

12 V - 400 W adapter based on L4984, L6699 and SRK2001

Data brief



Features

- Universal input mains voltage range: from 90 Vac to 264 Vac
 - frequency from 45 to 65 Hz
- Output voltage: 12 V at 33 A continuous operation
- Overall efficiency at full load: > 89%, according to **ENERGY STAR® 6.1** limit for computers
- Certified as **80Plus PLATINUM level at 115 Vac and GOLD level at 230 Vac** in the CLEAResult Plug Load Solutions website⁽¹⁾
- Average efficiency: > 89%, according to **European CoC ver. 5 Tier 2** for external power supplies
- Efficiency at 250 mW > 50%, well above **EuP lot 6 Tier 2** limit for household and office equipment

1. CLEAResult Plug Load Solutions site is owned and maintained by CLEAResult - the largest provider of energy efficiency programs and services in North America:
<https://www.plugloadsolutions.com/80PlusPowerSuppliesDetail.aspx?id=238&type=4>

- No load mains consumption: < 150 mW at 230 Vac, well below **European CoC ver. 5 Tier 2** limit for external power supplies
- 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 EVL400W-EUPL7 demonstration board is a 12 V - 400 W converter, tailored for the typical specification of an AC/DC adapter with wide input mains range, very low power consumption at light load and good average efficiency.

The architecture is based on a two-stage approach: a front-end PFC pre-regulator based on a CCM (continuous conduction mode) boost PFC controller using the L4984, and a downstream LLC resonant half-bridge converter, designed around the L6699.

At the secondary side, synchronous rectification is implemented by means of the SRK2001 that assures a very high rectification efficiency with consequent small Heat Sink required.

The PFC section uses a proprietary LM-FOT (line-modulated fixed-off-time) that allows control methodology at fixed frequency operation for boost PFC converters as long as its operating in CCM.

The LLC section uses the L6699, a double-ended controller specific to series-resonant half-bridge topology. The output voltage regulation is obtained by modulating the operating frequency.

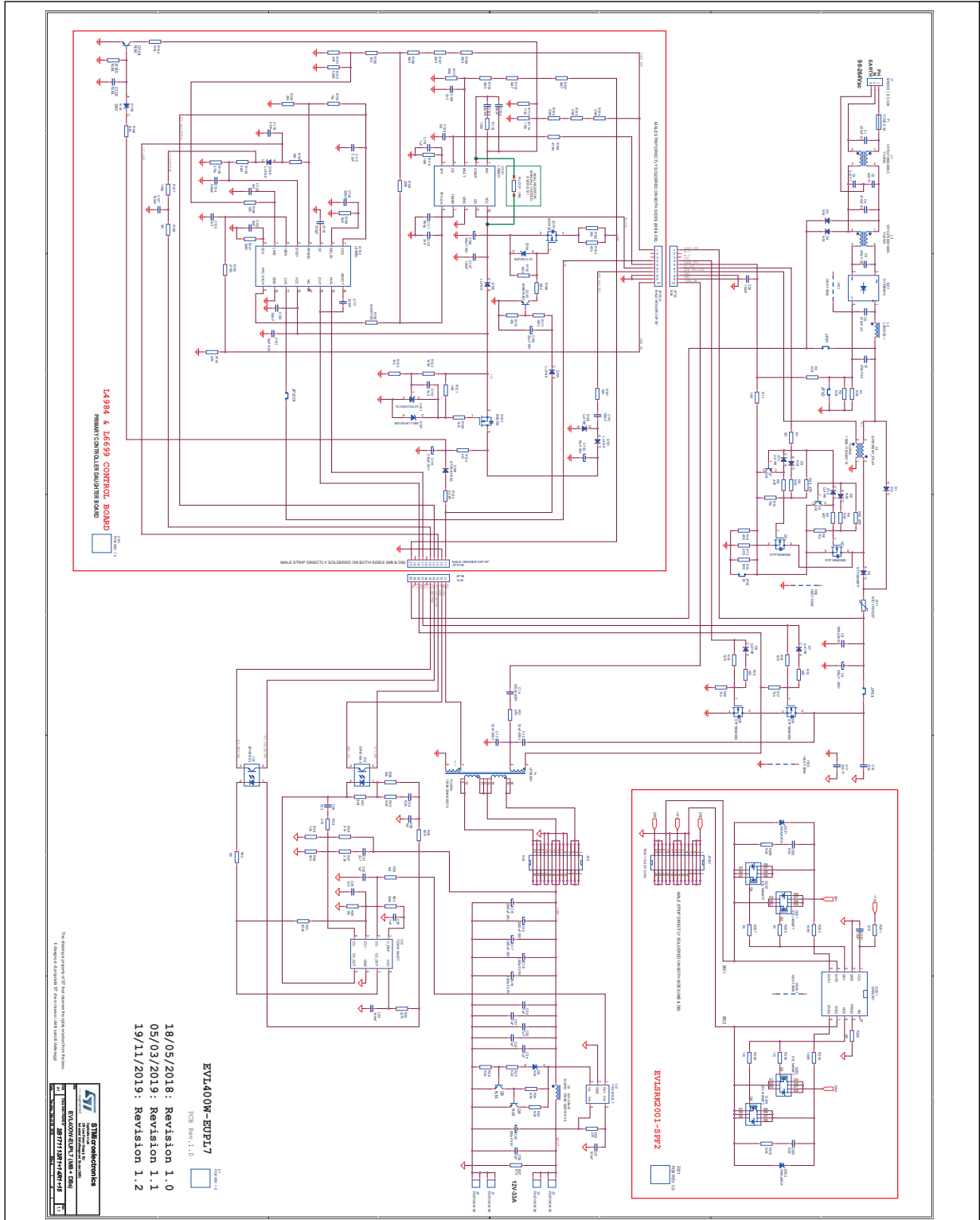
The main focus of this demonstration board is the light-load efficiency, achieved through the burst mode function of both PFC and LLC controllers with the self-adaptive deadtime of the L6699, modulated by the internal logic according to the

