200W AC-DC Power Supply

Reference Guide

RD015-RGUIDE-02

TOSHIBA ELECTRONIC DEVICES & STORAGE CORPORATION

Table of Contents

1. Introduction

This reference guide describes the specifications and characteristics of a 200W AC-DC power supply unit. This power supply unit is designed for LCD TV and other home appliance applications as well as for various embedded applications. The 200W AC-DC power supply unit has a universal input of 90-264 V AC and a 24V DC output, and incorporates a power factor correction (PFC) circuit and an LLC resonant power supply circuit. To reduce power losses, the DC-DC converter section uses an LLC circuit while the secondary side adopts synchronous rectification using MOSFET devices.

In order to achieve high efficiency, Toshiba's 650V power MOSFETs of the latest DTMOSV series are used in the PFC circuit and the primary side of the resonant power supply circuit, and 60-V MOSFETs of the U-MOS-IX-H series are used for synchronous rectification in the secondary side of the resonant power supply circuit. In addition, the TLP785F transistor-output photocoupler is used to transfer a secondary-side output information to the controller on the primary side.

To download the datasheets for the MOSFETs of the DTMOSV series→ Click Here

To download the datasheets for the MOSFETs of the U-MOSIX-H series→ Click Here

To download the datasheets for Toshiba's transistor-output photocouplers → Click Here

2. Specifications

2.1. Power supply specifications

Table 2.1 shows the input and output characteristics of the power supply unit.

Table 2.1 Power supply specifications

Parameter	**Condition**	Min	Typical	Max	Unit
Input characteristics					
AC input voltage (rms)		90		264	V
AC input current (rms)	VinAC = 90 V, Iout = 8.3 A			3	A
AC input frequency		47		63	Hz
Output characteristics					
Output voltage	Iout = 2 to 8.3 A	21.6	24	26.4	V
Output current				8.3	A
Output power				200	W

2.2. External view of the AC-DC power supply unit

Figure 2.2.1 shows the AC-DC power supply unit.

