

# AC-DC universal input 45 W power supply using CoolSET™ SiP ICE184XM

REF\_45W1\_ZVS\_184XM

## About this document

### Scope and purpose

This application note describes a switched mode power supply (SMPS) using Infineon's latest CoolSET™ System in Package (SiP) ICE184XM. The power supply is designed to work with universal line alternating current (AC) input and has an isolated 12 V, 3.75 A output plus an additional non-isolated 15 V, 150 mA output.

### Intended audience

This document is intended for power supply design, application engineers, or others who want to design efficient and reliable auxiliary power supplies.

### Keypoints

- Overall high efficiency to meet energy efficiency requirements
- Zero-voltage switching (ZVS) technology to boost efficiency performance and lower the electro-magnetic interference (EMI)
- Enable signal, secondary–primary communication sent through the integrated current transformer (CT)
- X-cap discharge function
- Ultra-low standby-power consumption (< 45 mW)
- Simplified circuitry with high-level integration of power control and protection features
- Auto-restart protection scheme to minimize interruption and enhance the end user experience

## About this product family

### Product family

Infineon's CoolSET™ AC-DC integrated power stages in fixed frequency and quasi-resonant switching schemes offer increased robustness and outstanding performance. This family offers superior energy efficiency, comprehensive protective features, and reduced system costs. The CoolSET™ controllers are ideally suited for auxiliary power supply applications.

### Target applications

- [SMPS](#)
- [Home appliances](#)
- [Server](#) power supply units
- [Telecom](#) AC-DC power conversion

## Table of contents

<b>About this document</b> .....	<b>1</b>
<b>About this product family</b> .....	<b>1</b>
<b>Table of contents</b> .....	<b>2</b>
<b>1 Introduction</b> .....	<b>3</b>
<b>2 Reference board</b> .....	<b>4</b>
<b>3 Power supply specifications</b> .....	<b>5</b>
<b>4 Circuit diagram</b> .....	<b>6</b>
<b>5 Circuit description</b> .....	<b>7</b>
5.1 EMI filtering and line rectification.....	7
5.2 CoolSET™ SiP power stage.....	7
5.2.1 CoolSET™ SiP primary side .....	7
5.2.2 CoolSET™ SiP secondary side .....	8
<b>6 PCB layout</b> .....	<b>9</b>
<b>7 Bill of materials</b> .....	<b>11</b>
<b>8 Transformer specification</b> .....	<b>14</b>
8.1 Electrical diagram and winding structure .....	14
8.2 Electrical characteristics .....	14
<b>9 Measurement data and graphs</b> .....	<b>15</b>
9.1 Efficiency result .....	15
9.2 Standby input power consumption.....	16
9.3 ESD immunity (EN 61000-4-2) .....	16
9.4 Surge immunity (EN 61000-4-5) .....	17
9.5 Conducted emissions (EN 55014) .....	17
9.6 Thermal measurement .....	20
<b>10 Waveforms and scope plots</b> .....	<b>22</b>
10.1 Startup at full load .....	22
10.2 Switching waveform at full load .....	22
10.3 SR FET voltage at full load .....	23
10.4 Output voltage ripple .....	23
10.5 Load-transient response .....	23
10.6 X-cap discharge function .....	24
<b>11 Related resources</b> .....	<b>25</b>
<b>References</b> .....	<b>26</b>
<b>Revision history</b> .....	<b>27</b>
<b>Disclaimer</b> .....	<b>28</b>

### Introduction

## 1 Introduction

This document describes a 12 V/3.75 A switched-mode power supply (SMPS) using Infineon's latest [CoolSET™ SiP ICE184XM](#). The reference design demonstrates high power efficiency, low power consumption, and cost-effectiveness, made possible by the high-level integration capabilities of CoolSET™ SiP.

[Table 1](#) lists the general system requirements for a power supply and the Infineon solution using ICE184XM.

**Table 1** General system requirements and reference design solution

S.No.	General system requirement	Reference design solution - ICE184XM
1	High efficiency to meet energy efficiency requirements	Primary zero-voltage switching and secondary optimal synchronous rectifier (SR) control
2	Low standby power consumption to comply to latest energy conservation standards	Optimized low supply currents for hysteretic mode operation to reach lowest stand-by power < 30 mW
3	Simplified circuitry with high-level integration	Integrated primary 800 V MOSFET, primary and secondary controller, and communication in a DSO-27 package
4	Minimize interruption to enhance end user experience	All protections are defined to enter auto-restart mode

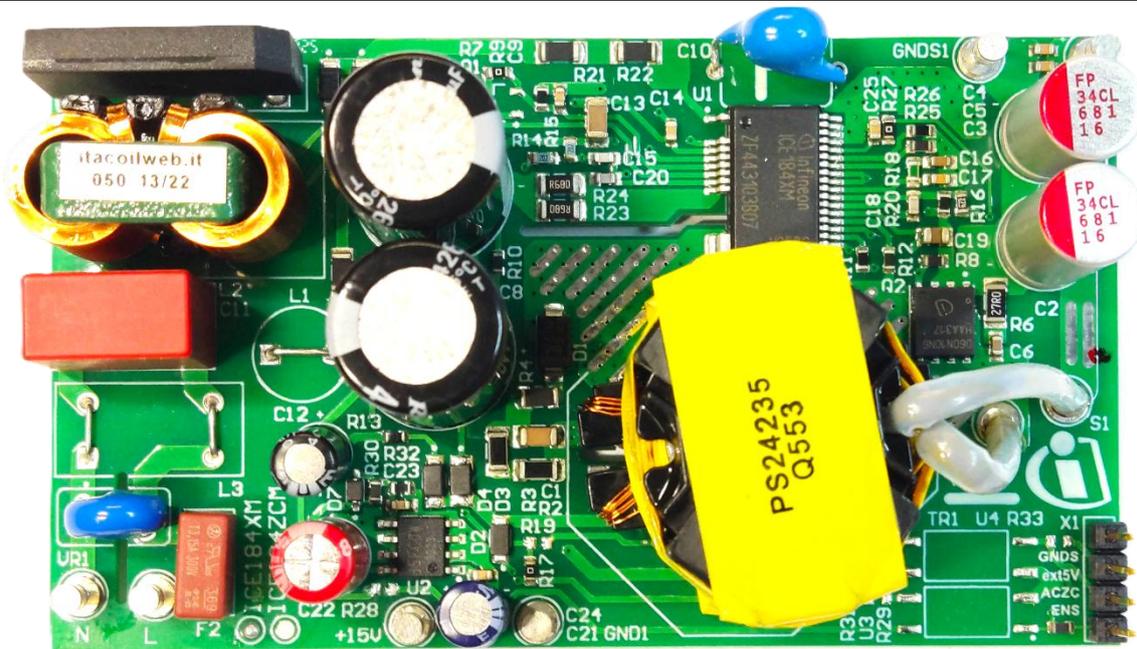
# AC-DC universal input 45 W power supply using CoolSET™ SiP ICE184XM

REF\_45W1\_ZVS\_184XM

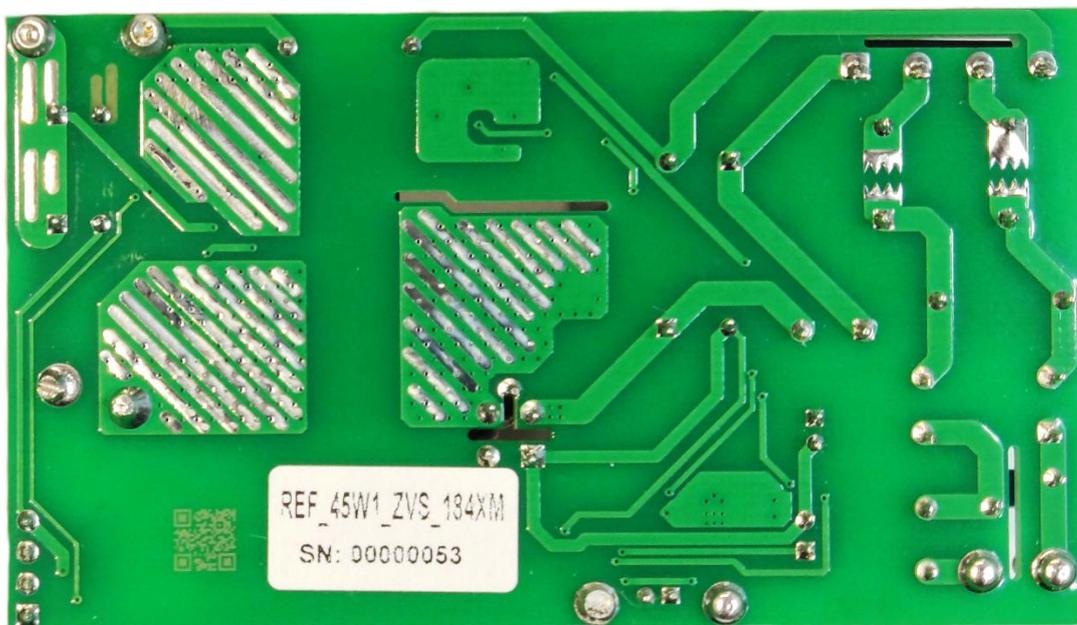
Reference board

## 2 Reference board

This document provides complete design details including power supply specifications, schematics, bill of materials, PCB layout, transformer specification, and performance data.



Top side of the board



Bottom side of the board

**Figure 1 Reference board REF\_45W1\_ZVS\_184XM**

### 3 Power supply specifications

The following table represents the minimum acceptance performance of the design. The actual performance is listed in the [Measurement data and graphs](#) section.

