EV44010-S+HR1000A-S-01C

90W LED Driver Evaluation Board

The Future of Analog IC Technology®

DESCRIPTION

The EV44010-S+HR1000A-S-01C is a general purpose evaluation board of MP44010, HR1000A, MP26085 and MP100 for 90W LED driver application.

MP44010 is a boundary conduction mode PFC controller which can provide simple and high performance active power factor correction with minimum external components.

HR1000A is a controller specific for the resonant half-bridge topology with two channels of 50% complementary duty cycle outputs driving signals.

MP26085 is a voltage and current control IC integrated a precision voltage reference and a current source, which is suitable for battery charger, second controller of switching regulator systems, and other types of application required an accurate voltage and current control systems.

MP100 is a compact, inductor-less, good-efficiency, off-line regulator. It steps down the AC line voltage to an adjustable DC output. It is a simple solution to provide a bias voltage to ICs in off-line applications.

The EV44010-S+HR1000A-S-01C provides up to 90W output power and operates with ultra wide input range from 100V to 305V. Besides, the EV44010-S+HR1000A-S-01C has output fault protections, such as short circuit protection, over voltage protection. It also can meet the Class C standard of IEC61000-3-2 and EN55015 standard.

ELECTRICAL SPECIFICATIONS

Parameter	Symbol	Value	Units
Input AC Voltage	V_{AC}	100 to 305	V
Output Current	I_{OUT}	2.1	A
Output Voltage	V_{OUT}	30 to 45	V
Output Power	P_{OUT}	90	W

FEATURES

- Ultra Wide Operating Input Range(from 100V to 305V)
- High efficiency up to 91%
- Meet Class C Standard of IEC61000-3-2
- Meet EN55015 Standard
- High Power Factor
- Short Circuit Protection (Hiccup Mode)
- Over Voltage Protection
- 0-10V Dimming

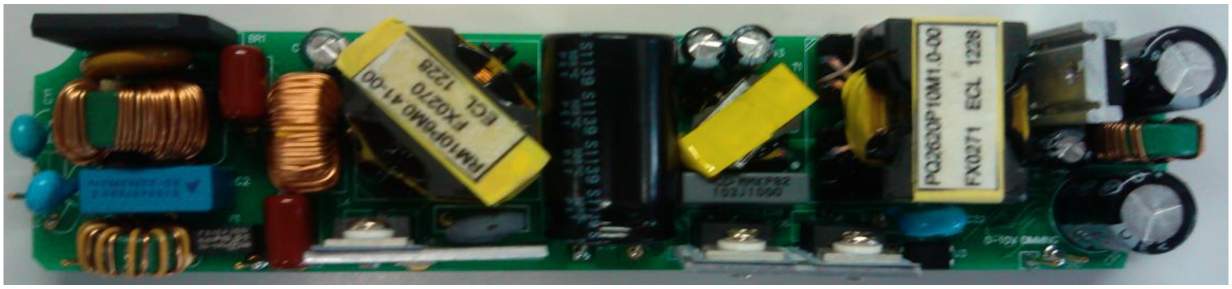
APPLICATIONS

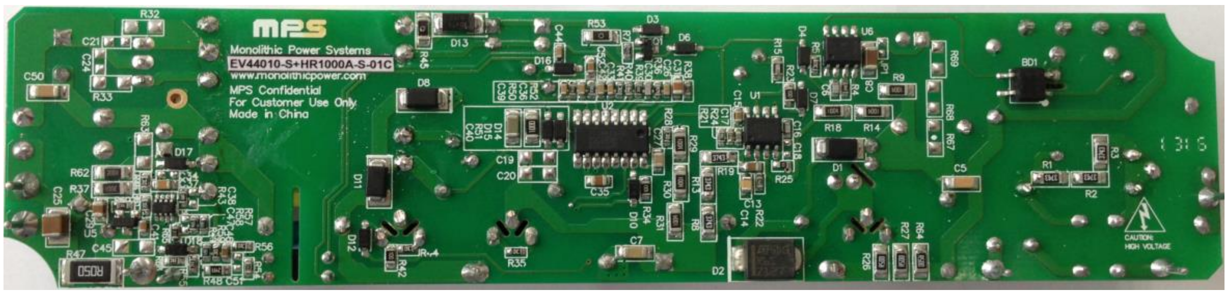
- LED Driver Application

High Voltage

Warning: Although this board is designed to satisfy safety requirements, the engineering prototype has not been agency approved. Therefore, all testing should be performed using an isolation transformer to provide the AC input to the prototype board.

