

# RRW21111-153+IW673-20 FOR 65W ADAPTER DESIGN EBC10298

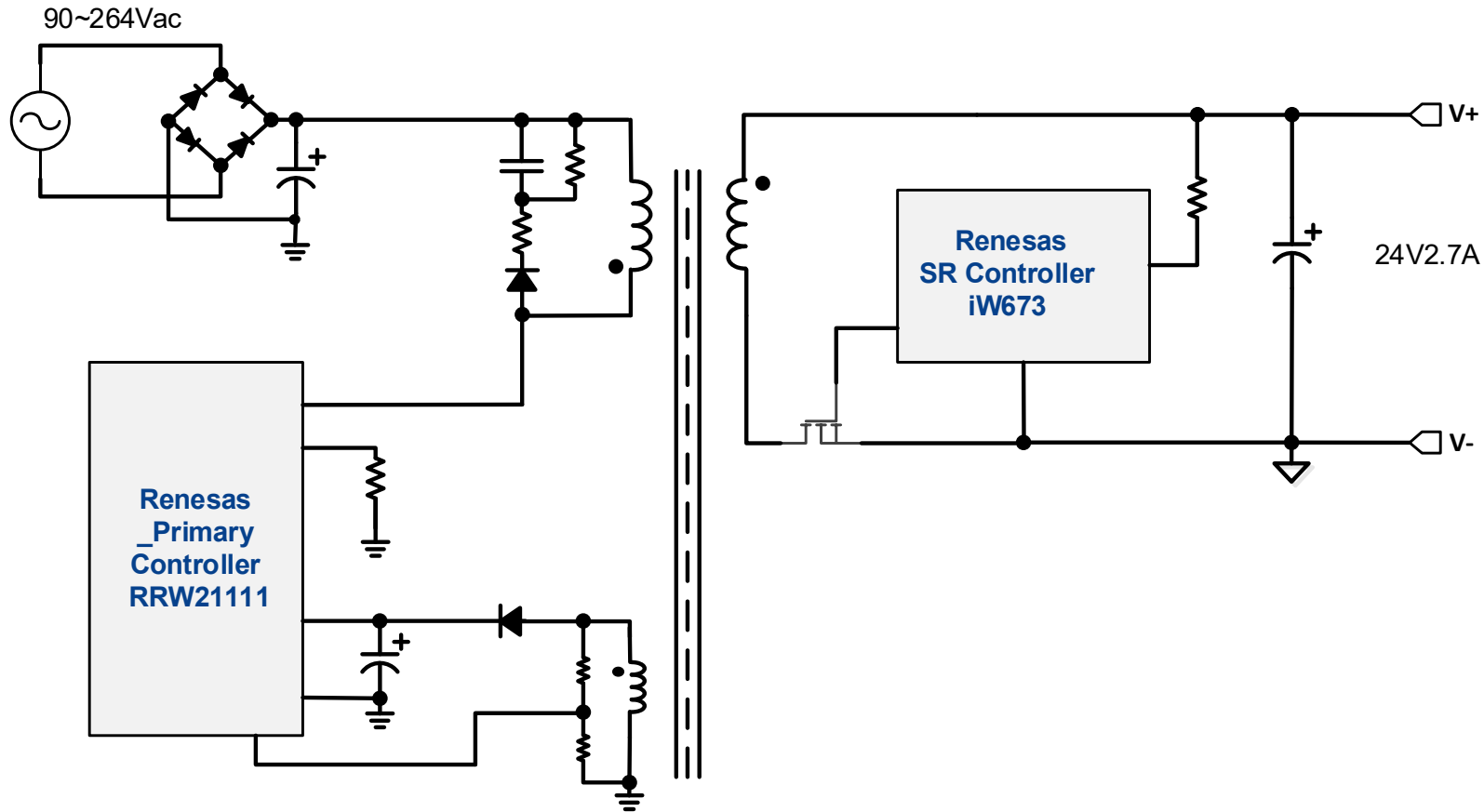
## GENERAL DESIGN SPECIFICATION:

1. AC INPUT RANGE: 90-264V<sub>AC</sub>
2. DC OUTPUT: 24V2.7A
3. MEET BOTH “COC\_V5\_TIER2” AND “DOE\_VII” EFFICIENCY REQUIREMENT
4. STANDBY POWER <150mW
5. INTEGRATED GaNFET APPLICATION

NOTE: This reference design document is intended as a design idea to show potential capability of this integrated circuit device. Evaluation boards may not be available.

August 2025; Rev. 1.0

# BLOCK DIAGRAM OF EBC10298



# WARNING

## DISCLAIMER FOR HIGH VOLTAGE (MAINS POWERED) EVALUATION BOARDS

### Warning

This evaluation board is powered by AC mains voltage. When powered, this evaluation board generates non-insulated high voltages which may produce electrical shock, burn, and/or fire hazards, resulting in risk of property damage, personal injury, and/or death.

**When the evaluation board is powered, never touch the board or its electrical circuits since they may be operating at high voltages that can cause an electrical shock hazard.**



### TO BE USED FOR EVALUATION PURPOSES ONLY

This board is intended for evaluation purposes only and not intended for commercial use in an end product. Any other use is strictly prohibited by Renesas Electronics Corporation and its Subsidiaries ("Renesas").

### WORK AREA AND PERSONAL SAFETY

This board should be used in a test area/laboratory specifically designed and designated for working with, and evaluating high-voltage electrical devices. Only trained and qualified professional personnel with experience, knowledge and training in the use of high-voltage electrical circuits should use this evaluation board. Trained personnel must use required personal protective equipment and required laboratory equipment when working with the evaluation board.

The professional personnel operating this evaluation board and the test area/laboratory in which it is operated must be qualified according to the local regulations, guidelines and labor laws applicable to working with non-isolated mains voltages and high voltage circuits.

An isolated housing is highly recommended when using this evaluation board.

Use this evaluation board at your own risk.

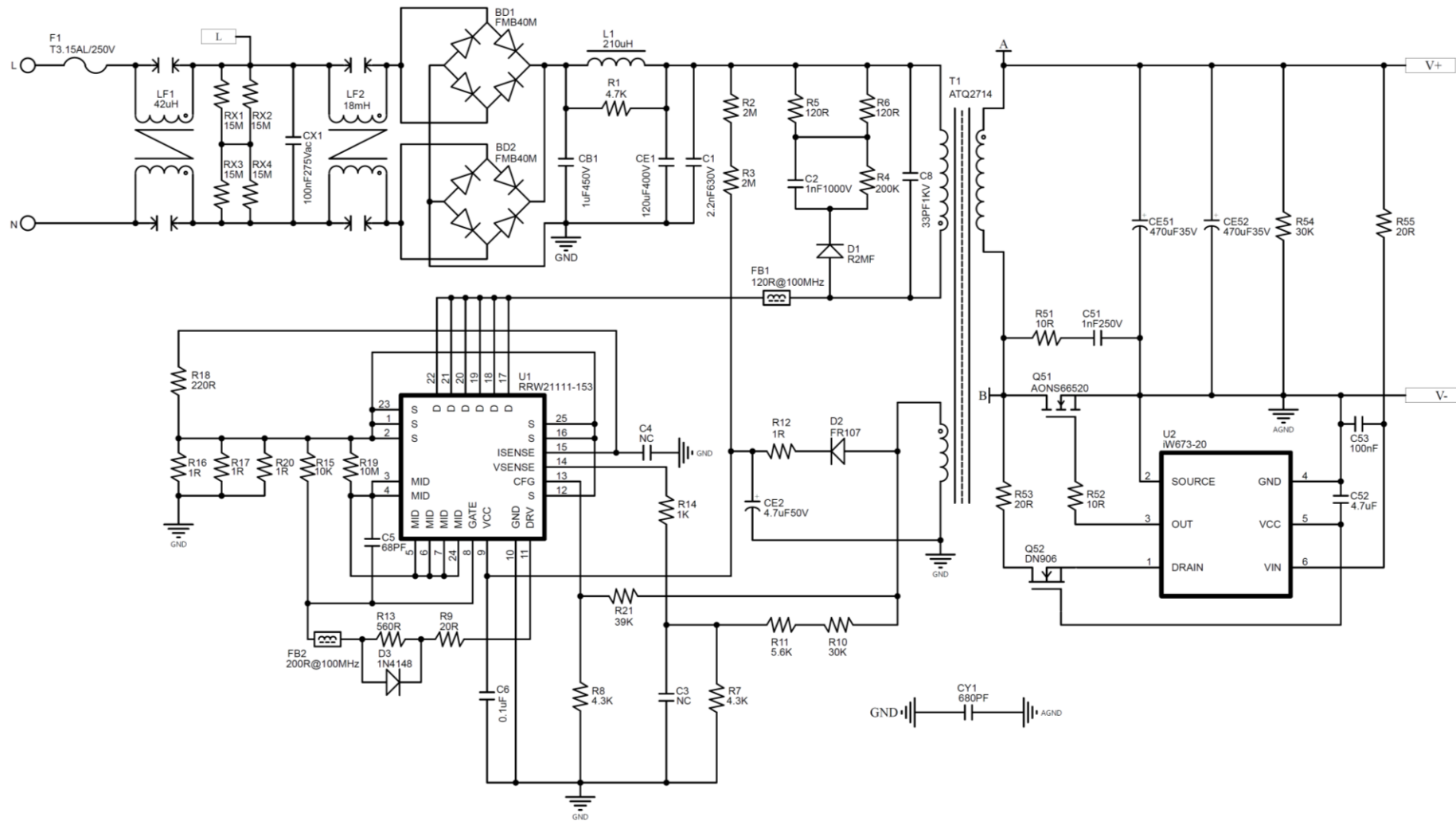
### NOT AGENCY APPROVED

This evaluation board has not been agency tested or approved for safety, technical performance, and/or regulatory requirements, such as electromagnetic interference or other technical regulatory or safety requirements.

