTOMER TERMINAL	RoHS	LEAD(Pb)-FREE
Sn 96%, Ag 4%	Yes	Yes

more than you expect!

PARAMETER	TEST CONDITIONS	VALUE
D.C. RESISTANCE	4-6 @20°C	ohms max.
D.C. RESISTANCE	7-8 @20°C	ohms max.
D.C. RESISTANCE	13-14 @20°C	ohms max.
D.C. RESISTANCE	1-2 @20°C	ohms max.
INDUCTANCE	4-6 100kHz, 100mV, Ls	550.00µH ±10%
LEAKAGE INDUCTANCE	4-6 tie(1+2+7+8+13+14), 100kHz, 100mV, Ls	µH max.
DIELECTRIC	6-7 tie(2+4,8+13), 1875VAC, 1 second	
TURNS RATIO	(4-6):(7-8)	6.5:1, ±2%
TURNS RATIO	(4-6):(13-14)	19.5:1, ±2%
TURNS RATIO	(4-6):(1-2)	7.09:1, ±2%

GENERAL SPECIFICATIONS:
 OPERATING TEMPERATURE RANGE: -40°C to +125°C including temp rise.
 Designed to comply with the following requirements as defined by IEC60950-1, EN60950-1, UL60950-1/CSA60950-1 and AS/NZS60950.1:
 - Functional insulation only

DFM	Packaging Specifications	Tolerances unless otherwise specified:	DRAWING TITLE	PART NO.
DATE	Method: Tray	Angles: ±1°	TRANSFORMER	750343698
ENG	PKG-0736	Decimals: ±.005 [.13]		
REV.		Fractions: ±1/64		
DATE	8/8/2017	Footprint: ± .001 [.03]		SPECIFICATION SHEET 1 OF 1

Wire insulation & RoHS status not affected by wire color. Wire insulation color may vary depending on availability.

Figure 6 Transformer structure

9 Test results

9.1 Efficiency and regulation

Table 4 Electrical measurement

Input (V AC/Hz)	Load percentage	P _{IN} (W)	15 V DC (V)	I _{OUT_15V} (mA)	5 V DC (V)	I _{OUT_5V} (mA)	P _{OUT} (W)	Efficiency (%)	Average efficiency (%)	OLP pin (W)	OLP I _{OUT_15V} (fixed 5 V at 0.4 A) (A)
85 V AC/ 60 Hz	0	0.075	15.110	0.000	5.020	0.000				20.13	0.96
	25%	4.312	15.171	0.205	5.010	0.092	3.571	82.81	83.04		
	50%	8.696	15.187	0.414	4.993	0.197	7.271	83.61			
	75%	13.046	15.187	0.615	4.980	0.302	10.844	83.12			
	100%	17.520	15.187	0.825	4.973	0.392	14.473	82.61			
115 V AC/ 60 Hz	0	0.076	15.156	0.000	5.020	0.000	0.000			20.15	0.97
	25%	4.305	15.171	0.205	5.010	0.092	3.571	82.95	83.78		
	50%	8.651	15.187	0.414	4.993	0.197	7.271	84.05			
	75%	12.888	15.187	0.615	4.980	0.302	10.844	84.14			
	100%	17.235	15.187	0.825	4.973	0.392	14.473	83.97			
230 V AC/ 50 Hz	0	0.088	15.170	0.000	5.010	0.000				20.56	1.01
	25%	4.395	15.187	0.205	4.990	0.092	3.572	81.28	83.22		
	50%	8.735	15.187	0.414	4.990	0.197	7.270	83.23			
	75%	12.938	15.187	0.615	4.980	0.302	10.844	83.81			
	100%	17.120	15.187	0.825	4.973	0.392	14.473	84.54			
265 V AC/ 50 Hz	0	0.093	15.156	0.000	5.020	0.000				21.05	1.03
	25%	4.428	15.187	0.205	4.990	0.092	3.572	80.68	82.65		
	50%	8.810	15.187	0.414	4.990	0.197	7.270	82.52			
	75%	12.990	15.187	0.615	4.980	0.302	10.844	83.48			
	100%	17.245	15.187	0.825	4.970	0.392	14.471	83.92			
300 V AC/ 50 Hz	0	0.100	15.150	0.000	5.020	0.000				21.68	1.07
	25%	4.468	15.187	0.205	4.990	0.092	3.572	79.96	81.85		
	50%	8.951	15.187	0.414	4.990	0.197	7.270	81.22			
	75%	13.064	15.187	0.615	4.980	0.302	10.844	83.01			
	100%	17.387	15.187	0.825	4.970	0.392	14.471	83.23			