**Table 2 Specifications of REF\_1\_ZVS\_184XM**

Description	Symbol	Min.	Typ.	Max.	Units	Comments
<b>Input</b>						
Voltage	$V_{IN}$	90	–	264	V AC	Live (L) and Neutral (N)/(no PE)
Frequency	$f_{LINE}$	47	50	64	Hz	–
Line overvoltage	$V_{IN\_OVP}$	–	268	–	V AC	–
<b>Output(12 V)</b>						
Output voltage	$V_{OUT1}$	–	12	–	V	±1 percent (isolated)
Output current	$I_{OUT1}$	–	3.75	–	A	–
Output voltage ripple	$V_{RIPPLE1}$	–	–	240	mV	Peak to peak
Overcurrent protection	$I_{OCP}$	–	–	4.5	A	Measured at 230 V AC
Total output power	$P_{OUT}$	–	45	–	W	–
<b>Output(15 V)</b>						
Output voltage	$V_{OUT2}$	–	15	–	V	Non-isolated
Output current	$I_{OUT2}$	–	0.15	–	A	–
Output power	$P_{OUT}$	–	2.25	–	W	–
<b>Efficiency</b>						
Maximum load efficiency	$\eta$	–	92.8	–	%	Measured at 230 V AC, 45 W w/o LDO
<b>Environmental</b>						
Conducted EMI	–	5			dB	Margin, CISPR 14
<b>ESD</b>						
EN 61000-4-2						
Contact discharge	–	±8			kV	–
Air discharge	–	±15			kV	–
<b>Surge immunity</b>						
EN 61000-4-5						
Differential mode	–	±2			kV	–
Common mode	–	±4			kV	–
PCB size	–	87 × 50			mm <sup>2</sup>	L × W
Ambient temperature	$T_a$	–	–	50	°C	Convection cooling



## 5 Circuit description

This section briefly describes the reference design circuit by different functional blocks. For more information on the design procedure and component selection for the flyback circuitry, see the IC datasheet [1] and design guide [2].

### 5.1 EMI filtering and line rectification

- The input of the power supply is fed from AC power grid, which is the typical universal range 90 V AC ~ 264V AC
- The slow blow F1 fuse is placed on the L terminal of the AC input to protect the system in case of excess current entering the system circuit due to a fault
- Following protection component is the varistor VR1, which is connected across L and N to protect the system in case of a line surge transient event
- The basic common noise filtering is made up from the common mode (CM) choke L2, and the X-capacitor C11
- There are some optional means to reduce the conducted EMI noise levels, by fitting L1 inductor (PI-filter with C7 and C8) and L3 high-frequency common-mode choke (HF CMC). These two components are not fitted and JP1, JP2, and JP3 wire jumpers are fitted on the current reference board to keep the cost and bill of materials (BOM) as low as possible
- The bridge rectifier BR1 rectifies the AC input into DC voltage, filtered by the bulk capacitors C7 and C8

### 5.2 CoolSET™ SiP power stage

The flyback converter power stage consists of:

- Power transformer
- Primary power MOSFET
- Secondary synchronous rectifier (SR) MOSFET
- Secondary output capacitors
- Filtering components

The primary-side and secondary side power management are separated for isolated power supply domains (VCCP, GNPD) and (VCCS, GNDS). CoolSET™ SiP ICE184XM controller IC provides reinforced and safe isolated communication between the primary and secondary sides.

#### 5.2.1 CoolSET™ SiP primary side

CoolSET™ SiP ICE184XM integrates a 950 V startup cell and an 800 V CoolMOS™ MOSFET in the primary side. The IC is directly connected to the AC input voltage through the resistors R21 R22 that are placed in series on the HV pin. This way, the VCCP pin capacitors C12, C13, and C14 will be charged when the reference board input is supplied with AC input voltage. The primary winding start pin of the transformer, TR1 pin 10 is connected to the drain of the CoolMOS™ MOSFET inside ICE184XM (U1 pin 9). When the integrated CoolMOS™ turns on, energy is stored in the transformer. When it turns off, the stored energy releases to the output capacitors and output loading through the output SR OptiMOS™ 6 power MOSFET Q2.

The resistors R1, R5, and R9 provide the divided voltage that is fed to controller pin 5 VINP for the input overvoltage protection (OVP). The shunt resistors R23 and R24 serve as ICE184XM primary current sensing, to limit the peak current cycle by cycle.

## AC-DC universal input 45 W power supply using CoolSET™ SiP ICE184XM

REF\_45W1\_ZVS\_184XM

### Circuit description

A low-cost snubber consisting of the D1 diode, the R2, R3, R4 resistors, and the C1 capacitor is implemented to suppress the drain voltage spike that appears when the integrated CoolMOS™ power switch is turned off. This passive clamp helps to dissipate the energy stored in the transformer leakage inductance and reduces the drain-to-source voltage stress of the integrated power MOSFET.

### 5.2.2 CoolSET™ SiP secondary side

The start-up sequence is the following: the integrated high voltage startup cell is energizing the VCC supply capacitors and when the VCC voltage reaches the desired level, the IC starts switching the primary MOSFET to bring up the output voltage. When the output voltage reaches 95% of its regulation target, the secondary side of CoolSET™ SiP ICE184XM starts to take over the PWM control. The ICE184XM PWM control is based on sensing the reflected voltage from the primary side to the secondary side via the ZCDS pin, and on the error amplifier output EA voltage. ICE184XM integrated PWM and SR control ensures that the timing of the SR power switch (Q2) and the primary side power switch are well-synchronized, which avoids the cross conduction of the two switches and provides reliable and efficient synchronous rectification.

In addition, the current injection function via the SR power switch Q2 enables zero-voltage switching operation on the primary-side:

- Two external resistors, R25 and R26 are used to configure the IC with the transformer turns ratio and the desired preset of operation parameters
- The passive components C16, C17, and R18 are for the compensation network, used to stabilize the output voltage regulation
- The output filtering capacitors C2 and C3 are dimensioned to keep the output voltage ripple in the specified limits, working together with the ceramic capacitors C4 and C5 that are used to reduce the high frequency output voltage ripple

# AC-DC universal input 45 W power supply using CoolSET™ SiP ICE184XM

REF\_45W1\_ZVS\_184XM

PCB layout

## 6 PCB layout

The REF\_45W1\_ZVS\_184XM consists of a standard 2-layer 75 µm copper thickness PCB with only top-side components placement. The PCB layers are shown in the following figures.

