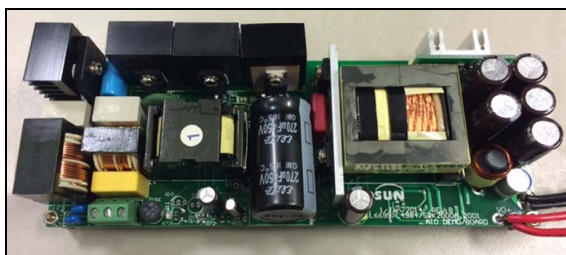


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**12 V – 400 W SMPS for adapter, desktop and AIO using L4984D,  
L6699 and SRK2000A**

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Data brief

**Features**

- Universal input mains voltage range:  
from 90 Vac to 264 Vac  
- frequency from 45 to 65 Hz
- Output voltage: 12 V  $\pm$  2% at 33 A continuous operation
- Overall efficiency at full load: above 87% according to **ENERGY STAR<sup>®</sup> 6.1** for computers and compliant with **80PLUS Gold Level**
- Average efficiency: > 89%, according to **European CoC ver. 5 Tier 2** for external power supplies
- No load mains consumption: < 0.15 W at 230 Vac, according to **European CoC ver. 5 Tier 2** for external power supplies
- Light-load efficiency: **European CoC ver. 5 Tier 2** requirements for external power supplies and **EuP lot 6 Tier 2** for office equipment (P<sub>in</sub> < 500 mW for P<sub>out</sub> = 250 mW at 115 Vac and 230 Vac)
- Mains harmonics: meets EN61000-3-2 Class-D and JEITA-MITI Class-D
- EMI: according to EN55022 Class-B
- Safety: meets EN60950 standards
- RoHS compliant

**Description**

The EVAL400W-ADP/ATX evaluation board is a 400 W, wide input mains range, power factor corrected solution for high power adapters and ATX power supplies with very low power consumption at no/light-load operation without a dedicated standby supply.

The application architecture is based on two stages: a front-end PFC pre-regulator based on a CCM (continuous conduction mode) boost PFC controller, using the L4984D, and a downstream LLC resonant half bridge converter, designed around the L6699 device, providing a 12 V regulated output voltage, dedicated to supply the ATX or similar applications requiring to meet the most stringent efficiency and standby regulations.

The main focus of this evaluation board is the light-load efficiency, achieved through the burst mode function of both PFC and LLC controllers and the self-adaptive deadtime of the L6699 device, modulated by the internal logic according to the half bridge node transition times, which allows the maximization of the transformer magnetizing inductance, reducing the primary current at light-load operation.

An active high voltage startup circuitry based on a depletion MOSFET provides a very fast startup time and minimizes the residual consumption during normal operation to a negligible level.

The very high efficiency during normal load operation and the very small heatsink used at the secondary side is obtained by using synchronous rectification, based on the SRK2000A device.



Table 1. Bill of material

Ref.	P. N.	Description	Supplier
BD1	BU1506	Enhanced PowerBridge <sup>®</sup> rectifiers 3.4 A 600 V	Vishay
C11	68 nF	50 V CERCAP X7R - general purpose	BC Components
C12	680 nF	50 V CERCAP X7R - general purpose	BC Components
C13	220 $\mu$ F/25 V	El. cap. RS 220 $\mu$ F, $\pm$ 20%, 25 V DC, +105 $^{\circ}$ C	RS
C14	0.1 $\mu$ F	50 V CERCAP X7R - general purpose	BC Components
C15	2200 pF	50 V CERCAP X7R - general purpose	BC Components
C16	470 pF	50 V CERCAP X7R - general purpose	BC Components
C19	1 $\mu$ F	50 V CERCAP X7R - general purpose	BC Components
C20	68 nF/400 V	B32652A6683 - resonant capacitor	EPCOS
C21	0.22 $\mu$ F	50 V CERCAP X7R - general purpose	BC Components
C22	0.22 $\mu$ F	50 V CERCAP X7R - general purpose	BC Components
C23	680 pF	50 V CERCAP X7R - general purpose	BC Components
C24	2.2 $\mu$ F	16V CERCAP X7R - general purpose	BC Components
C25	330 pF	50 V CERCAP X7R - general purpose	BC Components
C27	1 $\mu$ F	25V CERCAP X7R - general purpose	BC Components
C29	3900 pF	50 V CERCAP X7R - general purpose	BC Components
C30	10 $\mu$ F	50 V CERCAP X7R - general purpose	BC Components
C31	22 nF	50 V CERCAP X7R - general purpose	BC Components
C32	4700 pF	50 V CERCAP X7R - general purpose	BC Components
C33	10 nF	50 V CERCAP X7R - general purpose	BC Components
C34	220 pF/500 V	CERCAP 500 V X7R-C0805C221KDRACTU	KEMET
C35	1500 pF	50 V CERCAP X7R - general purpose	BC Components
C36	1000 pF	50 V CERCAP X7R - general purpose	BC Components
C39	68 nF	50 V CERCAP X7R - general purpose	BC Components
C4	0.47 $\mu$ F/400 V	El. cap. MM474K - 450V0V	EPCOS
C40	820 $\mu$ F/25 V	El. cap. EKZE250E00821MJ25S	Nippon Chemi-Con
C41	1000 pF	50 V CERCAP X7R - general purpose	BC Components
C44	1 $\mu$ F	25V CERCAP X7R - general purpose	BC Components
C46	0.1 $\mu$ F	50 V CERCAP X7R - general purpose	BC Components
C47	560 pF	50 V CERCAP X7R - general purpose	BC Components
C5	270 $\mu$ F/450 V	PFC output capacitor - EETHD2W271JJ	Panasonic
C501	4700 pF	50 V CERCAP X7R - general purpose	BC Components
C502	0.1 $\mu$ F	50 V CERCAP X7R - general purpose	BC Components
C503	1 $\mu$ F	25V CERCAP X7R - general purpose	BC Components
C504	100 pF	50 V CERCAP X7R - general purpose	BC Components