9.2 Efficiency curve

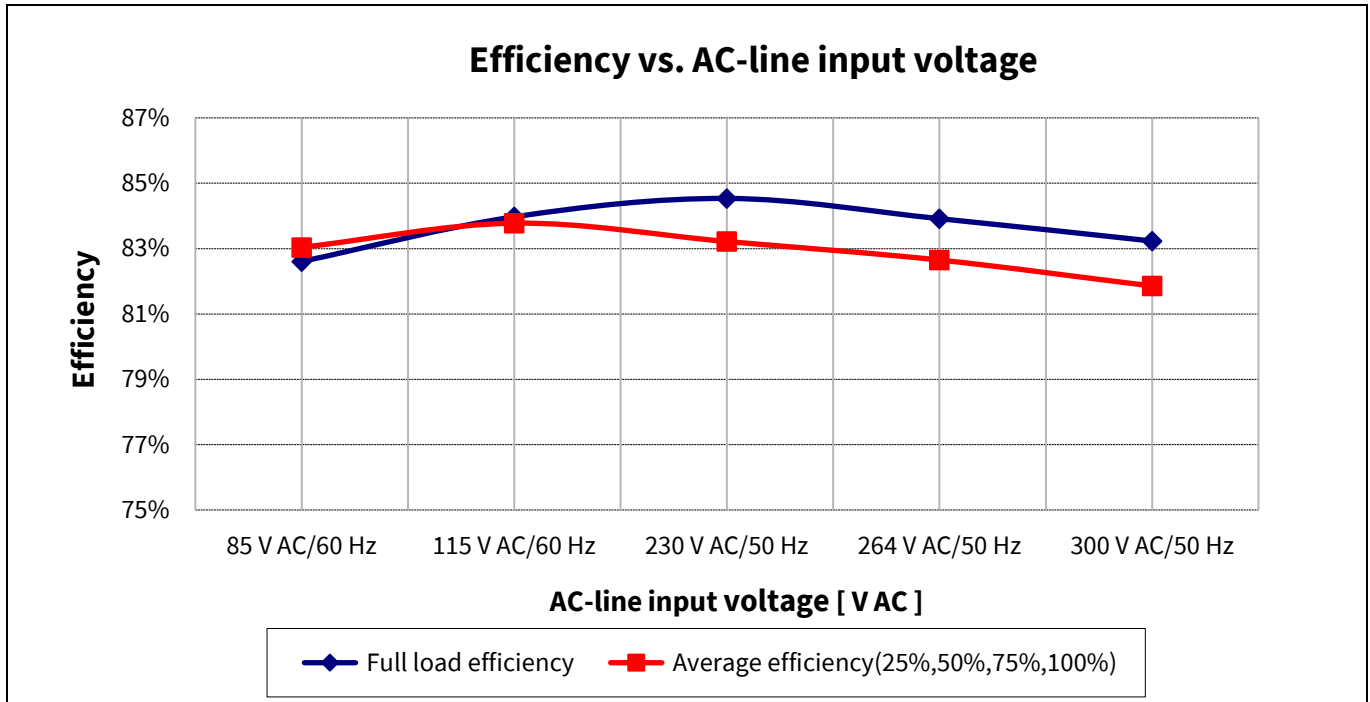


Figure 7 Efficiency vs. output load

9.3 Standby power

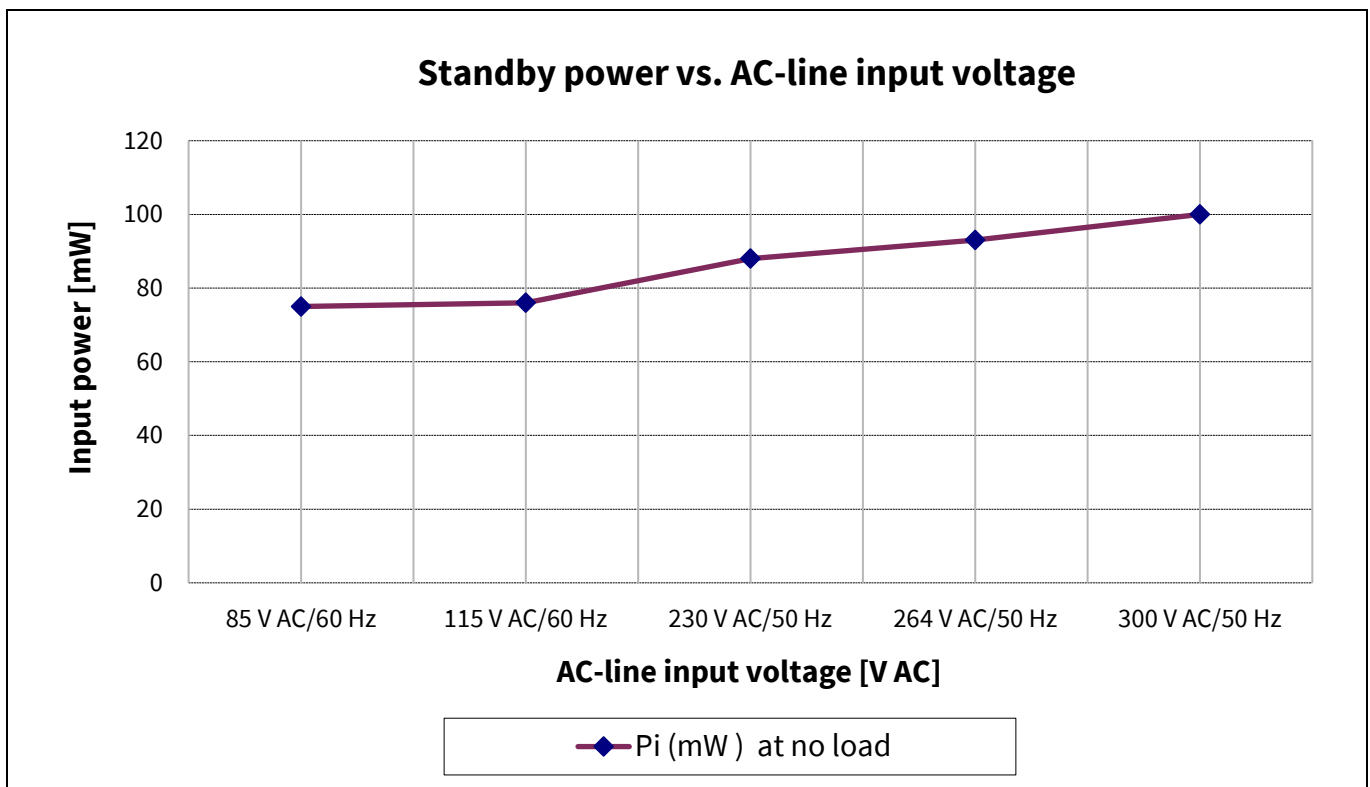


Figure 8 Standby power vs. AC line input voltage

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Test results

9.4 Line regulation

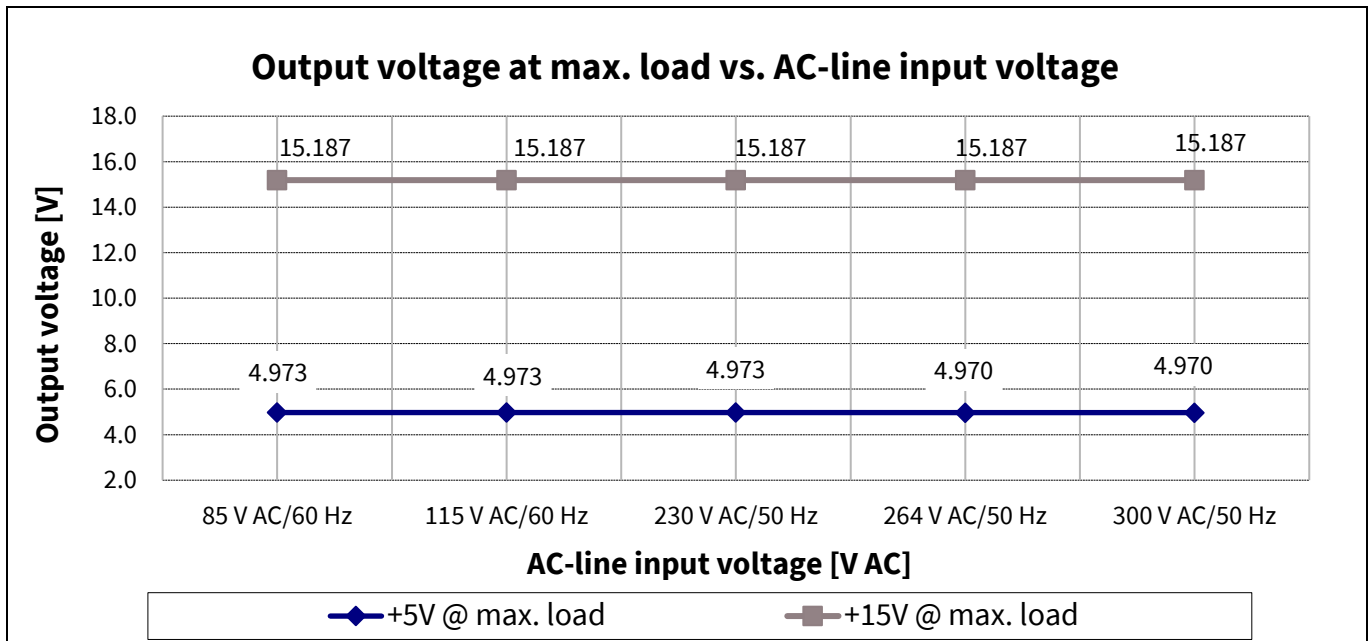


Figure 9 Output regulation at full load vs. AC line input voltage

9.5 Load regulation

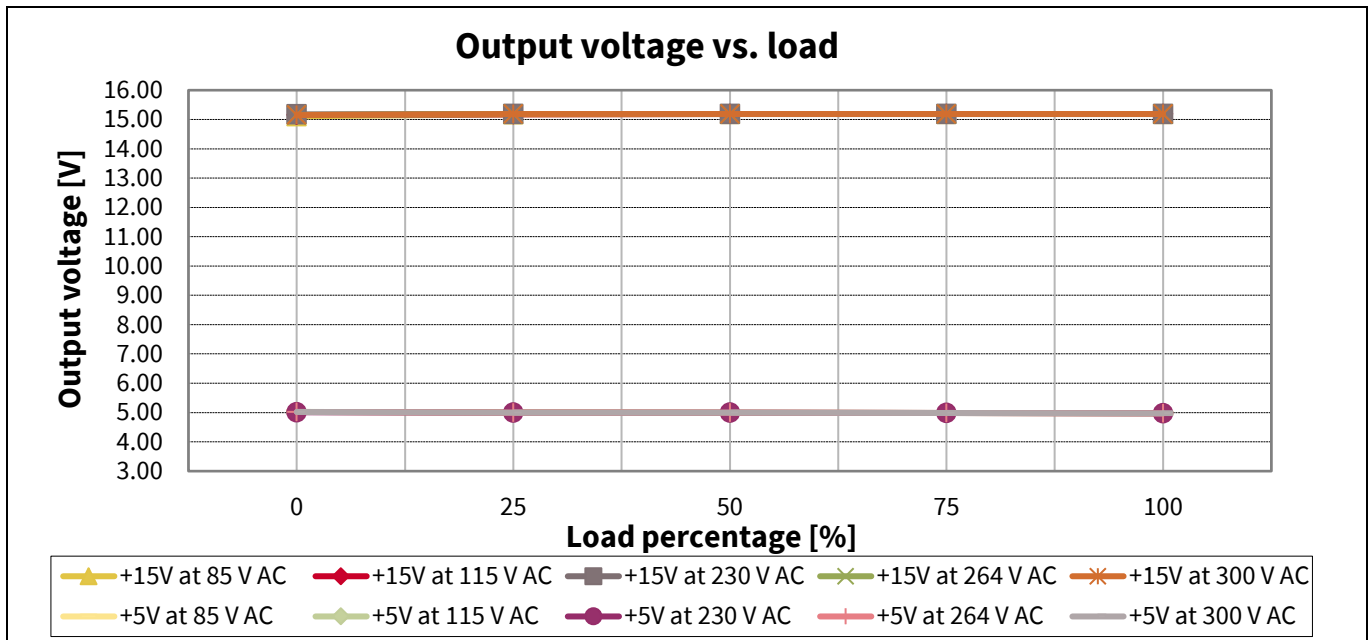


Figure 10 Output regulation vs. load

9.6 Maximum input power

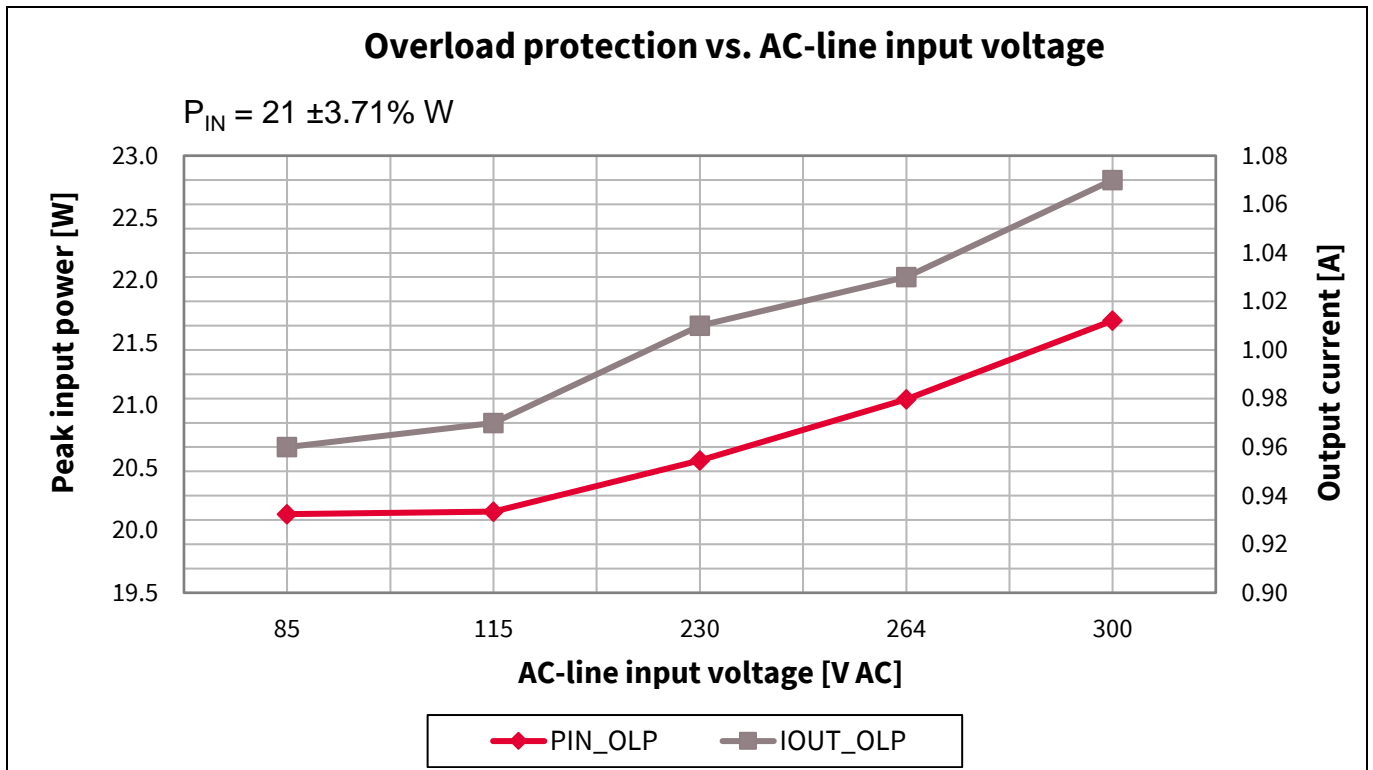