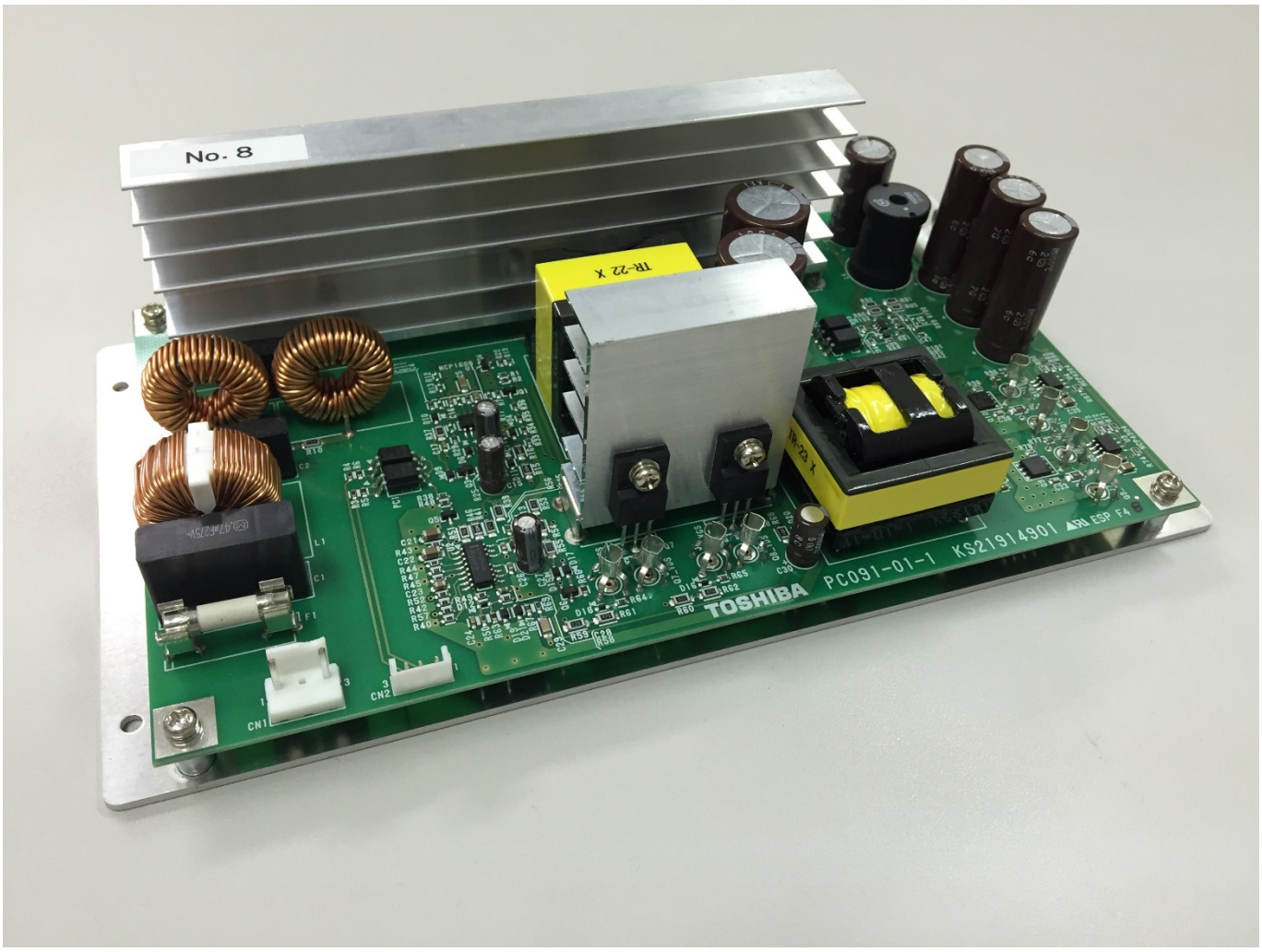


Figure 2.2.1 AC-DC power supply unit

External dimensions: 225 mm x 120 mm x 65 mm (including the base plate below the board and the heatsinks)

2.3. Block diagram

Figure 2.3.1 shows a functional block diagram of the AC-DC power supply unit. For a detailed circuit drawing, see RD015-SCHEMATIC-01.

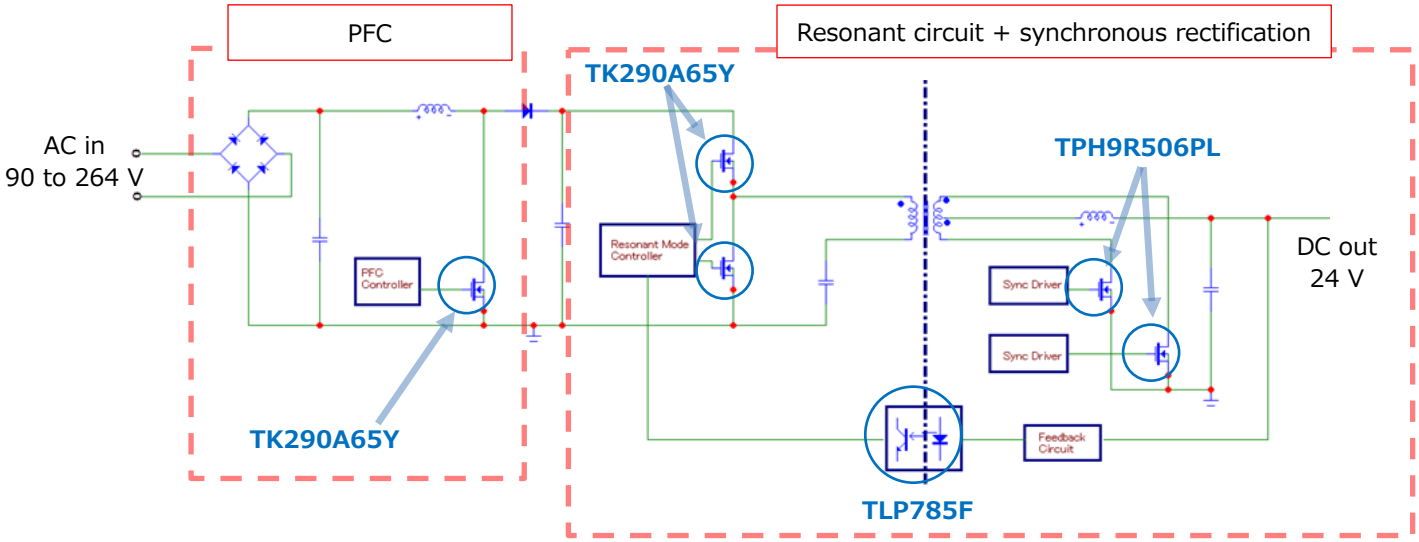


Figure 2.3.1 Block diagram

2.4. Bill of materials

Table 2.2 shows a bill of materials for the AC-DC power supply unit.