EV44010-S+HR1000A-S-01C EVALUATION BOARD

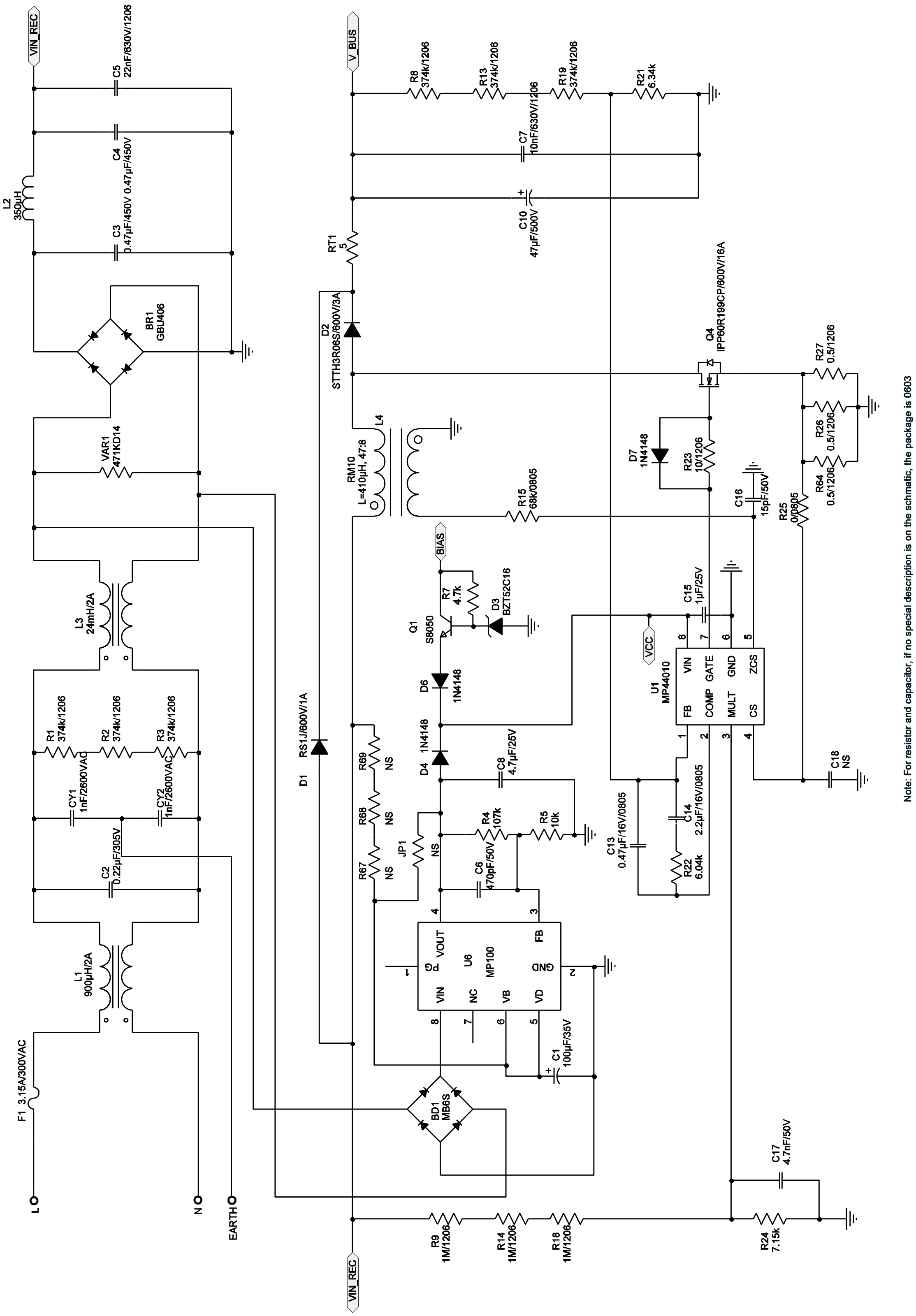




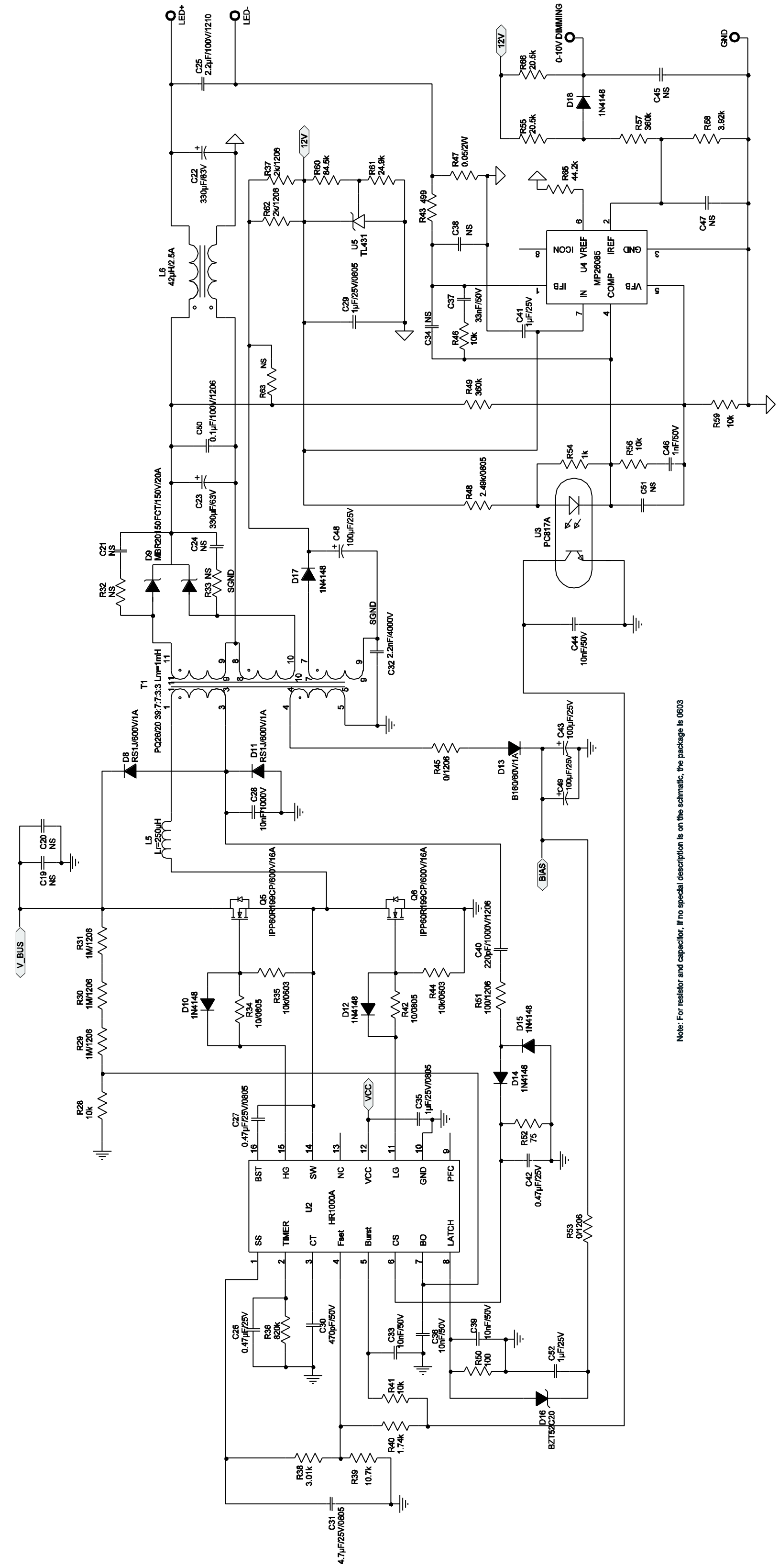
(L x W x H) (16.2cm x 3.8cm x 2.5cm)