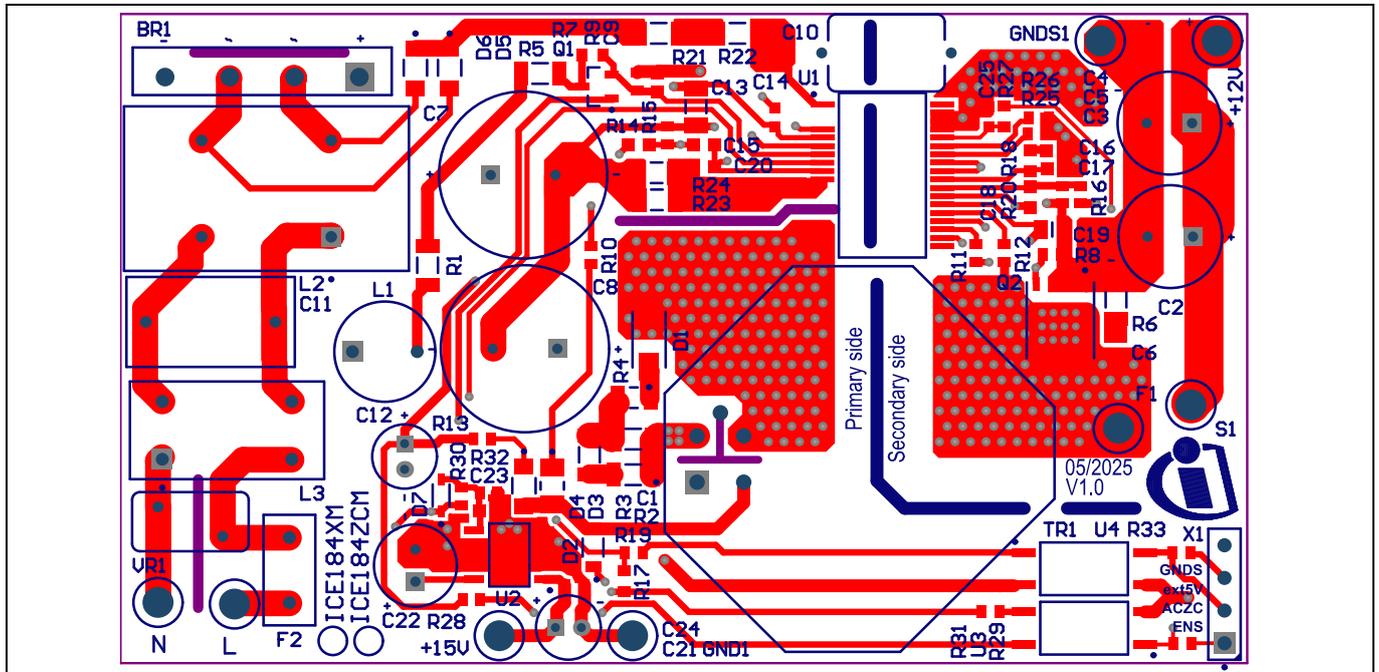


Figure 3 PCB top-side

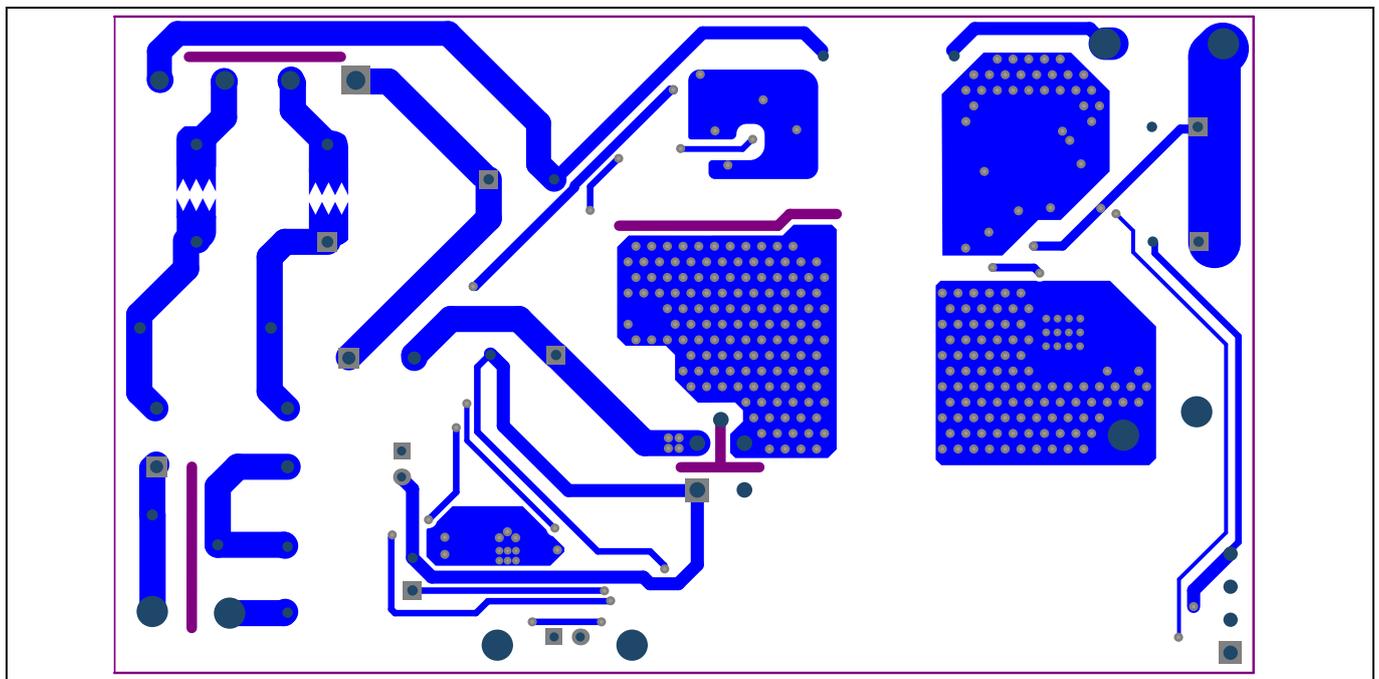


Figure 4 PCB bottom-side

### PCB layout

A good PCB layout is crucial for a successful design. Following are some recommendations:

1. Minimize the loop with pulse shape current or voltage, such as the loop formed by the bus voltage source, primary winding, main power switch, and current sense resistor or the loop consisting of the secondary winding, SR switch, and output capacitor, or the loop of the  $V_{CC}$  power supply
2. **Star connection of the primary side ground (GNDP) at the bulk capacitor:** All primary grounds should be connected to the ground of the bulk capacitors (C7 and C8) separately at one point. This can reduce the switching noise entering the sensitive pins of the CoolSET™ SiP device. The primary star ground can be split into four groups:
  - Combined signal (all small signal grounds connecting to the controller GNDP pin such as the filter capacitor C9, C15, and C20) and power ground (CS resistors R23 and R24)
  - $V_{CCP}$  ground includes the  $V_{CCP}$  capacitors ground and the auxiliary winding ground, pin 1 of the power transformer
  - EMI return ground includes the Y capacitor for isolated flyback application
  - DC ground from the bridge rectifier BR1
3. CoolSET™ SiP primary side GNDP pin 2 and pin 7 are recommended to be jointly connected to a PCB copper plane, and then star connected to the bulk capacitor ground
4. CoolSET™ SiP secondary side GNDS pin 11, pin 19, and pin 26 are recommended to be jointly connected to a PCB copper plane, and then star connected to the SR MOSFET source pin
5. **Place the filter capacitors close to the controller ground (GNDP and GNDS):** Filter capacitors should be placed as close to the controller ground and controller pin as possible to reduce the switching noise coupled into the controller
6. **High voltage (HV) trace clearance:** HV traces like startup, bulk capacitors + and primary switch drain traces should maintain sufficient spacing to the nearby traces — arcing may occur otherwise
7. Keep a minimum of 230 mm<sup>2</sup> copper area at both the primary drain pin and secondary GNDS for better thermal performance of the CoolSET™ SiP
8. SR drain copper plane surface area should be considered for a reasonable convection cooling capability

## 7 Bill of materials

Table 3 BOM

S.No.	Quantity	Designator	Description	Manufacturer	Part number
1	6	+12V, +15V, GND1, GNDS1, J1, J2	Con 1502-2/ CON-THT-TP- 1502-2	Keystone Electronics Corp.	1502-2
2	1	BR1	Dio 600 V/ THT	Taiwan Semiconductor	GBL06
3	1	C1	Cap 1 nF/ 1 kV/ 1206/ X7R/10%	KEMET	C1206C102KDRAC TU
4	2	C2, C3	Cap 680 µF/ 16V/ THT/Radial/ /20%	Nichicon	RNL1C681MDS1P X
5	5	C4, C5, C14, C24, C25	Cap 100 nF/ 50 V/ 0603/ X7R/10%	Würth Elektronik	885012206095
6	1	C6	Cap 1 nF/ 100 V/ 0603/ X7R/10%	TDK Corporation	CGA3E2X7R2A102 K080AA
7	2	C7, C8	Cap 47 µF/ 400 V/ THT/Radial/ /20%	Rubycon	400LXW47MEFR1 2.5X25
8	2	C9, C23	Cap 1 nF/ 25 V/ 0603/ X7R/10%	Würth Elektronik	885012206059
9	1	C10	Cap 1 nF/ THT/Radial/ Y5V/20%	KEMET	C721U102MSVDB A7317
10	1	C11	Cap 100 nF/ 630 V/ THT/Radial/ /10%	Würth Elektronik	890324023023CS
11	1	C12	Cap 33 µF/ 50 V/ THT/Radial/ /20%	KEMET	ESH336M050AC3 AA
12	1	C13	Cap 2.2 µF/ 50 V/ 1206/ X7R/10%	Murata	GCM31CR71H225 KA55
13	1	C15	Cap 33 pF/ 50 V/ 0603/ C0G/5%	Murata	GRM1885C1H330 JA01
14	1	C16	Cap 68 nF/ 25 V/ 0603/ X7R/10%	Murata	GCM188R71E683 KA57
15	1	C17	Cap 2.2 nF/ 25 V/ 0603/ X7R/10%	Würth Elektronik	885012206061
16	2	C18, C20	Cap 680 pF/ 50 V/ 0603/ X7R/5%	Murata	GRM188R71H681 JA01
17	1	C19	Cap 4.7 µF/ 25V/ 0805/ X7R/10%	Taiyo Yuden	TMK212AB7475K G-T
18	1	C21	Cap 100 µF/ 25 V/ THT/Radial/ /20%	KEMET	ESK107M025AC3A A
19	1	C22	Cap 220 µF/ 25 V/ THT/Radial/ /20%	Würth Elektronik	860010473011

# AC-DC universal input 45 W power supply using CoolSET™ SiP ICE184XM



REF\_45W1\_ZVS\_184XM

## Bill of materials

S.No.	Quantity	Designator	Description	Manufacturer	Part number
20	1	D1	Dio 700 V/ SMA (DO-214AC)	Taiwan Semiconductor	S1M
21	1	D2	Dio 200 V/ SOD-123	ROHM Semiconductors	RF071MM2STR
22	1	D3	Dio 200 V/ CFP3 (SOD-123W)	Nexperia	PNE20010ERX
23	1	D4	Dio 200 V/ SOD-123W	Taiwan Semiconductor	S1DLW
24	2	D5, D6	Dio 600 V/ SOD-123W (CFP3)	Taiwan Semiconductor	RS1JLW
25	1	D7	Dio 75 V/ SOD-323	Diodes Incorporated	1N4148WS-7-F
26	1	F1	Res 3.15 A/ 300 V/ THT/Radial/	Littelfuse	36913150000
27	3	JP1, JP2, JP3	Res 0R/ THT/Axial	YAGEO	ZOR-12-R-52-0R
28	1	L2	Ind 24 mH/ THT	ITACOIL	SCF1515050
29	1	Q2	Tra ISC060N10NM6/ PG-TDSON-8-36	Infineon Technologies	ISC060N10NM6
30	2	R1, R5	Res 5.1MEG/ 200 V/ 1206/ 1%	Vishay	CRCW12065M10F K
31	2	R2, R3	Res 150k/ 200 V/ 1206/ 1%	Vishay	CRCW1206150KF K
32	1	R4	Res 10R/ 200 V/ 1206/ 1%	Vishay	RCS120610R0FKE A
33	1	R6	Res 27R/ 200 V/ 1206/ 1%	Vishay	CRCW120627R0F K
34	3	R7, R17, R27	Res 0R/ 75 V/ 0603/ 0R	YAGEO	RC0603JR-070RL
35	3	R8, R29, R30	Res 10k/ 75 V/ 0603/ 1%	Vishay	CRCW060310K0F KEA
36	1	R9	Res 75k/ 75 V/ 0603/ 1%	Vishay	CRCW060375K0F K
37	2	R10, R25	Res 18k/ 75 V/ 0603/ 1%	Vishay	CRCW060318K0F K
38	2	R11, R13	Res 2.2R/ 75 V/ 0603/ 1%	Vishay	CRCW06032R20F K
39	1	R12	Res 15k/ 75 V/ 0603/ 1%	Vishay	CRCW060315K0F K
40	2	R14, R15	Res 2k/ 75 V/ 0603/ 1%	KOA Speer Electronics Inc.	RK73H1JTTD2001 F
41	1	R16	Res 270k/ 75 V/ 0603/ 1%	Vishay	CRCW0603270KF K