Table 2.2 Bill of materials

No.	Ref.	Qty	Value	Part Number	Manufacturer	Description	Package Name	Typical Dimensions mm (inches)
1	C1	1	0.47 µF	ECQU2A474ML	Panasonic	Polypropylene Film, 275 V, ±10 %		
2	C2, C7	2	0.1 µF	ECQUAAF104ML	PANASONIC	Polypropylene Film, 275 V, ±10%		
4	C4	1	0.68 µF			Ceramic, 16 V, ±10%		2.0 x1.25 (0805)
5	C5	1	3.3 µF			Ceramic, 10 V, ±10%		3.2 x 1.6 (1206)
6	C6, C8, C32	3	2200 pF	DE1E3KX222MA5BA01	MURATA	Ceramic, 250 VAC ±20%		
9	C9	1	1 nF			Ceramic, 50 V, ±10%		1.6 x 0.8 (0603)
10	C12	1	0.47 µF	ECWF2W474JAQ	PANASONIC	Polypropylene Film, 450V, ±10%		
11	C13, C25, C26	3	0.1 µF			Ceramic, 50 V, ±10%		1.6 x 0.8 (0603)
12	C14, C15, C27	3	33 µF	EKY-350ELL330ME110	NICHEMI	Aluminum Electrolytic, 35 V, ±20%		
14	C17	1	10 nF			Ceramic, 50 V, ±10%		1.6 x 0.8 (0603)
15	C18	1	100 pF	DEA1X3A101JN2A	MURATA	Ceramic, 1 KV, ±20%		
16	C19, C20	2	100 µF	EKXJ451ELL101MMP1S	NICHEMI	Aluminum Electrolytic, 450 V, ±20%		
18	C21, C22	2	4.7 µF			Ceramic, 25 V, ±15%		3.2 x 1.6 (1206)
20	C23	1	470 nF			Ceramic, 25 V		2.0 x1.25 (0805)
21	C24	1	2.2 nF			Ceramic, 50 V, ±15%		1.6 x 0.8 (0603)
25	C28	1	47 nF			Ceramic, 50 V, ±15%		1.6 x 0.8 (0603)
26	C29	1	47 pF			Ceramic, 1 kV, ±20%		3.2 x 1.6 (1206)
27	C30	1	56 µF	EKY-350ELL560MF110	NICHEMI	Aluminum Electrolytic, 35 V, ±20%		
28	C31	1	33 nF	ECWF4333JL	PANASONIC	Metallized PP 400 V		
30	C33, C38	2	330 pF			Ceramic, 100 V, ±60ppm/°C		1.6 x 0.8 (0603)
31	C34, C39	2	1 µF			Ceramic, 50 V, ±15%		3.2 x 1.6 (1206)
32	C35, C36, C37 C40, C42	5	100 nF			Ceramic, 50 V, ±15%		1.6 x 0.8 (0603)
38	C41, C43, C44	3	1500 µF	EKY-350ELL152MK35S	NICHEMI	Aluminum Electrolytic, 35 V, ±20%		
42	C45	1	1000 µF	EKY-350ELL102MK25S	NICHEMI	Aluminum Electrolytic, 35 V, ±20%		
43	CN1	1	AC INPUT	B2P3-VH	JST			
46	CN4	1	DC OUTPUT	B4P-VH	JST			
47	D1, D2, D5	3		S2G-13-F	DIO0ES			

