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Design Note – DN05072/D

125W Hi-PF Single Stage LED Driver

ON Semiconductor

Device	Application	Input Voltage	Output Power	Topology	I/O Isolation
NCL30001	LED Driver	85 – 265 V ac	- 265 V ac 125W		Yes
			Output	1	
		Output Current	2.5 A	<u> </u>	
		Ripple	560 mA p	-р	
		Nominal Voltage	48 V		
		Max Voltage	55 V		
		Min Voltage	16 V		
	Гт	vpical Power Factor	>0.98		
		Typical THDi	< 6%		
		Typical Efficiency>88 %			
		Cooling Method / Supply Orientation	Free Air		

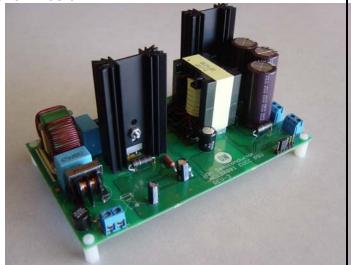
Circuit Description

Single stage power converters offer a cost effective way to provide power for LED applications with high input power factor and low THD. The most common CrM or Critical Conduction Mode solutions are typically limited to about 50 watts due to high peak currents characteristic of this approach. A CCM or Continuous Conduction Mode flyback converter offers higher power with reduced peak current while still providing high power factor and very low THD. This Design Note outlines modifying ON Semiconductor's NCL30001 CCM solution described in Application Note AND8470 extending the output power up to 125 watts. The standard evaluation board is the basis for this design.

The design guidelines for this LED driver are shown below:

- Input range: 85 265 V ac
- Output current: 2.5 A
- Output voltage: 48 V typical
- Efficiency: 88%
- Power Factor: >0.98

A photo of the modified evaluation board is shown below:



Design

The design process begins using the <u>NCL30001</u> <u>design worksheet</u> found at ON Semiconductor's website. Directions for using this worksheet are described in the first tab. The design started by entering design guidelines on tab 'Step1'. Progressing through tabs as directed, the critical changes to the standard evaluation board are noted below and highlighted in the Bill of Materials at the end of this document:

- R19 = 39k
- R12 = 71.5k
- C20,21,22 = 2200 uF

Increasing the power level requires adjustments outlined above. In particular, the output filter capacitance was increased to reduce ripple due to higher output current.

• T1 280 µH

The design worksheet also specified a power transformer with 280 μ H inductance and a primary to secondary turns ratio of 2.24. A new transformer is detailed at the end of this design note meeting the requirements with a larger core to process the increased power. The turns ratio was adjusted slightly to optimize fitting the wire in the bobbin. The transformer is available from Wurth Electronik as detailed in the BOM.

• F1 = 3.15 Amp

Current rating of the fuse must be increased to accommodate higher input current. Heatsinks for switching MOSFET Q1 and output rectifier D8 were increased to maintain device temperature with free-air cooling conditions. D7 voltage rating should be increased as well.

The output current is measured by a sense resistor and used by U3B to establish the current regulation feedback point. The formula for output current is shown below:

lout = (Vref * R31) / (R32 * Rsense)

This can be rearranged to solve for Rsense:

Rsense = (Vref * R31) / (R32 * lout)

Noting that Vref = 2.5 V as supplied by U3 pin 3 and R31 = 2.7k, R32 = 68k, and the desired output current is 2.5 A:

Rsense = (2.5 * 2.7k) / (68k * 2.5) = 0.0397 ohm

Multiple resistors will be used to create the proper value. Start with the original value of 0.1 ohms for R26, and place a second 0.1 ohm surface mount resistor (R26A) across the appropriate traces on the bottom of the board. Lastly, change C34 from a capacitor to a 0.2 ohm resistor resulting in an equivalent resistance of 0.04 ohms. Note that a filter capacitor like C34 is not always required across low inductance resistors.

- R26A = 0.1 ohm
- 'C34' = 0.2 ohm

The PWM dimming function was not required for this solution and therefore removed. In order to maintain functionality, Q5 and Q7 should be bypassed with wire from drain to source. The changes are highlighted below:

- Z5 = Not Fitted
- Q5 = Bypassed
- Q7 = Bypassed
- Q6 = Not Fitted
- C33 = Not Fitted
- R37 = Not Fitted
- R38 = Not Fitted
- R39 = Not Fitted
- R40 = Not Fitted
- R41 = Not Fitted
- R44 = Not Fitted