# 1. GENERAL SPECIFICATION

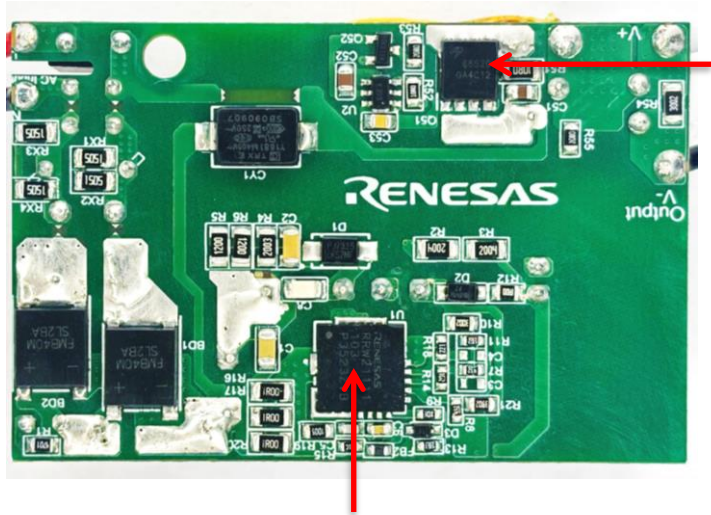
Description	Symbol	Min	Typ	Max	Units	Comment
Input Voltage	$V_{IN}$	90		264	V <sub>AC</sub>	2 Wire
Frequency	$f_{LINE}$	47	50/60	63	Hz	
No-load Input Power (230V <sub>AC</sub> )				150	mW	
Output Voltage	$V_{OUT_{CV}}$	22.8	24	25.2	V	Measured at PCB-end
Output Current	$I_{OUT}$		2.7		A	
Ripple & Noise	$V_{RIPPLE}$			300	mV <sub>P-P</sub>	Add 0.1uF Ceramic capacitor and 10uF E-cap at the end of cable and set oscilloscope at 20MHz bandwidth.
Over Current Protection	$I_{OCP}$			3.24	A	
Conducted EMI		Meets FCC Part 15B / EN55032B				Output is Connected to Ground
Safety		Designed to meet IEC60950, UL1950 Class II				
Ambient Temperature	$T_{AMB}$	0		25	° C	Free convection, sea level

## 2. SCHEMATIC



### 3. CIRCUIT BOARD PHOTOGRAPH

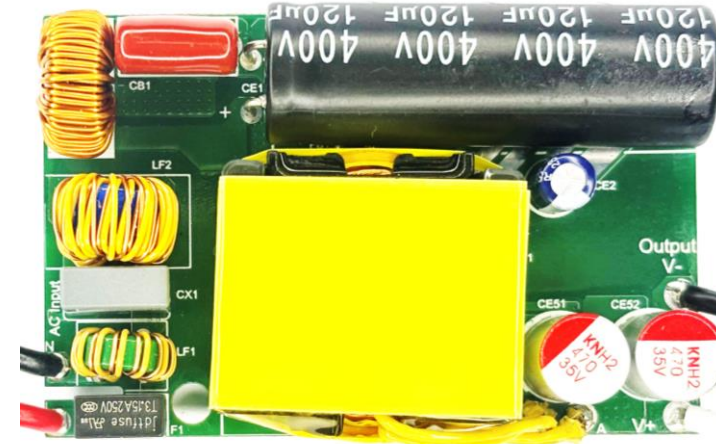
Bottom View



iW673-20  
SR Controller

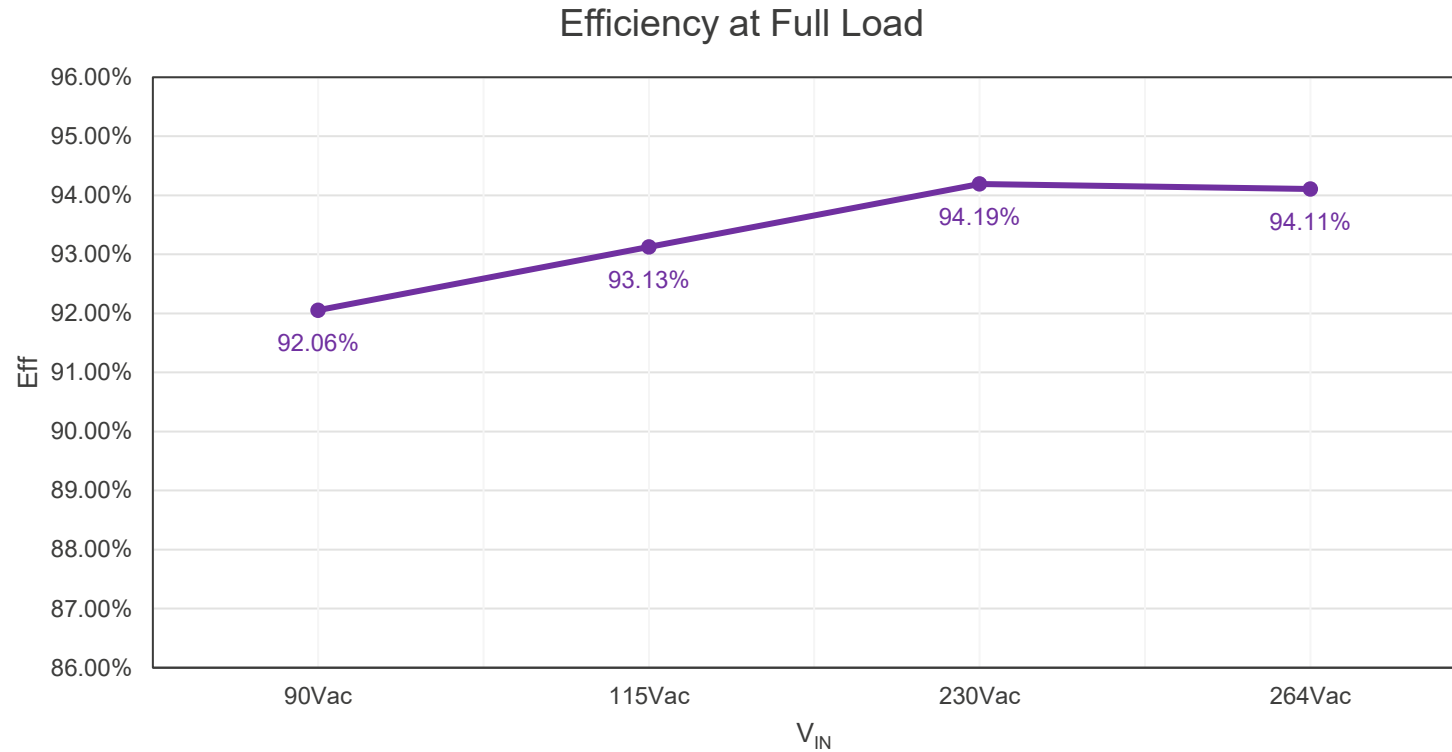
RRW21111-153  
Primary Controller  
Integrated GaNFET

Top View



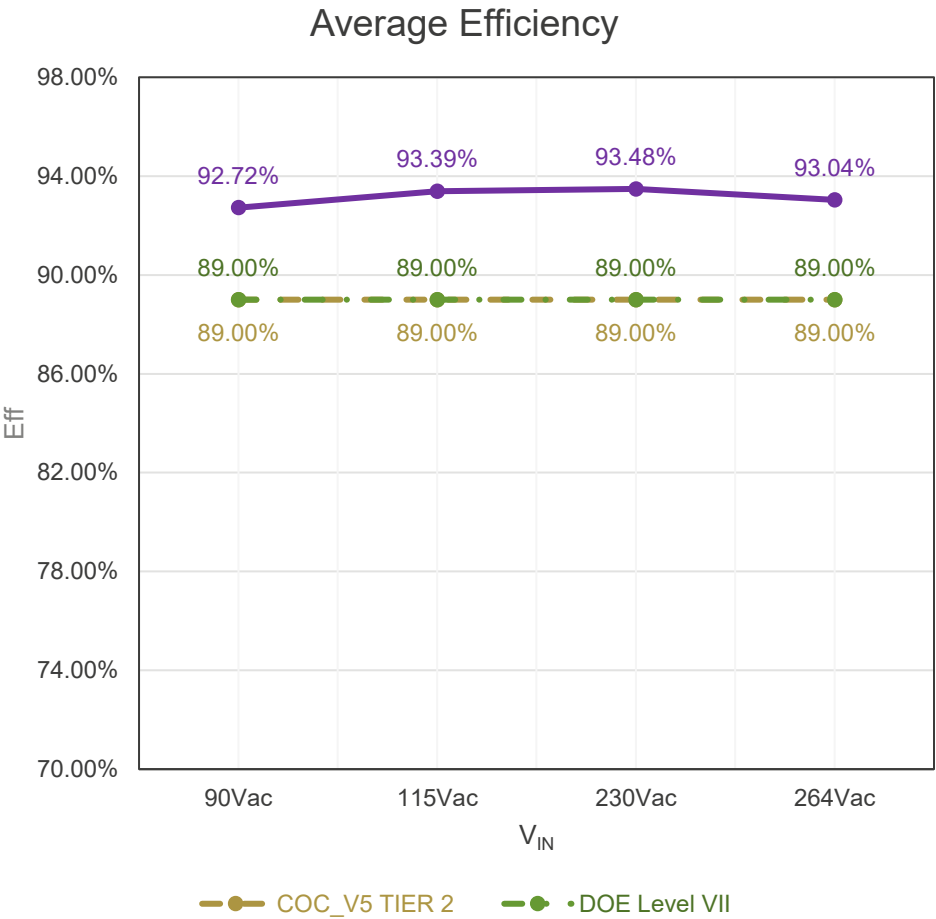
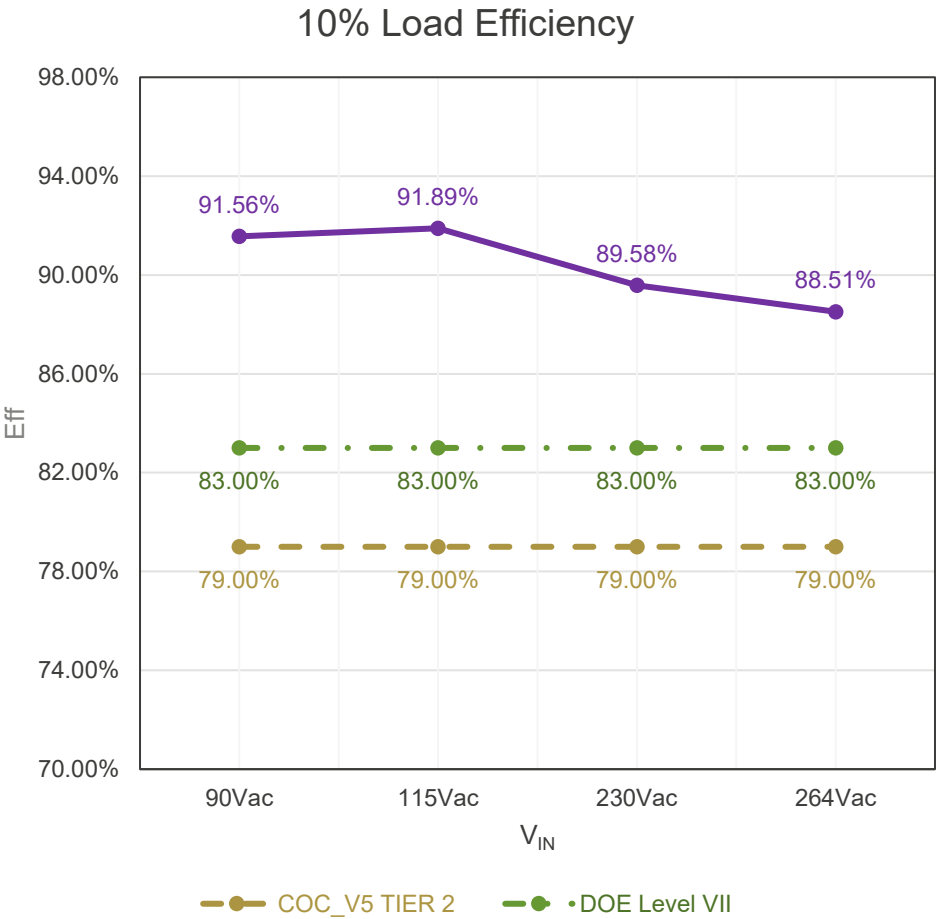
\*Power Density: 1.5w/cm<sup>3</sup>