No.	Ref.	Qty	Value	Part Number	Manufacturer	Description	Package Name	Typical Dimensions mm (inches)
49	D3, D12, D16 D18	4		RB521SM-40	ROHM			
50	D4, D14	2		UDZV18B	ROHM			
52	D6, D9, D10 D11, D15, D19 D20, D21	8		1SS355VM	ROHM			
53	D7	1		UDZV15B	ROHM			
54	D8	1		STTH5L06FP	ST MICRO			
59	D13	1		RFN1L6S	ROHM			
63	D17	1		UDZV15B	ROHM			
68	D22, D24	2		RB160M-90	ROHM			
69	D23	1		UDZV27B	ROHM			
71	DB1	1		D10XB60	SHINDENGEN	10 A / 600 V		
72	F1	1		021506.3	Littelfuse	6.3 A, 250 VAC		
83	L1	1		ADR20H-4A100S	UENO	4 A, 10 mH		
84	L2, L3	2		AFP12-50-100	UENO	5 A, 100 µH		
86	L4	1		15332C	MURATA	11.8 A, 3.3 µH		
87	L5	1		BL01RN1A1F1J	MURATA	10 A, 10 µH		
88	PC3, PC4	2		TLP785F(GB)	TOSHIBA		DIP4	10.16 x 4.6
90	Q1	1		RUC002N05	ROHM			
91	Q2, Q7, Q8	3		TK290A65Y	TOSHIBA		TO-220SIS	
92	Q3, Q6	2		2SC2412K	ROHM			
93	Q4, Q5	2		RUC002N05	ROHM			
98	Q9, Q10	2		TPH9R506PL	TOSHIBA		SOP Advance	5.0 x 6.0
100	R1,R19,R20, R38,R43,R64, R65,R77,R95, R96	10	10 kΩ			100 mW, ±5%		1.6 x 0.8 (0603)
101	R2,R22,R25, R48,R66,R102	6	4.7 kΩ			100 mW, ±5%		1.6 x 0.8 (0603)
102	R3,R4,R50,R9 3,R100	5	1.5 kΩ			100 mW, ±5%		1.6 x 0.8 (0603)
104	R5,R6,R42, R63	4	2.2 kΩ			100 mW, ±5%		1.6 x 0.8 (0603)
106	R7	1	22 kΩ			100 mW, ±1%		1.6 x 0.8 (0603)
107	R8, R9, R10	3	220 kΩ			250 mW, ±5%		3.2 x 1.6 (1206)
110	R11, R71, R88	3	22 kΩ			100 mW, ±5%		1.6 x 0.8 (0603)
111	R14	1	470 Ω			100 mW, ±5%		1.6 x 0.8 (0603)
112	R15, R16, R46	3	330 kΩ			250 mW, ±5%		3.2 x 1.6 (1206)
114	R17, R18, R61, R62	4	47 Ω			250 mW, ±5%		3.2 x 1.6 (1206)
118	R21, R23, R24	3	0.15 Ω			500 mW, ±1%		3.2 x 2.5 (1210)

No.	Ref.	Qty	Value	Part Number	Manufacturer	Description	Package Name	Typical Dimensions mm (inches)
123	R26,R27,R28, R30,R31,R32	6	120 Ω			250 mW, ±5%		3.2 x 1.6 (1206)
126	R29	1	100 kΩ			100 mW, ±5%		1.6 x 0.8 (0603)
130	R33	1	390 kΩ			100 mW, ±1%		1.6 x 0.8 (0603)
131	R34, R35, R36	3	1 M			100 mW, ±1%		1.6 x 0.8 (0603)
134	R37	1	100 Ω			250 mW, ±5%		3.2 x 1.6 (1206)
136	R39, R41	2	470 kΩ			250 mW, ±5%		3.2 x 1.6 (1206)
137	R40	1	15 kΩ			100 mW, ±5%		1.6 x 0.8 (0603)
141	R44	1	150 kΩ			100 mW, ±5%		1.6 x 0.8 (0603)
142	R45	1	3.9 kΩ			100 mW, ±1%		1.6 x 0.8 (0603)
144	R47	1	18 kΩ			100 mW, ±5%		1.6 x 0.8 (0603)
146	R49	1	8.2 kΩ			100 mW, ±5%		1.6 x 0.8 (0603)
148	R51	1	39 kΩ			250 mW, ±5%		3.2 x 1.6 (1206)
149	R52, R81	2	330 Ω			100 mW, ±5%		1.6 x 0.8 (0603)
150	R53, R54, R55	3	220 kΩ			250 mW, ±5%		3.2 x 1.6 (1206)
153	R56	1	10 Ω			100 mW, ±5%		1.6 x 0.8 (0603)
154	R57, R83, R94	3	1 kΩ			100 mW, ±5%		1.6 x 0.8 (0603)
155	R58	1	3.3 kΩ			100 mW, ±5%		1.6 x 0.8 (0603)
156	R59, R60	2	22 Ω			250 mW, ±5%		3.2 x 1.6 (1206)
164	R67	1	5.6 kΩ			100 mW, ±5%		1.6 x 0.8 (0603)
165	R68, R70, R84	3	10 Ω			250 mW, ±5%		3.2 x 1.6 (1206)
166	R69	1	4.7 Ω			100 mW, ±5%		1.6 x 0.8 (0603)
169	R72, R89	2	6.8 kΩ			100 mW, ±5%		1.6 x 0.8 (0603)
170	R74, R87	2	2.2 Ω			100 mW, ±5%		1.6 x 0.8 (0603)
171	R75, R76, R80, R82	4	10 kΩ			250 mW, ±5%		3.2 x 1.6 (1206)
174	R79, R97	2	1 Ω			100 mW, ±5%		1.6 x 0.8 (0603)
180	R85, R86, R91, R92	4	1 kΩ			250 mW, ±5%		3.2 x 1.6 (1206)
193	R101	1	39 kΩ			100 mW, ±1%		1.6 x 0.8 (0603)