Figure 11 Maximum input power and output current (before overload protection) vs. AC line input voltage

9.7 Surge immunity (EN 61000-4-5)

Pass EN 61000-4-5 installation Class 4 ($\pm 2 \text{ kV}$ for line-to-line).

9.8 Conducted emissions (EN 55022 Class-B)

The conducted EMI was measured by Schaffner (SMR4503) and followed the test standard of EN 55022 (CISPR 22) Class-B. The reference board is tested at full resistive load with input voltage of 115 V AC and 230 V AC.

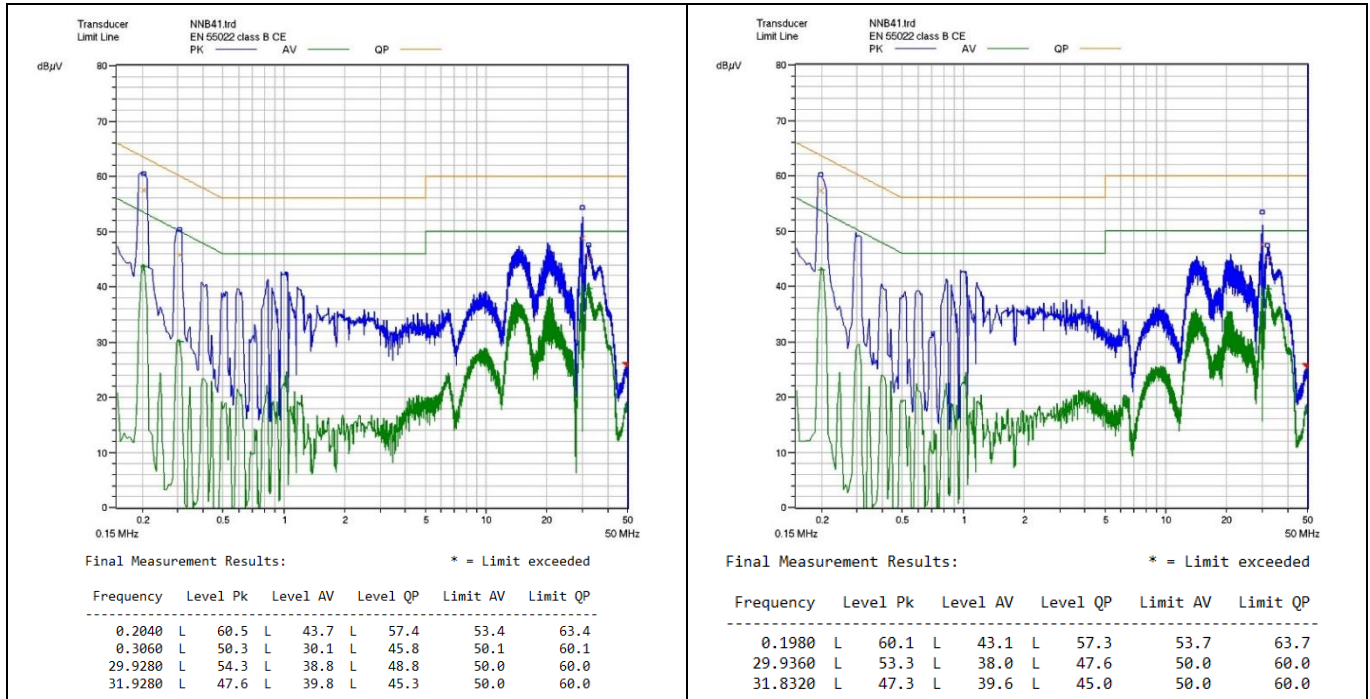


Figure 12 Conducted emissions at 115 V AC and full-load on line (left) and neutral (right)