Board Number	MPS IC Number
EV44010-S+HR1000A-S-01C	MP44010HS
	HR1000AGS
	MP26085DJ
	MP100GS

EVALUATION BOARD SCHEMATIC



PFC Stage



LLC Stage

EV44010-S+HR1000A-S-01C BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Part Number
2	CY1,CY2	1nF	Y Capacitor;2600V;20%	DIP	Panasonic	JYK08F102ML72N
1	C1	100μF	Electrolytic Capacitor;35V	DIP	SANYO	
1	C2	0.22μF	X-CAP;305V	DIP	EPCOS	B32922C322M
2	C3,C4	0.47μF	Capacitor;450V;CBB	DIP	CARLI	TF474K2Y10BL270D9R
1	C5	22nF	Ceramic Capacitor;630V;X7R	1206	TDK	C3216X7R2J223K
2	C6,C30	470pF	Ceramic Capacitor;50V;C0G	0603	Murata	GRM1885C1H471JA01
1	C7	10nF	Ceramic Capacitor;630V;X7R	1206	TDK	C3216X7R2J103K
1	C8	4.7μF	Ceramic Capacitor;50V;X7R	1206	Murata	GRM188R71H475KA01D
1	C10	47μF	Electrolytic Capacitor;500V	DIP	Rubycon	500BXC47M
1	C13	0.47μF	Ceramic Capacitor;50V;X7R	0805	Murata	GRM21BR71H474KA01L
1	C14	2.2μF	Ceramic Capacitor;25V;X7R	0805	TDK	C2012X7R1E225K
3	C15,C41,C52	1μF	Ceramic Capacitor;25V;X7R	0603	Murata	GRM188R71E105KA01D
1	C16	15pF	Ceramic Capacitor;50V;X7R	0603	TDK	C1608X7R1H150K
1	C17	4.7nF	Ceramic Capacitor;50V;X7R	0603	Murata	GRM188R71H472KA01D
0	C18,C19,C20, C21,C24,C34, C38,C45,C47, C51	NS				
2	C22,C23	330μF	Electrolytic Capacitor;63V	DIP	JiangHai	CD286-63V330
1	C25	2.2μF	Ceramic Capacitor;100V;X7R	1210	Murata	GRM32ER72A225KA35L
2	C26,C42	0.47μF	Ceramic Capacitor;25V;X7R	0603	Murata	GRM188R71E474KA12
1	C27	0.47μF	Ceramic Capacitor;25V;X7R	0805	HHEC	C0805X474K025T
1	C28	10nF	Capacitor;1000V	DIP	FaLa	MMKP82-1000V-103P15JA
2	C29,C35	1μF	Ceramic Capacitor;25V;X7R	0805	Murata	GRM21BR71E105KA99L
1	C31	4.7μF	Ceramic Capacitor;25V;X5R	0805	Murata	GRM21BR61E475KA88
1	C32	2.2nF	Capacitor;4000V;20%	DIP	HongKe	JN12E222MY02N

EV44010-S+HR1000A-S-01C BILL OF MATERIALS *(continued)*

Qty	Ref	Value	Description	Package	Manufacturer	Part Number
4	C33,C36,C39, C44	10nF	Ceramic Capacitor;50V;X7R	0603	Murata	GRM188R71H103KA01D
1	C37	33nF	Ceramic Capacitor;25V;X7R	0805	LION	0805B333K250T
1	C40	220pF	Ceramic Capacitor;1000V;	1206	TDK	C3216C0G3A221J
3	C43,C48,C49	100μF	Electrolytic Capacitor;25V	DIP	Rubycon	25YXF100M
1	C46	1nF	Ceramic Capacitor;50V;X7R	0603	LION	0603B102K500T
1	C50	0.1μF	Ceramic Capacitor;100V;X7R	1206	TDK	C3216X7R2A104K
6	R1,R2,R3,R8, R13,R19	374k	Film Resistor;1%;	1206	Yageo	RC1206FR-07374KL
1	R4	107k	Film Resistor;1%;	0603	Yageo	RC0603FR-07107KL
8	R5,R28,R41, R46,R56,R59, R35,R44	10k	Film Resistor;1%;	0603	Yageo	RC0603FR-0710KL
1	R7	4.7k	Film Resistor;1%	0603	Yageo	RC0603FR-074K7L
6	R9,R14,R18, R29,R30,R31	1M	Film Resistor;1%;	1206	Yageo	RC1206FR-071ML
1	R15	68k	Film Resistor;1%;	0805	Yageo	RC0805FR-0768KL
1	R21	6.34k	Film Resistor;1%;	0603	Yageo	RC0603JR-076K34L
1	R22	6.04k	Film Resistor;1%;	0603	Yageo	RC0603FR-076K04L
3	R23,R34,R42	10	Film Resistor;1%;	0805	Yageo	RC0805FR-0710RL
1	R24	7.15k	Film Resistor;1%;	0603	Yageo	RC0603FR-077K15L
1	R25	0	Film Resistor;5%;	0603	Yageo	RC0603JR-070RL
3	R26,R27,R64	0.5	Film Resistor;1%;	1206	Yageo	RC1206FR-070R5L
0	R32,R33,R63, R67,R68,R69, JP1	NS				
1	R36	820k	Film Resistor;1%;	0603	Yageo	RC0603FR-07820KL
2	R37,R62	2k	Film Resistor;1%;	1206	Yageo	RC1206FR-072KL
1	R38	3.01k	Film Resistor;1%;	0603	Yageo	RC0603FR-073K01L
1	R39	10.7k	Film Resistor;1%;	0603	Yageo	RC0603FR-0710K7L
1	R40	1.74k	Film Resistor;1%;	0603	Yageo	RC0603FR-071K74L
1	R43	499	Film Resistor;1%;	0603	Yageo	RC0603FR-07499RL
2	R45,R53	0	Film Resistor;5%;	1206	Yageo	RC1206JR-070RL
1	R47	0.05	Resistor;1%;2W	2512	Yageo	RL2512FK-070R05L
1	R48	2.49k	Film Resistor;1%;	0805	Yageo	RC0805FR-072K49L
2	R49,R57	360k	Film Resistor;1%;	0603	Yageo	RC0603FR-07360KL
1	R50	100	Film Resistor;1%;	0603	Yageo	RC0603FR-07100RL
1	R51	100	Film Resistor;1%;	1206	Yageo	RC1206FR-07100RL