## 4. EFFICIENCY AT FULL LOAD



\*Note: The output voltage is measured at PCB-end.

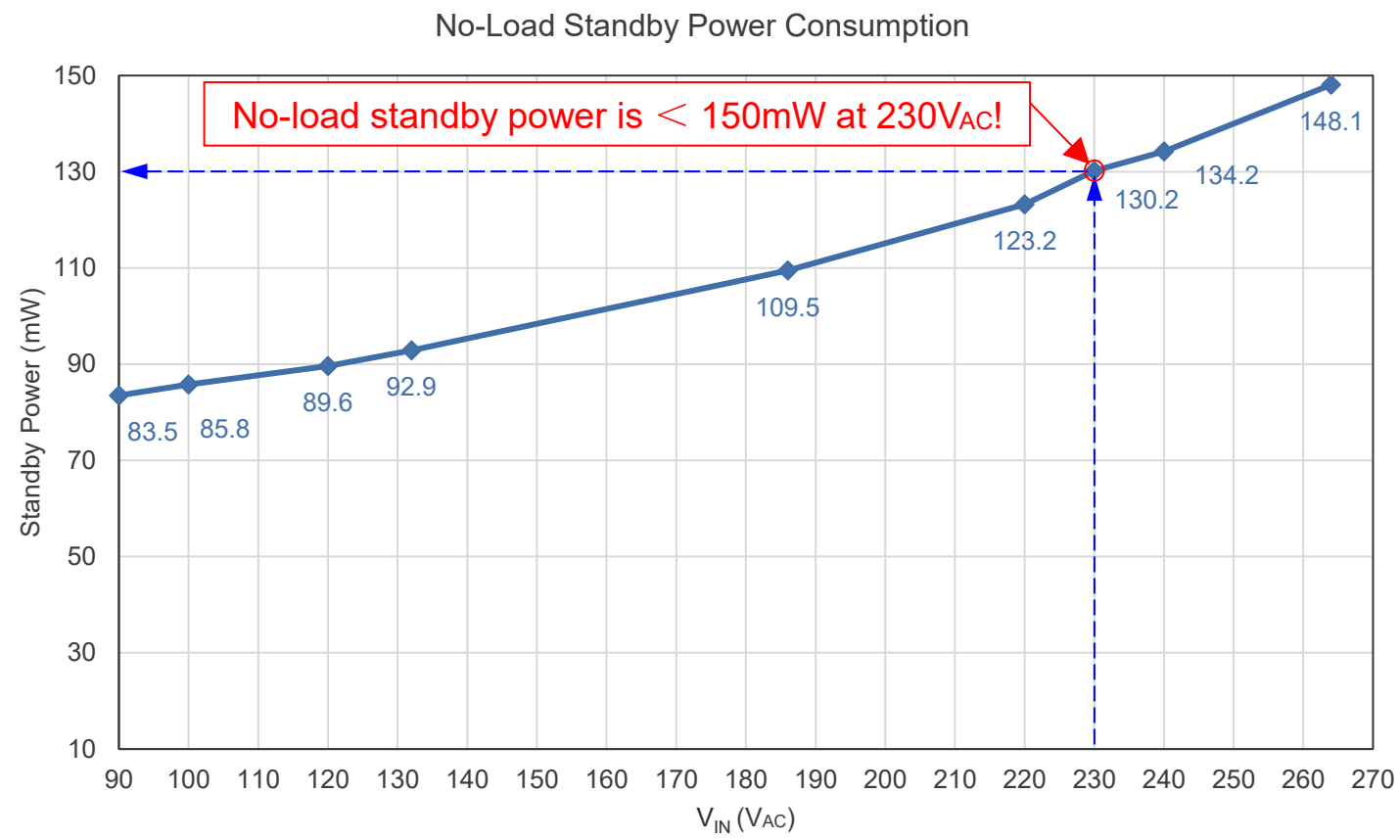
# 5. ACTIVE MODE EFFICIENCY



\*Note: The output voltage is measured at PCB-end.

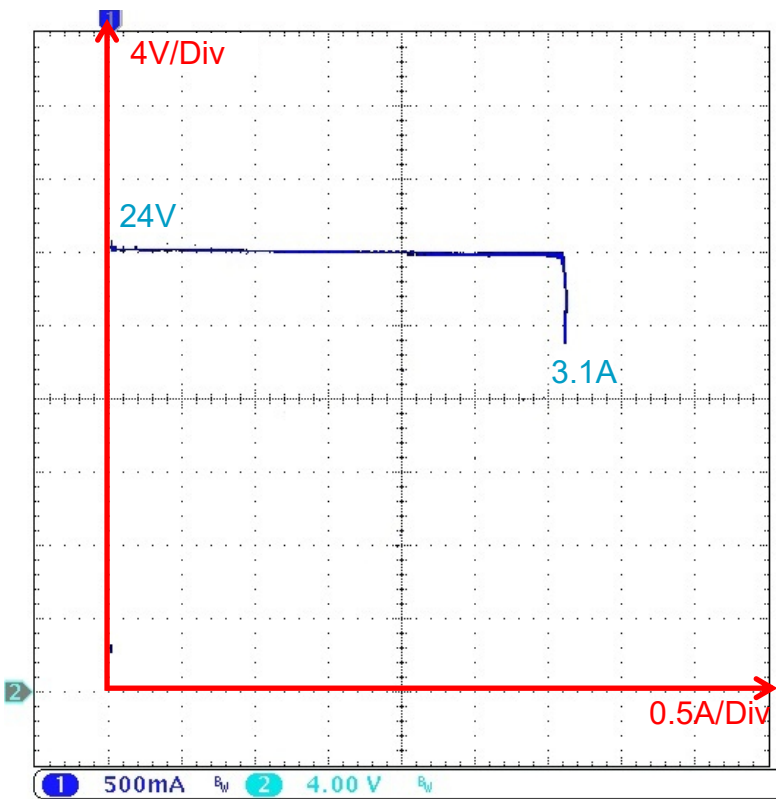


# 6. NO-LOAD STANDBY POWER

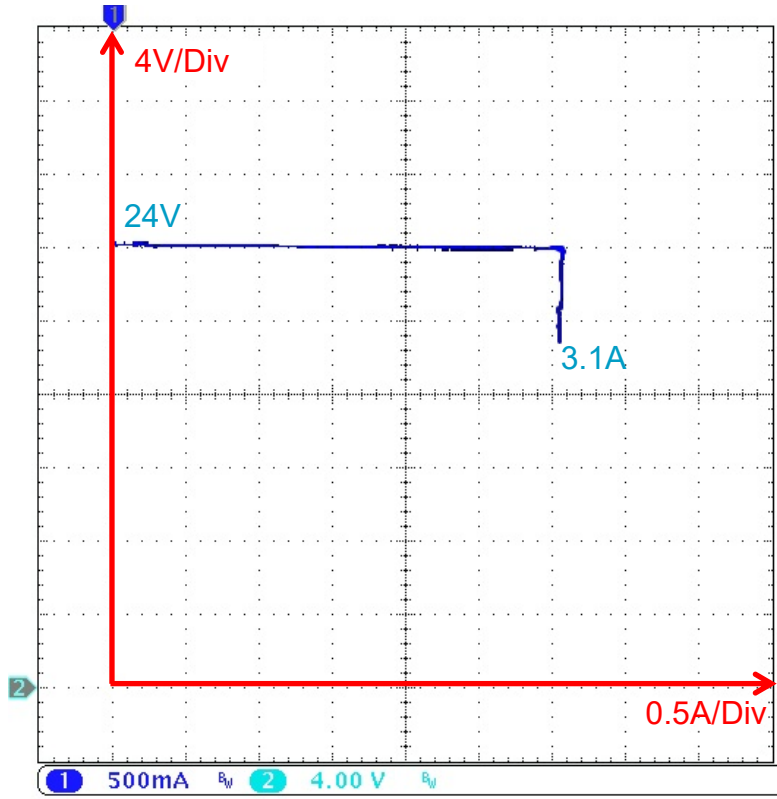


# 7. OUTPUT VI CHARACTERISTICS

$V_{IN}=90V_{AC}/60Hz$



$V_{IN}=264V_{AC}/50Hz$



\*Note:  
1. The output voltage is monitored at PCB-end.