# AC-DC universal input 45 W power supply using CoolSET™ SiP ICE184XM



REF\_45W1\_ZVS\_184XM

## Bill of materials

S.No.	Quantity	Designator	Description	Manufacturer	Part number
42	1	R18	Res 20k/ 75 V/ 0603/ 0.1%	Vishay	TNPW060320K0B Y
43	2	R20, R32	Res 30k/ 75 V/ 0603/ 1%	Vishay	CRCW060330K0F K
44	2	R21, R22	Res 57.6k/ 200 V/ 1206/ 1%	Vishay	CRCW120657K6F K
45	2	R23, R24	Res 680 mR/ 1206/ 1%	Bourns	CRM1206-FX- R680ELF
46	1	R26	Res 3.9k/ 75 V/ 0603/ 1%	Vishay	CRCW06033K90F K
47	1	TR1	Tra PS24-235/ THT	Sumida	PS24-235
48	1	U1	CoolSET™ SiP IC Controller	Infineon Technologies	ICE184XM-V001
49	1	U2	Pow BDJ5FC0WEFJ-E2/ HTSOP-J8	ROHM Semiconductors	BDJ5FC0WEFJ-E2
50	1	VR1	Res / 320 V/ Radial type/ 10%	Epcos	B72207S2321K10 1
51	1	X1	Con TSW-104-07-L-S/ THT	Samtec	TSW-104-07-L-S
52	1	VR1	Res / 320 V/ Radial type/ 10%	Epcos	B72207S2321K10 1
53	1	X1	Con TSW-104-07-L-S/ THT	Samtec	TSW-104-07-L-S

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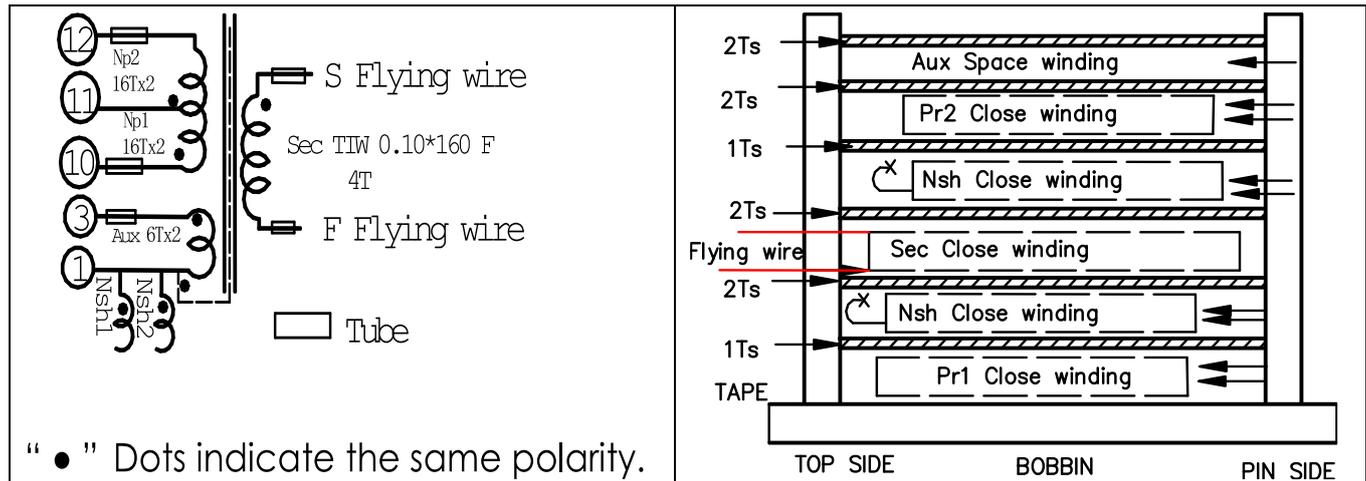
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## Transformer specification

### 8 Transformer specification

#### 8.1 Electrical diagram and winding structure

The transformer used for this 45W CoolSET™ SiP reference design is manufactured by Sumida and the part number is PS24-235. It is based on RM10 ferrite core, and the windings are fitted on a through-hole standard bobbin. The interleaved winding structure can be seen on the right side in [Figure 5](#).



**Figure 5 Schematic and winding structure of PS24-235 transformer**

#### 8.2 Electrical characteristics

2-2. Electrical characteristic (at 25°C, unless of otherwise specified)

Items	Specification	Measuring conditions
Inductance (10-12)	360μH±10% Within	100kHz/0.1V
DCR (10-12)	Max. 280mΩ	
DCR (S Fly wire-F Fly wire)	Max. 4.5mΩ	
DCR (3-1)	Max. 130mΩ	
Hi top (1,3,10,11,12)-(S Fly wire, F Fly wire)	AC 3000Vrms	50/60Hz, 1mA, 2s
Hi top (1,3)-(10,11,12)	AC 1000Vrms	50/60Hz, 1mA, 2s
Turns ratio (10-12):(S Fly wire-F Fly wire):(1-3)	32:4:6 ±3%	

**Figure 6 Electrical characteristics of PS24-235 transformer**

## 9 Measurement data and graphs

All performance data is measured at room temperature  $T_a = 25^\circ\text{C}$ , unless otherwise specifically mentioned.

### 9.1 Efficiency result

Measurements were performed at 25%, 50%, 75%, and 100% of the nominal load after 5 minutes of burn-in time.

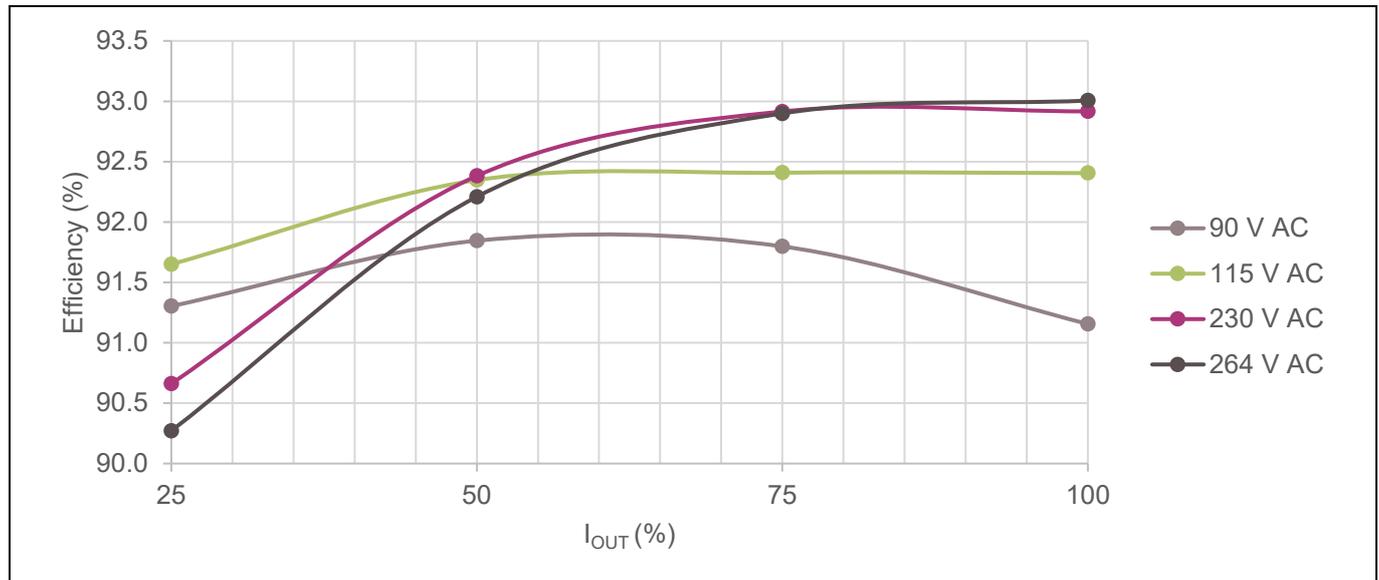
**Table 4 Efficiency and four-point average efficiency**

Input (V AC/Hz)	Load / %	$P_{IN}$ (W)	$V_{OUT}$ (V)	$I_{OUT}$ (A)	$P_{OUT}$ (W)	Efficiency (%)	Average efficiency (%)
90 V AC/60 Hz	100	49.75	12.07	3.76	45.35	91.16	91.54
	75	36.98	12.08	2.81	33.95	91.80	
	50	24.74	12.08	1.88	22.72	91.85	
	25	12.37	12.08	0.93	11.29	91.30	
115 V AC/60 Hz	100	49.07	12.07	3.76	45.34	92.41	92.19
	75	36.73	12.08	2.81	33.94	92.41	
	50	24.59	12.08	1.88	22.71	92.35	
	25	12.31	12.08	0.93	11.28	91.65	
230 V AC/50 Hz	100	48.79	12.07	3.76	45.34	92.92	92.25
	75	36.53	12.08	2.81	33.94	92.92	
	50	24.59	12.08	1.88	22.72	92.38	
	25	12.45	12.09	0.93	11.29	90.66	
264 V AC/50 Hz	100	48.74	12.07	3.76	45.33	93.01	92.05
	75	36.53	12.08	2.81	33.94	92.90	
	50	24.64	12.08	1.88	22.72	92.21	
	25	12.51	12.09	0.93	11.29	90.27	