EV44010-S+HR1000A-S-01C BILL OF MATERIALS *(continued)*

Qty	Ref	Value	Description	Package	Manufacturer	Part Number
1	R52	75	Film Resistor;1%;	0603	Yageo	RC0603FR-0775RL
1	R54	1k	Film Resistor;1%;	0603	Yageo	RC1206FR-071KL
2	R55,R66	20.5k	Film Resistor;1%;	0603	Yageo	RC0603FR-0720K5L
1	R58	3.92k	Film Resistor;1%;	0603	Yageo	RC0603FR-073K92L
1	R60	84.5k	Film Resistor;1%	0603	Yageo	RC0603FR-0784K5L
1	R61	24.9k	Film Resistor;1%	0603	Yageo	RC0603FR-0724K9L
1	R65	44.2k	Film Resistor;1%;	0603	Yageo	RC0603FR-0744K2L
1	RT1	5	Resistor	DIP	Semitec	5D2-10
1	VAR1	471KD14	MOV	DIP	Thinking	TVR14471KS42Y
1	BD1	MB6S	Diode;600V;0.5A;	SOIC-4	TaiWan Semiconductor	MB6S
1	BR1	GBU406	BRIDGE RECTIFIER/DF02S;600V;4A	DIP	Diodes	GBU406
3	D1,D8,D11	RS1J	Diode;600V;1A;	SMA	Diodes	RS1J
1	D2	STTH3R06S	Diode;600V;3A;	SMC	ST	STTH3R06S
1	D3	BZT52C16	Zener Diode;16V;5mA	SOD-123	Diodes	BZT52C16
1	D13	B160	Schottky Diode;60V;1A;	SMA	Diodes	B160
9	D4,D6,D7, D10,D12,D14, D15,D17,D18	1N4148W	Diode;75V;0.15A;	SOD-123	Diodes	1N4148W
1	D9	MBR20150	Diode;150V;20A	TO-220AB	MCC	MBR20150FCT
1	D16	BZT52C20	Zener Diode;20V;5mA	SOD-123	Diodes	BZT52C20-F
1	F1	3.15A/300VAC	FUSE-SS-5	DIP	COOPER BUSSMANN	SS-5-3.15A
1	L1	900μH	Common Choke,900μH,2A	DIP	DEKELONG	T60-26
1	L2	300μH	Filter Inductor;300μH	DIP	DEKELONG	T12.7*7.92*5.08
1	L3	20mH	Common Choke,20mH,2A	DIP	DEKELONG	T16*12*8
		20mH	Common Choke,20mH,2A	DIP	Wurth	744823220
1	L4	410μH	PFC Inductor, L=410μH, N1:N2=47:8,RM10	DIP	Emei	FX0270
1	L5	250μH	Resonant Inductor,L=250μH,RM6	DIP	Emei	FX0269
1	L6	47μH	Common Choke,47μH,2.5A	DIP	Wurth	744841247

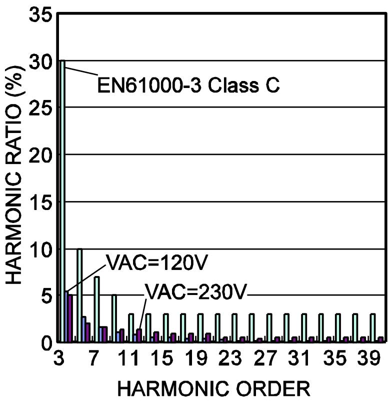
EV44010-S+HR1000A-S-01C BILL OF MATERIALS *(continued)*

Qty	Ref	Value	Description	Package	Manufacturer	Part Number
1	Q1	S8050	Transistor;25V;0.5A	SOT-23	Changjiang Electronics	S8050
3	Q4,Q5,Q6	IPP60R199CP	N-Channel Mosfet;650V;16A	TO220	Infineon	IPP60R199CP
1	T1	1mH	Transformer,Lp=1mH N1:N2:N3:N4:N5=39: 7:7:3:3, BPQ26-20	DIP	Emei	FX0271
1	U1	MP44010	PFC controller	SOIC8	MPS	MP44010HS
1	U2	HR1000A	LLC controller	SOIC16	MPS	HR1000AGS
1	U3	PC817A	Photocoupler;1-Channel	DIP	SHARP	PC817A
1	U4	MP26085	voltage and current controller	SOIC8	MPS	MP26085DJ
1	U5	CJ431	Vref=2.5V	SOT-23	Changjiang Electronics	CJ431
1	U6	MP100	MP100	SOIC8	MPS	MP100GS
6	0-10V DIMMING,GND,LED+,LED-,L, N		Connector			

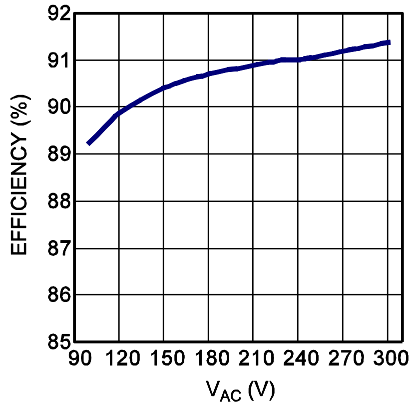
EVB TEST RESULTS

Performance waveforms are tested on the evaluation board.
V_{AC}=100V to 305V, I_{OUT}=2.1A, P_{OUT}=90W