No.	Ref.	Qty	Value	Part Number	Manufacturer	Description	Package Name	Typical Dimensions mm (inches)
195	T1	1		PQ3220	-	Turn ratio = 24:2 Ls = 120 µH Ip = 9.8 Apk / 3.86 Arms		
196	T2	1		ETD34	-	Turn ratio = 42:5:5:3 Lp = 800 µH Ls = 109 µH Ip = 2.4 Apk / 1.72 Arms Is = 8.76 Arms		
197	TH1	1		B57211P120M301	EPCOS	4 A		
202	IC1	1		NCP1608BDR2G	ON SEMI			
203	IC2	1		NCP1396ADR2G	ON SEMI			
204	IC3, IC4	2		NCP4304ADR2G	ON SEMI			
206	IC5	1		NJM1431AF	NJRC			

2.5. Printed wiring board (PWB)

Figure 2.5.1 shows Layer 1 of the printed wiring board.

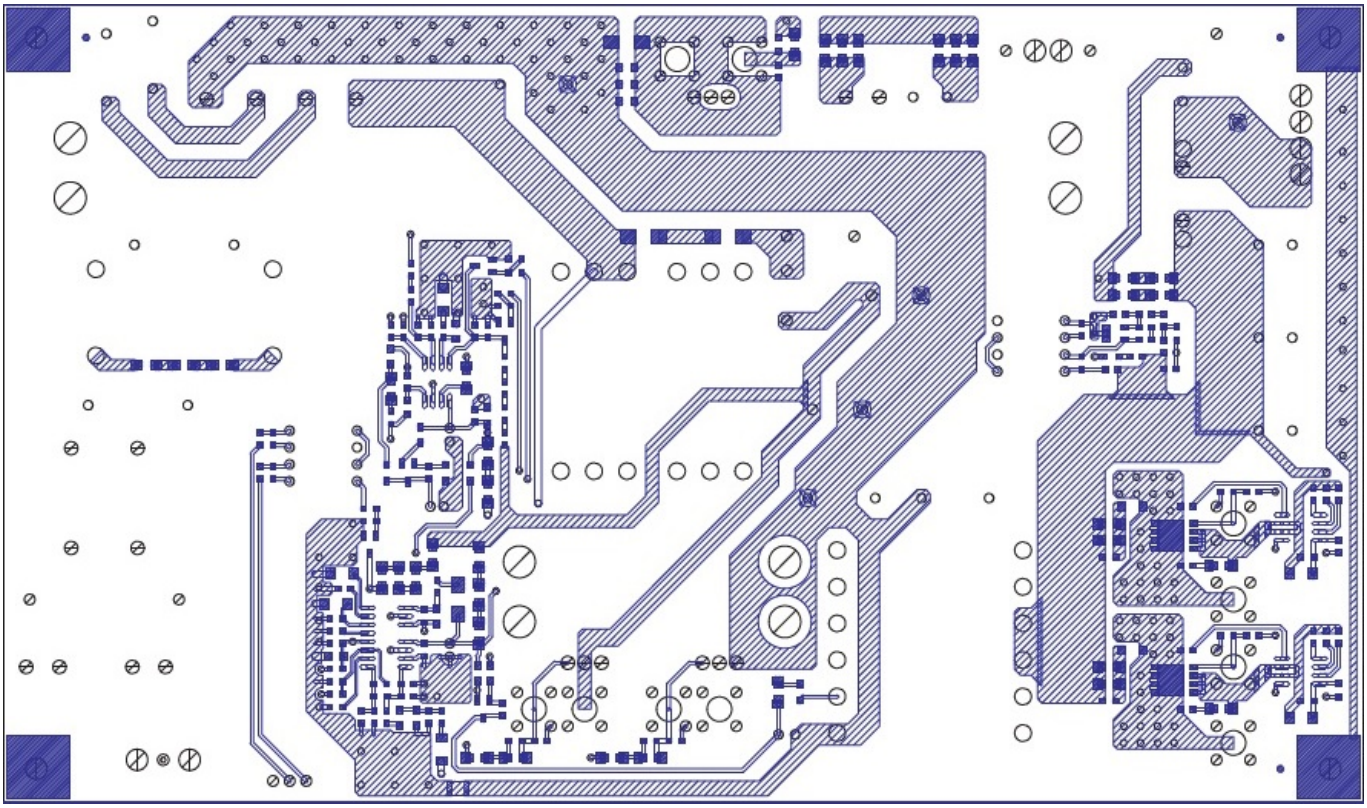


Figure 2.5.1 Layer 1

Figure 2.5.2 shows Layer 2 of the printed wiring board.

