

RRW22101-153+RRW43010-160 FOR 100W ADAPTER DESIGN EBC10320

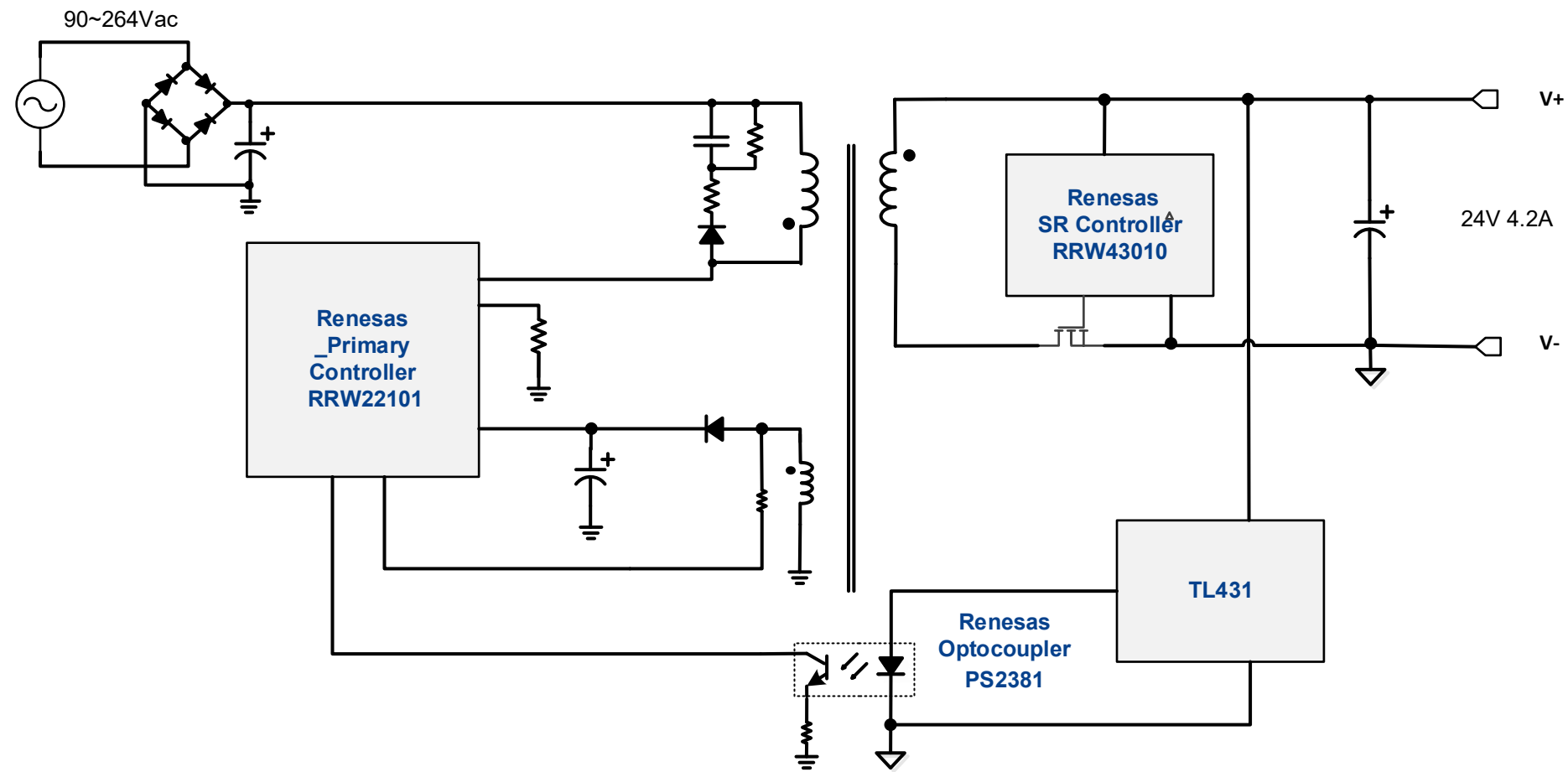
GENERAL DESIGN SPECIFICATION:

1. AC INPUT RANGE: 90-264V_{AC}
2. DC OUTPUT: 24V4.2A
3. MEET BOTH “COC_V5_TIER2” AND “DOE_VII” EFFICIENCY REQUIREMENT
4. STANDBY POWER <75mW
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.

November 2025; Rev. 1.1

BLOCK DIAGRAM OF EBC10320



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.

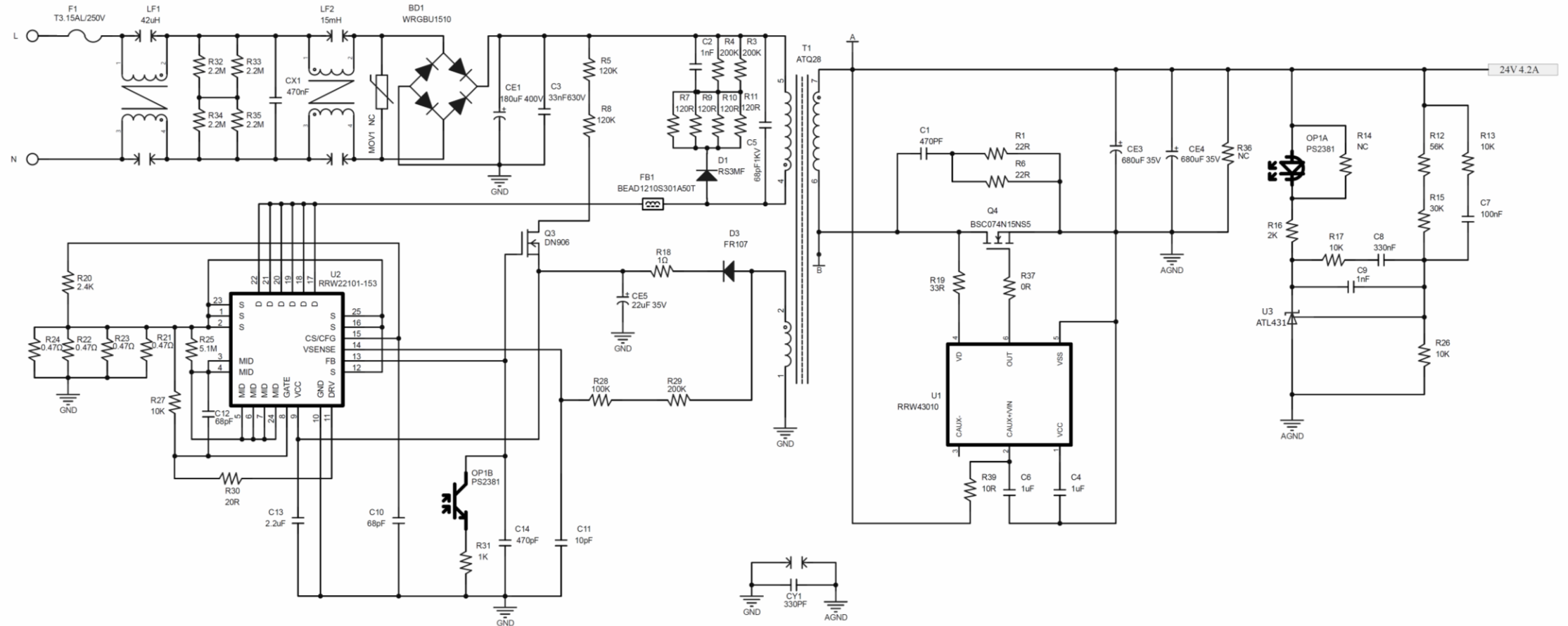
NOT AGENCY APPROVED

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 _{AC}	2 Wire
Frequency	f_{LINE}	47	50/60	63	Hz	
No-load Input Power (230V _{AC})				75	mW	
Output Voltage	$V_{OUT_{CV}}$	22.8	24	25.2	V	Measured at PCB-end
Output Current	I_{OUT}		4.2		A	
Ripple & Noise	V_{RIPPLE}			200	mV _{P_P}	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}			6	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