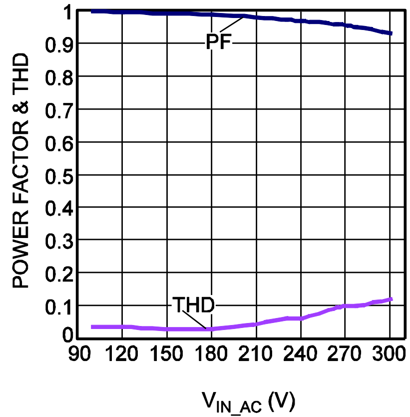
Harmonic
VAC=120V & 230V, full load



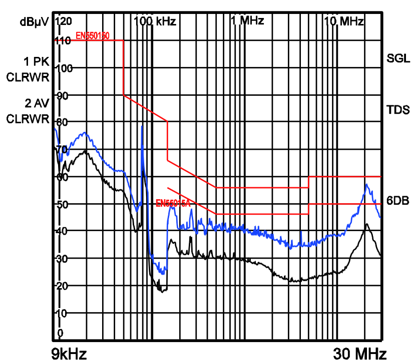
Efficiency vs. V_{IN}



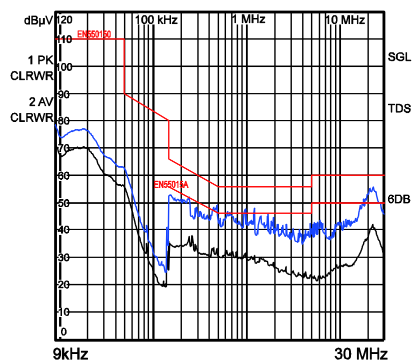
Power Factor & THD vs. V_{AC}



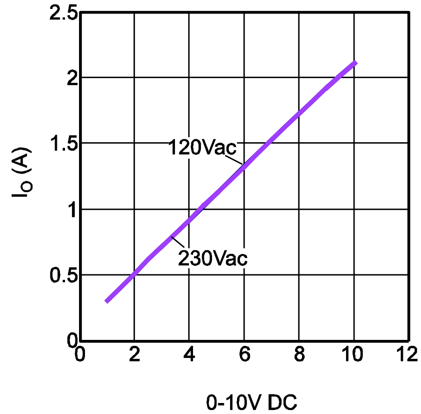
Conducted EMI
VAC=115V, full load



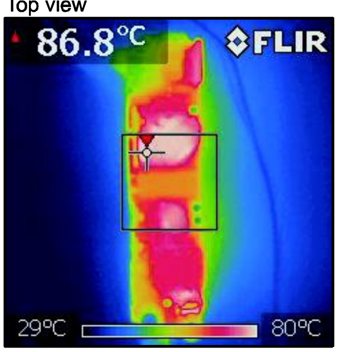
Conducted EMI
VAC=230V, full load



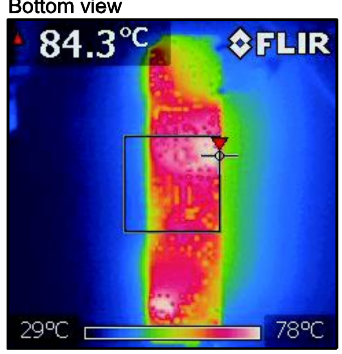
I_O vs. 0-10V DC (0-10V Dimming)



Thermal Figure
VAC=100V, full load, T_A=28°C
Top view



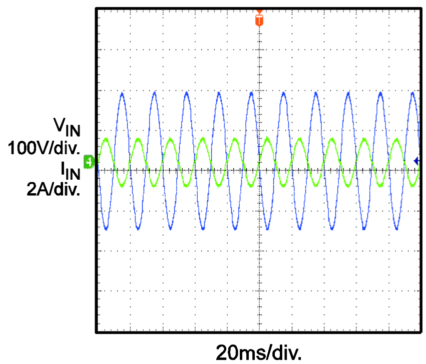
Thermal Figure
VAC=100V, full load, T_A=28°C
Bottom view



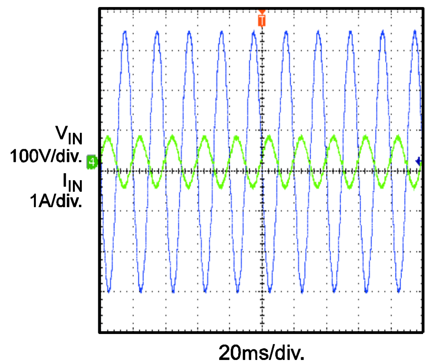
EVB TEST RESULTS *(continued)*

Performance waveforms are tested on the evaluation board.
V_{AC}=100V to 305V, I_{OUT}=2.1A, P_{OUT}=90W

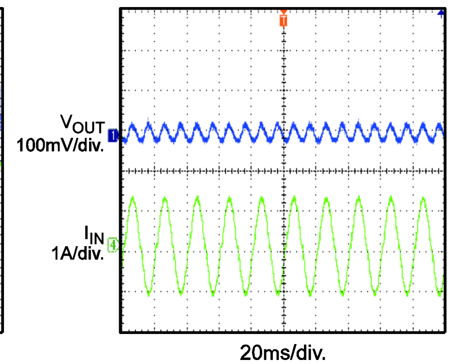
Input Voltage and Current
V_{IN} = 120VAC/60Hz, full load



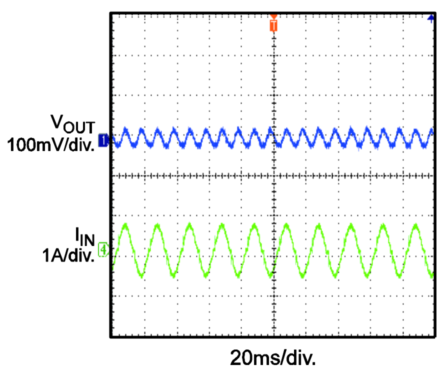
Input Voltage and Current
V_{IN} = 230VAC/60Hz, full load



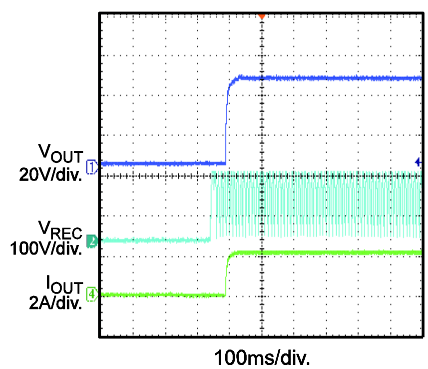
Steady State
V_{IN} = 120VAC/60Hz, full load