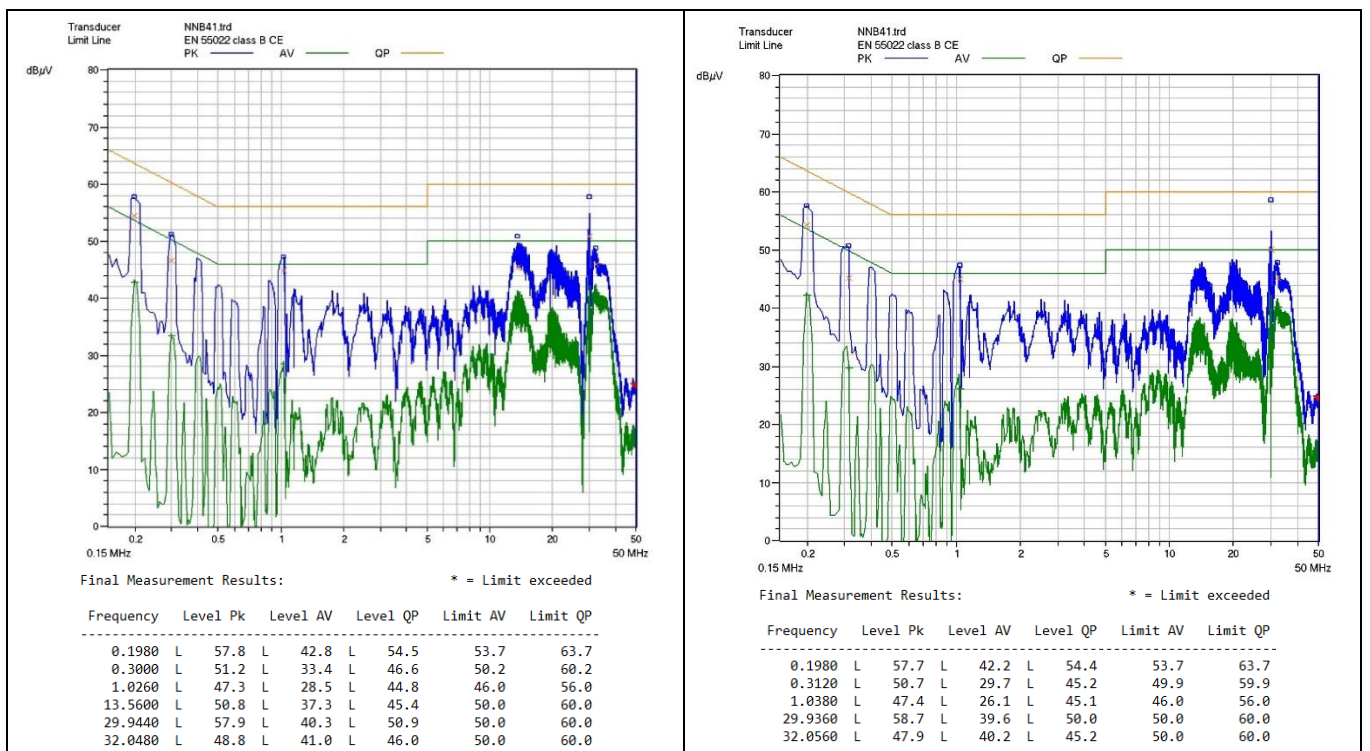


Figure 13 Conducted emissions at 230 V AC and full-load on line (left) and neutral (right)

14 W, 15 V and 5 V SMPS reference board with CoolSET™ ICE5AR3995BZ-1

REF_5AR3995BZ-1_14W1

Test results

9.9 Thermal measurements

The thermal testing of the open-frame reference board is done using an infrared thermography camera (FLIR-T62101) at an ambient temperature of 25°C. The measurements are taken after one hour running at full load condition.

Table 5 Hottest components on the reference board

No.	Components	Temperature at 85 V AC (°C)	Temperature at 300 V AC (°C)
1	D151 (15 V diode)	54.6	60.2
2	TR1 (transformer)	52.3	64.7
3	IC1 (ICE5AR3995BZ-1)	61.7	63.3