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 start-up circuitry based on a depletion MOSFET provides a very fast start-up time and minimizes the residual consumption during normal operation to a negligible level.

1 Electrical diagram

Figure 1. EVL400W-EUPL7 electrical diagram



2 Bill of material

Table 1. EVL400W-EUPL7 motherboard BOM

Reference	Value	Description	Package	Manuf. code	Manufacturer
BD1	D15XB60H	Single phase bridge rectifier	5S	D15XB60H	SHINDENGEN
C1	220nF-X2	X2 - film cap - R46 series, class X2, 310 Vac, 110°C	6 x 26.5 h 15 p22.5mm	R463N322000M1 M	KEMET
C2, C3, C11	2n2-Y1	Y1 safety cap. DE1E3KX222M	p10mm	DE1E3KX222M	MURATA
C4, C5, C6	470nF-X2	X2 - film cap - R46 series, class X2, 310 Vac, 110°C	7 x 26.5 p22.5mm	R463N347000N0 M	KEMET
C7	470nF-X2	X2 - film cap - R46 series, class X2, 275 VAC, 110°C	10 x 18 h16 p15mm	R46KI347000N0 M	KEMET
C8	1000p-500V	500Vac CERCAP - 1206	1206		VISHAY
C9	330uF - 450V	Aluminum ELCAP - 330uF-450V 20% - LLG2W331MELA45	DIA 25 x 45 mm	LLG2W331MELA 45	NICHICON
C10	N.M.	Y1 safety cap. DE1E3KX222M	p10mm	DE1E3KX222M	MURATA
C12, C13	33nF-630V	630Vdc cap. - B32652A6333	5 x 18 h10.5 p15mm	B32652A6333	EPCOS
C14	220pF-630V	630V CERCAP - GRM31A7U2J221JW31	1206		MURATA
C15, C16, C17, C18, C19	2200uF-25V	ELCAP KZE series- EKZE250ELL222MK35S	12.5 x 35mm	EKZE250ELL222 MK35S	NIPPON CHEMI-CON
C20, C21, C22, C23, C24, C26, C29	1uF	50V CERCAP - X7R - 10%	1206		TDK
C25	820uF-25V	25V aluminum cap - EEUTP1E821	DIA 10 x 20mm	EEUTP1E821	PANASONIC
C27, C33, C36	100nF	50V CERCAP - general purpose	805		AVX
C28	N.M.	50V CERCAP - general purpose	805		AVX
C30, C34	1n0	50V CERCAP - general purpose	805		AVX
C31	2n7	50V CERCAP - general purpose	805		AVX
C32	1uF	50V CERCAP - general purpose	805		AVX
C35	2n2	50V CERCAP - C0G - 10%	805		AVX
D1	S3J	General purpose rectifier 600V 3A	SMC (DO-214AB)	S3J	ON SEMI
D2	STTH8S06FP	Ultrafast high voltage rectifier	TO220FPAC		STMicroelectronics
D3, D4	N.M.	General purpose rectifier, SMT	DO214AC		FAIRCHILD
D5, D6	N.M.	High speed signal diode	MINIMELF SOD-80		VISHAY