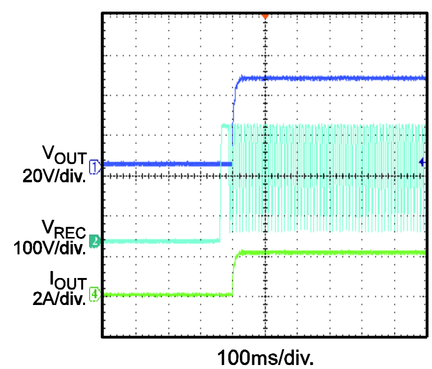
Steady State
V_{IN} = 230VAC/60Hz, full load



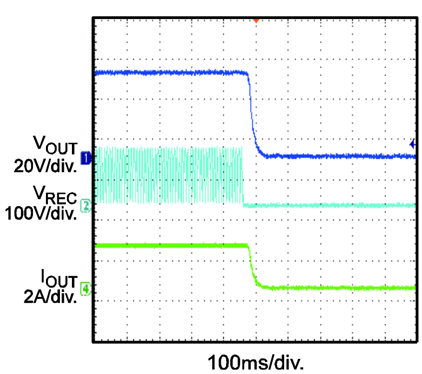
Start Up
V_{IN} = 120VAC/60Hz, full load



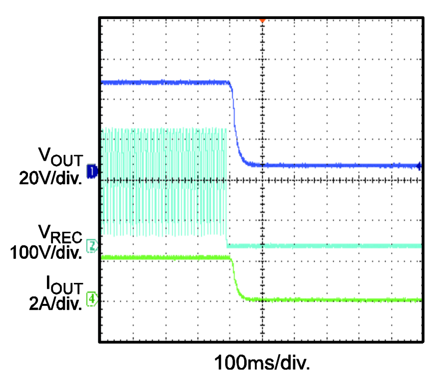
Start Up
V_{IN} = 230VAC/60Hz, full load



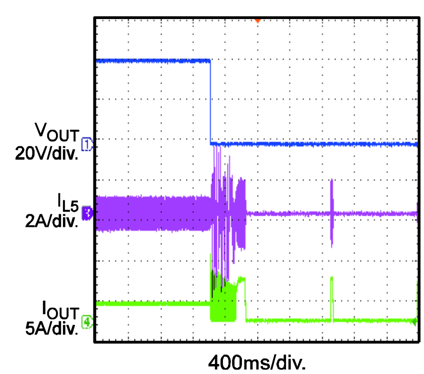
Shut Down
V_{IN} = 120VAC/60Hz, full load



Shut Down
V_{IN} = 230VAC/60Hz, full load



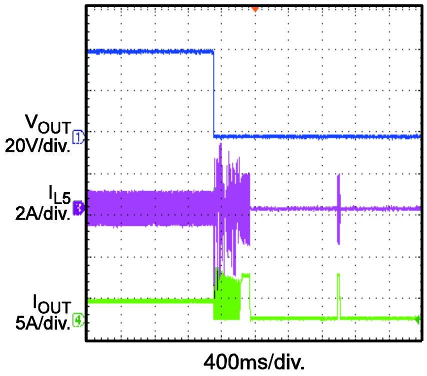
SCP Entry
V_{IN} = 120VAC/60Hz, full load



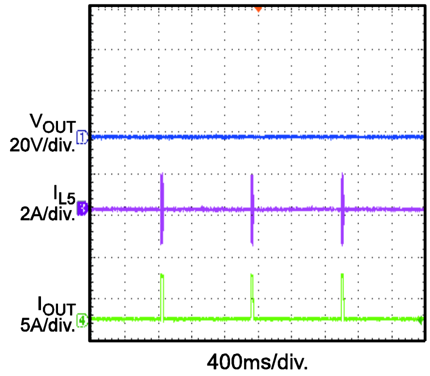
EVB TEST RESULTS *(continued)*

Performance waveforms are tested on the evaluation board.
V_{AC}=100V to 305V, I_{OUT}=2.1A, P_{OUT}=90W

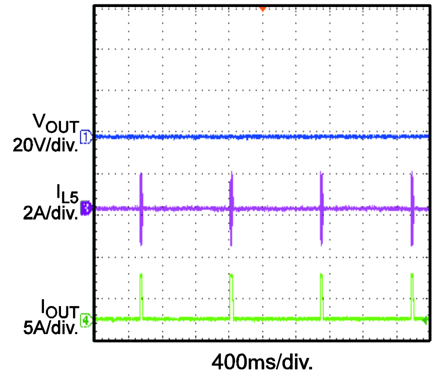
SCP Entry
V_{IN} = 230VAC/60Hz, full load



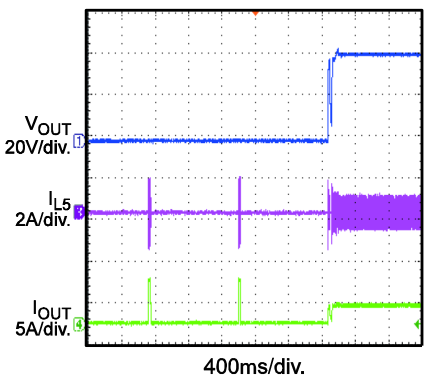
SCP steady state
V_{IN} = 120VAC/60Hz, full load



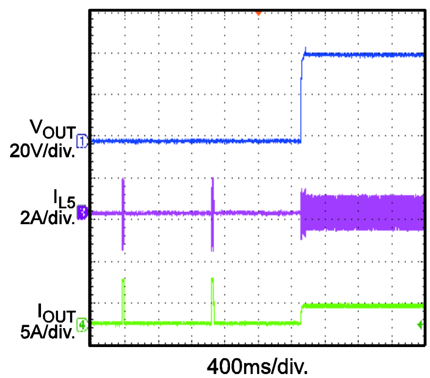
SCP steady state
V_{IN} = 230VAC/60Hz, full load