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REF\_45W1\_ZVS\_184XM

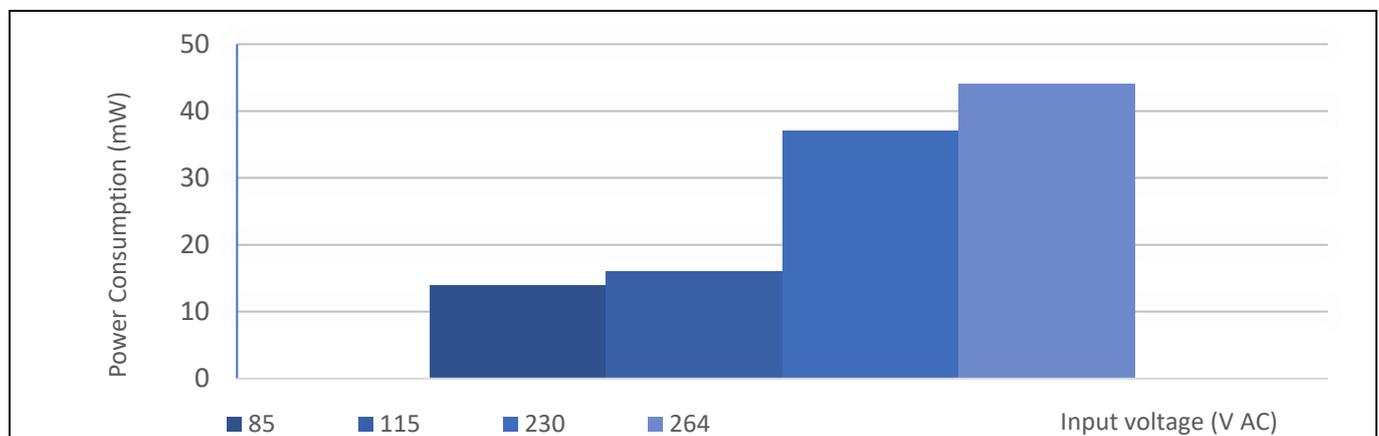
## Measurement data and graphs



**Figure 7** Efficiency vs. load and AC line RMS voltage

## 9.2 Standby input power consumption

The standby power consumption is as low as 16 mW at low line input operating voltage 115 V AC, and increases to 37 mW at high line 230 V AC. Multiple measurements were performed, including the max. and min. of the input operating voltage, as shown below in [Figure 8](#).



**Figure 8** Standby power consumption

## 9.3 ESD immunity (EN 61000-4-2)

The reference board has successfully passed the system ESD test, according to EN 61000-4-2 level 3 ( $\pm 8$  kV contact and  $\pm 15$  kV air discharge), as described in [Table 5](#). The test was conducted with the system supplied with 230 V AC and a resistive load of  $3.2 \Omega$  was connected at the output, to deliver full power. A test failure was defined as non-recoverable.

Measurement data and graphs

**Table 5 System ESD test result**

Description	ESD test	Level	Number of strikes		Test result
			V <sub>01</sub>	GNDS	
230 V AC, 45 W	Contact	±8 kV	10	10	Pass
	Air	±15 kV	10	10	Pass

**9.4 Surge immunity (EN 61000-4-5)**

The reference board was subjected to a surge immunity test according to EN 61000-4-5 level 4 (±2 kV DM and ±4 kV CM), as shown in [Table 6](#). The test was conducted with the system supplied with 230 V AC and a resistive load of 3.2 Ω was connected at the output, to deliver full power. A test failure was defined as non-recoverable.

*Note: The input line OVP was disabled to avoid triggering the protection while testing ±4 kV CM.*

**Table 6 System lightning surge immunity test result**

Description	Test	Level		Number of strikes				Test result
				0°	90°	180°	270°	
230 V AC, 45 W	DM	±2 kV	L → N	3	3	3	3	Pass
	CM	±4 kV	L → G	3	3	3	3	Pass
		±4 kV	N → G	3	3	3	3	Pass

**9.5 Conducted emissions (EN 55014)**

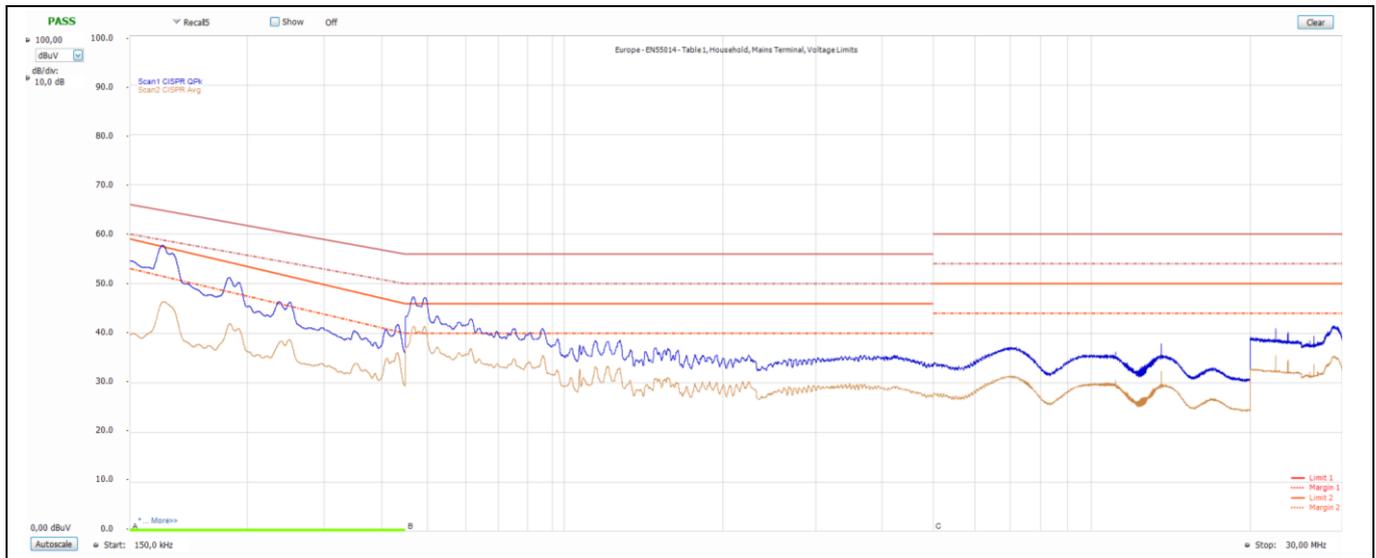
The conducted emissions test was performed at full output power following the test standard of EN 55014 (CISPR 14). The measurement was performed in phase and neutral configuration with a rated input voltage of 115 V AC/50 Hz and 230 V AC/50 Hz. The measurement equipment used for this emissions test was Rohde & Schwarz HM6050-2 and Tektronix RSA503A. A variable wire wound power resistor adjusted to 3.2 Ω was used as a load.

The results are shown in the plots below, from [Figure 9](#) to [Figure 12](#).

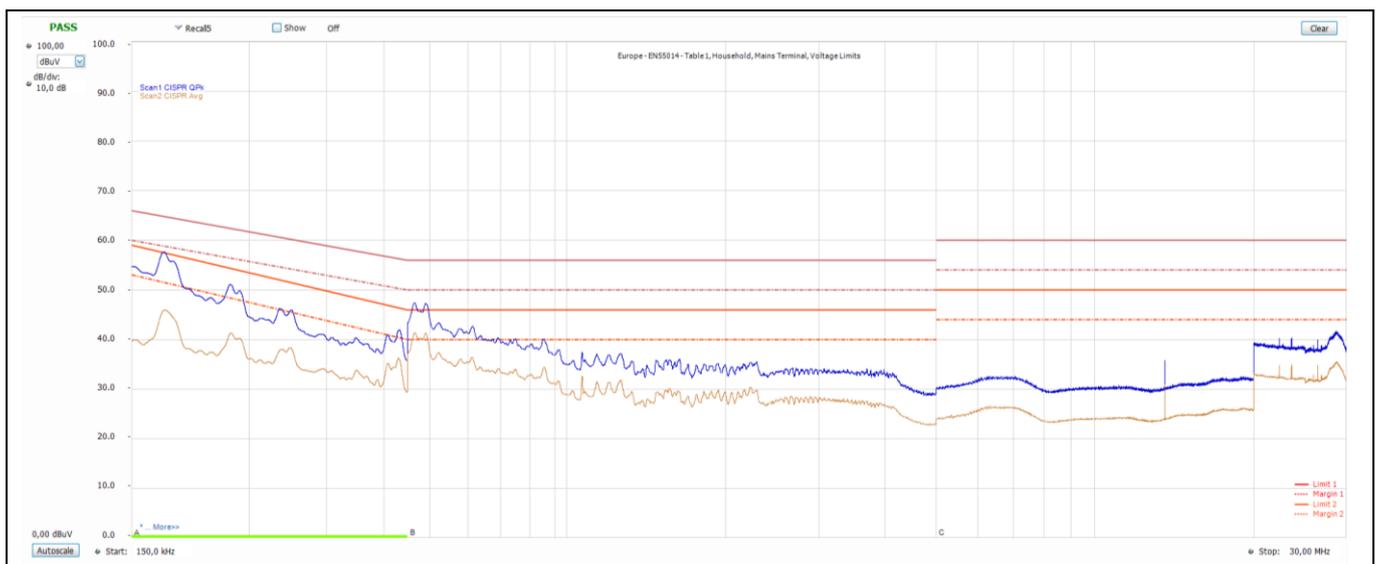
# AC-DC universal input 45 W power supply using CoolSET™ SiP ICE184XM