Table 1. EVL400W-EUPL7 motherboard BOM (continued)

Reference	Value	Description	Package	Manuf. code	Manufacturer
D7, D8, D10, D11	LL4148	High speed signal diode	MINIMELF SOD-80		VISHAY
D9	N.M.	High junction temperature Transil™	MINIMELF SOD-80		STMicroelectronics
F1	FUSE 6.3A	Fuse TR5/TE5 250V - 6.3A	8.5x4 p.5.08mm		LITTLEFUSE
HS1	HEAT-SINK	Heat Sink for BD1	PADA_8359_85		
HS2	HEAT-SINK	Heat Sink for Q2,Q3,D2	PADA_8359_85		
HS3	HEAT-SINK	Heat Sink for Q4, Q5	DWG		
IC1	TSC101CILT	High side current sense amplifier	SOT23-5		STMicroelectronics
IC2, IC3	SFH6156-3	Optocoupler, Phototransistor Output, High Reliability, 5300 VRMS	SMD-4	SFH6156-3	VISHAY
IC4	TSM1014AIDT	Low consumption CV/CC controller	SO-8		STMicroelectronics
JPX1, JPX2, JPX4	SHORTED	Wire jumper (see Mech Parts)	PTH		
JPX3	1R	RSMF1TB - metal film res - 1W - 2% - 250ppm/°C	PTH	RSMF1TB 1R0 G PB-FREE	AKANEOHM
JP1	N.M.	Female header p.2,54mm PRECI-DIP	DWG		
JP2	N.M.	13x2p Straight Female Receptacle SSQ Series	13x2 p2.54mm	SSQ-113-02-G-D	SAMTEC
J1	MKDSN 1,5/ 3-5,08	PCB TERM. BLOCK, SCREW CONN., PITCH 5.08mm - 3 W.	DWG		PHOENIX CONTACT
J2, J3, J4, J5	FASTON M 90	FASTON - CONNECTOR	FASTON PCB	63951-1	TE Connectivity
L1	VOTC2109000 200A	Input EMI filter 2mHx2 - 4.7A	22 x 21 mm	VOTC210900020 0A	YUJING
L2	VOTC2708001 500A	Input EMI filter 15mHx2 - 3.7A	28 x 24.5 mm	VOTC270800150 0A	YUJING
L3	LSR2306-1	51uH-6A DM Inductor	DWG	LSR2306-1	DELTA ELECTRONICS
L4	QP303825H_3 70uH	PFC inductor QP3038-25H-370uH-40-70kHz	DWG	11999-115H400110	YUJING
L6	1uH-0.8mR	Output ripple filter inductor	p 16mm - dia 14mm	13999-102R100110	YUJING
Q2, Q3	STF18N60M2	N-channel Power MOSFET	TO-220FP		STMicroelectronics
Q4, Q5	STF19NM50N	N-channel Power MOSFET	TO-220FP		STMicroelectronics
Q6, Q7	N.M.	PNP general purpose amplifier	SOT-23		FAIRCHILD
Q8, Q9	N.M.	NPN small signal BJT	SOT-23		VISHAY

Table 1. EVL400W-EUPL7 motherboard BOM (continued)

Reference	Value	Description	Package	Manuf. code	Manufacturer
RT1	NTC 1R0-S237	NTC resistor P/N B57237S0109M000	DWG	B57237S0109M	EPCOS
R1, R2	N.M.	Not mounted	PTH		
R3	N.M.	SMD standard film res - 1/4W - 5% - 250ppm/°C	1206		VISHAY
R4, R8, R23, R24, R25, R26	N.M.	SMD standard film res - 1/8W - 5% - 200ppm/°C	805		VISHAY
R5, R9	4R7	SMD standard film res - 1/8W - 5% - 200ppm/°C	805		VISHAY
R6, R10, R17, R20	75k	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R7	0R	SMD standard film res - 1/8W - 5% - 250ppm/°C	805		VISHAY
R11	10R	SMD standard film res - 1/4W - 5% - 250ppm/°C	1206		VISHAY
R12, R13, R14	0R3	RSMF1TB - metal film res - 1W - 2% - 250ppm/°C	PTH	RSMF1TB 0R30 G PB-FREE	AKANEOHM
R15, R18	10R	SMD standard film res - 1/8W - 5% - 250ppm/°C	805		VISHAY
R43, R44	47R	SMD standard film res - 1/8W - 5% - 250ppm/°C	805		VISHAY
R16, R19	15R	SMD standard film res - 1/8W - 5% - 250ppm/°C	805		VISHAY
R21	47R	PTH standard film res - 1/8W - 5% - 200ppm/°C	PTH		VISHAY
R22	0R	SMD standard film res - 1/8W - 5% - 200ppm/°C	805		VISHAY
R27	51K	SMD standard film res - 1/4W - 5% - 250ppm/°C	1206		VISHAY
R28	56R	SMD standard film res - 1/8W - 5% - 250ppm/°C	805		VISHAY
R29	3k9	SMD standard film res - 1/8W - 5% - 250ppm/°C	805		VISHAY
R30	N.M.	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R31	6k8	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R32	22R	SMD standard film res - 1/8W - 5% - 200ppm/°C	805		VISHAY
R33	1k0	SMD standard film res - 1/8W - 5% - 250ppm/°C	805		VISHAY