# 8. OUTPUT VOLTAGE RIPPLE

$V_{OUT}$	$V_{IN}$ / $I_{OUT}$	0A	0.27A	0.68A	1.35A	2.03A	2.70A
24V	90V <sub>AC</sub>	46mV	52mV	103mV	127mV	177mV	256mV
	115V <sub>AC</sub>	52mV	45mV	43mV	102mV	151mV	274mV
	230V <sub>AC</sub>	52mV	156mV	46mV	119mV	175mV	271mV
	264V <sub>AC</sub>	51mV	112mV	49mV	126mV	192mV	243mV

\*Note:  
1. Add 0.1uF Ceramic capacitor and 10uF E-cap at PCB-end.  
2. Set oscilloscope to 20MHz bandwidth.

# 9. DYNAMIC LOAD RESPONSE

Dynamic Load Condition			24V 0.27A-2.43A-0.27A, Slew:0.5A/us				
			1Hz	10Hz	100Hz	1kHz	5kHz
24V (22.8V<Vo<25.2V)	90V <sub>AC</sub> / 60Hz	V <sub>O_MIN</sub> (V)	23.33	23.31	23.29	23.51	23.92
		V <sub>O_MAX</sub> (V)	24.36	24.39	24.47	24.52	24.37
	264V <sub>AC</sub> / 50Hz	V <sub>O_MIN</sub> (V)	23.42	23.32	23.39	23.45	23.80
		V <sub>O_MAX</sub> (V)	24.43	24.45	24.50	24.51	24.34



Dynamic Load  
esponse Waveforr

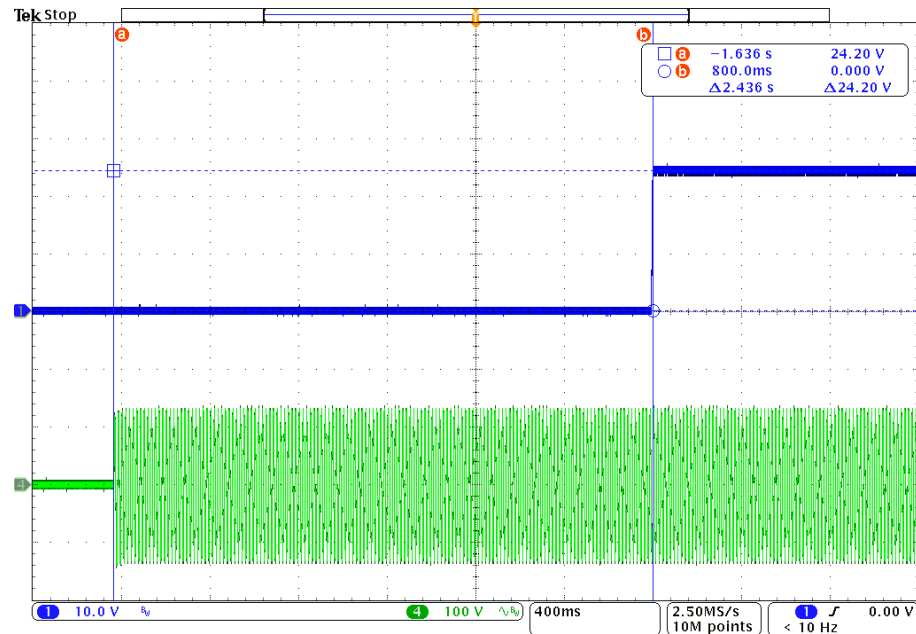
\*Note

- 1. The output voltage is measured at PCB-end.
- 2. Refers to detail waveform as enclosed file.