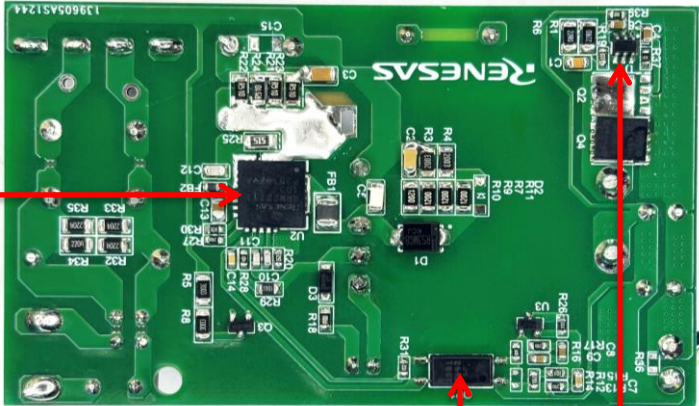
2. SCHEMATIC



3. CIRCUIT BOARD PHOTOGRAPH

Bottom View

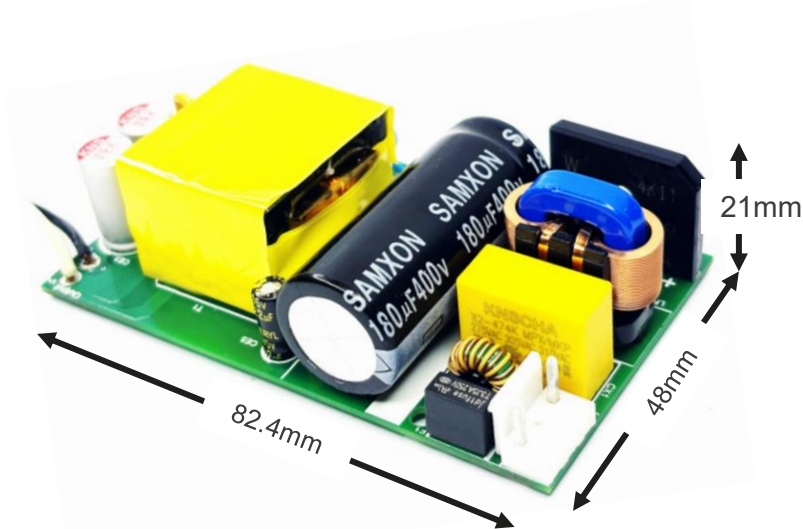
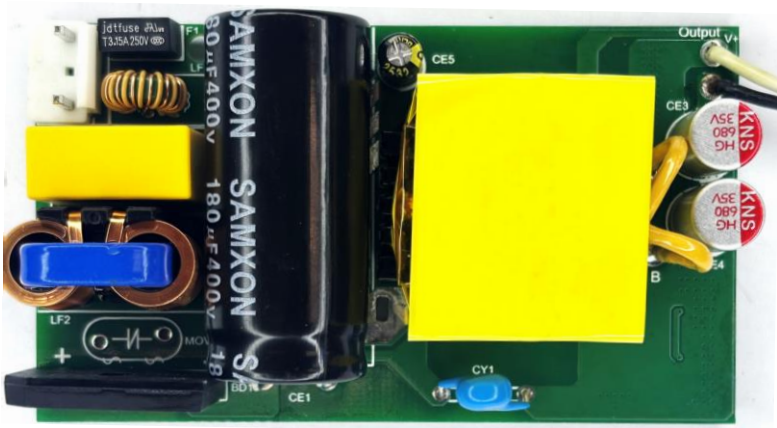
RRW22101-153
Primary Controller
Integrated GaFET



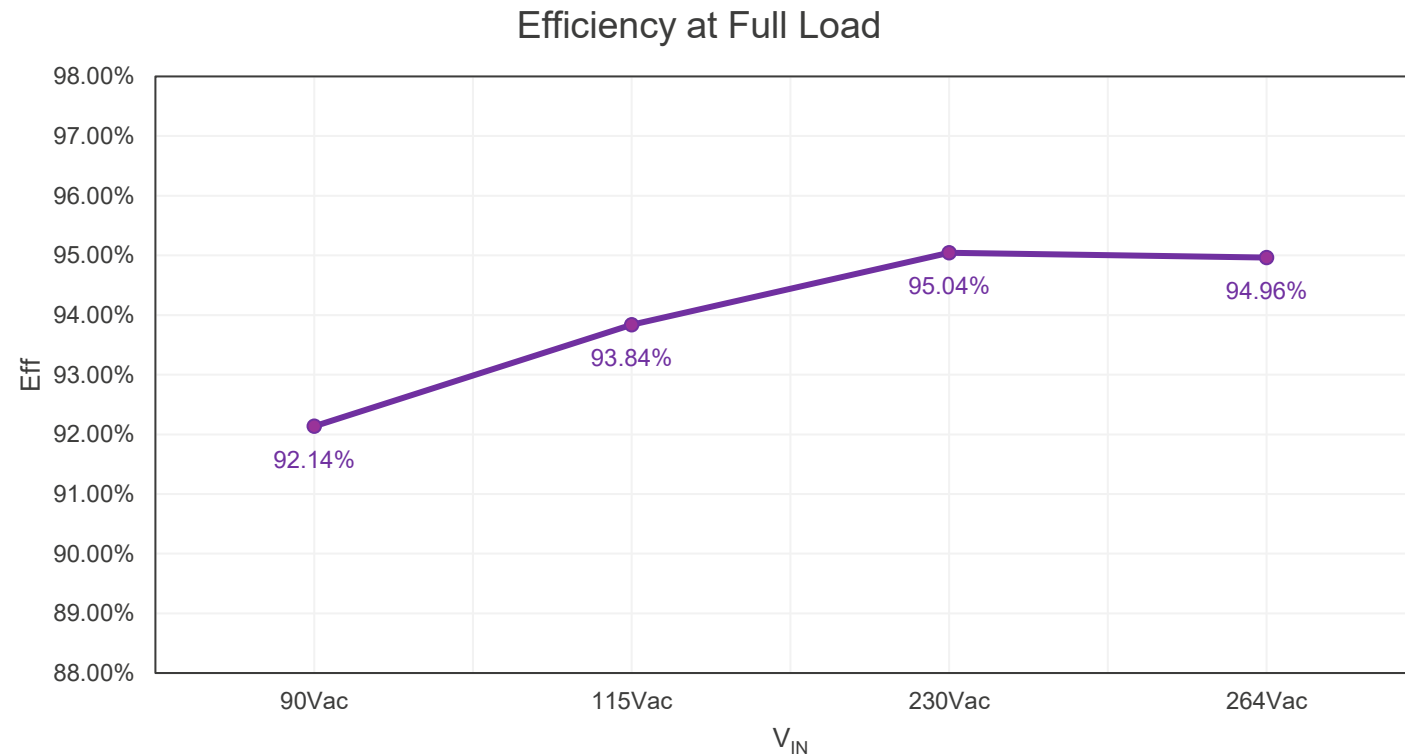
PS2381-1
Optocoupler

RRW43010-160
SR Controller

Top View

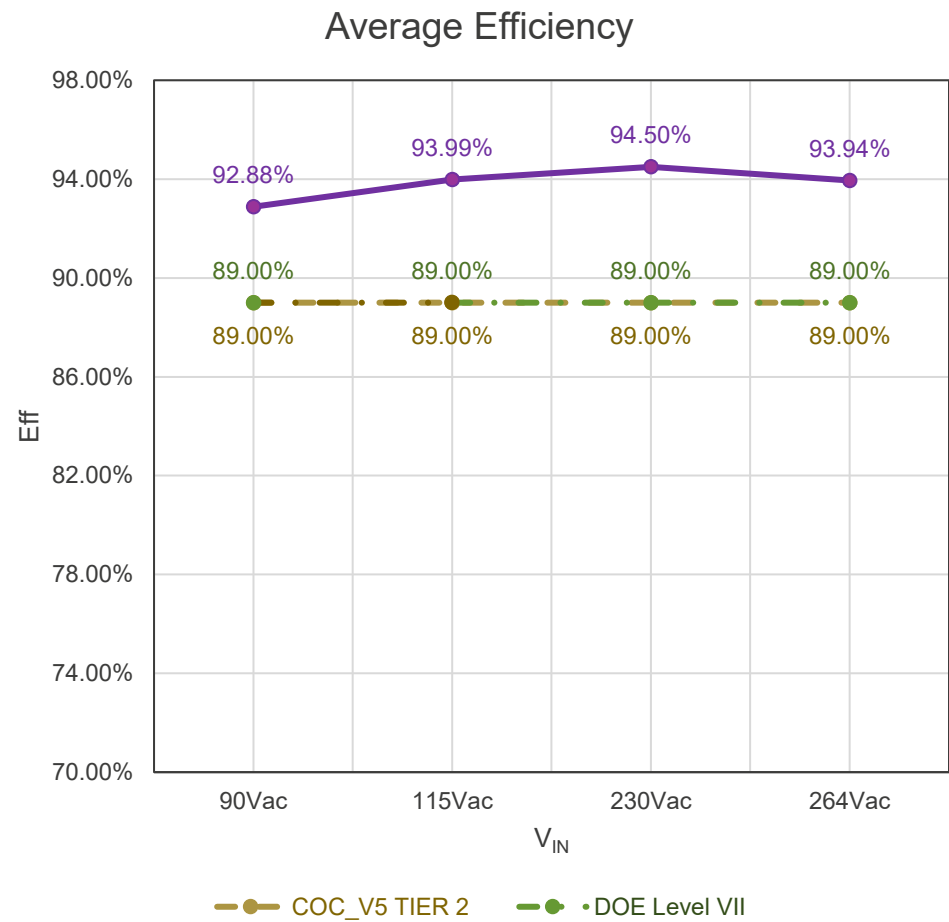
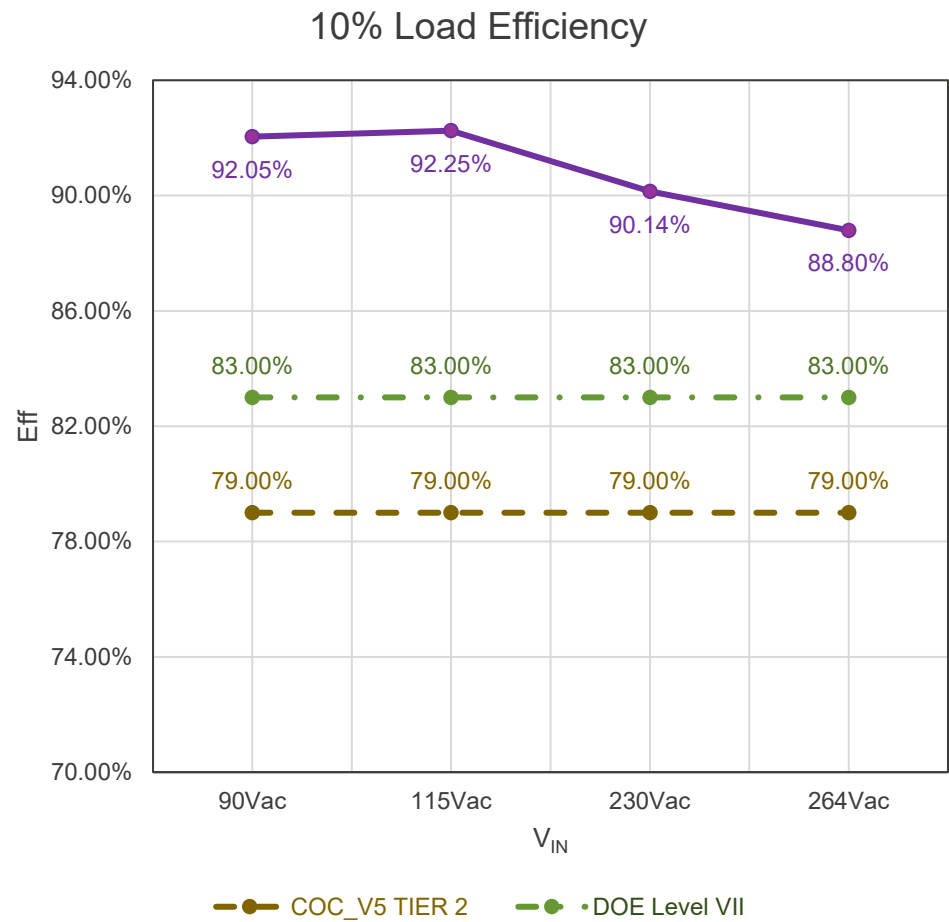