Table 1. Bill of material (continued)

Ref.	P. N.	Description	Supplier
C505	100 pF	50 V CERCAP X7R - general purpose	BC Components
C51	2200 µF	El. cap. - KZE series - EKZE250E00222MK35S	Nippon Chemi-Con
C52	2200 µF	El. cap. - KZE series - EKZE250E00222MK35S	Nippon Chemi-Con
C53	2200 µF	El. cap. - KZE series - EKZE250E00222MK35S	Nippon Chemi-Con
C54	2200 µF	El. cap. - KZE series - EKZE250E00222MK35S	Nippon Chemi-Con
C55	2200 µF	El. cap. - KZE series - EKZE250E00222MK35S	Nippon Chemi-Con
C56	820 µF	EEUTP1E821	Panasonic
C57	1 µF	50 V CERCAP X7R - general purpose	BC Components
C6	1000 pF/1 kV	C330C102JDG5TA CAP. MLCC, 1000 pF, 1 kV, 5%	EPCOS
C70	0.1 µF	50 V CERCAP X7R - general purpose	BC Components
C71	22 µF /50 V	SK050M0022B2F-0511	Yageo
C72	0.1 µF	50 V CERCAP X7R - general purpose	BC Components
C73	1 µF	25 V CERCAP X7R - general purpose	BC Components
CX	0.22 µF	X2 - film cap. B32922C3224K	EPCOS
CX1	0.47 µF	X2 - film cap. B32922C3474K	EPCOS
CX2	0.47 µF	X2 - film cap. B32922C3474K	EPCOS
CY1	2200 pF	Y1 safety cap. CD12-E2GA222MYGSA	TDK
CY2	2200 pF	Y1 safety cap. CD12-E2GA222MYGSA	TDK
CY4	3300 pF	Y1 safety cap. CD14-E2GA332MY	TDK
D1	STTH5L06	Turbo 2 ultrafast high voltage rectifier 600 V - 5 A	STMicroelectronics
D6	0R0	SMD standard film res. - 1/4 W - 5% - 250 ppm/°C	BC Components
D8	0R0	SMD standard film res. - 1/8 W - 5% - 200 ppm/°C	BC Components
D11	1N4148WS	Fast switching diode	Vishay
D13	1N4148WS	Fast switching diode	Vishay
D14	1N4148WS	Fast switching diode	Vishay
D16	1N4148WS	Fast switching diode	Vishay
D18	0R0	SMD standard film res. - 1/4 W - 5% - 250 ppm/°C	BC Components
D2	STTH8S06FP	Turbo 2 ultrafast high voltage rectifier	STMicroelectronics
D20	STPS1H100A	High voltage power Schottky rectifier	STMicroelectronics
D3	LL4148	Fast switching diode	Vishay
D503	1N4148WS	Fast switching diode	Vishay
D504	1N4148WS	Fast switching diode	Vishay
D9	1N4148WS	Fast switching diode	Vishay
FUSE	6.3 A	TR5/TE5 250 V 6,3A	Littelfuse
IC1	L4984D	CCM PFC controller	STMicroelectronics