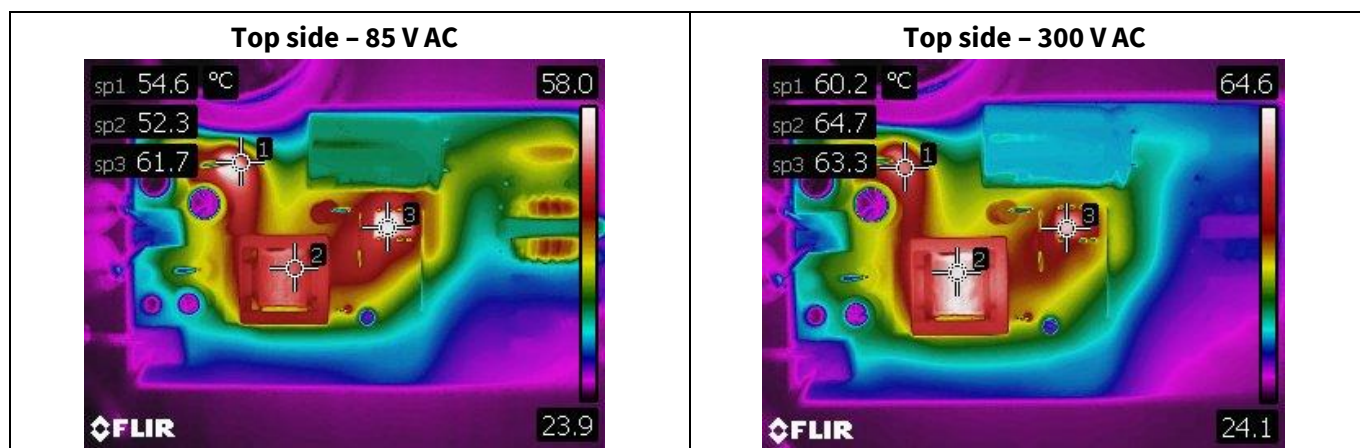


Figure 14 Infrared thermal image of REF_5AR3995BZ-1 at full-load condition

14 W, 15 V and 5 V SMPS reference board with CoolSET™ ICE5AR3995BZ-1

REF_5AR3995BZ-1_14W1

Waveforms and oscilloscope plots

10 Waveforms and oscilloscope plots

10.1 Start-up at full-load

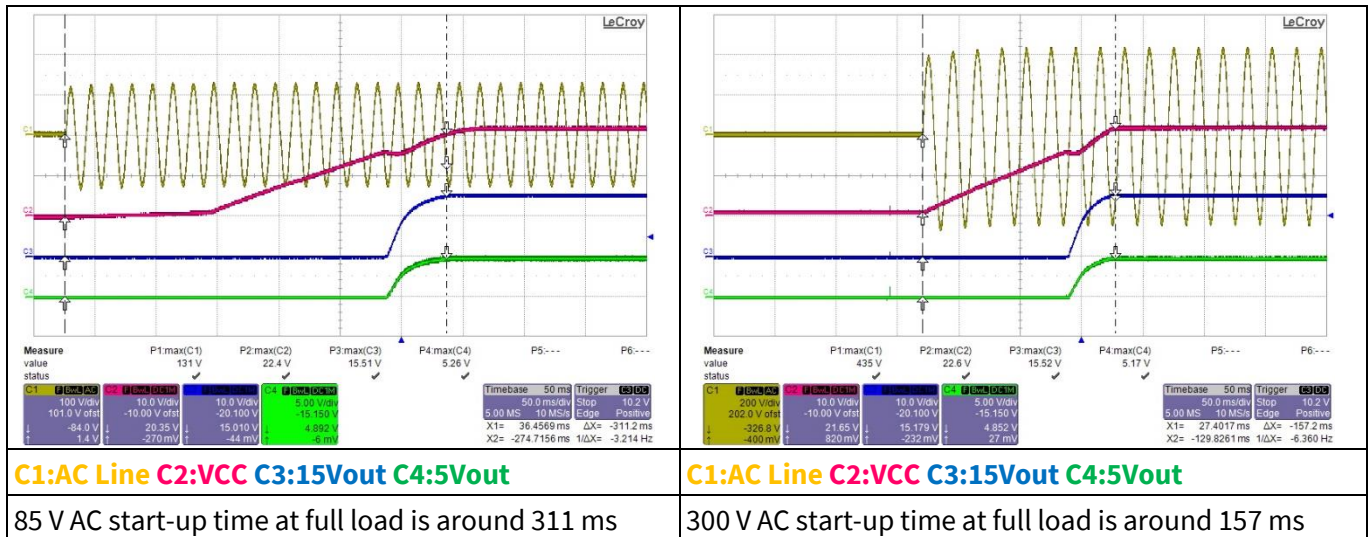


Figure 15 Start-up

10.2 Soft-start at full-load

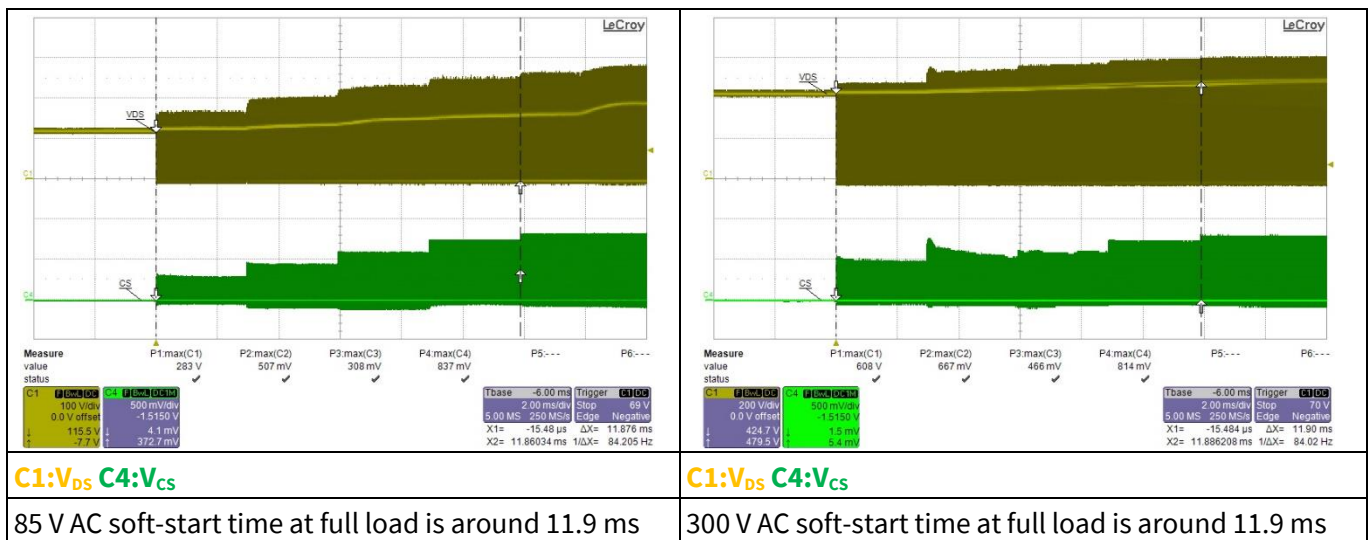


Figure 16 Soft-start

14 W, 15 V and 5 V SMPS reference board with CoolSET™ ICE5AR3995BZ-1

REF_5AR3995BZ-1_14W1

Waveforms and oscilloscope plots

10.3 Drain and CS voltage at full load

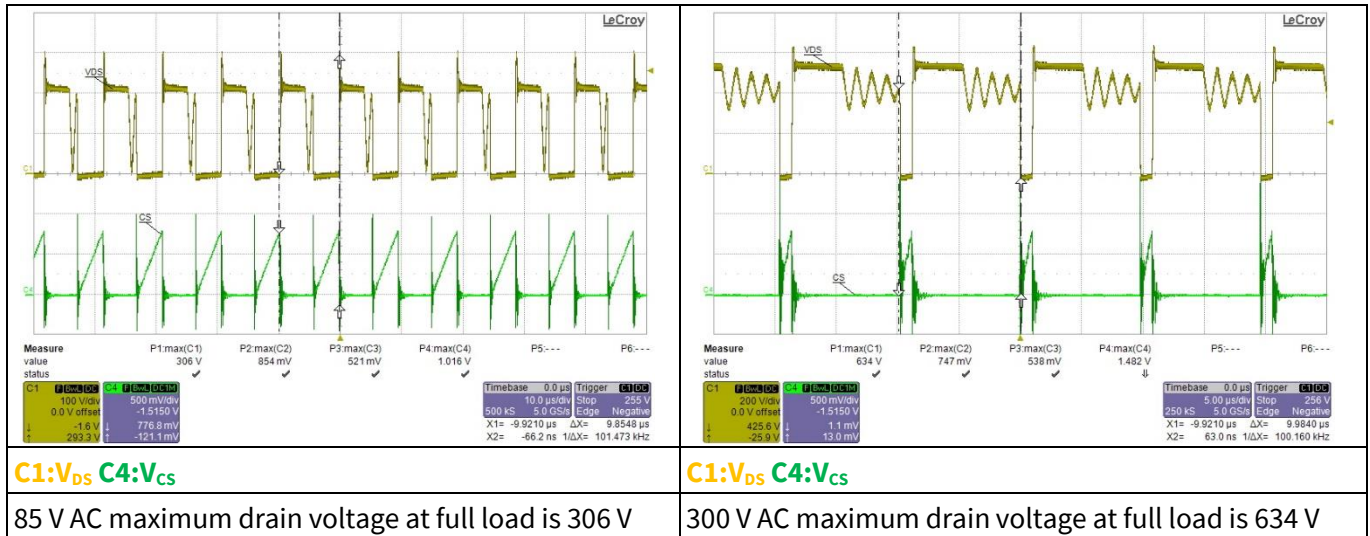