4. EFFICIENCY AT FULL LOAD



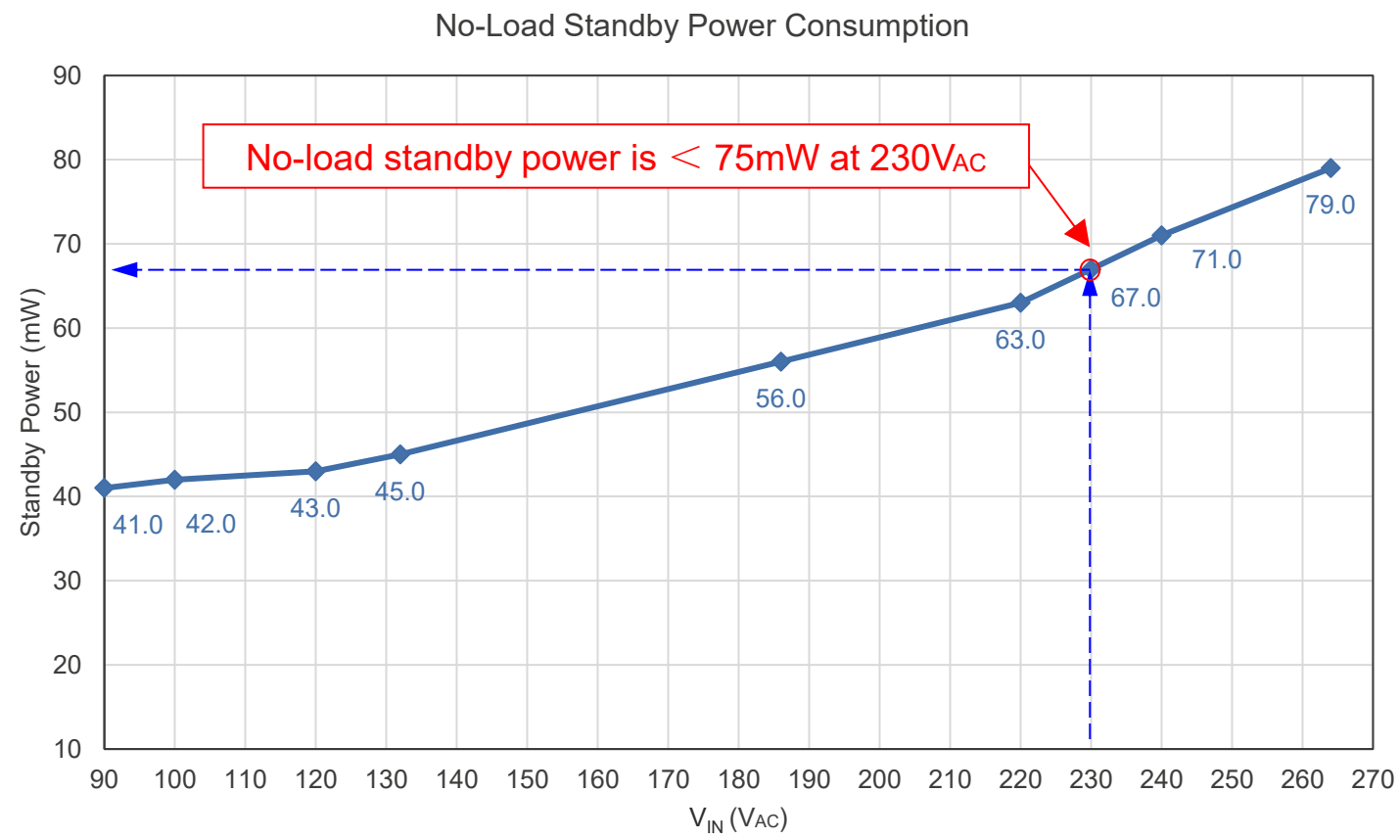
*Note: The output voltage is measured at PCB-end.

5. ACTIVE MODE EFFICIENCY



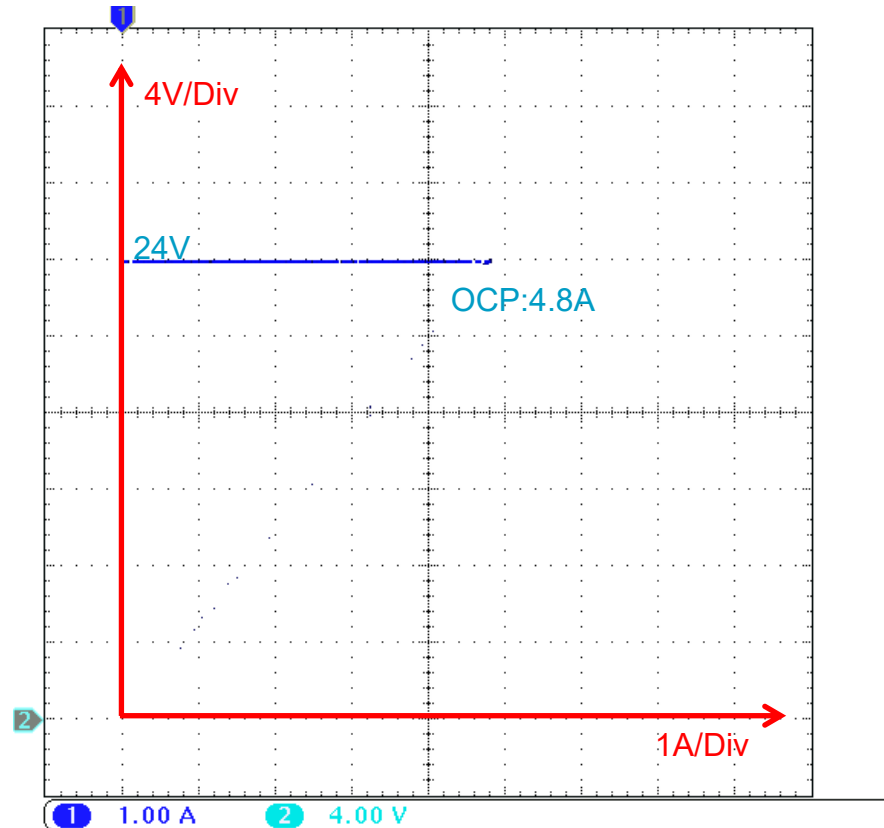
*Note: The output voltage is measured at PCB-end.

6. NO-LOAD STANDBY POWER

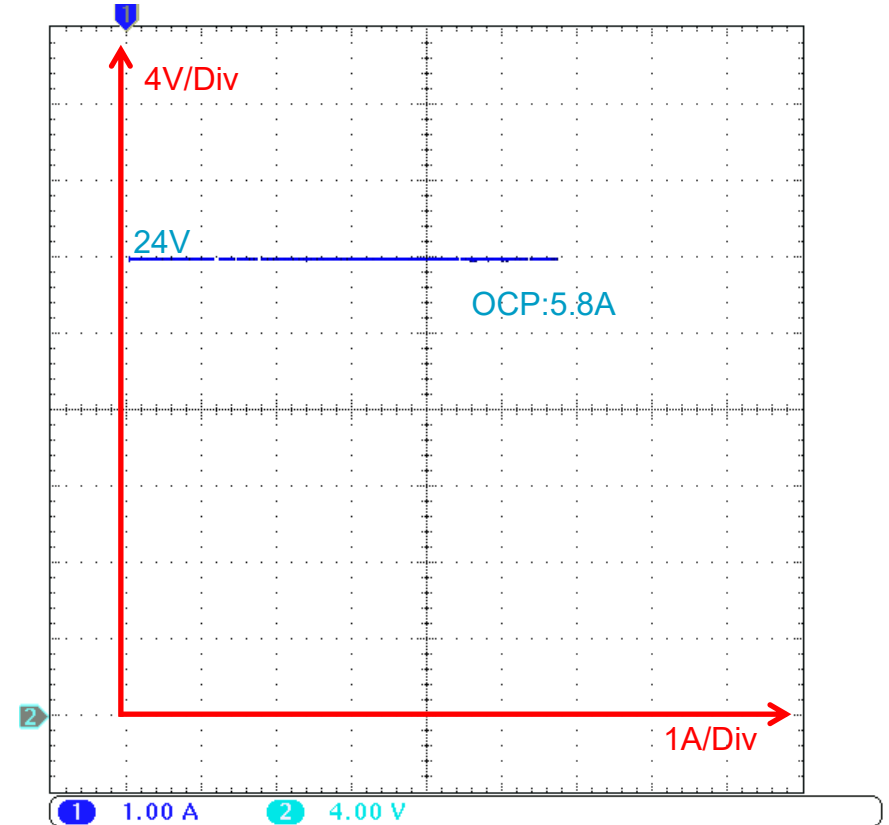


7. OUTPUT VI CHARACTERISTICS

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



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



*Note:

1. The output voltage is monitored at PCB-end.

8. OUTPUT VOLTAGE RIPPLE

V _{OUT}	I _{OUT}		0A	0.42A	1.05A	2.1A	3.15A	4.2A
	V _{IN}							
24V	90V _{AC}		26mV	42mV	54mV	62mV	86mV	104mV
	115V _{AC}		26mV	42mV	58mV	70mV	98mV	108mV
	230V _{AC}		32mV	44mV	66mV	72mV	96mV	126mV
	264V _{AC}		34mV	42mV	68mV	72mV	96mV	122mV

*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 0A-4.2A-0A, Slew:0.5A/us				
			1Hz	10Hz	100Hz	1kHz	5kHz
24V (22.8V<Vo<25.2V)	90V _{AC} / 60Hz	V _{O_MIN} (V)	23.6	23.6	23.6	23.6	23.7
		V _{O_MAX} (V)	24.5	24.5	24.5	24.5	24.4
	264V _{AC} / 50Hz	V _{O_MIN} (V)	23.6	23.6	23.6	23.6	23.7
		V _{O_MAX} (V)	24.5	24.5	24.5	24.5	24.4



Dynamic Load
esponse Waveforr

*Note

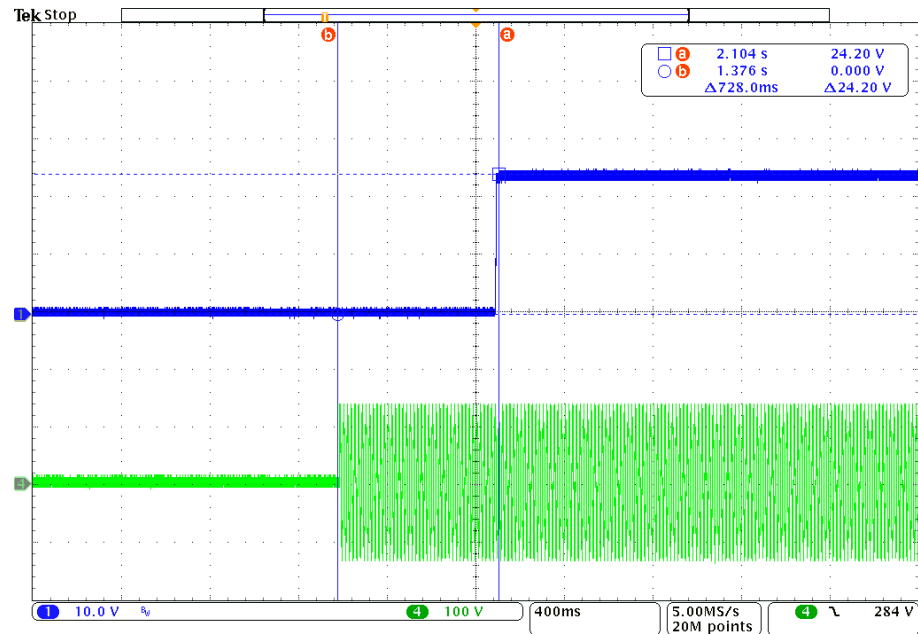
1. The output voltage is measured at PCB-end.