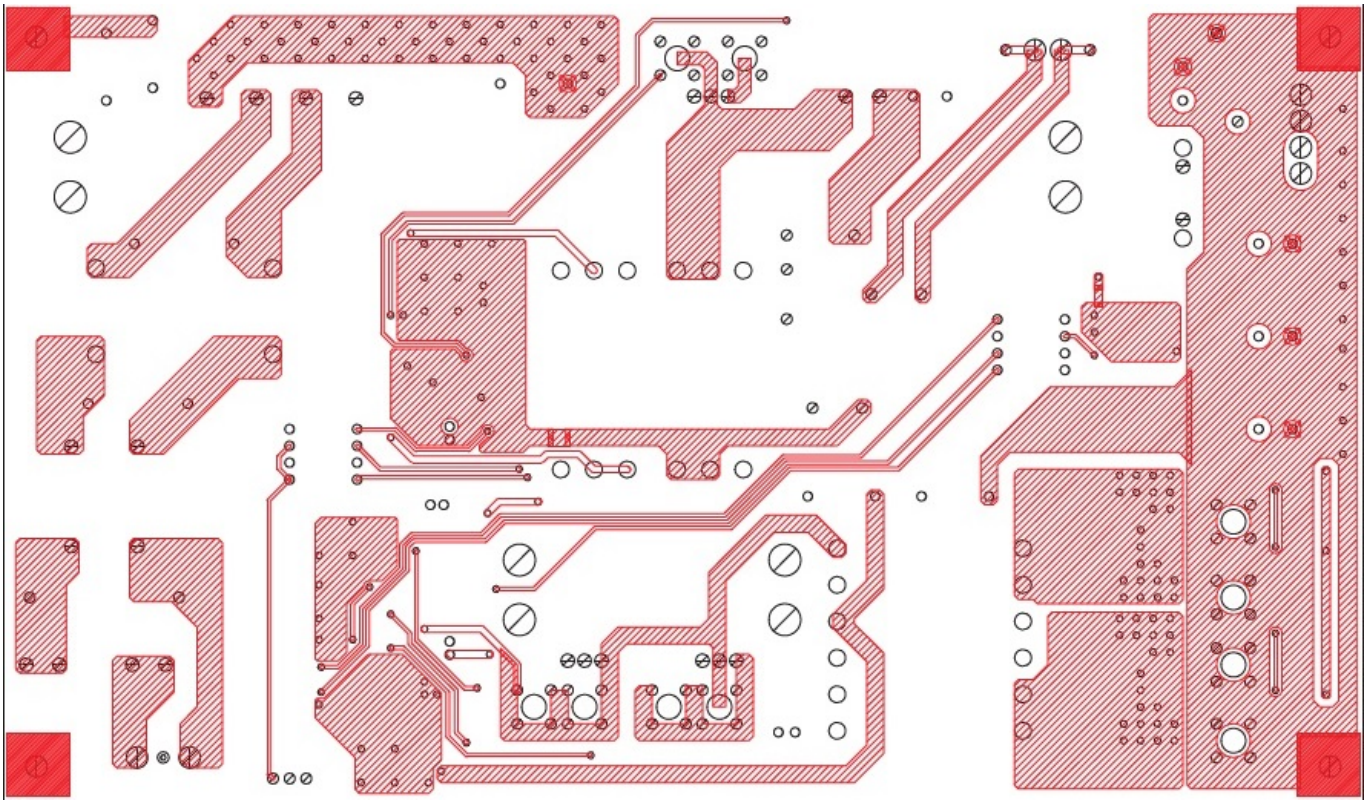


Figure 2.5.2 Layer 2

3. Power supply characteristics

This section shows the AC-DC power supply unit efficiency.

3.1. Current transfer ratio

Figure 3.1.1 shows the results of efficiency measurements at different input voltages (Vin): 90 V, 100 V, 230 V, and 264 V.

At 100% load, the AC-DC power supply unit provides 93.5% efficiency when Vin = 230 V and 90.6% efficiency when Vin = 100 V.