Figure 17 Drain and CS voltage

10.4 Frequency jittering

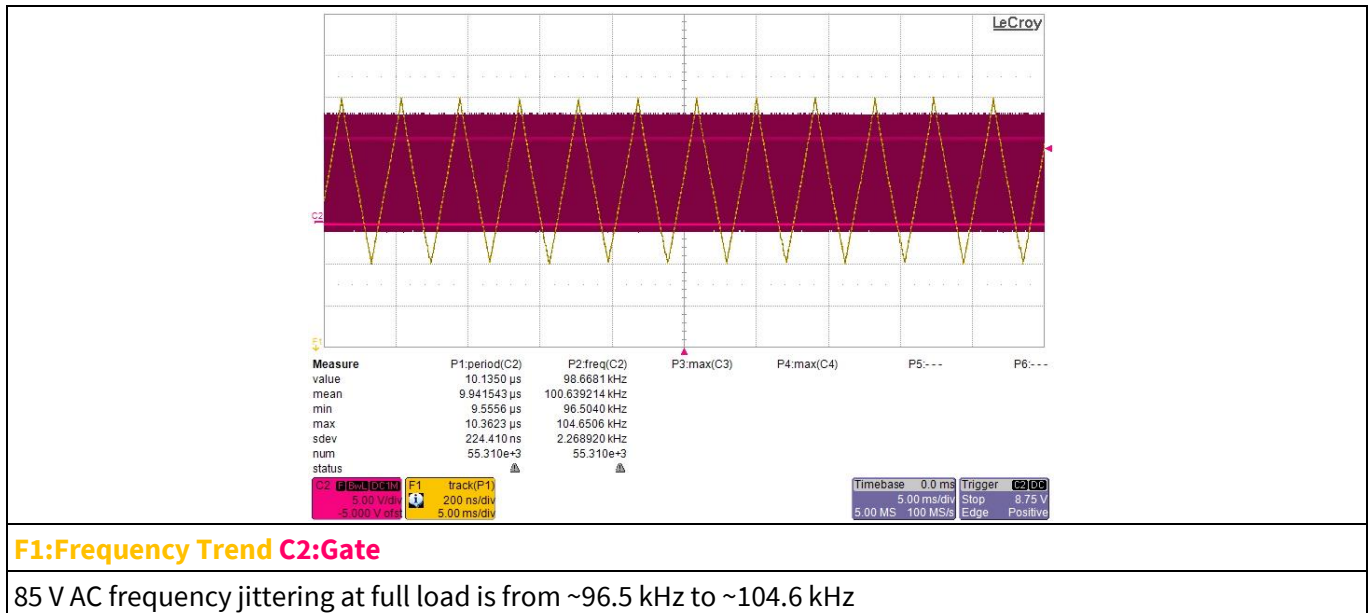


Figure 18 Frequency jittering

10.5 Output ripple voltage at full load

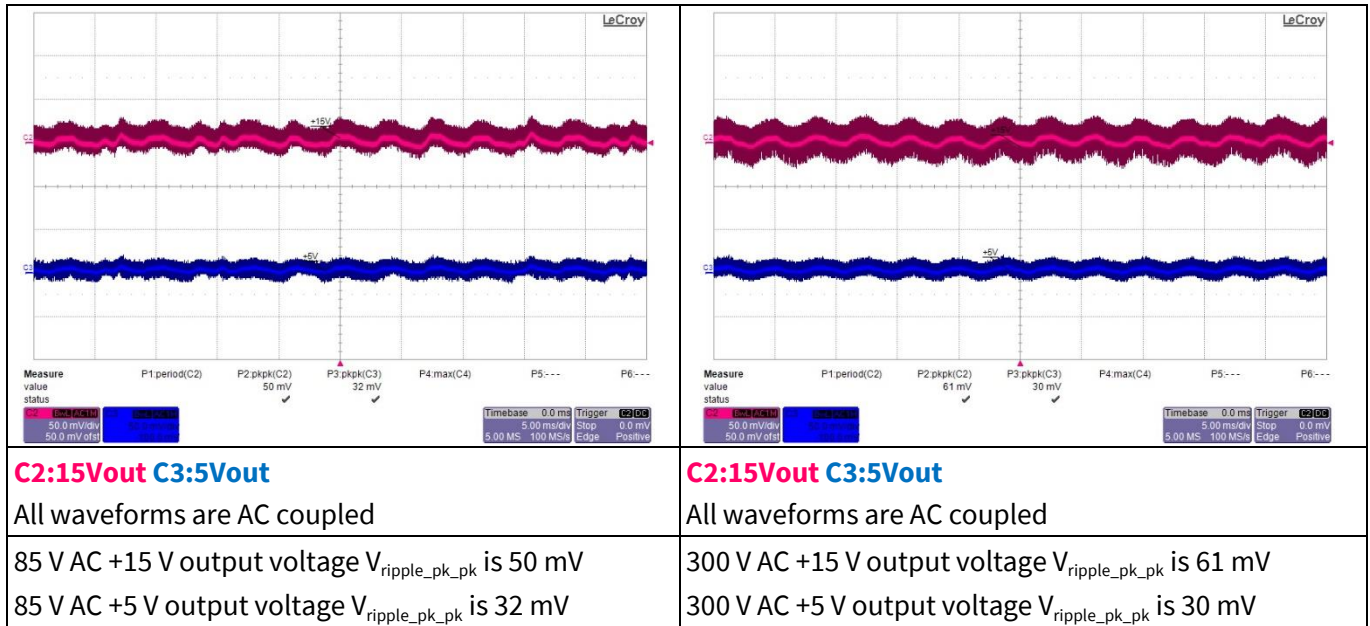


Figure 19 Output ripple voltage at full load. Probe terminals are decoupled with a 10 μ F electrolytic capacitor and a 0.1 μ F ceramic capacitor. Oscilloscope bandwidth is limited to 20 MHz.

10.6 Output ripple voltage at ABM

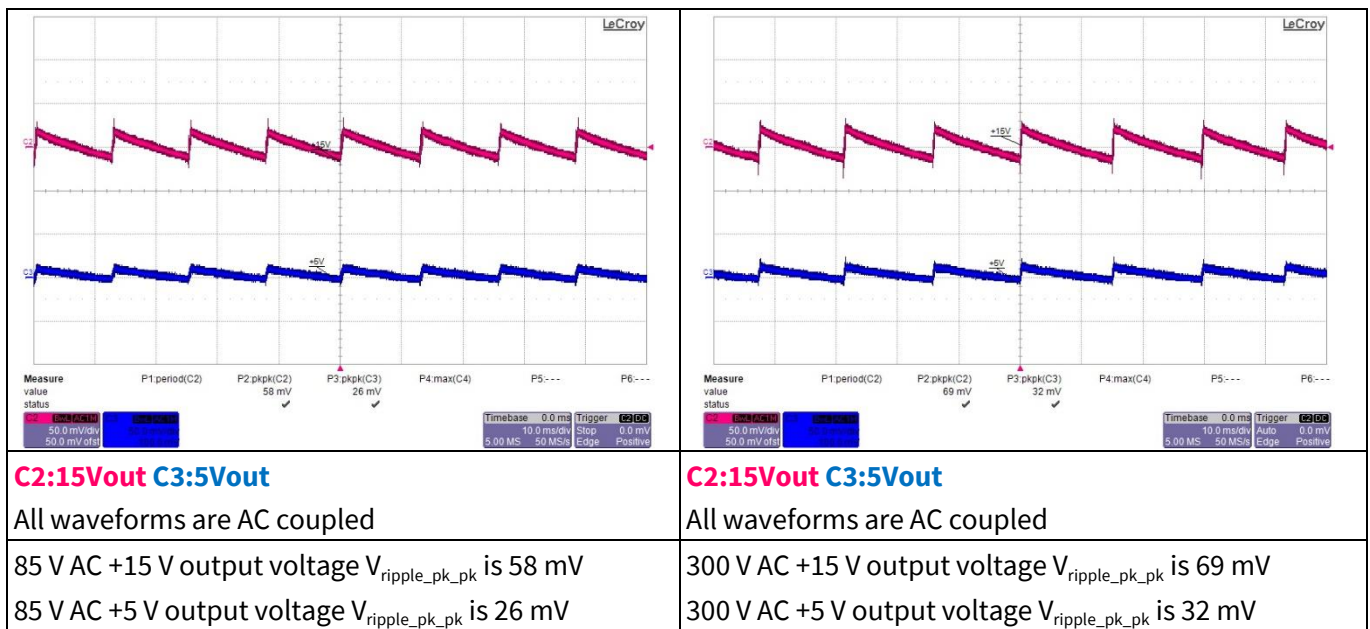


Figure 20 Output ripple voltage at no load. Probe terminals are decoupled with a 10 μ F electrolytic capacitor and a 0.1 μ F ceramic capacitor. Oscilloscope bandwidth is limited to 20 MHz.