REF\_45W1\_ZVS\_184XM

## Measurement data and graphs



**Figure 9** Conducted emissions – phase line (L) 230 V AC

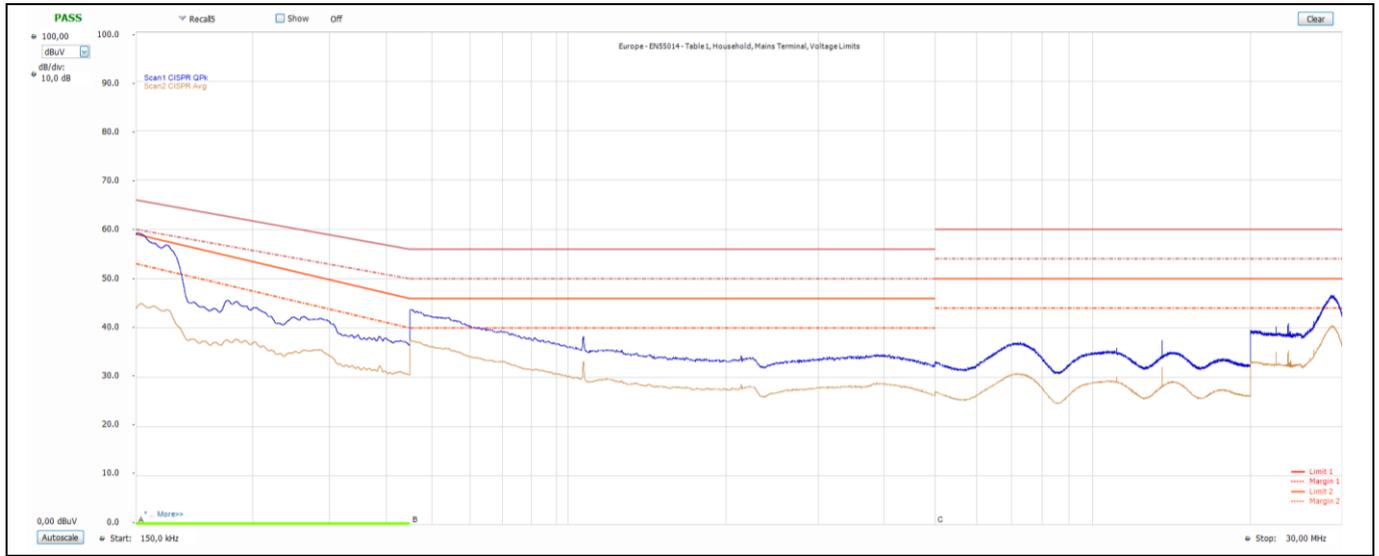


**Figure 10** Conducted emissions – neutral line (N) 230 V AC

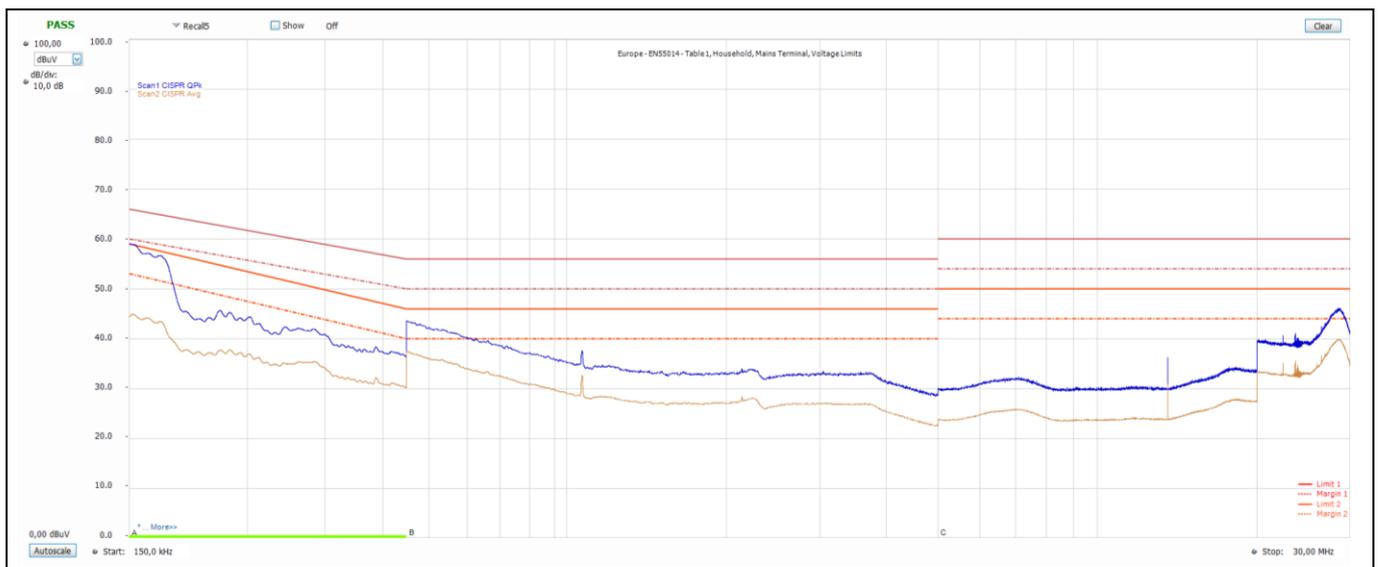
# AC-DC universal input 45 W power supply using CoolSET™ SiP ICE184XM

REF\_45W1\_ZVS\_184XM

## Measurement data and graphs



**Figure 11** Conducted emissions – phase line (L) 115 V AC



**Figure 12** Conducted emissions – neutral line (N) 115 V AC

## 9.6 Thermal measurement

The thermal testing of the reference board was executed in open air without forced ventilation at an ambient temperature of 25°C. An infrared thermography camera (FLIR-T600) was used to capture the thermal reading of critical components. The measurements were taken in both cases of 90 V AC and 264 V AC with the maximum load of 45 W on 12 V output, plus the LDO maximum load of 2.25 W on 15 V non-insulated output and one hour warm-up time.

**Table 7** Component temperature at full load under  $T_a = 25^\circ\text{C}$

IR image spot	Schematic identifier	Major component	Input voltage 90 V AC	Input voltage 264 V AC
			Temperature (°C)	Temperature (°C)
1	BR1	Bridge rectifier	73.2	–
	R21, R22	HV resistors	–	84.5
2	U1	ICE184XM controller	86.7	68.3
3	Q2	SR MOSFET	60.9	63.1
4	D1	Primary snubber diode	75.2	69.7
5	TR1	Transformer	63.2	66.5
6	U2	LDO	79.1	77.9

# AC-DC universal input 45 W power supply using CoolSET™ SiP ICE184XM



REF\_45W1\_ZVS\_184XM

Measurement data and graphs

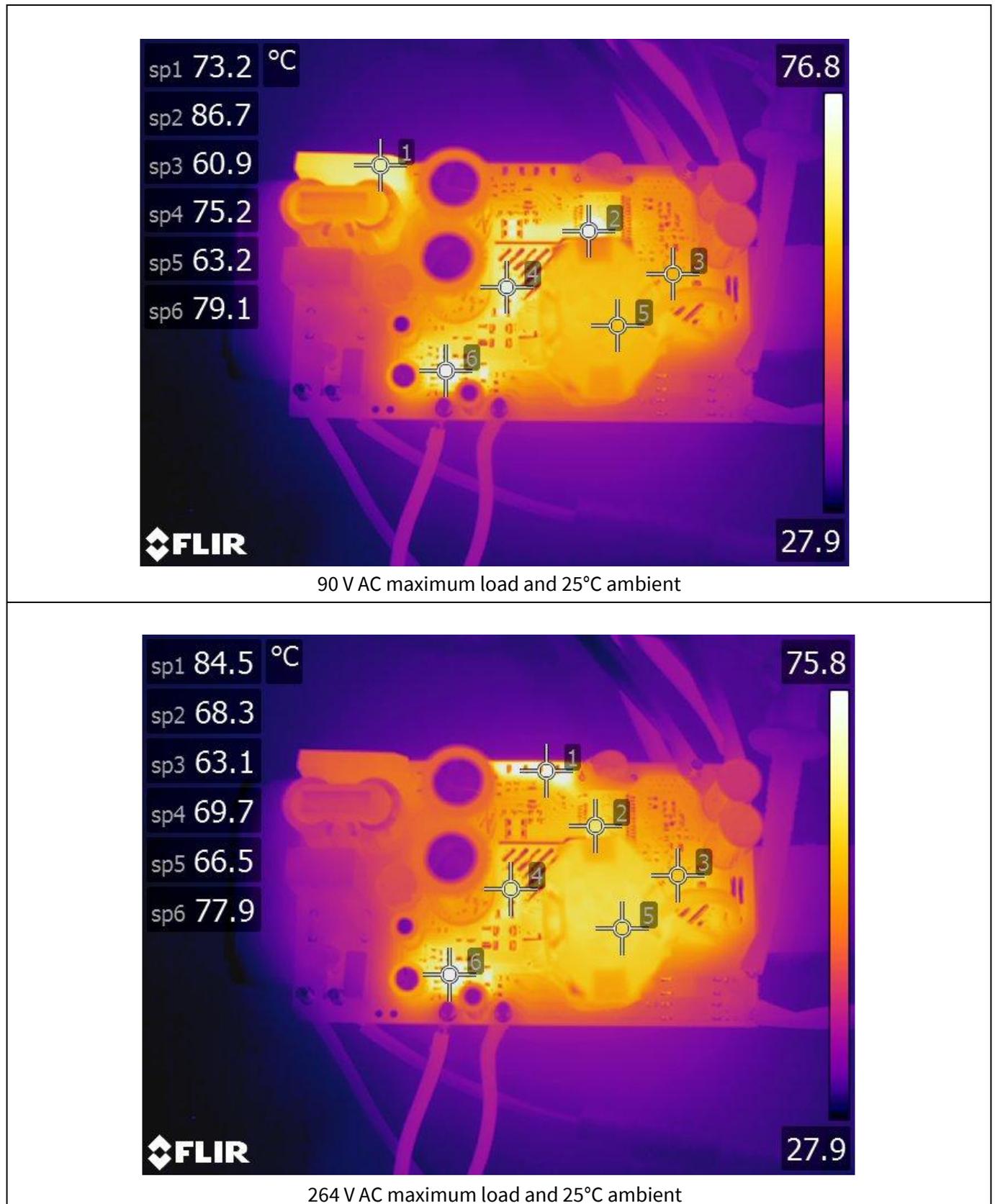


Figure 13 Thermal image of REF\_45W1\_ZVS\_184XM

# AC-DC universal input 45 W power supply using CoolSET™ SiP ICE184XM

REF\_45W1\_ZVS\_184XM

## Waveforms and scope plots

### 10 Waveforms and scope plots

The following waveforms and scope plots demonstrate the behavior of the reference board.