# 10. TURN-ON DELAY TIME

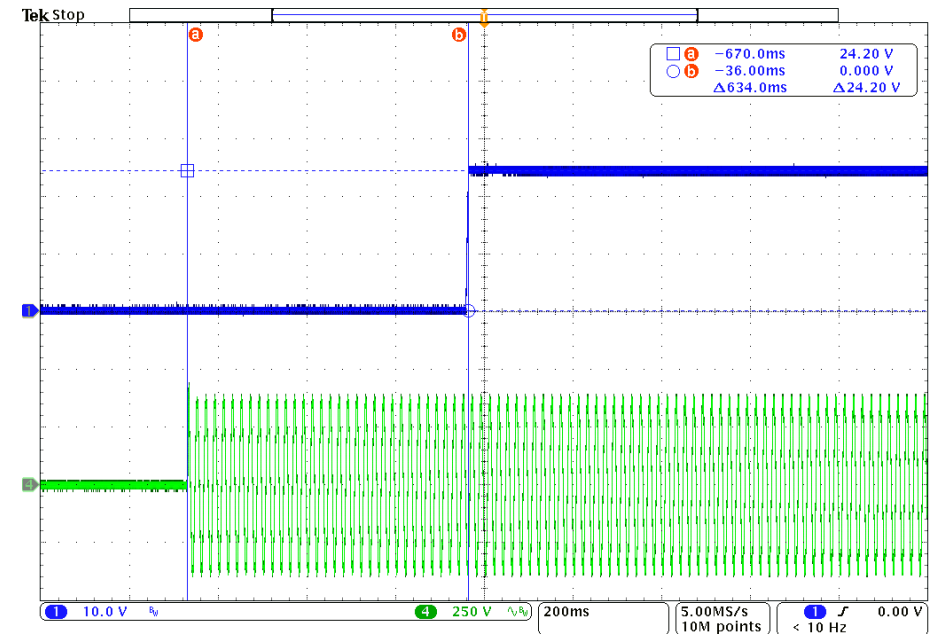
90VAC, No Load

$T_{ST\_DELAY} = 2.436S$



264VAC, No Load

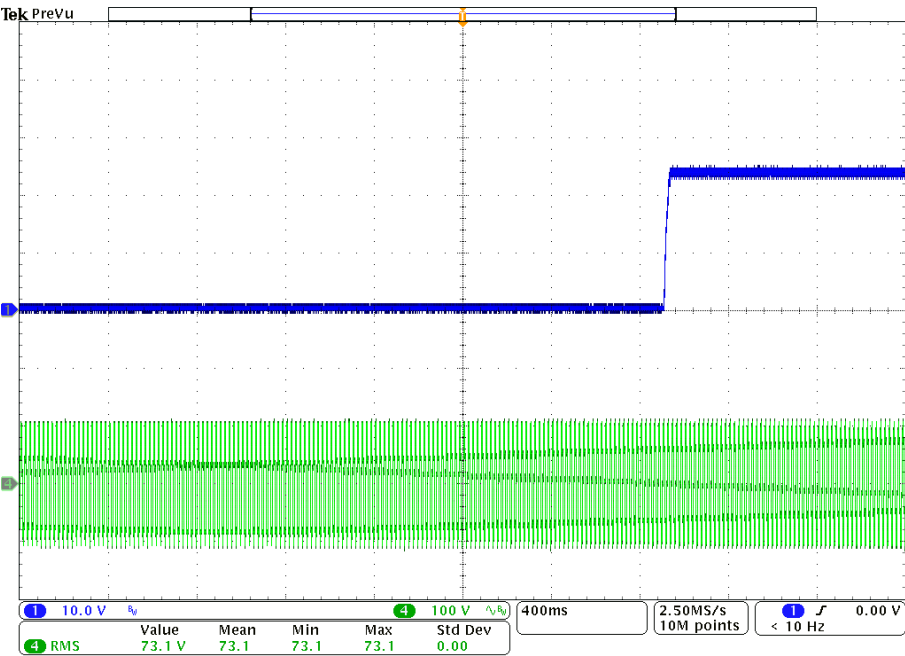
$T_{ST\_DELAY} = 0.634S$



# 11. AC BROWN IN/OUT VOLTAGE

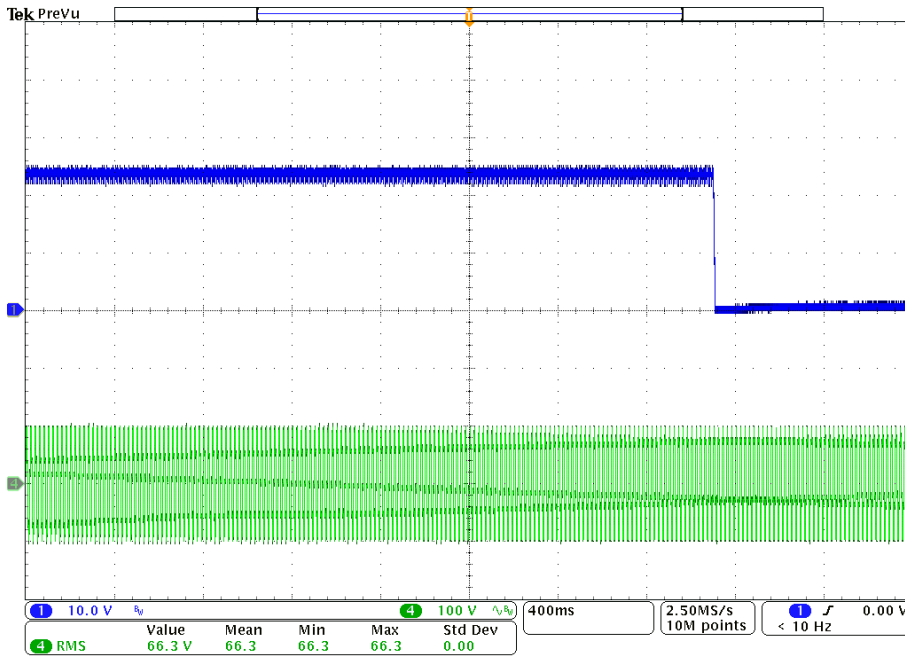
Full Load

$V_{IN\_STARTUP} = 73.1V_{AC}$



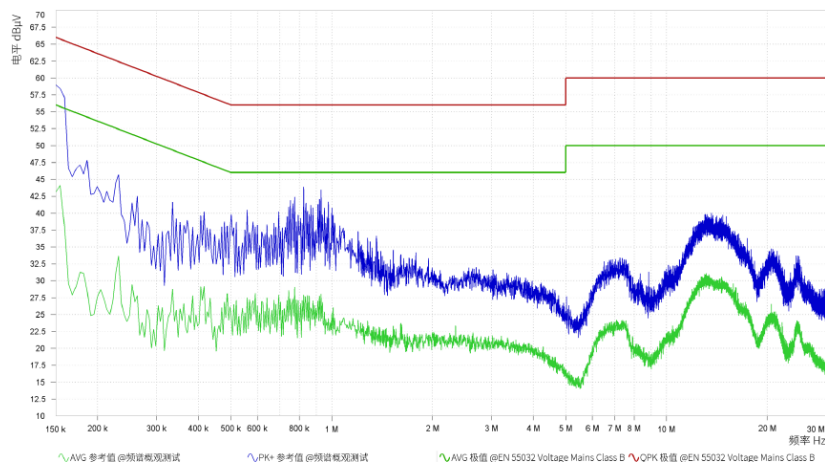
Full Load

$V_{IN\_BROWNOUT} = 66.3V_{AC}$

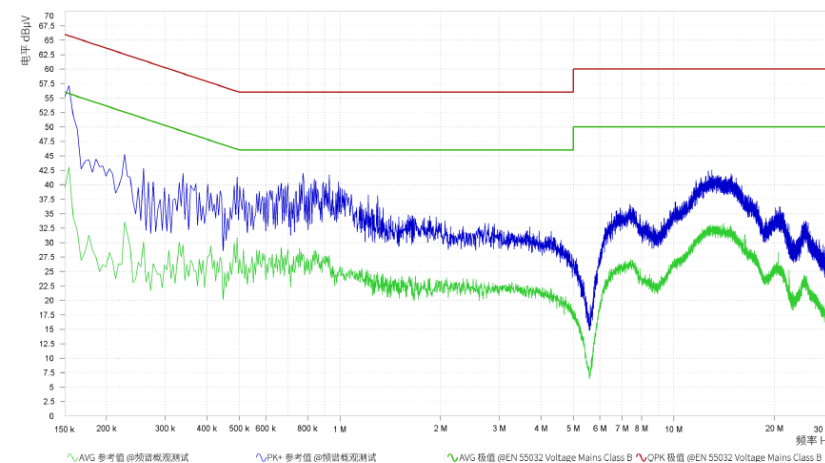


# 12. CONDUCTED EMI WITH FULL LOAD

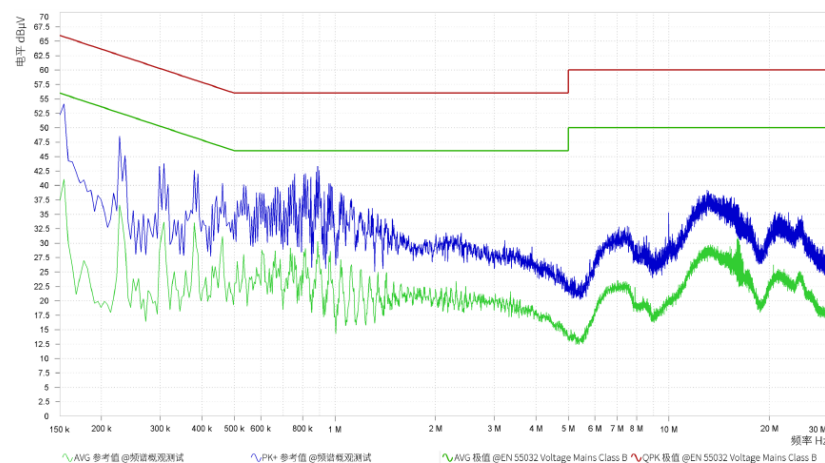
$V_{IN}=120V_{AC}/60Hz$ , Live



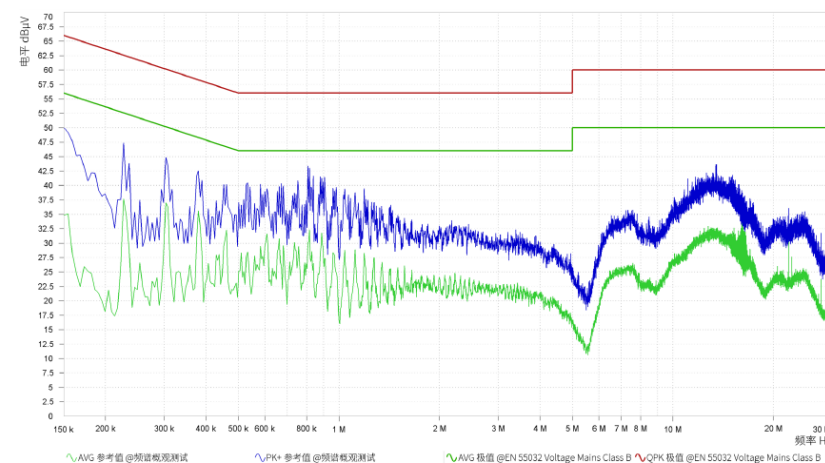
$V_{IN}=120V_{AC}/60Hz$ , Neutral



$V_{IN}=230V_{AC}/50Hz$ , Live



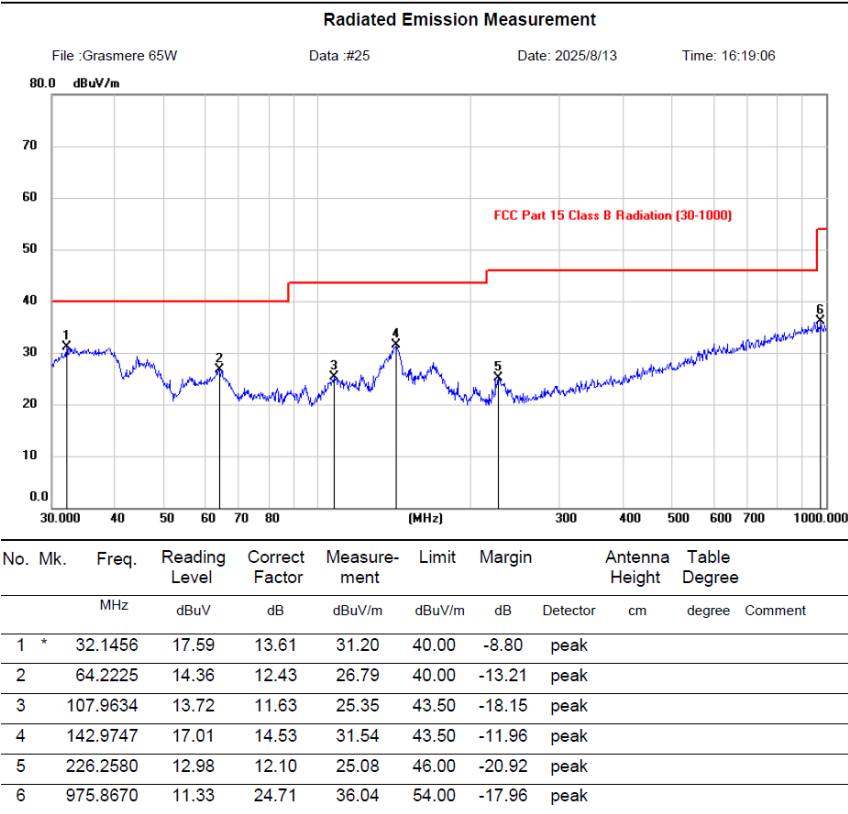
$V_{IN}=230V_{AC}/50Hz$ , Neutral



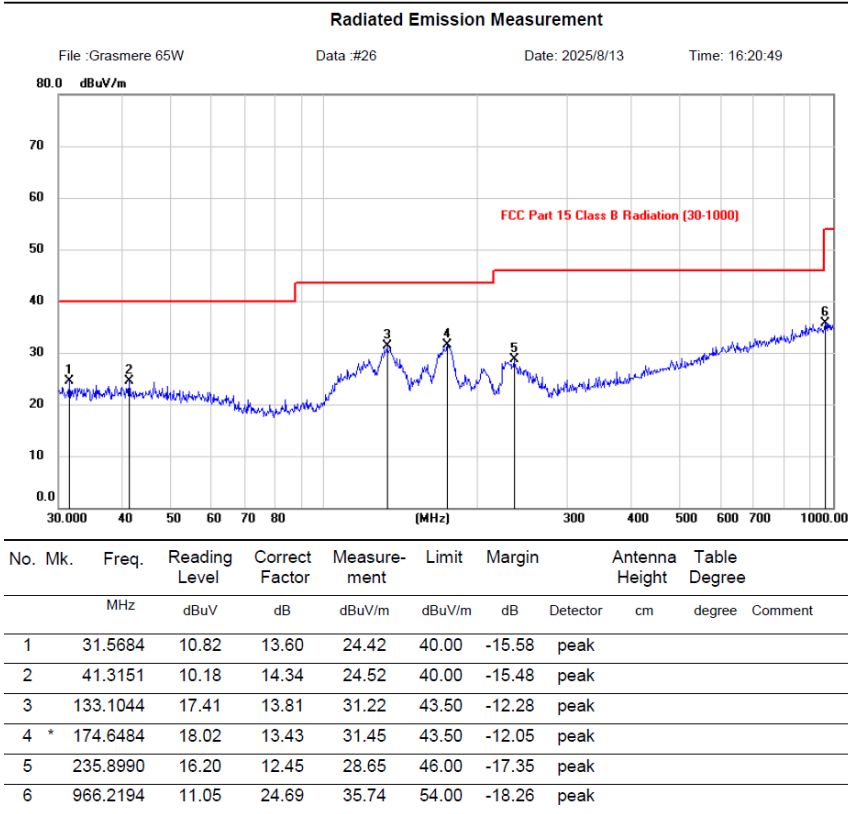
\*Note: Output “-” is connected to Earth.