SCP Recovery
V_{IN} = 120VAC/60Hz, full load



SCP Recovery
V_{IN} = 230VAC/60Hz, full load



PRINTED CIRCUIT BOARD LAYOUT

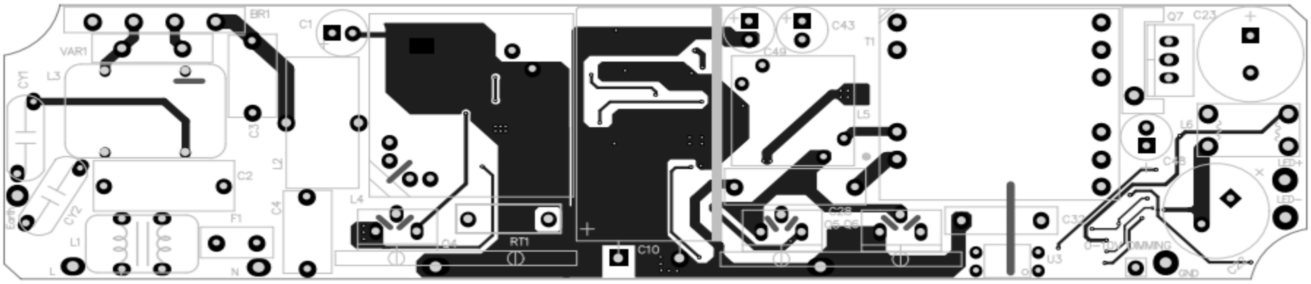


Figure 1—Top Layer

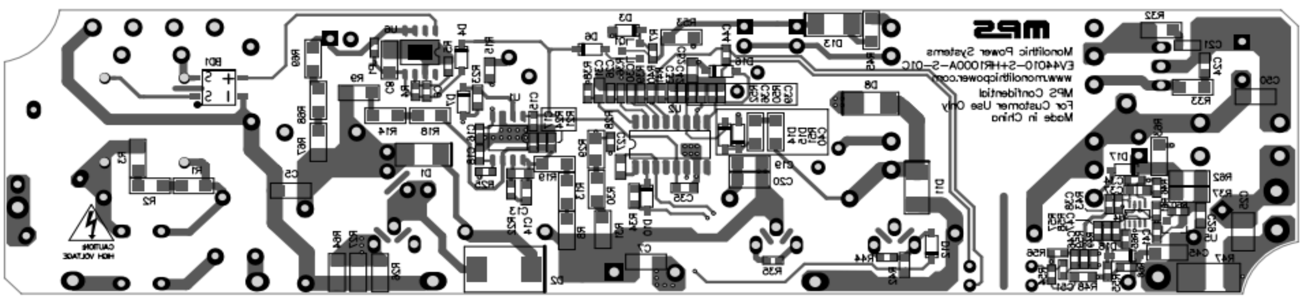


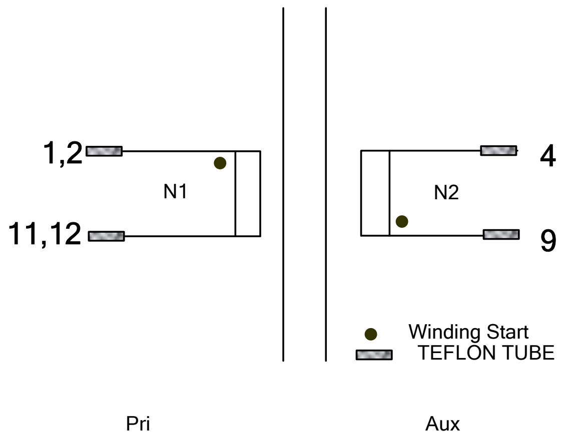
Figure 2—Bottom Layer

QUICK START GUIDE

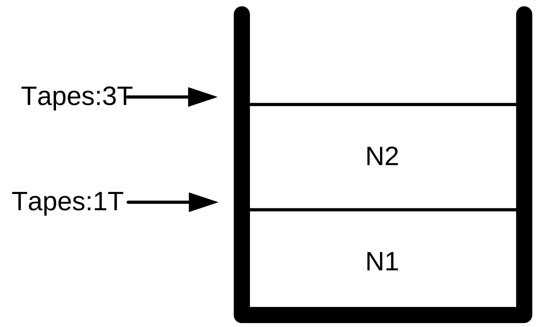
1. Preset AC input voltage between 100V and 305V. Then turn off AC power supply.
2. Connect the output pins, LED+ & LED- to the LEDs.
3. Connect the Line and Neutral terminals of the power supply output to AC input pins, L & N.
4. Turn on the power supply. The board will start up automatically.

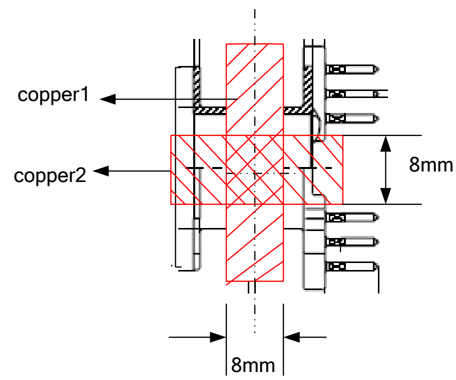
APPENDIX1: PFC INDUCTOR SPECIFICATION

Electrical Diagram



Winding Diagram

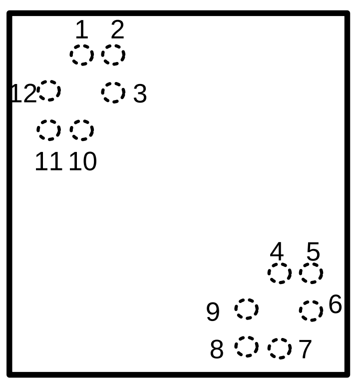




Note: use copper wires to connect copper1 & copper2 with pin 9 of bobbin.