Table 1. Bill of material (continued)

Ref.	P. N.	Description	Supplier
IC2	L6699D	Enhanced high voltage resonant controller	STMicroelectronics
IC3	SFH6156-3	Optoc., 5300 VRMS - CTR 100 - 200%	Vishay
IC4	SFH6156-3	Optoc., 5300 VRMS - CTR 100 - 200%	Vishay
IC5	SRK2000A	Synchronous rectifier for LLC resonant converters	STMicroelectronics
IC6	TSC888CILT	High-side current sense amplifier-fixed gain $A_V = 100$	STMicroelectronics
IC7	TSM1014AID	Low consumption voltage and current	STMicroelectronics
L1	L1-370 $\mu$ H	Boost inductor- QP3038 - 25 H- 370 $\mu$ H - 40 - 70 kHz	YUJING
L2	1 $\mu$ H	Output ripple filter	YUJING
LF1	FOTC21	Common mode choke - EMI filter	YUJING
LF2	FOTC27	Common mode choke - EMI filter	YUJING
Q1	BTA42	NPN small signal surface mount transistor	Diodes
Q11	BSS126	SIPMOS small signal transistor	Infineon
Q2	STF20N60M2-EP	N-channel 600 V, 0.2 $\Omega$ , 16 A MDmesh™ II power MOS	STMicroelectronics
Q3	STF20N60M2-EP	N-channel 600 V, 0.2 $\Omega$ , 16 A MDmesh™ II power MOS	STMicroelectronics
Q4	STF25N60M2-EP	N-channel 500 V - 0.2 $\Omega$ - 14 A MDmesh™ II power MOS	STMicroelectronics
Q5	STF25N60M2-EP	N-channel 500 V - 0.2 $\Omega$ - 14 A MDmesh™ II power MOS	STMicroelectronics
Q501	STL140N4LLF5	N-channel 40 V, 0.00275 $\Omega$ , 32 A - STripFET™ V powerMOS	STMicroelectronics
Q502	STL140N4LLF5	N-channel 40 V, 0.00275 $\Omega$ , 32 A - STripFET™ V powerMOS	STMicroelectronics
Q503	STL140N4LLF5	N-channel 40 V, 0.00275 $\Omega$ , 32 A - STripFET™ V powerMOS	STMicroelectronics
Q504	STL140N4LLF5	N-channel 40 V, 0.00275 $\Omega$ , 32 A - STripFET™ V powerMOS	STMicroelectronics
Q7	MMBT4401	Small signal transistors (NPN)	Vishay
Q8	MMBT2907	PNP general purpose amplifier	Fairchild
Q9	MMBT2907	PNP general purpose amplifier	Fairchild
R10	2.2 M $\Omega$	SMD standard film res. - 1/4 W - 5% - 250 ppm/°C	BC Components
R11	4.7 K $\Omega$	SMD standard film res. - 1/4 W - 5% - 250 ppm/°C	BC Components
R12	4.75 M $\Omega$	SMD standard film res. - 1/4 W - 5% - 250 ppm/°C	BC Components
R13	3.32 M $\Omega$	SMD standard film res. - 1/4 W - 5% - 250 ppm/°C	BC Components
R14	75 K $\Omega$	SMD standard film res. - 1/8 W - 5% - 200 ppm/°C	BC Components
R15	82.5 K $\Omega$	SMD standard film res. - 1/8 W - 5% - 200 ppm/°C	BC Components
R16	82.5 K $\Omega$	SMD standard film res. - 1/8 W - 5% - 200 ppm/°C	BC Components
R17	0.30 $\Omega$	RSMF1TB - metal film res. - 1 W - 2% -250 ppm/°C	Akane:ohm
R19	8.2 K $\Omega$	SMD standard film res. - 1/8 W - 5% - 200 ppm/°C	BC Components
R2	2.2 M $\Omega$	SMD standard film res. - 1/4 W - 5% - 250 ppm/°C	BC Components
R20	100 k $\Omega$	SMD standard film res. - 1/8 W - 5% - 200 ppm/°C	BC Components
R21	1 $\Omega$	SMD standard film res. - 1/8 W - 5% - 200 ppm/°C	BC Components

Table 1. Bill of material (continued)