#### 10.1 Startup at full load

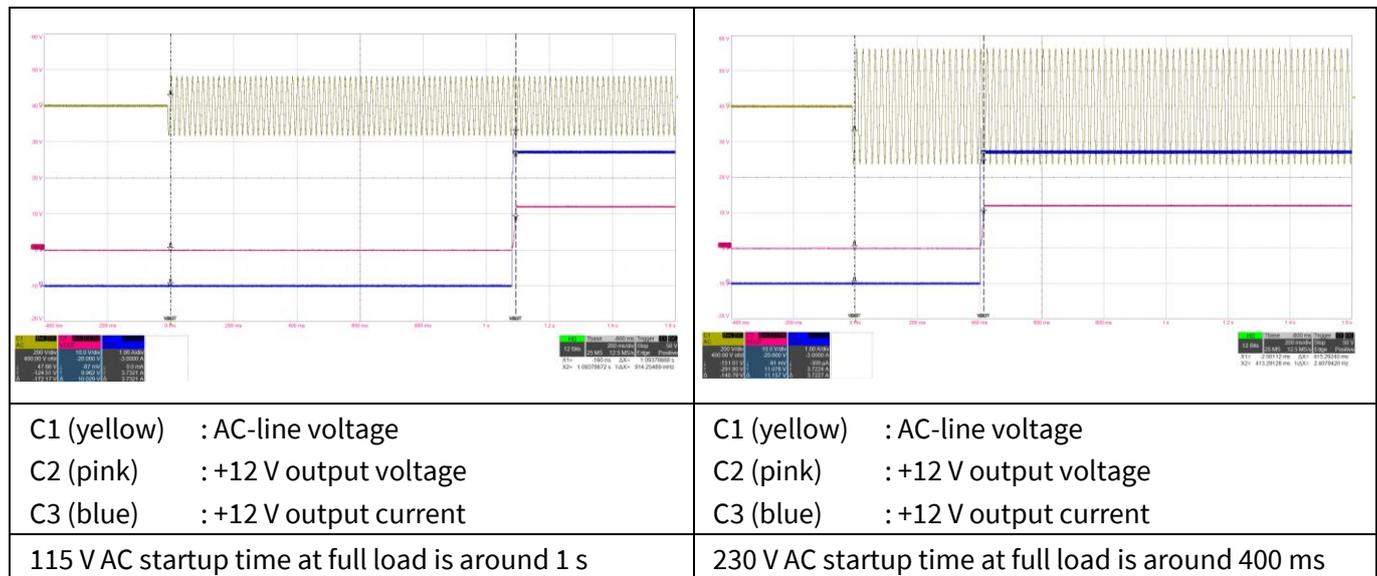


Figure 14 Startup at full load

#### 10.2 Switching waveform at full load

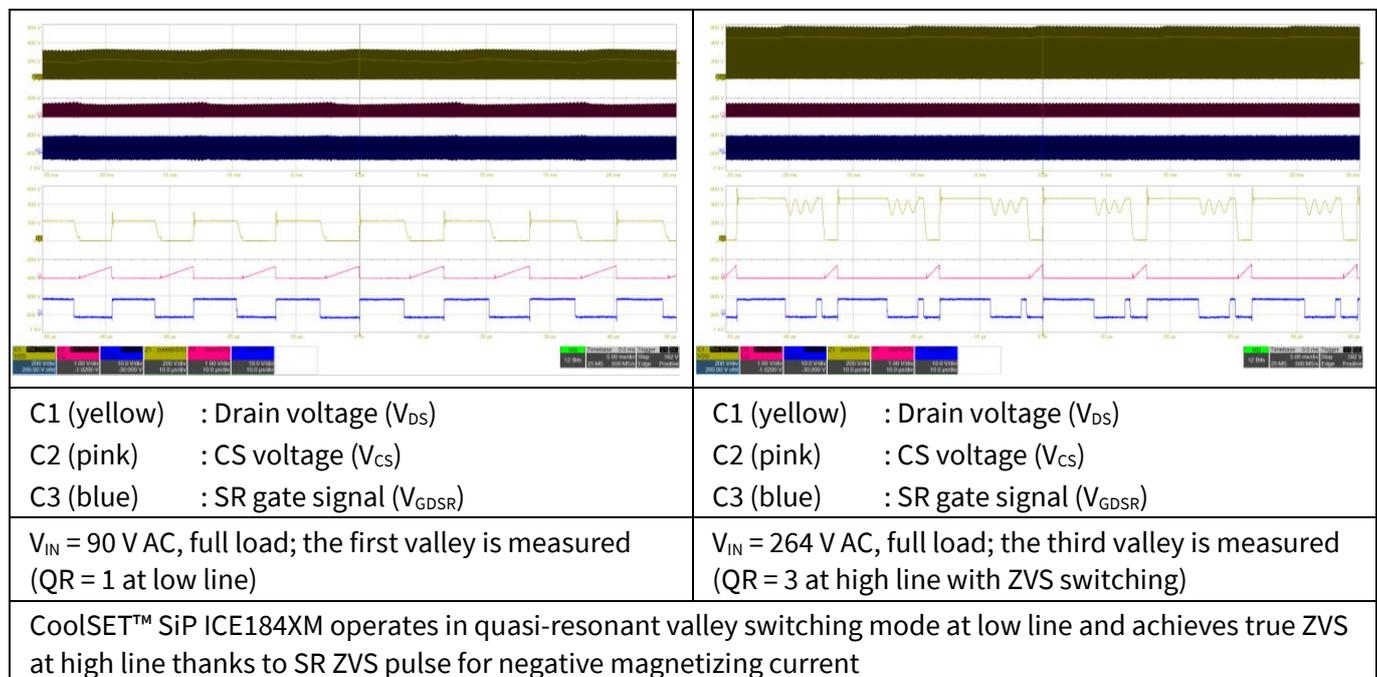


Figure 15 Switching waveform at full load

# AC-DC universal input 45 W power supply using CoolSET™ SiP ICE184XM

REF\_45W1\_ZVS\_184XM

Waveforms and scope plots

## 10.3 SR FET voltage at full load

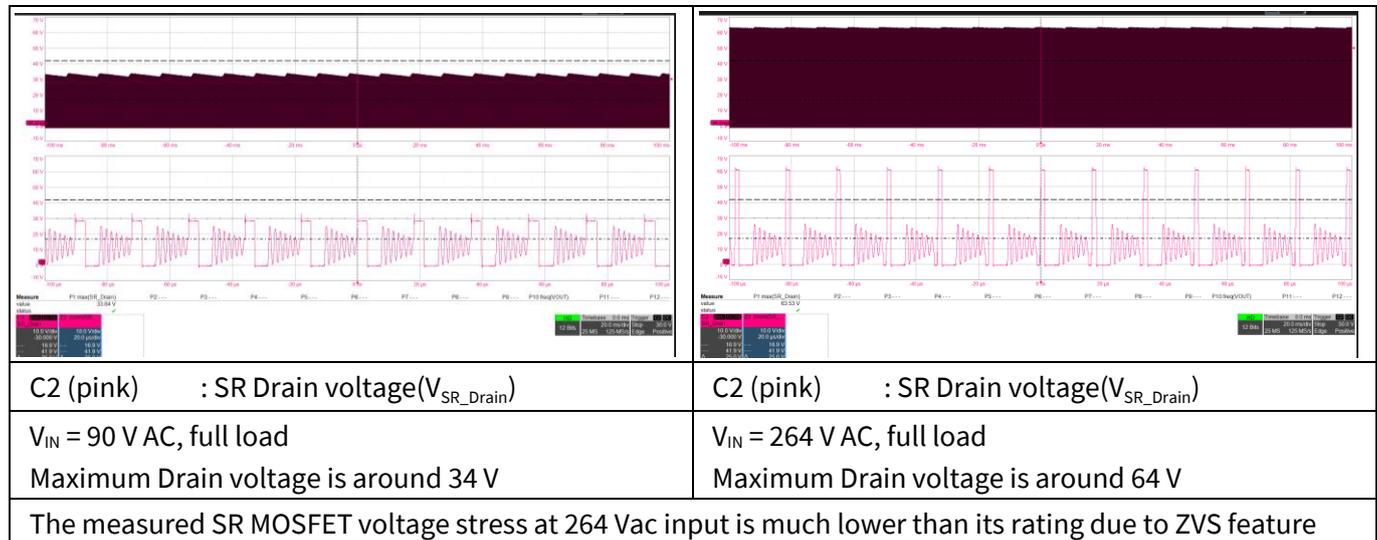


Figure 16 SR FET voltage

## 10.4 Output voltage ripple

The output voltage ripple was measured at 90 V AC and 264 V AC input and 45 W (full load) output, as shown in Figure 17. One 47  $\mu\text{F}$  electrolytic capacitor in parallel with 0.1  $\mu\text{F}$  ceramic capacitor is placed on the output for the ripple voltage reading. The oscilloscope probes were limited to 20 MHz bandwidth.