2. Refers to detail waveform as enclosed file.

10. TURN-ON DELAY TIME

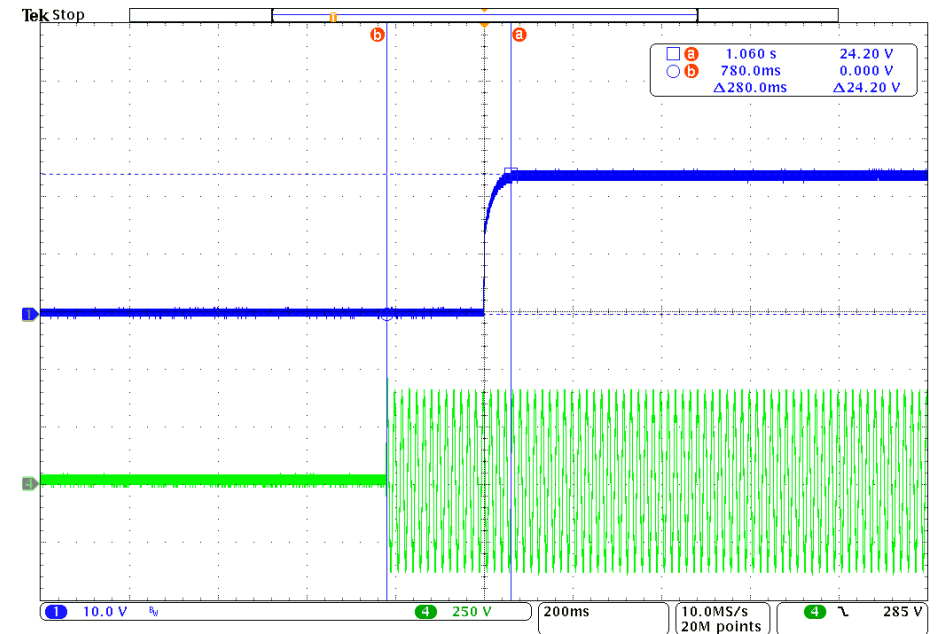
90VAC, No Load

$T_{ST_DELAY} = 0.728S$



264VAC, No Load

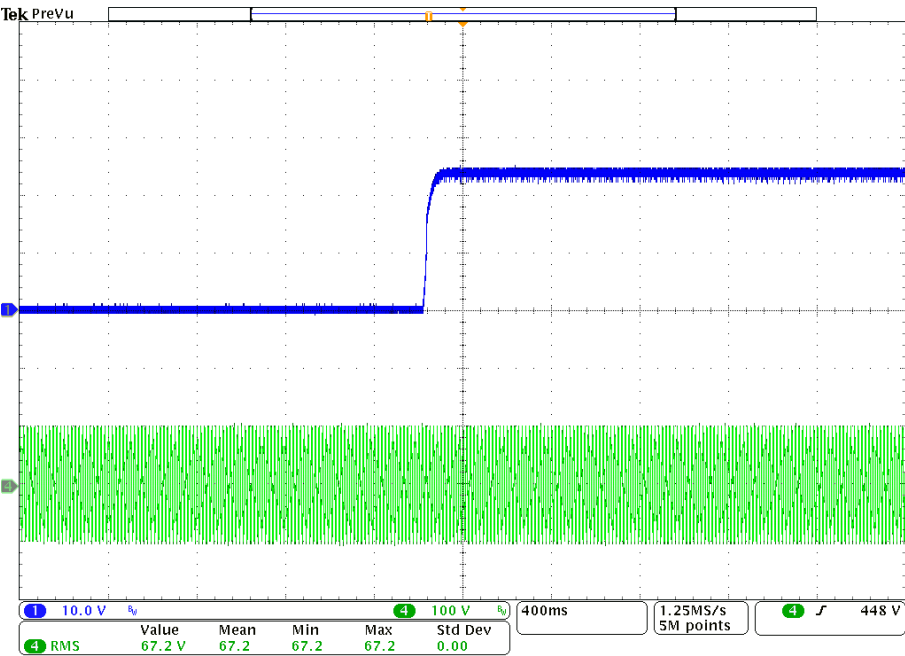
$T_{ST_DELAY} = 0.28S$



11. AC BROWN IN/OUT VOLTAGE

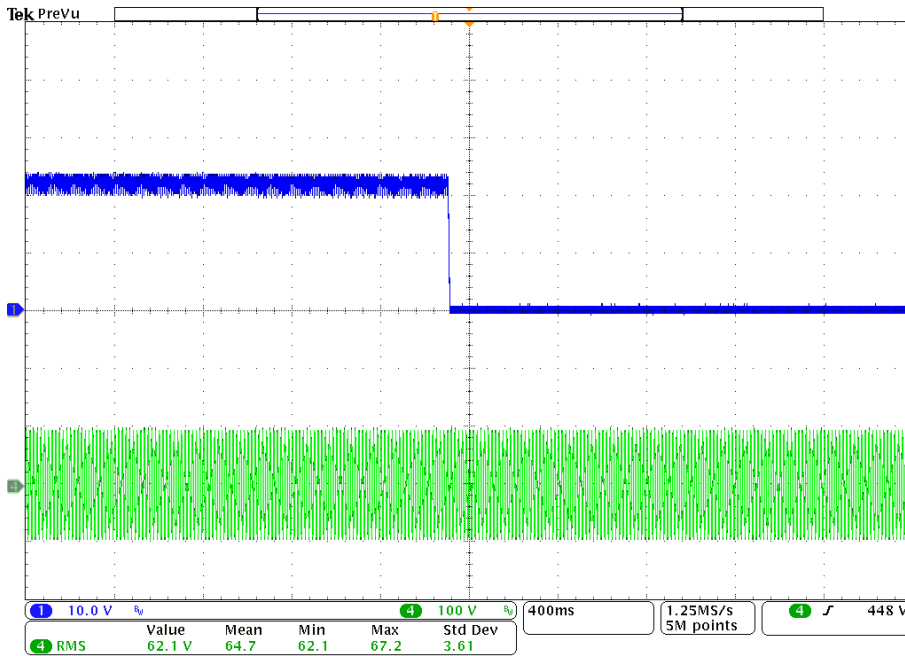
Full Load

$V_{IN_STARTUP} = 67.2V_{AC}$



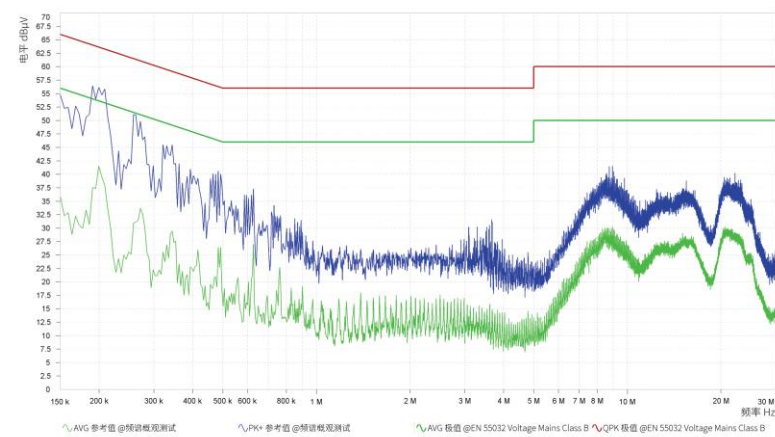
Full Load

$V_{IN_BROWNOUT} = 62.1V_{AC}$

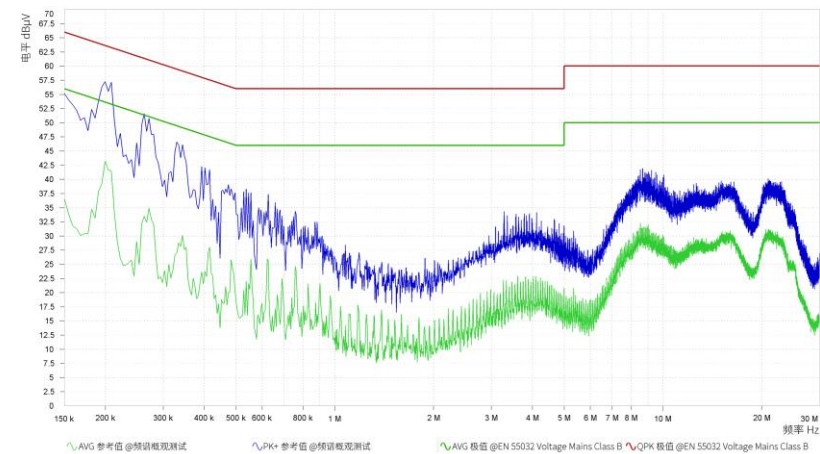


12. CONDUCTED EMI WITH FULL LOAD

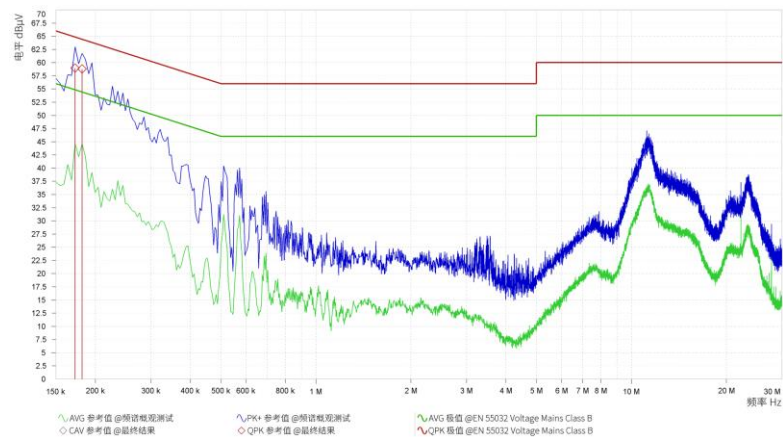
$V_{IN}=120V_{AC}/60Hz$, Live



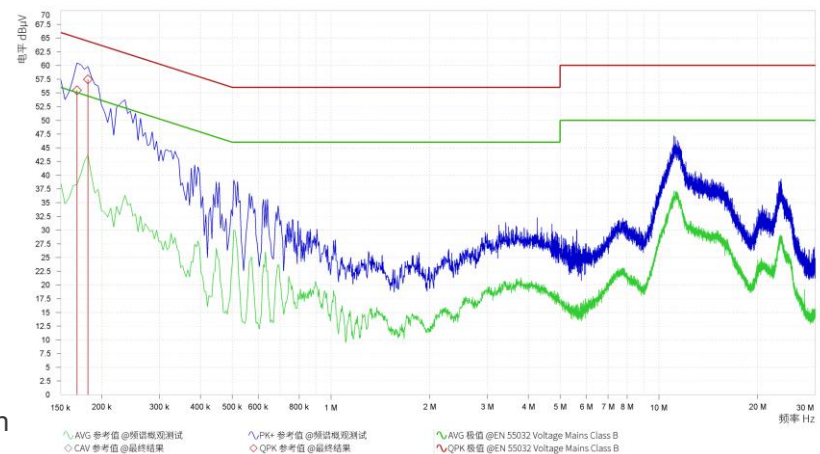
$V_{IN}=120V_{AC}/60Hz$, Neutral



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



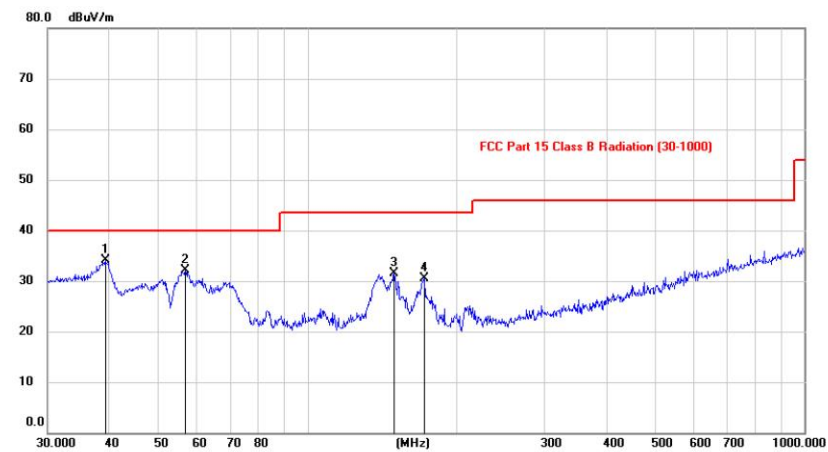
$V_{IN}=230V_{AC}/50Hz$, Neutral



*Note: Output “-” is connected to Earth

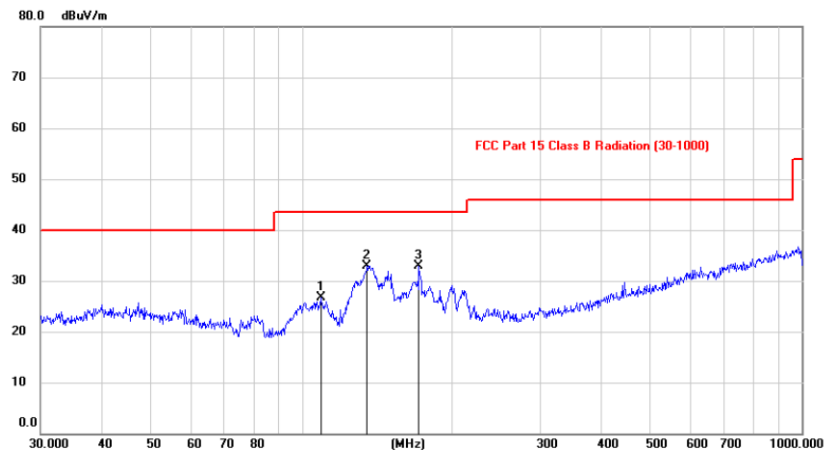
13.1 RADIATED EMI WITH FULL LOAD

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



o.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Margin	Antenna		
		MHz	Level	Factor	ment			Height	Table	Degree
			dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1	*	39.2440	19.57	14.46	34.03	40.00	-5.97	peak		
2		56.7917	18.72	13.44	32.16	40.00	-7.84	peak		
3		149.6954	16.40	15.04	31.44	43.50	-12.06	peak		
4		172.0348	16.79	13.79	30.58	43.50	-12.92	peak		