14 W, 15 V and 5 V SMPS reference board with CoolSET™ ICE5AR3995BZ-1

REF_5AR3995BZ-1_14W1

Waveforms and oscilloscope plots

10.7 Entering ABM

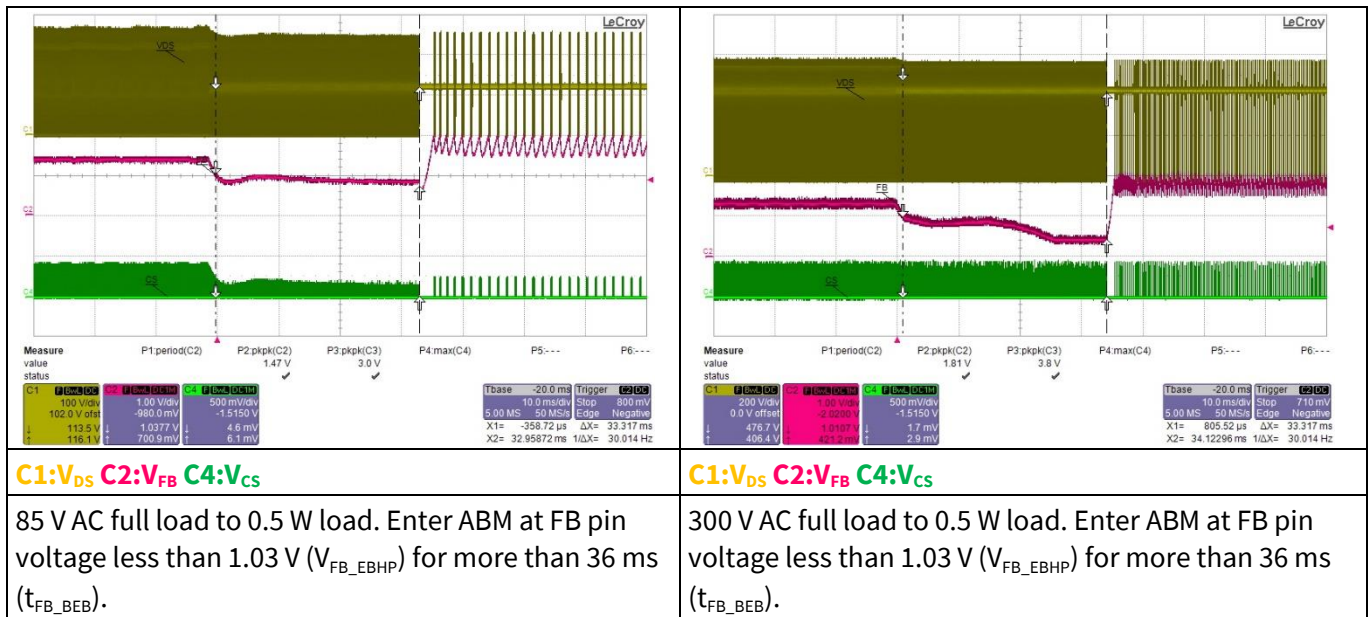


Figure 21 Entering ABM

10.8 During ABM

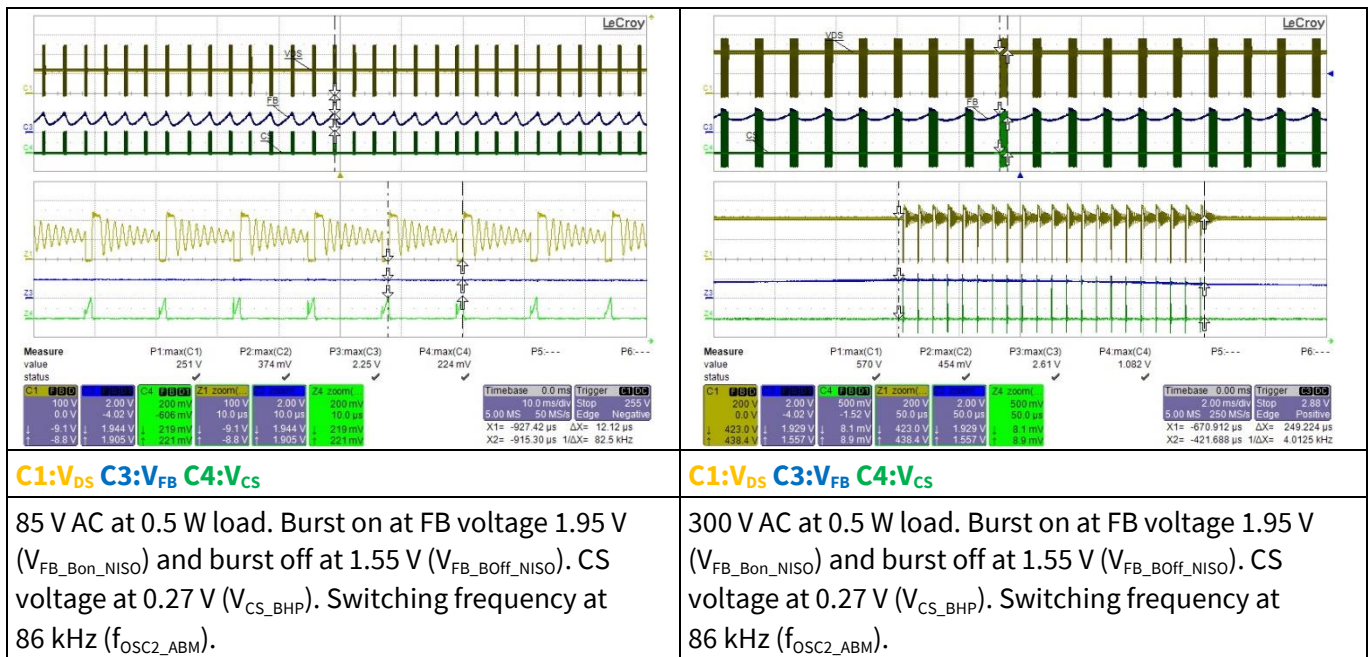


Figure 22 During ABM

14 W, 15 V and 5 V SMPS reference board with CoolSET™ ICE5AR3995BZ-1

REF_5AR3995BZ-1_14W1

Waveforms and oscilloscope plots

10.9 Leaving ABM

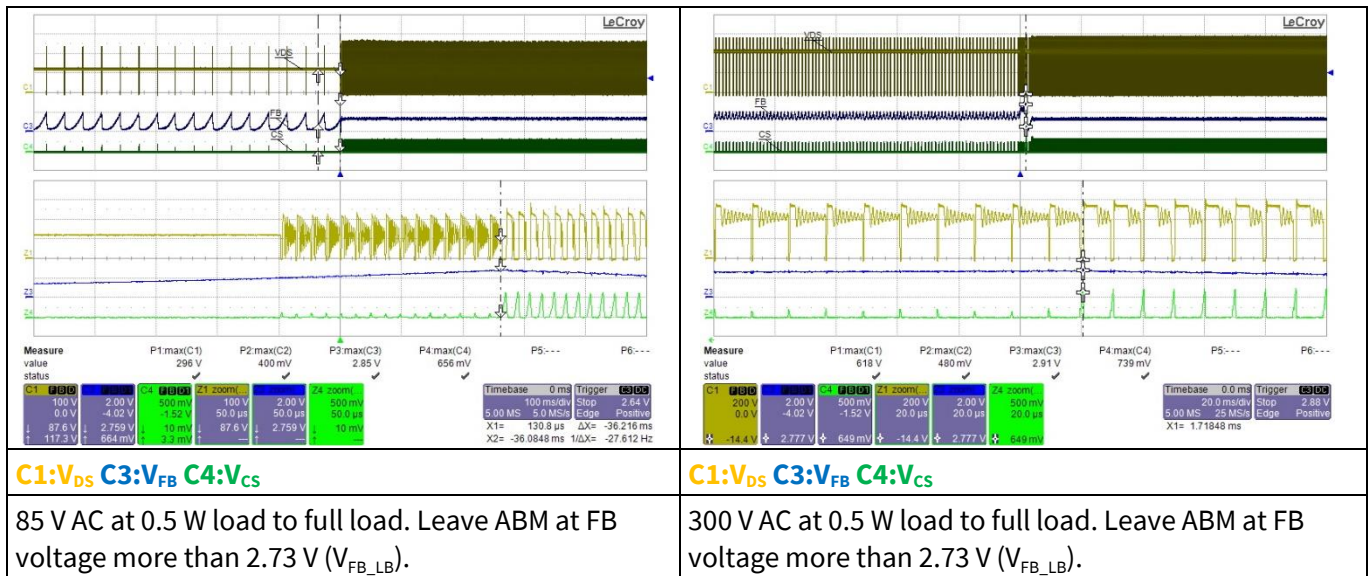


Figure 23 Leaving ABM

10.10 V_{CC} OV/UV protection

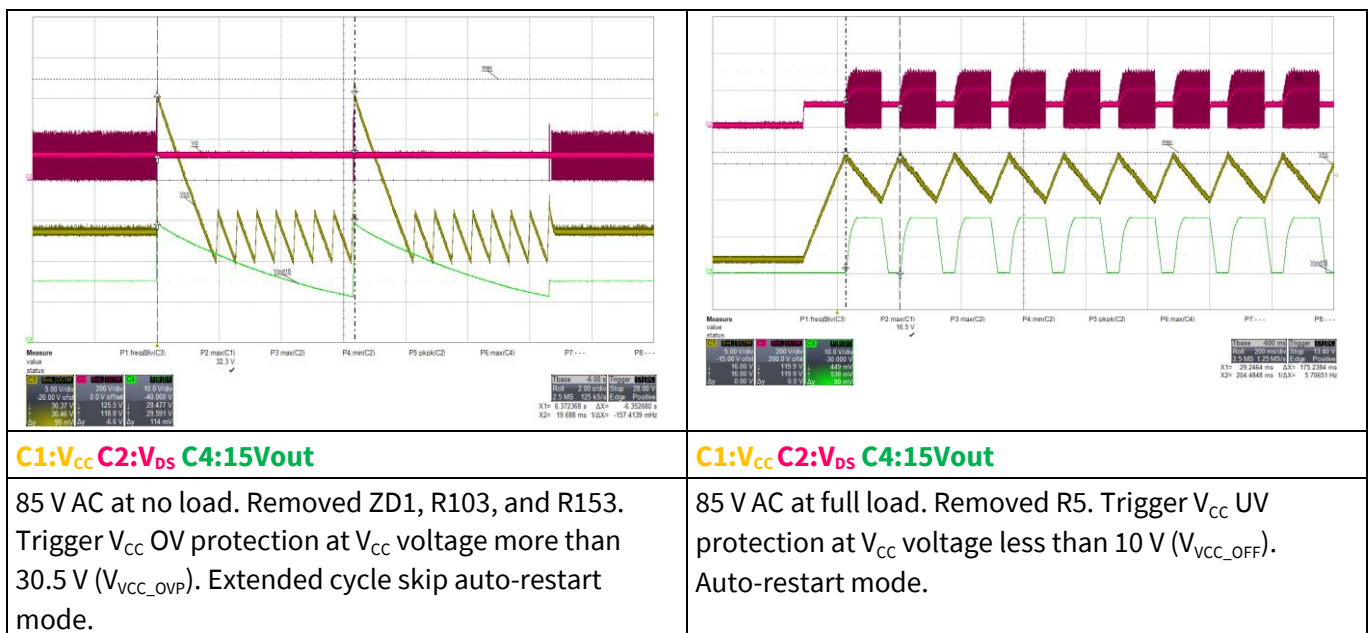


Figure 24 V_{CC} OV/UV protection