# 13.1 RADIATED EMI WITH FULL LOAD

$V_{IN}=120V_{AC}/60Hz$ , Vertical



$V_{IN}=120V_{AC}/60Hz$ , Horizontal

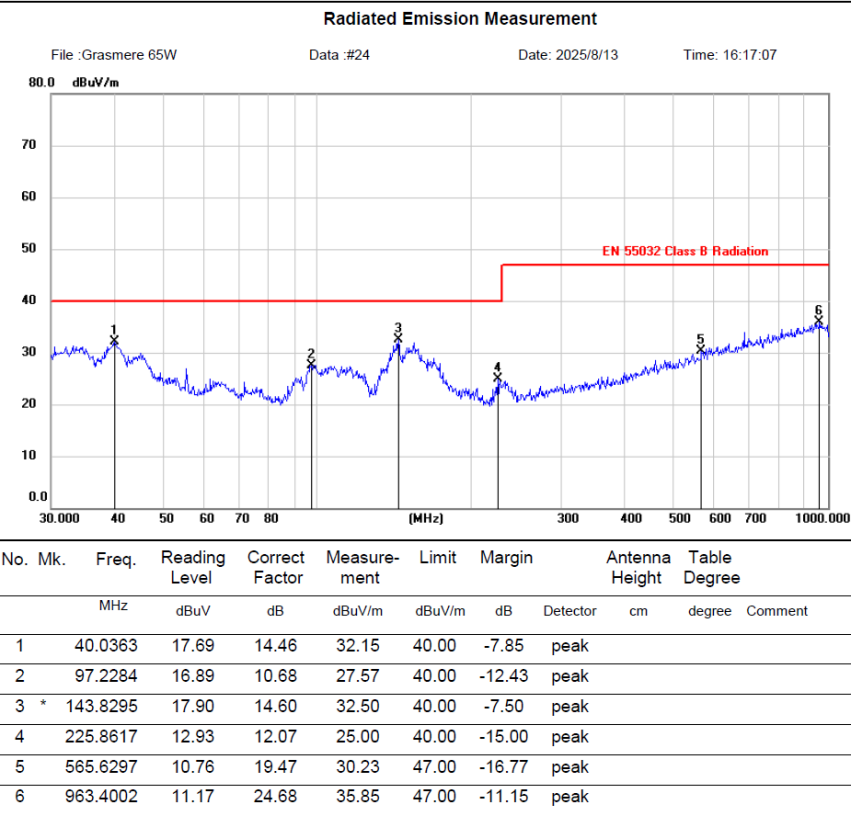


\*Note: Output “-” is connected to Earth.

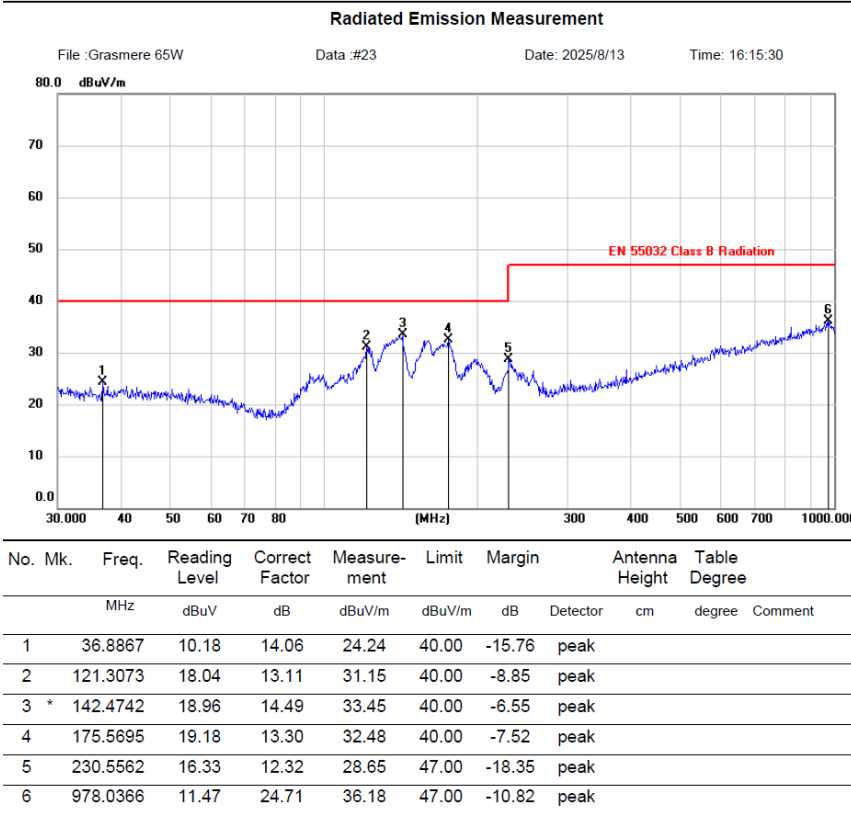


# 13.2 RADIATED EMI WITH FULL LOAD

V<sub>IN</sub>=230V<sub>AC</sub>/50Hz, Vertical



V<sub>IN</sub>=230V<sub>AC</sub>/50Hz, Horizontal

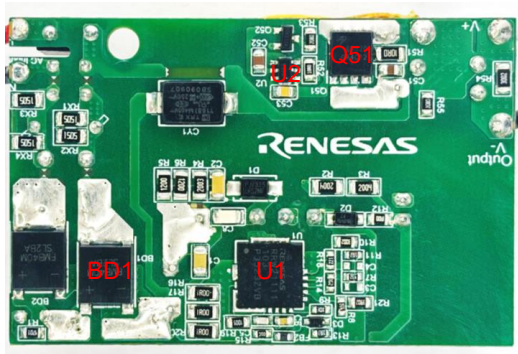


\*Note: Output “-” is connected to Earth.

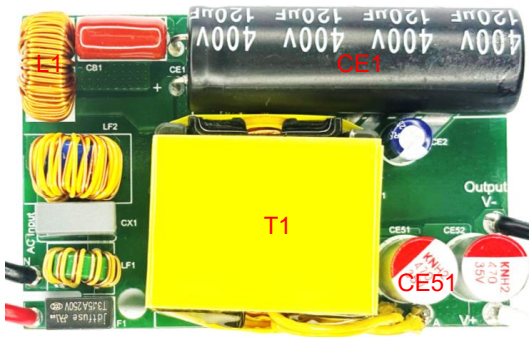
# 14. THERMAL FOR CRITICAL COMPONENT

Item	V <sub>IN</sub> =90V <sub>AC</sub> , V <sub>OUT</sub> =24V I <sub>OUT</sub> =2.7A		V <sub>IN</sub> =264 <sub>AC</sub> , V <sub>OUT</sub> =24V I <sub>OUT</sub> =2.7A	
	Temp.(°C)	Rising Temp.(°C)	Temp.(°C)	Rising Temp.(°C)
BD1, FMB40M	99.3	74.3	66.5	41.5
CE1, 120uF400V	82.2	57.2	69.5	44.5
L1, 210uH	83.6	58.6	58.5	33.5
T1, ATQ27 Core	82.2	57.2	76.0	51.0
T1, ATQ27 Wire	90.2	65.2	82.8	57.8
CE51, 470uF35V	81.5	56.5	78.6	53.6
U1, RRW21111-153	88.6	63.6	76.8	51.8
U2, iW673-20	82.7	57.7	80.7	55.7
Q51, AONS66520	87.3	62.3	87.8	62.8
Ambient (Chamber) Temp.(°C)	25			

Bottom View



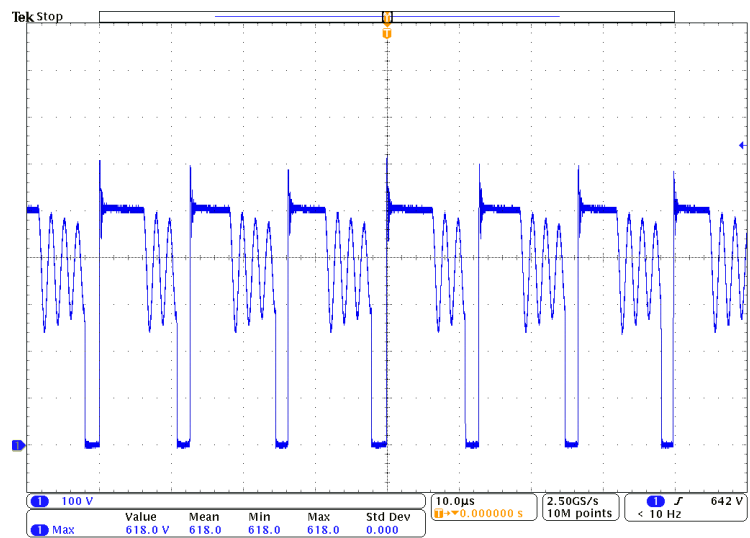
Top View



\*Note:

1. Place UUT without plastic housing in a 40cm\*40cm\*40cm acrylic box.

# 15. MAXIMUM DRAIN VOLTAGE OF GaNFET DEVICE



Test Condition (Full Load):

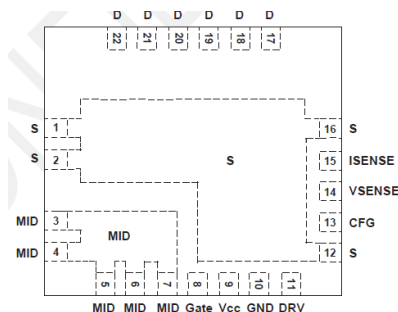
$V_{IN}=264V_{AC}$

Output=24V/2.7A

Result:

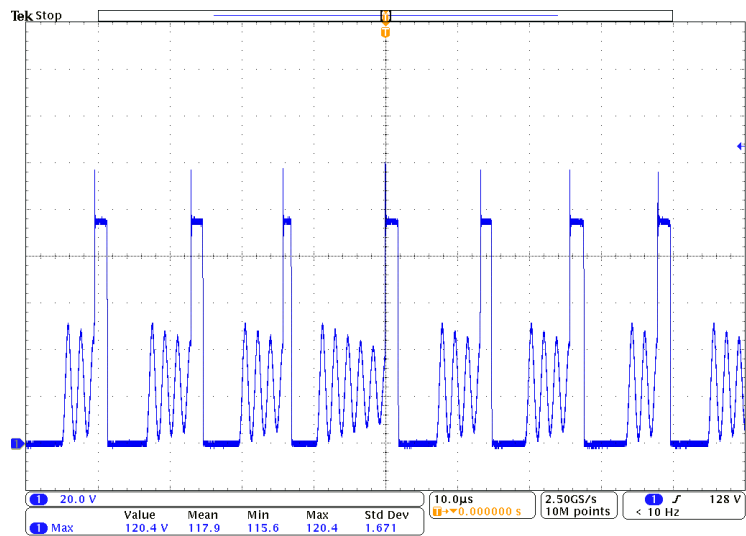
$V_{DS\_MAX}= 618V$

The below is Key Performance Parameters of Integrated GaNFET Device (RRW21111-153)