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

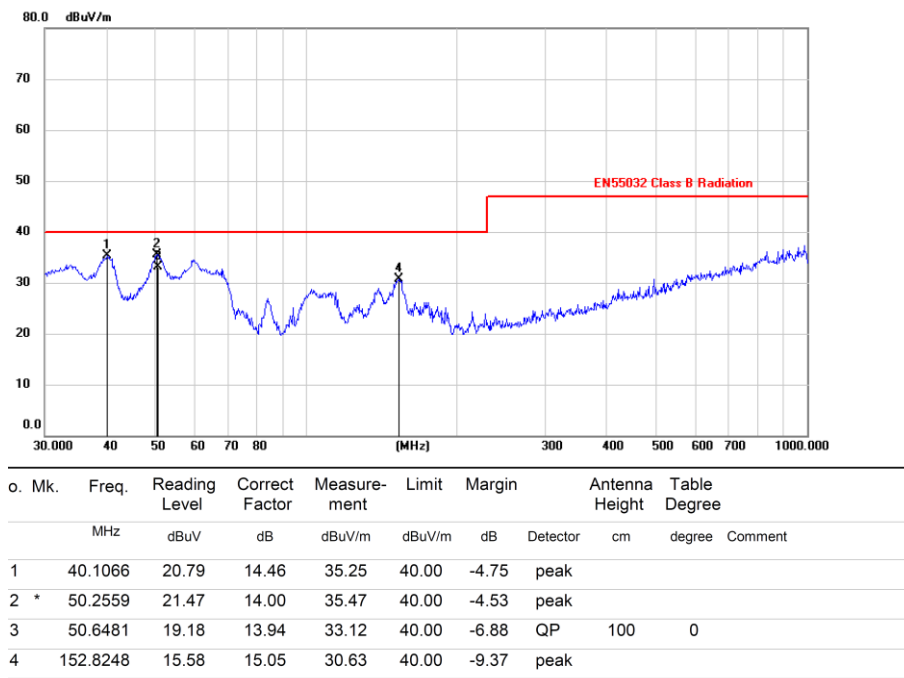


o.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Margin	Antenna		
		MHz	Level	Factor	ment			Height	Table	Degree
			dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1		109.2711	15.02	11.76	26.78	43.50	-16.72	peak		
2	*	135.4112	18.94	13.98	32.92	43.50	-10.58	peak		
3		171.8339	19.06	13.82	32.88	43.50	-10.62	peak		

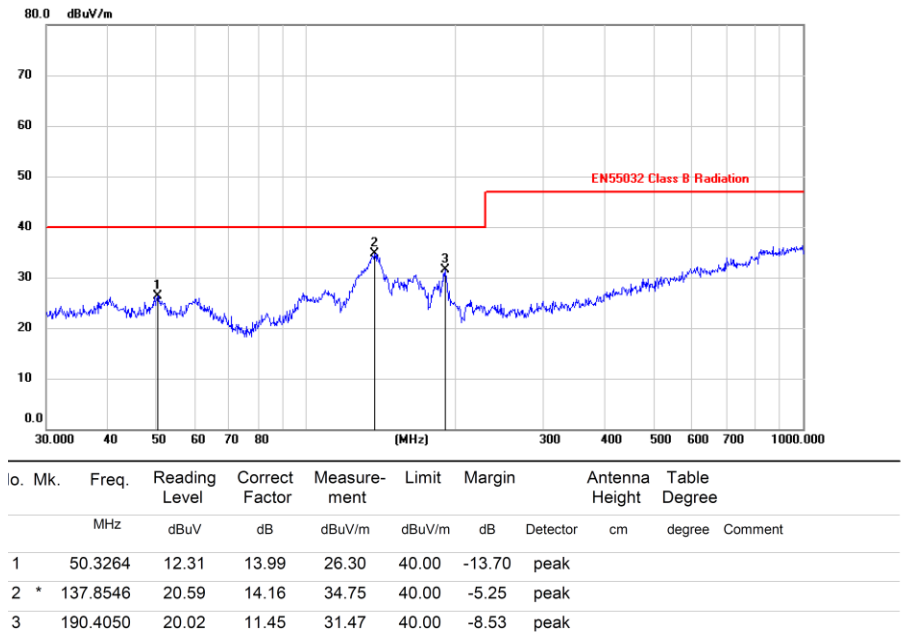
*Note: Output “-” is connected to Earth.

13.2 RADIATED EMI WITH FULL LOAD

V_{IN}=230V_{AC}/50Hz, Vertical



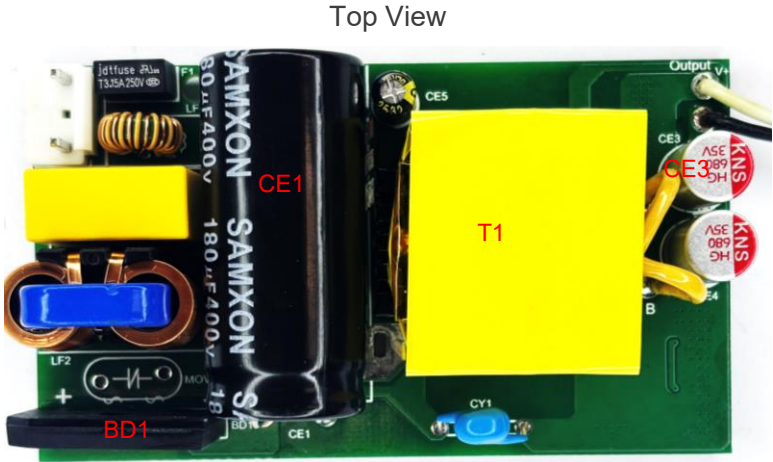
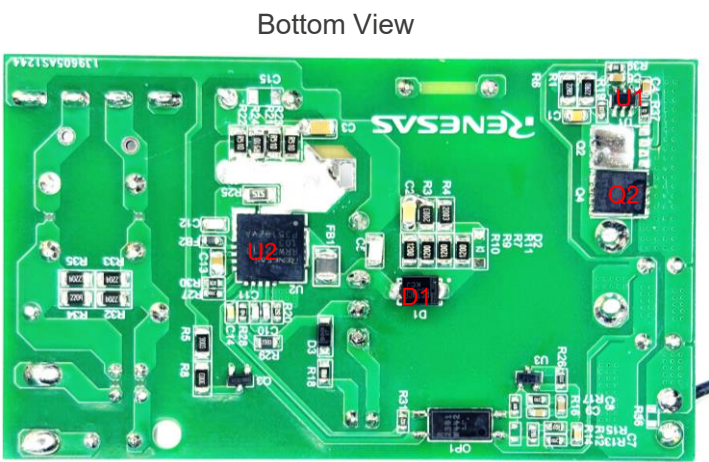
V_{IN}=230V_{AC}/50Hz, Horizontal



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

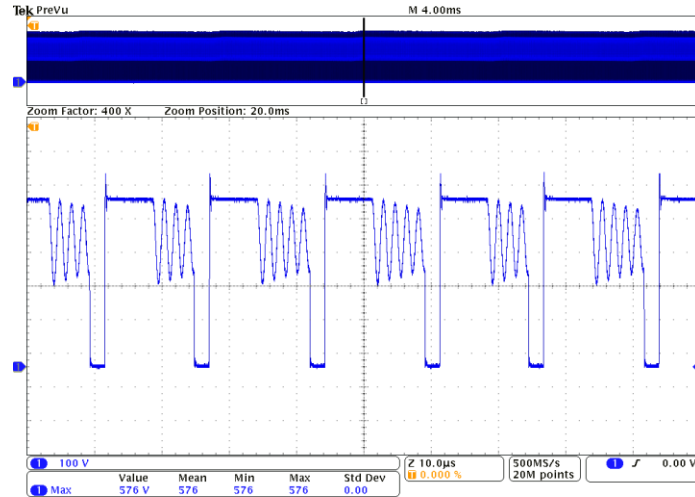
14. THERMAL FOR CRITICAL COMPONENT

Item	V _{IN} =90V _{AC} , V _{OUT} =24V I _{OUT} =4.2A		V _{IN} =264 _{AC} , V _{OUT} =24V I _{OUT} =4.2A	
	Temp.(°C)	Rising Temp.(°C)	Temp.(°C)	Rising Temp.(°C)
BD1, WRGBU1510	90.2	65.2	57.7	32.7
CE1, 180uF400V	82.2	57.2	68.5	43.5
D1, RS3MF	83.6	58.6	82.2	57.2
T1, ATQ28 Core	72.2	47.2	70.5	45.5
T1, ATQ28 Wire	81.5	56.5	79.5	54.5
CE3, 680uF35V	63.2	38.2	65.1	40.1
U2, RRW22101-153	90.7	65.7	84.8	59.8
U1, RRW43010-160	77.2	52.2	78.1	53.1
Q2, BSC074N15NS5	80.7	55.7	81.4	56.4
Ambient (Chamber) Temp.(°C)	25			



*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):

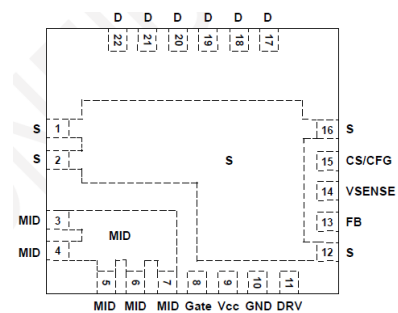
$$V_{IN}=264V_{AC}$$

Output=24V/4.2A

Result:

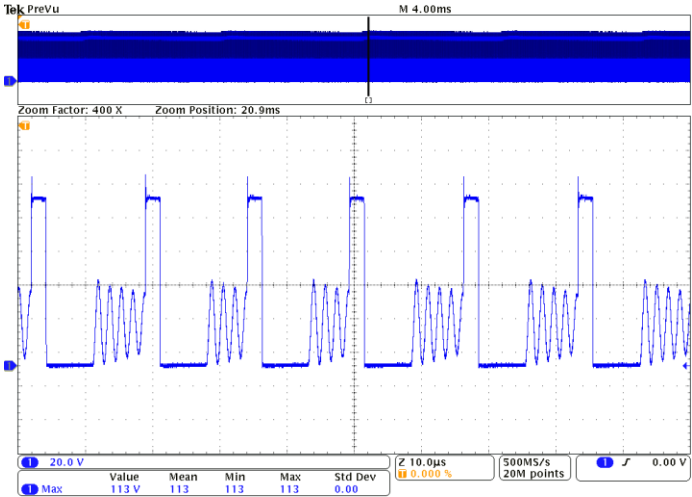
$$V_{DS_MAX} = \underline{576V}$$

The below is Key Performance Parameters of Integrated GaNFET Device (RRW22101-153)

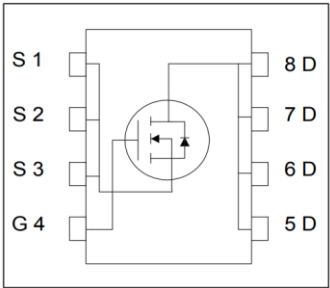


V_{DSS}	Drain to source voltage ($T_J = -55^{\circ}\text{C}$ to 150°C)			700	V	
$V_{DSS(TR)}$, non-repetitive	Transient drain to source voltage, non-repetitive ⁽¹⁾			800	V	
$V_{DSS(TR)}$, repetitive	Transient drain to source voltage, repetitive ⁽²⁾			750	V	
V_{GSS}	Gate to source voltage			± 12	V	

16. MAXIMUM DRAIN VOLTAGE OF SR MOSFET



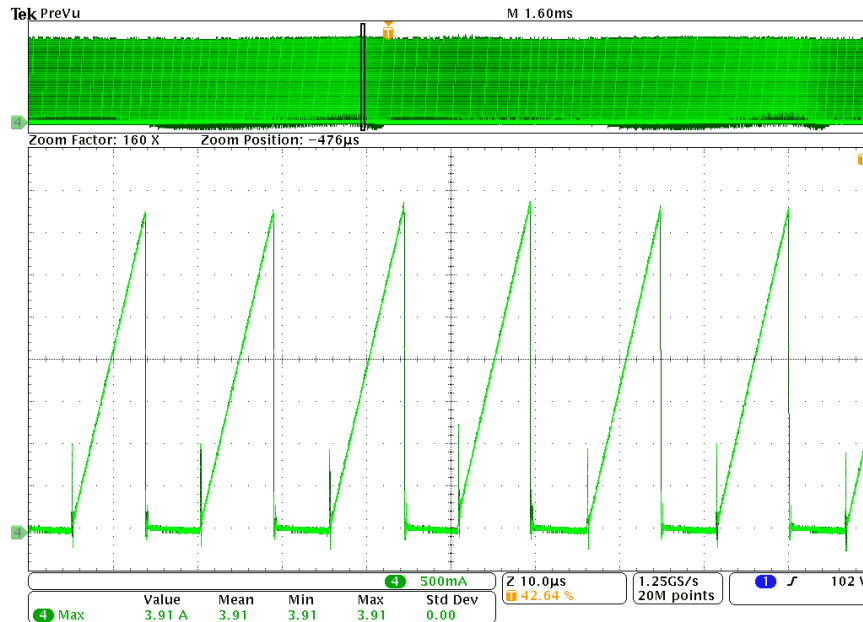
The below is Key Performance Parameters of SR MOSFET (BSC074N15NS5)



Parameter	Value	Unit
V_{DS}	150	V
$R_{DS(on),max}$	7.4	mΩ
I_D	114	A
Q_{oss}	116	nC
Q_{rr}	23	nC

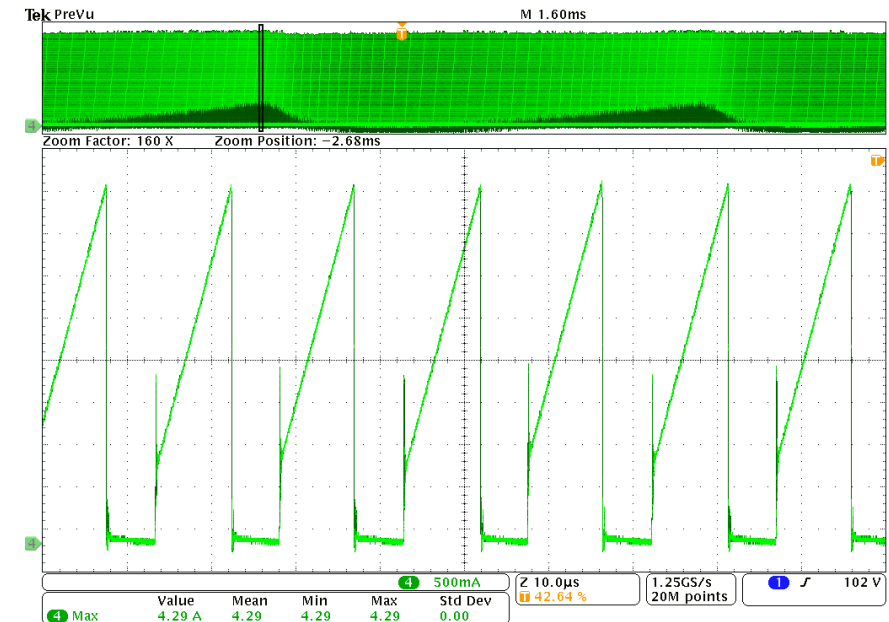
17. TRANSFORMER FLUX DENSITY

(N=20Ts, L=210uH, Ae=161mm²)



I_p is monitored at 90VAC and 4.2A@24V (full load)

$$B_{MAX} = \frac{L_M \times I_{pk}}{N \times A_e} = \frac{0.21 \times 3910}{20 \times 161} = 0.255(Tesla)$$



I_p is monitored at 90VAC and 5A@24V (OCP)

$$B_{MAX} = \frac{L_M \times I_{pk}}{N \times A_e} = \frac{0.21 \times 4290}{20 \times 161} = 0.28(Tesla)$$

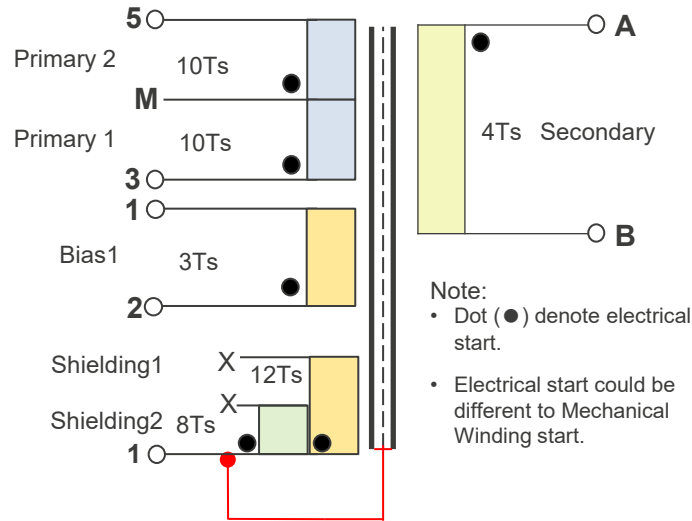
APPENDIX-1 BILL OF MATERIAL

Item	Qty.	Ref. designator	Description	Manufacturer	Part no.
1	1	U1	Synchronous Rectifier controller, SOT23-6	Renesas	RRW43010-160
2	1	U2	Primary Side Integrated GaN controller, QFN8*8	Renesas	RRW22101-153
3	1	U3	2.5V Low Iq Adjustable Precision Shunt Regulator	TI	ATL431
4	1	OP1	Photo-coupler	Renesas	PS2381-1Y-F3-AX/W, CTR: 130%-260%
5	1	F1	Fuse, size: 8mmX4mmX7mm,3.15A	Littelfuse	40013150000
6	1	LF1	Common-mode inductor, TC8×4×3, 42uH	DELI ELECTRONICS	240305191
7	1	LF2	Common-mode Inductor, 15mH, Core: Nanocrystalline, Wire: 0.2*1.5mm flat wire 34Ts REF	Lucky-tenda	TD1815FN
8	1	FB1	Multilayer Chip Ferrite Bead	Baorenhong	BEAD1210S301A50T
9	1	FB2	Resistor	YAGEO	0Ω ±5%, SMD-0603
10	1	BD1	Fast Recovery Bridge Rectifier	World	WRGBU1510
11	1	Q4	N-Channel Power Mosfet	Infineon	BSC074N15NS5
12	1	Q3	N-Channel Depletion-Mode Power Mosfet	PolySemi	DN906
13	1	T1	Transformer, Vertical type	Xinyuanyang	ATQ2803
14	1	CE1	Electrolytic capacitor, 180uF400V,Φ18mmX40mm	MAN YUE	ERT187M2GL40RR
15	2	CE3, CE4	Solid Capacitor, 680uF35V, Φ8mmX16mm	MAN YUE	ULR687M1EF16CB
16	1	CE5	Electrolytic capacitor, 22uF35V, Φ5mmX11mm	BERYL	RG035M220LO5*11
17	1	CX1	X2 capacitor, 0.47uF275V 18*14.5*8.5mm	KNSCHA	474K 275V
18	1	C1	Ceramic capacitor	SAMSUNG	470pF, 250V, X7R, SMD-0805
19	1	C2	Ceramic capacitor	SAMSUNG	1nF, 1000V, X7R, SMD-1206
20	1	C3	Ceramic capacitor	SAMSUNG	33nF, 630V, X7R, SMD-1206
21	2	C4, C6	Ceramic capacitor	SAMSUNG	1uF, 50V, X7R, SMD-0603
22	1	C5	Ceramic capacitor	SAMSUNG	68pF, 1000V, NPO, SMD-1206
23	1	C7	Ceramic capacitor	SAMSUNG	0.1uF, 50V, X7R, SMD-0603
24	1	C8	Ceramic capacitor	SAMSUNG	330nF, 25V, X7R, SMD-0603
25	1	C9	Ceramic capacitor	SAMSUNG	1nF, 25V, X7R, SMD-0603
26	1	C10	Ceramic capacitor	SAMSUNG	68pF, 50V, NPO, SMD-0603