14 W, 15 V and 5 V SMPS reference board with CoolSET™ ICE5AR3995BZ-1

REF_5AR3995BZ-1_14W1

Waveforms and oscilloscope plots

10.11 Overload protection

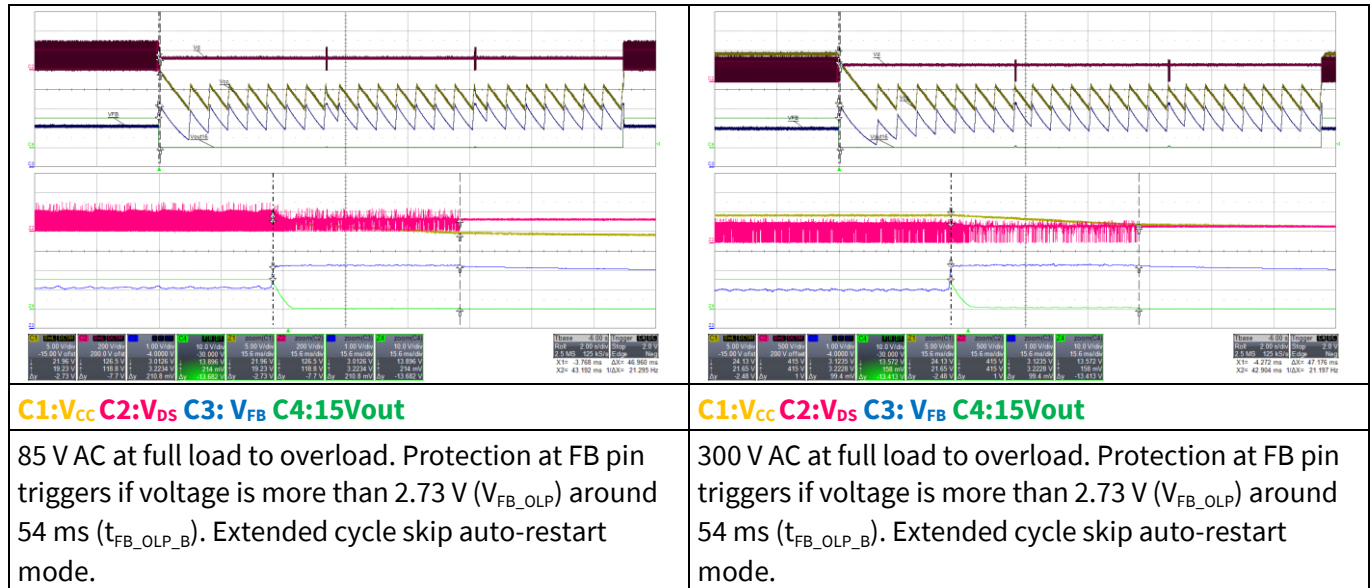


Figure 25 Overload protection

10.12 V_{CC} short-to-GND

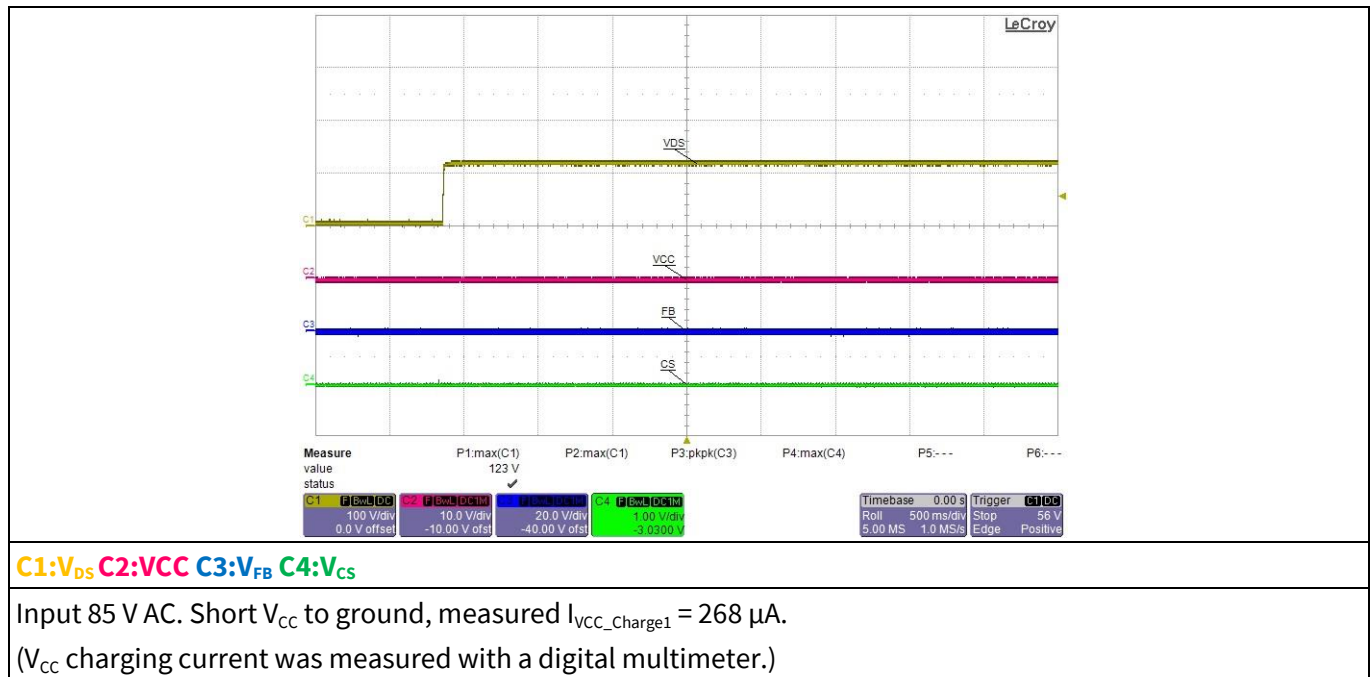


Figure 26 V_{CC} short-to-GND

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14 W, 15 V and 5 V SMPS reference board with CoolSET™ ICE5AR3995BZ-1

REF_5AR3995BZ-1_14W1

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Revision history

Document revision	Date	Description of changes
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