Ref.	P. N.	Description	Supplier
R22	100 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R23	15 $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R24	2.2 M $\Omega$	SMD standard film res.- 1/4 W - 5% - 250 ppm/ $^{\circ}$ C	BC Components
R25	180 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R26	33 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R27	470 $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R28	15 $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R29	1 $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R30	5 m $\Omega$	SMD standard film res.	BC Components
R31	5 m $\Omega$	SMD standard film res.	BC Components
R32	1 M $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R33	0.3 $\Omega$	RSMF1TB - metal film res. - 1 W - 2% - 250 ppm/ $^{\circ}$ C	Akane:ohm
R34	0.3 $\Omega$	RSMF1TB - metal film res. - 1 W - 2% - 250 ppm/ $^{\circ}$ C	Akane:ohm
R35	5 m $\Omega$	SMD standard film res.	BC Components
R37	7.5 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R39	15 $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R4	2.2 M $\Omega$	SMD standard film res.- 1/4 W - 5% - 250 ppm/ $^{\circ}$ C	BC Components
R41	56 $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R42	20 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R43	8.2 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R44	75 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R45	75 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R46	15 $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R47	27 K $\Omega$	SMD standard film res.- 1/4 W - 5% - 250 ppm/ $^{\circ}$ C	BC Components
R47A	27 k $\Omega$	SMD standard film res.- 1/4 W - 5% - 250 ppm/ $^{\circ}$ C	BC Components
R48	27 K $\Omega$	SMD standard film res.- 1/4 W - 5% - 250 ppm/ $^{\circ}$ C	BC Components
R48A	27 k $\Omega$	SMD standard film res.- 1/4 W - 5% - 250 ppm/ $^{\circ}$ C	BC Components
R49	75 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R50	3.92 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R501	10 $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R502	10 $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R503	10 $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R504	150 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R505	33 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R506	330 $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components

Table 1. Bill of material (continued)

Ref.	P. N.	Description	Supplier
R507	330 $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R508	100 $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R509	100 $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R51	1 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R510	10 $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R511	10 $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R52	10 $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R53	47 $\Omega$	SMD standard film res.- 1/4 W - 5% - 250 ppm/ $^{\circ}$ C	BC Components
R54	6.8 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R55	270 $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R56	330 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R57	56 $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R58	90.9 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R59	0.33 $\Omega$	3 x SMD standard film res.- 1/4 W - 5% - 250 ppm/ $^{\circ}$ C	BC Components
R6	2.2 M $\Omega$	SMD standard film res.- 1/4 W - 5% - 250 ppm/ $^{\circ}$ C	BC Components
R60	12 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R61	33 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R62	47 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R63	220 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R66	1 MV	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R69	4.75 M $\Omega$	SMD standard film res.- 1/4 W - 5% - 250 ppm/ $^{\circ}$ C	BC Components
R70	120 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R71	43 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R72	100 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R73	100 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R74	0 $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R75	47 $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R76	820 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R80	15 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R81	22 $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R82	392 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R83	392 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R88	82.5 K $\Omega$	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
R9	2.2 M $\Omega$	SMD standard film res.- 1/4 W - 5% - 250 ppm/ $^{\circ}$ C	BC Components
R99	N. C.	SMD standard film res.- 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components

Table 1. Bill of material (continued)

Ref.	P. N.	Description	Supplier
RA	6.8 K $\Omega$	SMD standard film res. - 1/8 W - 5% - 200 ppm/ $^{\circ}$ C	BC Components
JP3	1.5 $\Omega$	B57237S109M	BC Components
T1	T1	HB transformer - LP3925 - 3C94 - 65 - 70 kHz - Lp = 720 $\mu$ H - Llk = 95 $\mu$ H	YUJING
ZD3	BZV55-C15	Zener diode 5% - Sz 11.4 mV/K - SMD	SOD80C SMD
ZD6	BZV55-C15	Zener diode 5% - Sz 11.4 mV/K - SMD	SOD80C SMD
H1	Heatsink	Extrusion 8359	PADA
H2	heatsink	Extrusion 8359	PADA
H3	Heatsink	Extrusion 8359	PADA
H4	Heatsink	Extrusion 8359	PADA
H5	Heatsink	Extrusion 8380	PADA
H6	Heatsink	Half bridge	PADA
Conn.1	Line input	Connector MKDS	1.5/3 - 5.08 - PS.5.08
RT	0 $\Omega$	Wire jumper 0 $\Omega$	-
Rb	36 k $\Omega$	Film res. - 1/4 W - 5% - 250 ppm/ $^{\circ}$ C <b>(in parallel to C57, by rework)</b>	BC Components



# Revision history

**Table 2. Document revision history**

Date	Revision	Changes
26-Feb-2015	1	Initial release.

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