Pin Definition of Bobbin

Pin out



View from the top

Table 1—Electrical Characteristic

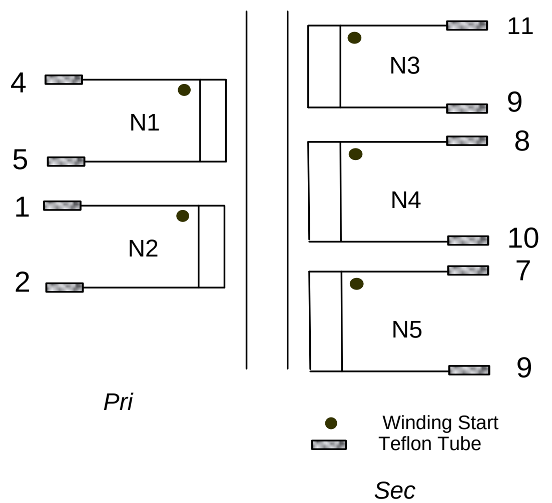
Parameter	Condition	Value
Primary Inductance	L（1—12）	410μH±5%
Core		RM10
Bobbin		RM10
Core Material		DMR40 or equivalent
Turn Ratio	N1:N2	47:8

Table 2—Winding Specification

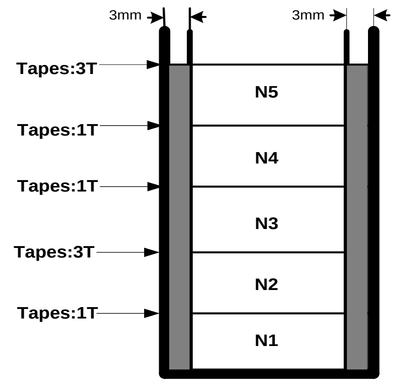
Tape Turns	Winding No.	Margin Tapes	Start& End	Wire Diameter (mm)	Turns
1	N1		1&2→11&12	0.33×5	47
3	N2		9→4	0.2×1	8

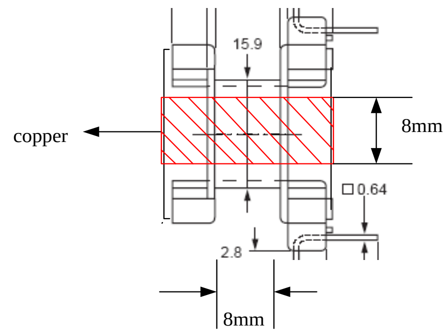
APPENDIX2: LLC TRANSFORMER SPECIFICATION

Electrical Diagram



Winding Diagram





Note: use a copper wire to connect copper with pin 2 of bobbin.

Pin Definition of Bobbin

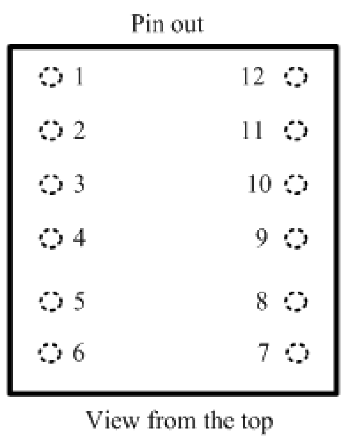


Table 1—Electrical Characteristic

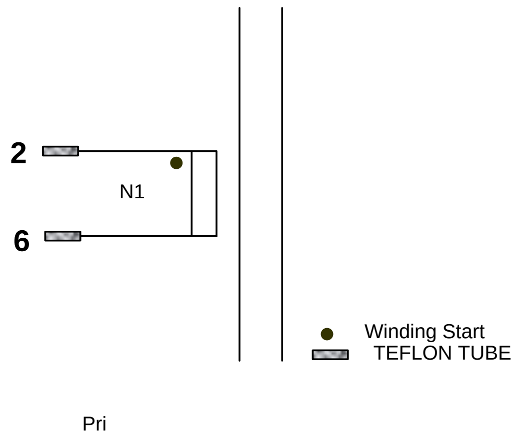
Parameter	Condition	Value
Primary Inductance	L(4-5)	1mH±5%
Core		PQ26-20
Bobbin		PQ26-20
Core Material		DMR40 or equivalent
Turn Ratio	N1:N2:N3:N4:N5	39:3:7:7:3

Table 2—Winding Specification

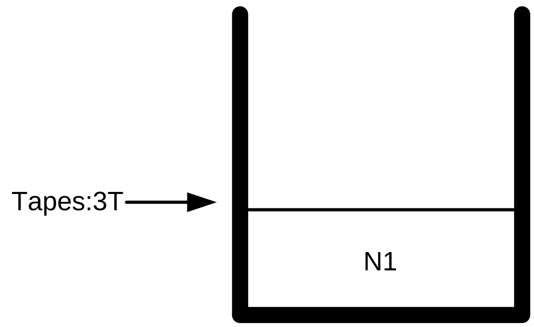
Tape Turns	Winding No.	Margin Tapes	Start& End	Wire Diameter (mm)	Turns
1	N1	3mm	4→5	0.25×2	39
3	N2	3mm	1→2	0.2×8	3
1	N3	3mm	11→9	0.33×4	7
1	N4	3mm	8→10	0.33×4	7
3	N5	3mm	7→9	0.2×1	3

APPENDIX3: LLC RESONANT INDUTOR SPECIFICATION

Electrical Diagram

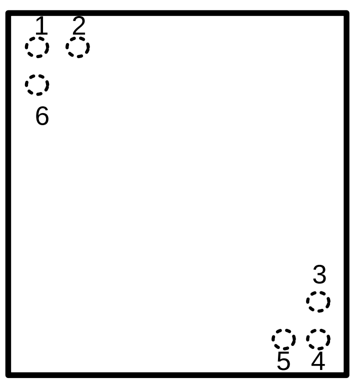


Winding Diagram



Pin Definition of Bobbin

Pin out



View from the top

Table 1—Electrical Characteristic

Parameter	Condition	Value
Primary Inductance	L(2-6)	250μH±5%
Core		RM6
Bobbin		RM6
Core Material		DMR40 or equivalent
Turn Ratio	N1	43

Table 2—Winding Specification

Tape Turns	Winding No.	Margin Tapes	Start& End	Wire Diameter (mm)	Turns
3	N1		2→6	0.27×3	43