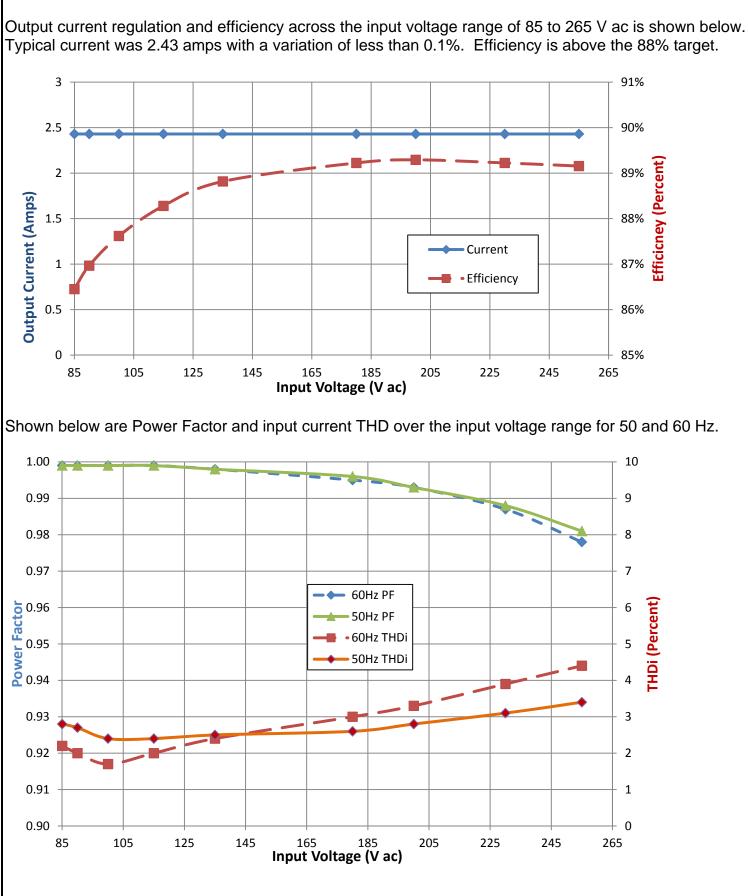
Additionally, the primary Over Voltage Protection circuit was not used. Changes shown below:

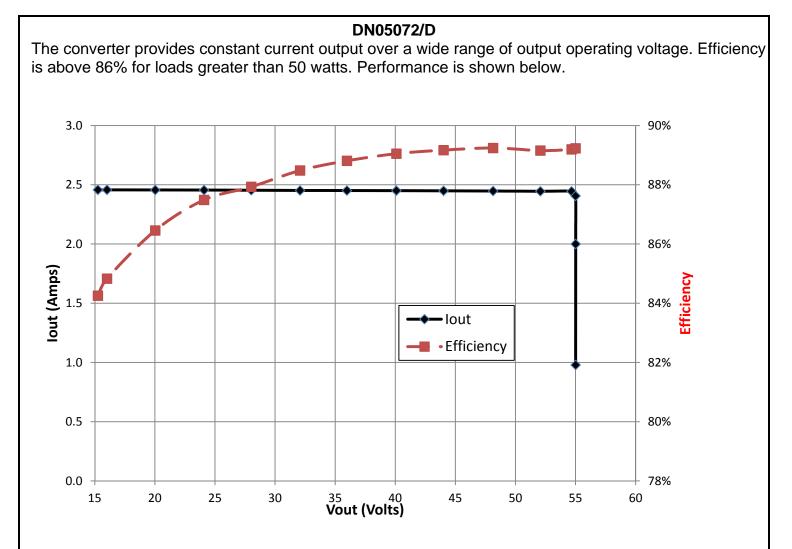
- C8 = Not Fitted
- R5 = Not Fitted
- D9 = Not Fitted
- Z2 = Not Fitted

Summary

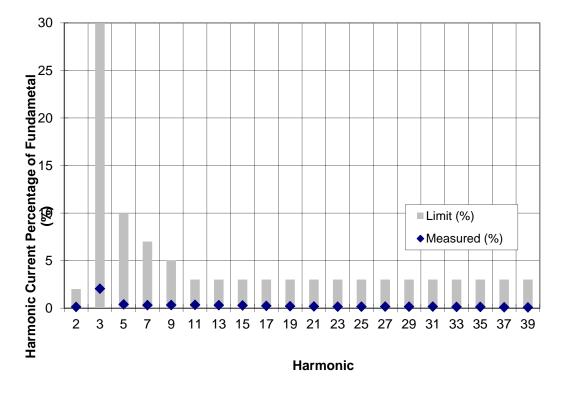
After modifications, the NCL30001 evaluation board met all of the design goals. Detailed performance is outlined on the following pages along with a schematic and Bill of Materials.