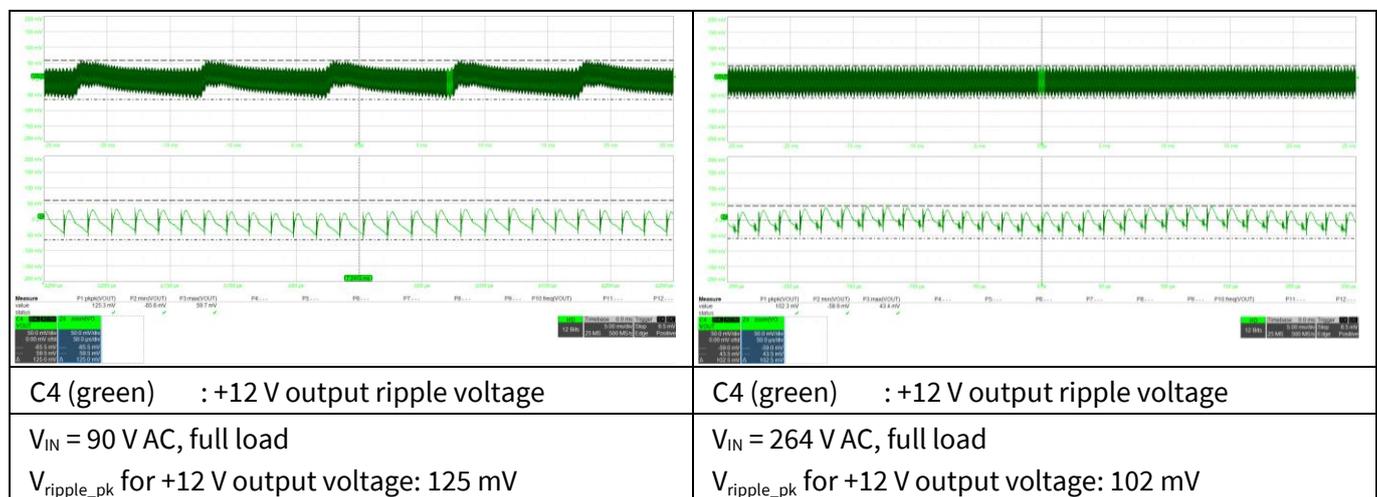


Figure 17 Output voltage ripple at full load

## 10.5 Load-transient response

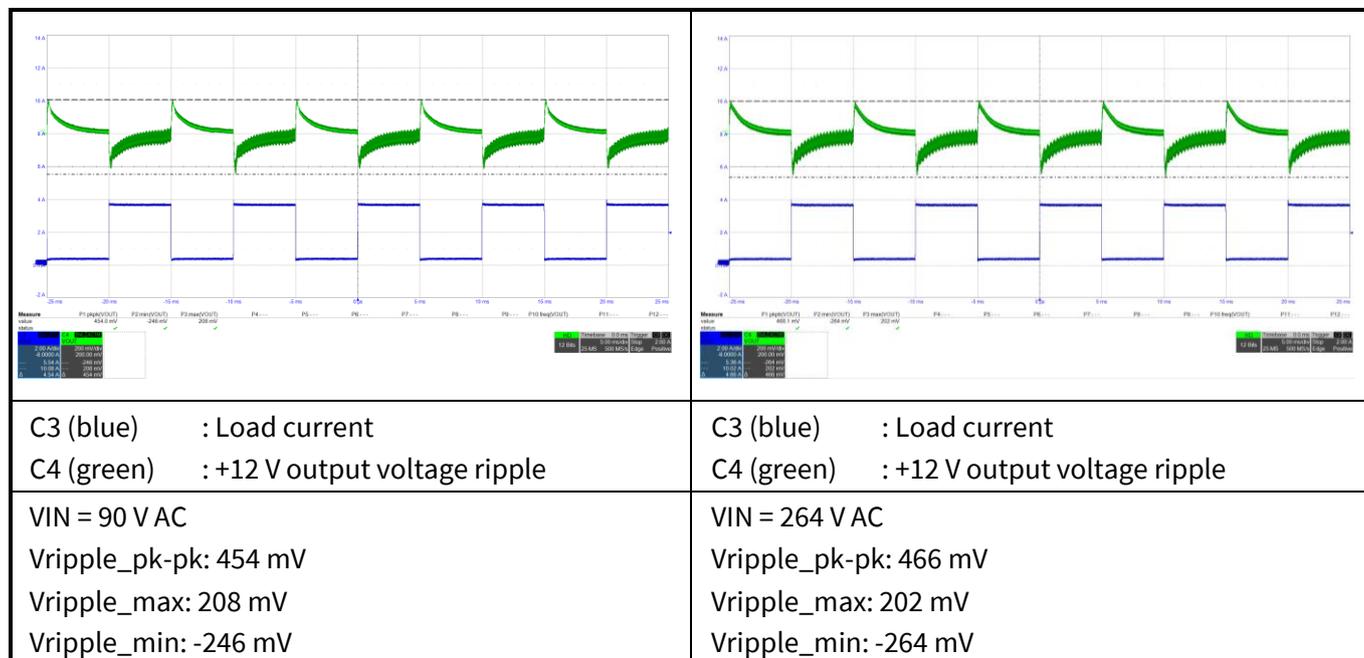
The load-transient response of the system was tested at 90 V AC and 264 V AC input, as shown in Figure 18. The load-transient conditions are the following: +12 V output load change from 10% (0.375 A) to 100% (3.75 A) at 0.4 A/ $\mu\text{s}$  slew rate, 50 percent duty cycle and 100 Hz frequency. Oscilloscope probes were limited to 20 MHz bandwidth. One 47  $\mu\text{F}$  electrolytic capacitor in parallel with 0.1  $\mu\text{F}$  ceramic capacitor were placed on the output for the ripple voltage reading.

# AC-DC universal input 45 W power supply using CoolSET™ SiP ICE184XM

## REF\_45W1\_ZVS\_184XM

### Waveforms and scope plots

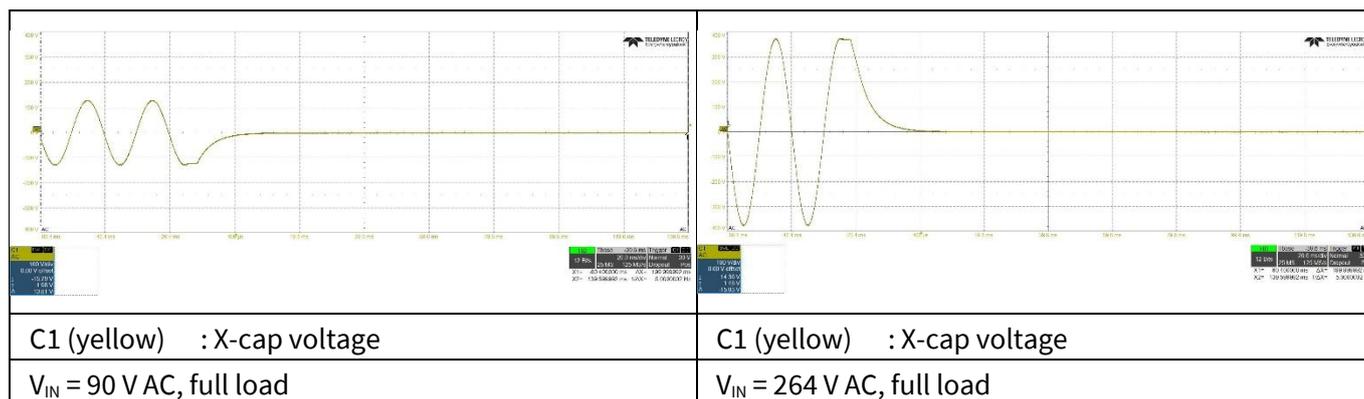
The yellow trace from bottom plot represents the output voltage ripple at 264 V AC input, and the blue trace overlapped under it represents the output voltage ripple at 85 V AC input. Small differences between the two results can be observed.



**Figure 18** Output voltage response at load-transient 10% - 100%

## 10.6 X-cap discharge function

The integrated function of X-cap discharge is demonstrated by the oscilloscope captures shown in [Figure 19](#).



**Figure 19** X-cap discharge after AC input off

## **11 Related resources**

- [AC-DC integrated power stage - CoolSET™](#)
- [Power Management ICs](#)
- [REF\\_45W1\\_ZVS\\_184XM](#)

# AC-DC universal input 45 W power supply using CoolSET™ SiP ICE184XM

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REF\_45W1\_ZVS\_184XM

## References

## References

- [1] Infineon Technologies AG: Datasheet - ICE18xXM CoolSET™ SiP System in Package IC Gen 1 (G1) XM Series; [Available online](#)
- [2] Infineon Technologies AG: Design guide – Design guide for ZVS QR flyback converter using CoolSET™ SiP; [Available online](#)
- [3] Infineon Technologies AG: Calculation tool - CoolSET™ SiP; [Available online](#)

# AC-DC universal input 45 W power supply using CoolSET™ SiP ICE184XM



REF\_45W1\_ZVS\_184XM

## Revision history

### Revision history

Document revision	Date	Description of changes
V 1.0	2025-09-30	Initial release

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