APPENDIX-2 BILL OF MATERIAL

Item	Qty.	Ref. designator	Description	Manufacturer	Part no.
27	1	C11	Ceramic capacitor	SAMSUNG	10pF, 50V, NPO, SMD-0603
28	1	C12	Ceramic capacitor	SAMSUNG	68pF, 50V, NPO, SMD-0805
29	1	C13	Ceramic capacitor	SAMSUNG	2.2uF, 25V, X7R, SMD-0805
30	1	C14	Ceramic capacitor	SAMSUNG	470pF, 25V, X7R, SMD-0603
31	1	CY1	Y-Cap, AC 400V, 330pF	SHM	DCF331K26Y5PG6JL0A0
32	1	D1	Diode, SMBF	PINGWEI	RS3MF
33	1	D3	Diode, SOD-123	Diodes	FR107
34	2	R1, R6	Resistor	YAGEO	22Ω ±5%, SMD-1206
35	2	R3, R4	Resistor	YAGEO	200KΩ ±5%, SMD-1206
36	2	R5, R8	Resistor	YAGEO	120KΩ ±5%, SMD-1206
37	4	R7, R9, R10, R11	Resistor	YAGEO	120Ω ±5%, SMD-1206
38	1	R12	Resistor	YAGEO	56KΩ ±1%, SMD-0603
39	4	R13, R17, R26, R27	Resistor	YAGEO	10KΩ ±1%, SMD-0603
40	1	R15	Resistor	YAGEO	30KΩ ±1%, SMD-0603
41	1	R16	Resistor	YAGEO	2KΩ ±5%, SMD-0603
42	1	R18	Resistor	YAGEO	1Ω ±5%, SMD-0805
43	1	R19	Resistor	YAGEO	33Ω ±1%, SMD-0603
44	1	R20	Resistor	YAGEO	2.4KΩ ±1%, SMD-0603
45	4	R21, R22, R23, R24	Resistor	YAGEO	0.47Ω ±1%, SMD-1206
46	1	R25	Resistor	YAGEO	5.1MΩ ±5%, SMD-1206
47	1	R28	Resistor	YAGEO	100KΩ ±1%, SMD-0603
48	1	R29	Resistor	YAGEO	200KΩ ±1%, SMD-0805
49	1	R30	Resistor	YAGEO	20Ω ±5%, SMD-0603
50	1	R31	Resistor	YAGEO	1KΩ ±5%, SMD-0603
51	4	R32, R33, R34, R35	Resistor	YAGEO	2.2MΩ ±5%, SMD-1206
52	1	R37	Resistor	YAGEO	0Ω ±5%, SMD-0603
53	1	R39	Resistor	YAGEO	10Ω ±5%, SMD-0603
54	1	PCB	PCB	Renesas	2layer side, 2oz, FR-4

APPENDIX-3 TRANSFORMER (T1)



ELECTRICAL SPECIFICATIONS:

1. Primary Inductance (L_p) = $210 \pm 5\% \mu H$ @10KHz
2. Electrical Strength = 3KV, 50/60Hz, 1Min (pins 1~5 to pins A~B)

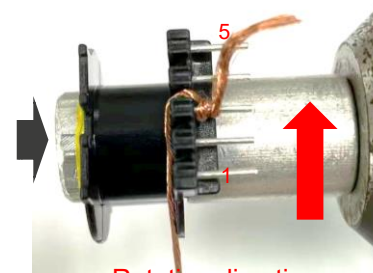
MATERIALS:

1. Core: ATQ28(Ferrite Material DMR97 or equivalent)
2. Bobbin: ATQ28
3. Magnet Wires (pri): Type 2-UEW
4. Magnet wires(sec): Triple Insulated Wire
5. Layer Insulation Tape: 3M1298 or equivalent.

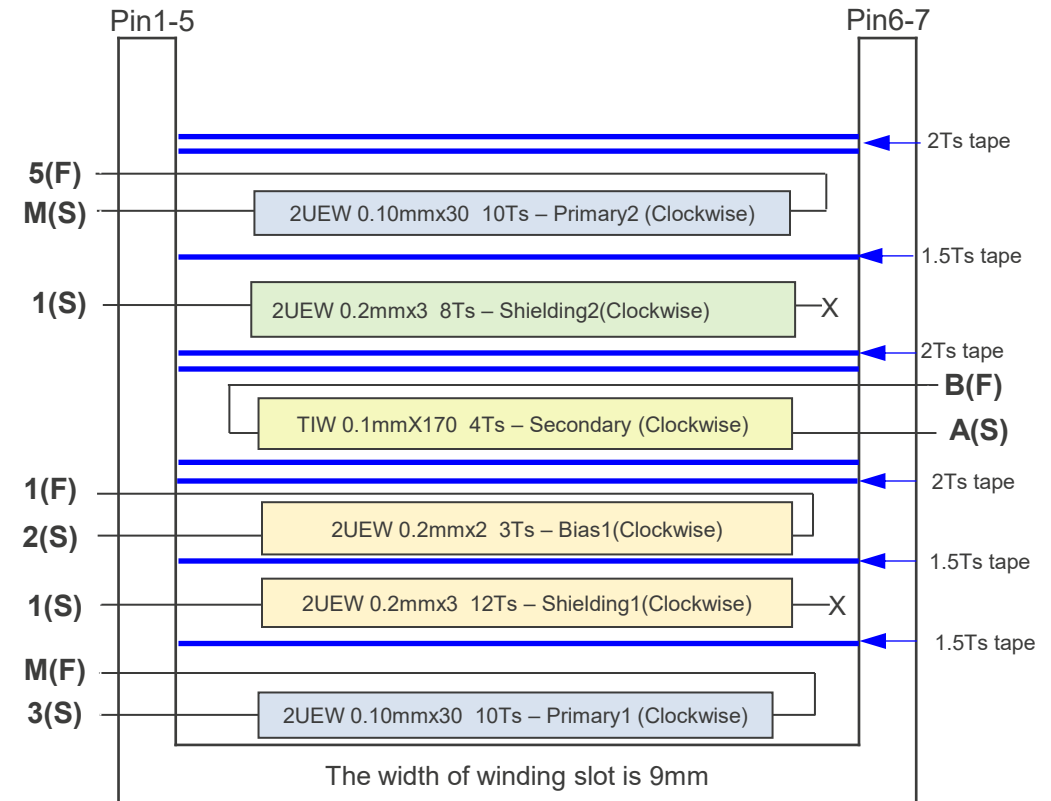
FINISHED :

1. Vacuum varnish.
2. Core and winding around 1T copper and connect to Pin1.

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

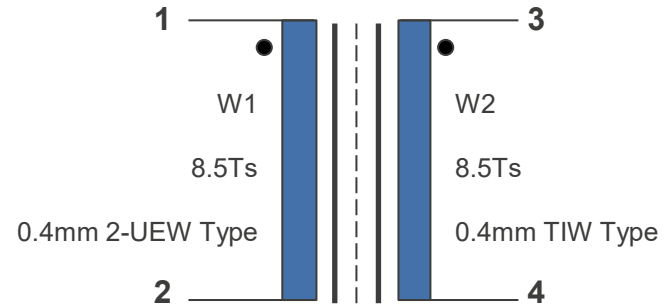


Rotating direction of winding machine



APPENDIX-4 COMMON MODE INDUCTOR

SCHEMATIC LF1:

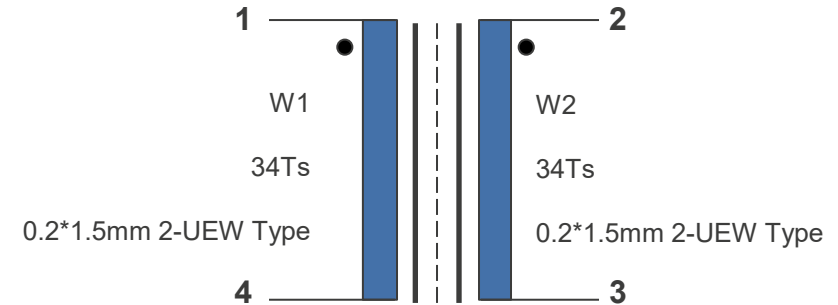


ELECTRICAL SPECIFICATIONS:

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) = 12mH@100KHz, 1V
2. Ferrite Material: Nanocrystalline
3. CORE: TD1815
4. Electrical Strength = 500V, 50/60Hz, 1Min(W1 to W2)



REVISION HISTORY

Revision history

Document version	Date of release	Description of changes
V1.0	2025/09/30	Initial release
V1.1	2025/11/26	Updated Bill of Material Updated Schematic Updated Turn-on Delay Time

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