Table 1. EVL400W-EUPL7 motherboard BOM (continued)

Reference	Value	Description	Package	Manuf. code	Manufacturer
R34	330k	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R35, R42	15k	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R36	91k	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R37	2.2k	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R38	47k	SMD standard film res - 1/8W - 5% - 250ppm/°C	805		VISHAY
R39	12k	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R40	82k	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R41	820k	SMD standard film res - 1/8W - 5% - 200ppm/°C	805		VISHAY
T1	LP3925H	Resonant power transformer - LP3925H	DWG	11999-204H400210	YUJING

Table 2. EVL400W-EUPL7 control board BOM

Reference	Value	Description	Package	Manuf. code	Manufacturer
C101	100nF	100V CERCAP - general purpose	1206		AVX
C102	10uF-50V	Aluminum ELCAP - YXF series - 105°C	DIA 5.0 x 11 p2mm	50YXF10MEFC5 X11	RUBYCON
C103	22uF-50V	50V-ELCAP SK Type tol 20%	DIA 5 x 11 p 2mm	SK050M0022B2F -0511	YAGEO
C104	68nF	50V CERCAP - general purpose	805		AVX
C105	820nF	25V CERCAP - general purpose	1206		AVX
C106	100uF-50V	Aluminum ELCAP - YXF series - 105°C	DIA 8 x 11.5 p3.5mm	50YXF100MEFC8 X11.5	RUBYCON
C107, C127	100nF	50V CERCAP - general purpose	805		AVX
C108, C113	2n2	50V CERCAP - C0G - 10%	805		AVX
C109, C125	1n5	50V CERCAP - general purpose	805		AVX
C110	1uF	CERCAP - 25V - X7R - 10%	805		AVX
C111	680p	50V CERCAP - general purpose	805		AVX
C112	3n9	50V CERCAP - general purpose	805		AVX
C114	330uF-50V	Aluminum ELCAP - 105°C	DIA10 x 16 p5mm	ECA-1HHG331	PANASONIC
C115	2.2uF	25V CERCAP - general purpose	1206		AVX

Table 2. EVL400W-EUPL7 control board BOM (continued)

Reference	Value	Description	Package	Manuf. code	Manufacturer
C116, C117	220nF	25V CERCAP - general purpose	805		AVX
C118	330pF	50V CERCAP - general purpose	805		AVX
C119	47nF	50V CERCAP - general purpose	805		AVX
C120	100nF	50V CERCAP - general purpose	1206		AVX
C121	10uF-50V	50V CERCAP - general purpose	1210	C3225X7S1H106 M250AB	TDK
C122	4n7	50V CERCAP - general purpose	805		AVX
C123	10nF	50V CERCAP - general purpose	805		AVX
C124	560pF	50V CERCAP - general purpose	805		AVX
C126	N.M.	50V CERCAP - X7R - 10%	805		AVX
D101, D102, D103, D105, D108	LL4148	High speed signal diode	MINIMELF SOD-80		VISHAY
D104	BZV55-C15	ZENER diode	MINIMELF SOD-80		VISHAY
D106	STPS1H100A	Power Schottky diode	SMA-DO- 214AC		STMicroelectr onics
D107	BZV55-B11-NM	ZENER diode	MINIMELF SOD-80		VISHAY
D109	N.M.	ZENER diode	SOD-123		DIODES
IC101	L4984D	CCM PFC CONTROLLER	SSOP10		STMicroelectr onics
R-IC101	10M	1/8W Axial Resistor	PTH		VISHAY
IC102	L6699D	Improved HV resonant controller	SO-16		STMicroelectr onics
JPX101	SHORTED	Wire jumper	PTH		
JP101	MALE HEADER 20P 90°	Male header p.2,54mm 90°	DWG		
Q101	BSS126	N-CH depletion MOSFET	SOT-23	BSS126	INFINEON
Q102	MMBT4401	NPN small signal BJT	SOT-23		VISHAY
Q103	BSS159	N-CH depletion MOSFET	SOT-23	BSS159	INFINEON
Q104	N.M.	NPN small signal BJT	SOT-23		VISHAY
R101, R140	10R	SMD standard film res - 1/4W - 1% - 100ppm/°C	1206		VISHAY
R102, R103	62k	SMD standard film res - 1/4W - 1% - 100ppm/°C	1206		VISHAY
R104, R126	2M4	Standard film res - 1/8W - 1% - 100ppm/°C	PTH		VISHAY