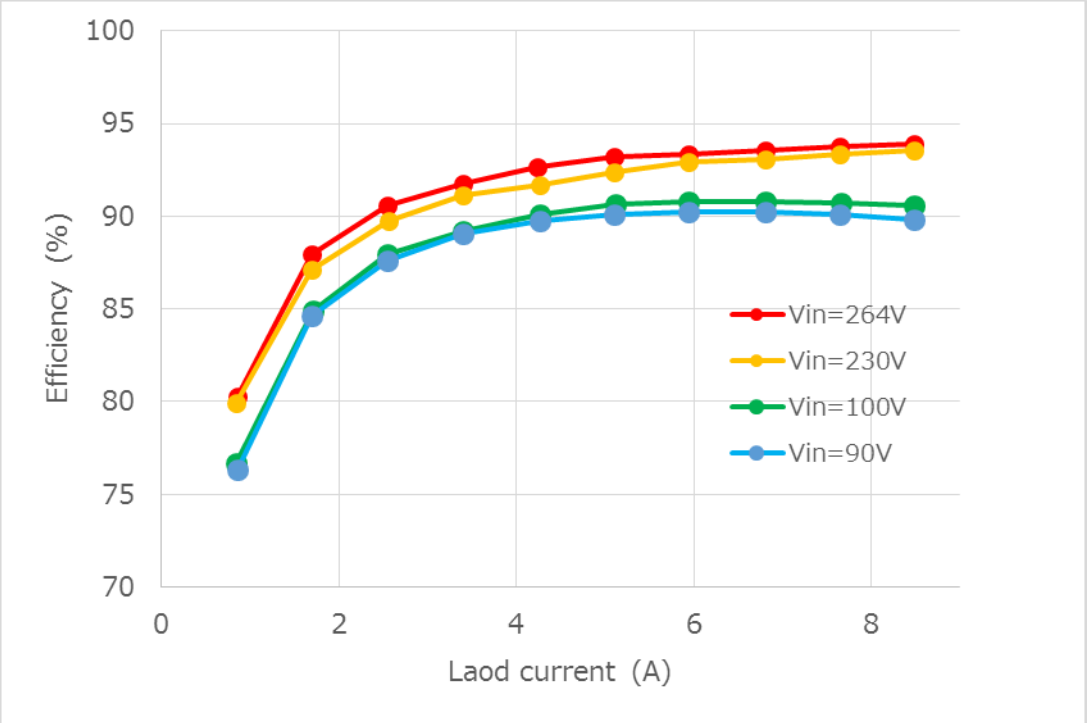


Figure 3.1.1 Results of efficiency measurements

4. Overview of the devices used

Table 4.1 summarizes Toshiba's major devices used in the AC-DC power supply unit.

Table 4.1 Toshiba's devices used

Part Number	Product	Section / Quantity	Characteristics
TK290A65Y	MOSFET	PFC, 1	DTMOSV, 650 V, 290 mΩ (max) at V_{GS} = 10 V TO-220SIS
TK290A65Y	MOSFET	Primary side, 2	DTMOSV, 650 V, 290 mΩ (max) at V_{GS} = 10 V TO-220SIS
TPH9R506PL	MOSFET	Secondary side, 2	U-MOSIX-H, 60 V, 9.5 mΩ (max) at V_{GS} = 10 V, high switching speed, SOP Advance
TLP785F	Photocoupler	Signal transfer between the primary and secondary sides, 2	DC input, transistor output, BV_S = 5000 Vrms, DIP4 (lead forming)