Drain to source voltage ( $T_J = -55^{\circ}C$ to $150^{\circ}C$ )	$V_{DSS}$	700	V
Transient drain to source voltage, non-repetitive <sup>(1)</sup>	$V_{DSS(TR), non-repetitive}$	800	V
Transient drain to source voltage, repetitive <sup>(2)</sup>	$V_{DSS(TR), repetitive}$	750	V
Gate to source voltage	$V_{GSS}$	$\pm 20$	V

# 16. MAXIMUM DRAIN VOLTAGE OF SR MOSFET



Test Condition (Full Load):

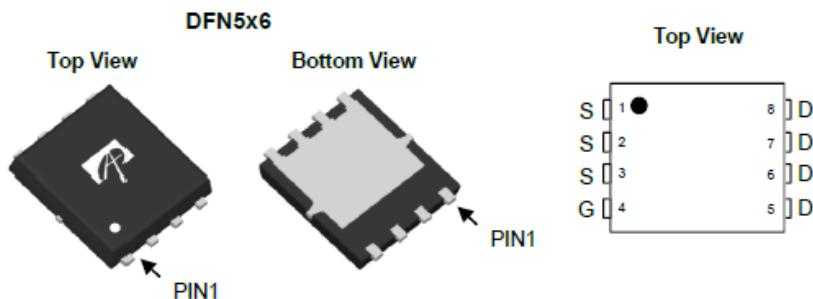
$V_{IN}=264V_{AC}$

Output=24V/2.7A

Result:

$V_{DS\_MAX}= 120.4V$

The below is Key Performance Parameters of SR MOSFET (AONS66520)

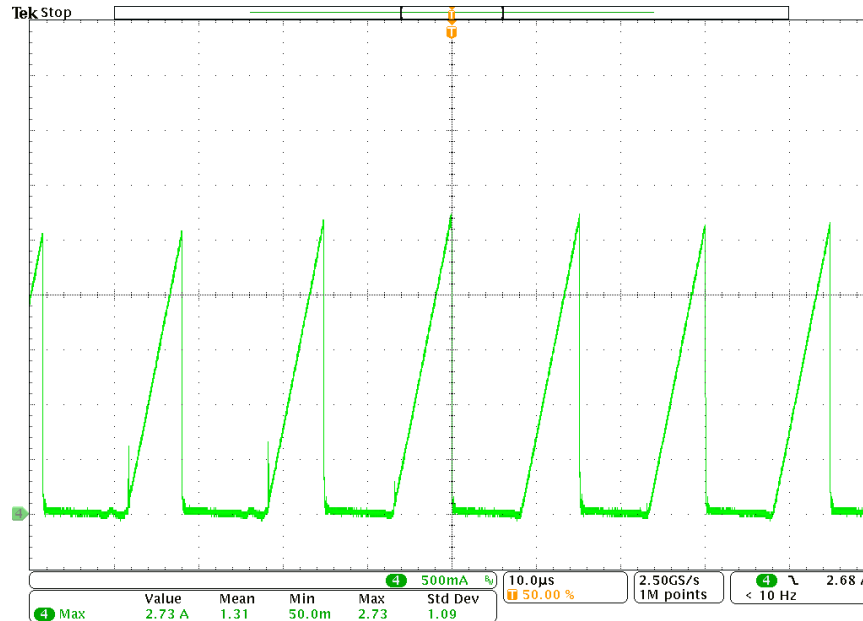


## Product Summary

$V_{DS}$	150V
$I_D$ (at $V_{GS}=10V$ )	100A
$R_{DS(ON)}$ (at $V_{GS}=10V$ )	< 9.5mΩ
$R_{DS(ON)}$ (at $V_{GS}=4.5V$ )	< 12mΩ

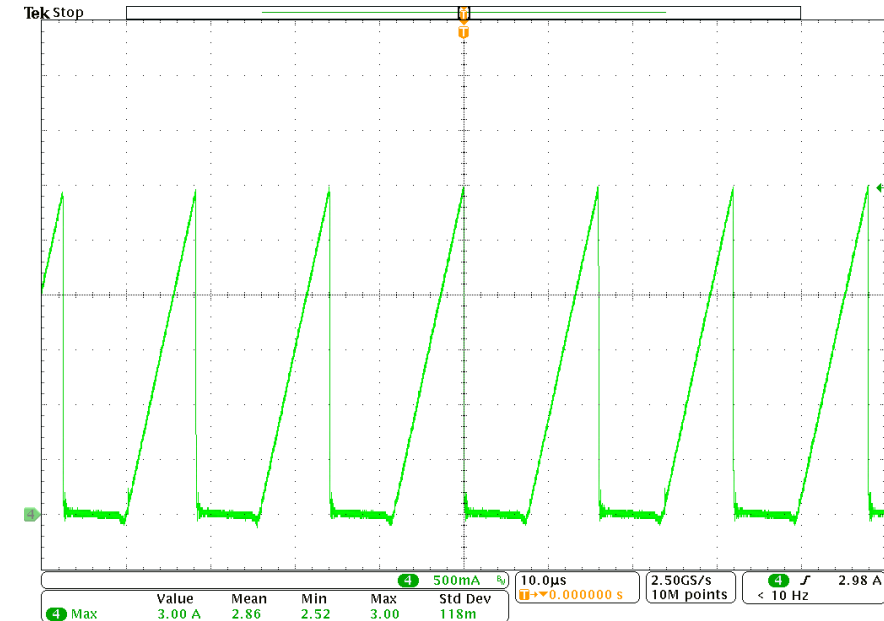
# 17. TRANSFORMER FLUX DENSITY

(N=26Ts, L=270uH, Ae=126.52mm<sup>2</sup> )



$I_p$  is monitored at 90VAC and 2.7A@24V (full load)

$$B_{MAX} = \frac{L_M \times I_{pk}}{N \times A_e} = \frac{0.27 \times 2730}{26 \times 126.52} = 0.224(\text{Tesla})$$



$I_p$  is monitored at 90VAC and 3.1A@24V (OCP)

$$B_{MAX} = \frac{L_M \times I_{pk}}{N \times A_e} = \frac{0.27 \times 3000}{26 \times 126.52} = 0.246(\text{Tesla})$$

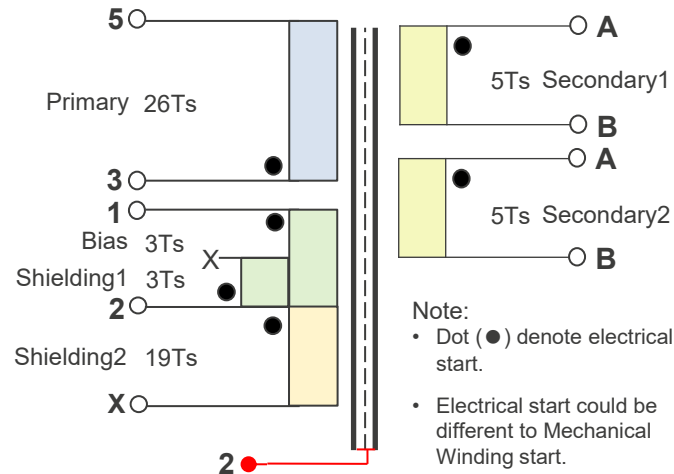
# APPENDIX-1 BILL OF MATERIAL

Item	Qty.	Ref. designator	Description	Manufacturer	Part no.
1	1	U1	Primary Side Integrated GaN controller, QFN8*8	Renesas	RRW21111-153
2	1	U2	Synchronous Rectifier controller, SOT23-6	Renesas	iW673-20
3	1	F1	Fuse, size: 8mmX4mmX7mm	Littelfuse	40013150000
4	1	LF1	Common-mode inductor, TC8×4×3, 42uH	DELI ELECTRONICS	240305191
5	1	LF2	Common-mode inductor, TC9×6×5, 18mH	B&M Magnetism	QYT09060503827018ML
6	1	L1	Differential-mode inductor, TC11.5×6×4-210uH/min	B&M Magnetism	QYS11214705561210UL
7	1	FB1	Multilayer Chip Ferrite Bead	Baorenhong	BEAD1206S121A60T
8	1	FB2	Multilayer Chip Ferrite Bead	Baorenhong	BEAD0603S201A30T
9	2	BD1, BD2	Fast Recovery Bridge Rectifier	Samwin	FMB40M
10	1	Q51	N-Channel Power Mosfet	AOS	AONS66520
11	1	Q52	N-Channel Depletion-Mode Power Mosfet	PolySemi	DN906
12	1	T1	Transformer, Vertical type	Renesas	ATQ2714
13	1	CE1	Electrolytic capacitor, 120uF400V, Φ13mmX40mm	KNSCHA	MHT400V120UF87EC0448
14	1	CE2	Electrolytic capacitor, 4.7uF50V, Φ5mmX11mm	AISHI	ERS1HM4R7D09OT
15	2	CE51, CE52	Solid Capacitor, 470uF35V, Φ8mmX14mm	KNSCHA	KNH2470UF35V149EC029
16	1	CB1	CBB capacitor, 1uF450V, P10, size:11.5mm*13.5mm*4.5mm	KYET	MPP 105J450V
17	1	CX1	X2 capacitor, 0.1uF275V	KNSCHA	MPX104K31B3KN20600
18	1	C1	Ceramic capacitor	SAMSUNG	2.2nF, 630V, X7R, SMD-1206
19	1	C2	Ceramic capacitor	SAMSUNG	1nF, 1000V, X7R, SMD-1206
20	1	C5	Ceramic capacitor	SAMSUNG	68pF, 50V, NPO, SMD-0603
21	1	C6	Ceramic capacitor	SAMSUNG	0.1uF, 25V, X7R, SMD-0603
22	1	C8	Ceramic capacitor	SAMSUNG	33pF, 1000V, NPO, SMD-1206
23	1	C51	Ceramic capacitor	SAMSUNG	1nF, 250V, X7R, SMD-0805
24	1	C52	Ceramic capacitor	SAMSUNG	4.7uF, 25V, X7R, SMD-0805
25	1	C53	Ceramic capacitor	SAMSUNG	0.1uF, 50V, X7R, SMD-0805
26	1	CY1	Y-Cap, SMD	TRX	TMY1681M