Table 2. EVL400W-EUPL7 control board BOM (continued)

Reference	Value	Description	Package	Manuf. code	Manufacturer
R105, R106, R116, R128	2M4	SMD standard film res - 1/4W - 1% - 100ppm/°C	1206		VISHAY
R127	2M4	SMD standard film res - 1/4W - 1% - 100ppm/°C	1206		VISHAY
R107, R115	4M7	SMD standard film res - 1/4W - 1% - 100ppm/°C	1206		VISHAY
R108	470R	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R109	100k	SMD standard film res - 1/4W - 5% - 250ppm/°C	1206		VISHAY
R110, R117, R118, R147	100k	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R111	120k	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R112	43k	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R113, R114	110k	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R119, R136	1M0	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R120	10R	SMD standard film res - 1/8W - 5% - 200ppm/°C	805		VISHAY
R121	16K	SMD standard film res - 1/8W - 5% - 200ppm/°C	805		VISHAY
R122	150K	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R123	15k	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R124	0R	SMD standard film res - 1/4W - 5% - 250ppm/°C	1206		VISHAY
R125	0.33R	SMD standard film res - 1/4W - 5% - 250ppm/°C	1206		VISHAY
R129	220k	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R130	1K5	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R131	47K	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R132	560K	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R133	15k	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY

Table 2. EVL400W-EUPL7 control board BOM (continued)

Reference	Value	Description	Package	Manuf. code	Manufacturer
R134	20k	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R135	SHORTED	Wire jumper	PTH		
R137	10K	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R138	56R	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R139	270k	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R141	100R	SMD standard film res - 1/8W - 5% - 200ppm/°C	805		VISHAY
R142	270R	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R143	47R	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
R144, R145, R146	N.M.	SMD standard film res - 1/8W - 5% - 200ppm/°C	805		VISHAY
R148	0R	SMD standard film res - 1/8W - 1% - 100ppm/°C	805		VISHAY
U101	TLVH431AIL3T	1.24V programmable shunt voltage reference	SOT-23		STMicroelectronics

Table 3. EVL400W-EUPL7 rectification board BOM

Reference	Value	Description	Package	Manuf. code	Manufacturer
C201	10uF	35V CERCAP X5R - general purpose	1206		TDK
C202, C203	N.M.	100V CERCAP - X7R - 10%	1206		TDK
D201, D202	SMAJ40CA	High junction temperature Transil™	DO-214AC		STMicroelectronics
HS201	Heat Sink	Heat Sink for Q201,Q202,Q203,Q204	DWG		
IC201	SRK2001	SRK2001 SR controller	SSOP10	SRK2001	STMicroelectronics
JP201	TSW-113-22-F-D-RA	13x2p right angle male header TSW series	13x2 p2.54mm	TSW-113-22-F-D-RA	SAMTEC
Q201, Q202, Q203, Q204	STL140N6F7	N-channel Power MOSFET	PowerFLAT 5x6	STL140N6F7	STMicroelectronics
R201	10R	SMD standard film res - 1/4W - 1% - 100ppm/°C	1206		VISHAY
R202	0R	SMD standard film res - 1/8W - 5% - 250ppm/°C	805		VISHAY

Table 3. EVL400W-EUPL7 rectification board BOM (continued)

Reference	Value	Description	Package	Manuf. code	Manufacturer
R203, R204	100R	SMD standard film res - 1/8W - 5% - 250ppm/°C	805		VISHAY
R205, R206, R207, R208	1R	SMD standard film res - 1/8W - 5% - 250ppm/°C	805		VISHAY
R209, R210	N.M.	SMD standard film res - 1/4W - 5% - 250ppm/°C	1206		VISHAY

3 Revision history

Table 4. Document revision history

Date	Revision	Changes
22-May-2019	1	Initial release
31-May-2019	2	Updated cover image on page 1
05-Dec-2019	3	Updated Features on page 1 . Changed R127 from 3.3 MΩ to 2.4 MΩ on the Schematic (Figure 1. on page 3) and in the BOM (Table 2. on page 7).Rev 3