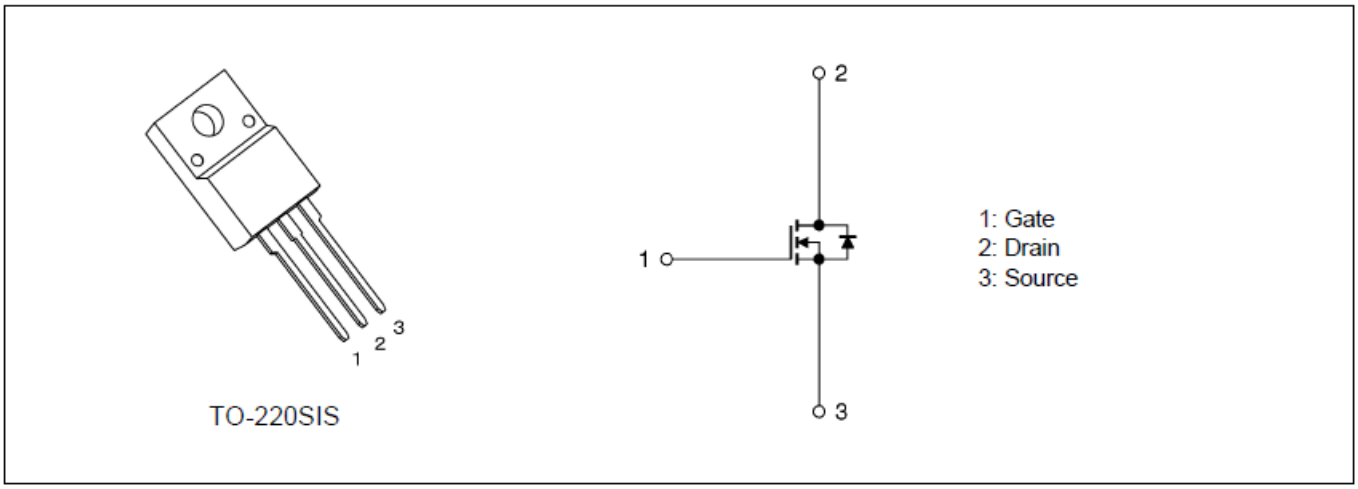
4.1. TK290A65Y

4.1.1. Overview

The TK290A65Y is Toshiba's 650V low-on-resistance super-junction MOSFET fabricated using the latest DTMOSV process.

- Low on-resistance: $R_{DS(ON)}$= 230 mΩ (Typ.) (at V_{GS} = 10 V)
- Maximum drain-source voltage: V_{DSS} = 650 V
- Isolated package

4.1.2. External view and pin assignment



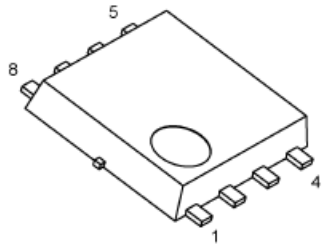
4.2. TPH9R506PL

4.2.1. Overview

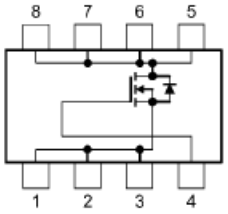
The TPH5R906PL is Toshiba's 60V MOSFET with low output charge fabricated using the latest low-voltage U-MOSIX-H process.

- Low input gate charge: Q_{SW} = 6.6 nC (Typ.)
- Low output charge: Q_{oss} = 18 nC (Typ.)
- Low on-resistance: $R_{DS(ON)}$ = 7.3 mΩ (Typ.) (at V_{GS} = 10 V)
- Maximum drain-source voltage: V_{DSS} = 60 V

4.2.2. External view and pin assignment



SOP Advance



1, 2, 3: Source
4: Gate
5, 6, 7, 8: Drain

4.3. TLP785F

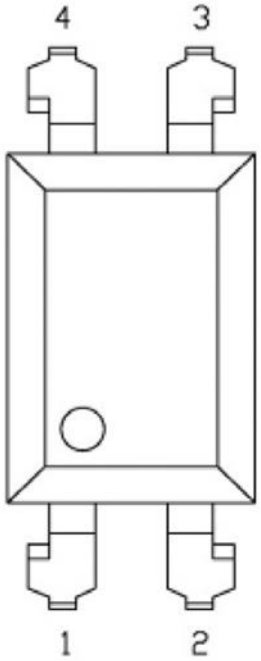
4.3.1. Overview

The TLP785F is a high isolation voltage photocoupler consisting of a GaAs infrared LED and a silicon phototransistor. Housed in the lead-formed DIP4 package, the TLP785F provides a creepage distance of 8.0 mm (min).

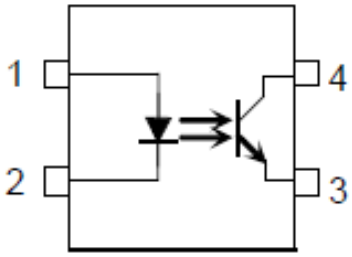
- Maximum isolation voltage: BV_S = 5000 Vrms
- Creepage distance: 8.00 mm (min)
- Maximum collector-emitter voltage: V_{CEO} = 80 V
- Current transfer ratio (Rank GB): 100% (min)

4.3.2. External view and pin assignment

Lead-formed DIP4



Pin Configurations (top view)



1 : Anode
2 : Cathode
3 : Emitter
4 : Collector

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