# APPENDIX-2 BILL OF MATERIAL

Item	Qty.	Ref. designator	Description	Manufacturer	Part no.
27	1	D1	Diode, SMAF	PINGWEI	R2MF
28	1	D2	Diode, SOD-123	Diodes	FR107
29	1	D3	Diode, SOD-323	Onsemi	1N4148WT
30	4	RX1, RX2, RX3, RX4	Resistor	YAGEO	15MΩ ±5%, SMD-1206
31	1	R1	Resistor	YAGEO	4.7KΩ ±5%, SMD-0805
32	2	R2, R3	Resistor	YAGEO	2MΩ ±5%, SMD-1206
33	1	R4	Resistor	YAGEO	200KΩ ±5%, SMD-1206
34	2	R5, R6	Resistor	YAGEO	120Ω ±5%, SMD-1206
35	2	R7, R8	Resistor	YAGEO	4.3KΩ ±1%, SMD-0603
36	1	R9	Resistor	YAGEO	20Ω ±5%, SMD-0603
37	1	R10	Resistor	YAGEO	30KΩ ±1%, SMD-0805
38	1	R11	Resistor	YAGEO	5.6KΩ ±1%, SMD-0603
39	1	R12	Resistor	YAGEO	1Ω ±5%, SMD-0805
40	1	R13	Resistor	YAGEO	560Ω ±5%, SMD-0603
41	1	R14	Resistor	YAGEO	1KΩ ±5%, SMD-0603
42	1	R15	Resistor	YAGEO	10KΩ ±5%, SMD-0603
43	3	R16, R17, R20	Resistor	YAGEO	1.0Ω ±1%, SMD-1206
44	1	R18	Resistor	YAGEO	220Ω ±5%, SMD-0603
45	1	R19	Resistor	YAGEO	10MΩ ±5%, SMD-0805
46	1	R21	Resistor	YAGEO	39KΩ ±1%, SMD-0805
47	1	R51	Resistor	YAGEO	10Ω ±5%, SMD-1206
48	1	R52	Resistor	YAGEO	10Ω ±5%, SMD-0805
49	2	R53, R55	Resistor	YAGEO	20Ω ±5%, SMD-0805
50	1	R54	Resistor	YAGEO	30KΩ ±5%, SMD-1206
51	1	PCB		Renesas	2layer side, 2oZ, FR-4

# APPENDIX-3 TRANSFORMER (T1)



## ELECTRICAL SPECIFICATIONS:

1. Primary Inductance ( $L_p$ ) =  $270 \pm 5\% \mu H$  @10KHz
2. Electrical Strength = 3KV, 50/60Hz, 1Min (pins1~5 to pins A~B)

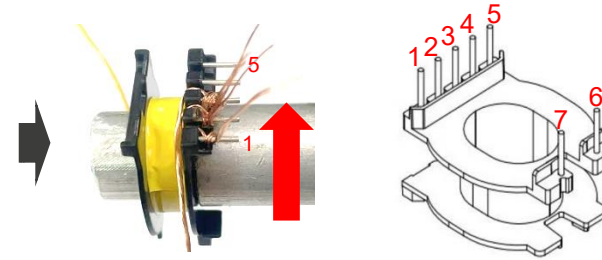
## MATERIALS:

1. Core: ATQ2714 (Ferrite Material DMR97T or equivalent)
2. Bobbin: ATQ2714
3. Magnet Wires (pri): Type 2-UEW
4. Magnet wires(sec): Triple Insulated Wire
5. Layer Insulation Tape: 3M1298 or equivalent.

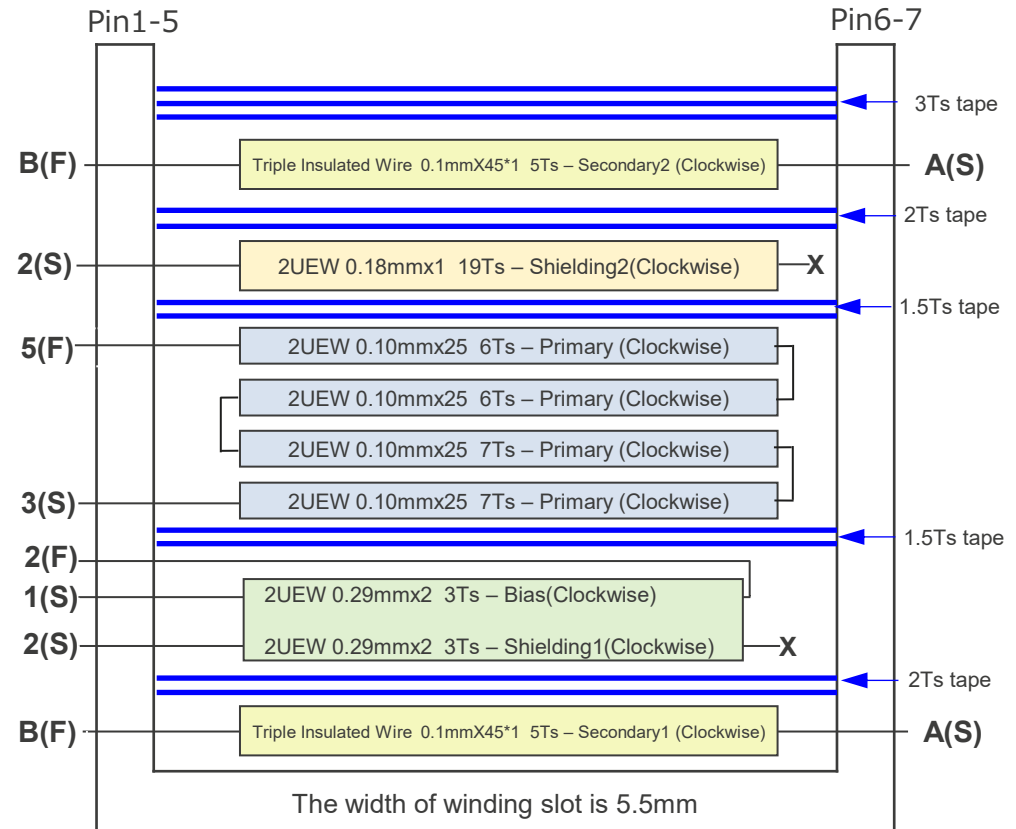
## FINISHED :

1. Varnish the complete assembly.
2. Core around 1T copper and connect to Pin2.
3. Remove Pin4.

Winding Start pin-3& End 5 to "Clockwise" direction- looking from bottom side of the Bobbin



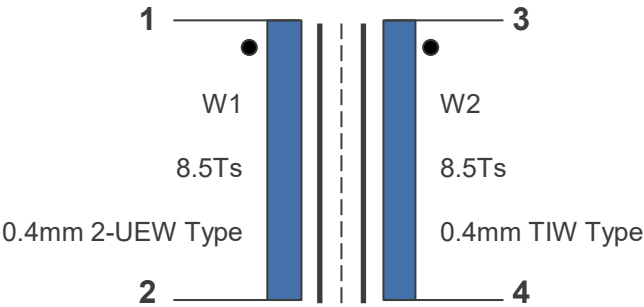
Rotating direction of winding machine





# APPENDIX-4 COMMON MODE INDUCTOR

**SCHEMATIC LF1:**

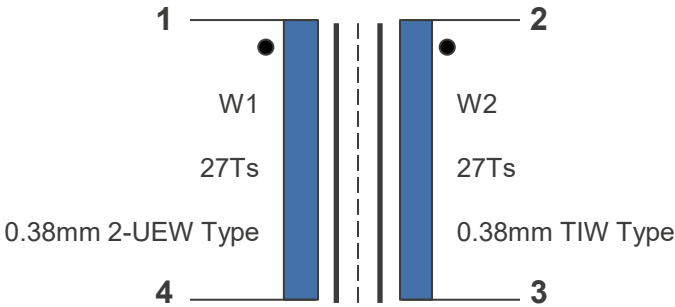


**ELECTRICAL SPECIFICATIONS:**

1. Primary Inductance ( $L_m$ ) = 42uH@10KHz, 1V
2. Ferrite Material: Ni-Zn
3. CORE: T8X4X3mm
4. Electrical Strength = AC 1000V 3mA 3S

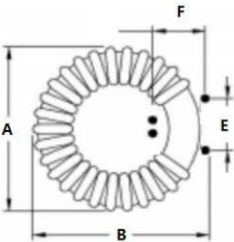


**SCHEMATIC LF2:**



**ELECTRICAL SPECIFICATIONS:**

1. Primary Inductance ( $L_m$ ) = 18mH MIN@1KHz, 0.25V
2. Ferrite Material: Nanocrystalline
3. CORE: T9\*6\*5
4. Electrical Strength = AC 1000V 3mA 3S

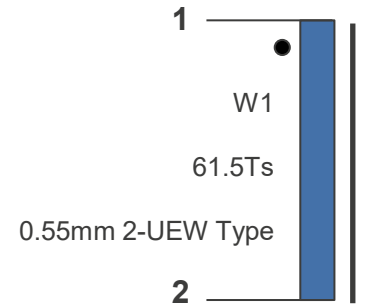


A	12.5	MAX
B	13.0	MAX
C	9.5	MAX
D	3.5	±0.5
E	7.2	±0.5
F	2.6	±0.5

# APPENDIX-5 DIFFERENTIAL MODE INDUCTOR

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## SCHEMATIC L1:



## ELECTRICAL SPECIFICATIONS:

1. Primary Inductance (Lm) >210uH@10KHz, 1V
2. Ferrite Material: Fe-Si-Al
3. CORE: T11.5X6X4mm



# REVISION HISTORY

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## Revision history

Document version	Date of release	Description of changes
V1.0	2025/08/20	Initial release

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