Performance

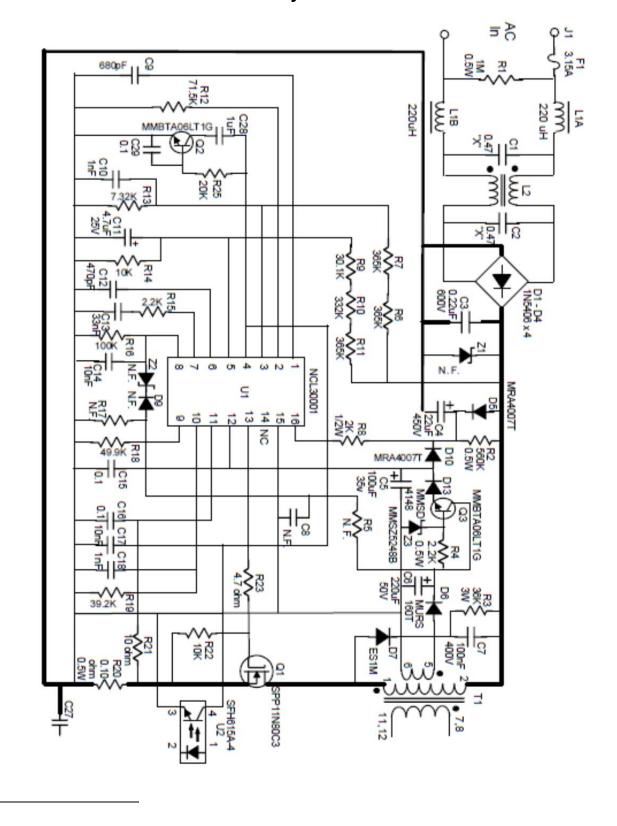


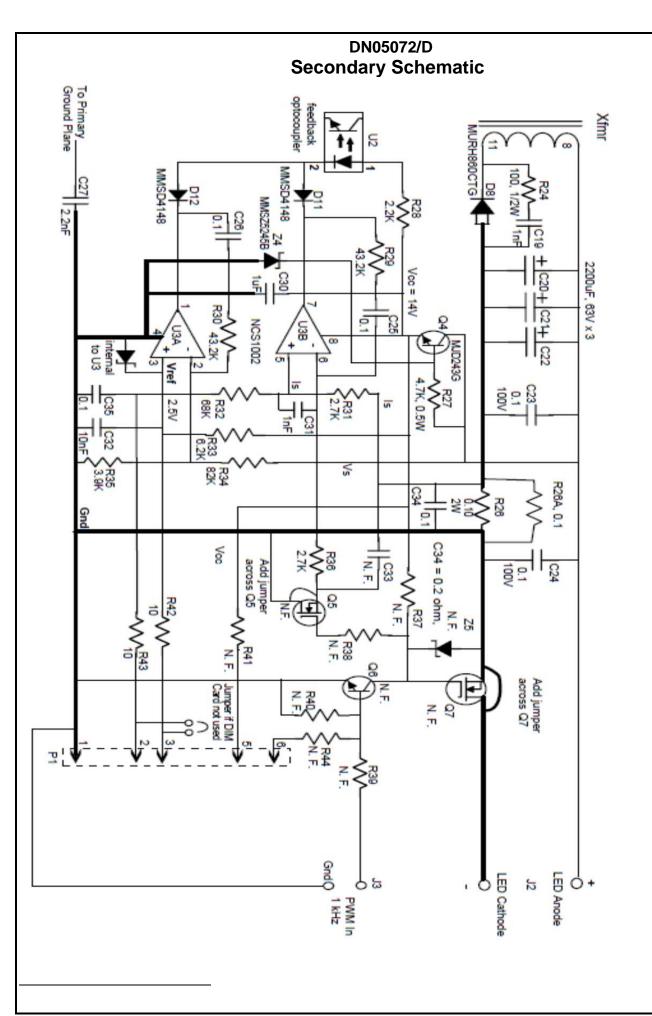


IEC 61000-3-2 Class C data is shown below for 100 V ac 50 Hz input and 2.43 A at 48 V load. The driver is well below the maximum allowed limits:



Primary Schematic



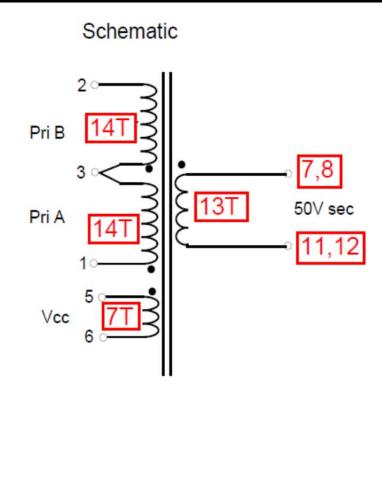


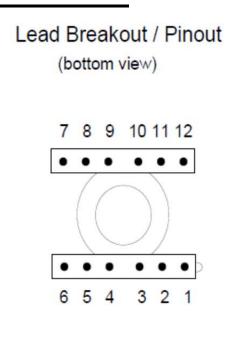
MAGNETICS DESIGN DATA SHEET

Project / Customer: NCL30001 Demo Part Description: 125 Watt 50V 2.5A LED Driver Inductance: 280uH Bobbin Type: 12 pin vertical Core Type: PQ3535-Core Gap: Gap for 280uH, ~0.028 inches

Winding Number / Type		Turns / Material / Gauge / Insulation Data				
Step	Winding	Start	Finish	Turns	Material	Notes
1	¹ / ₂ Primary	1	3	14	•• #26 TEX-E	Wind bifilar in one layer
2	Insulate			2	Mylar Tape	
3	Secondary	7,8	11,12	13	•• #24	Wind bifilar in one layer,
						terminate one wire per pin
4	Insulate			2	Mylar Tape	
5	¹ / ₂ Primary	3	2	14	•• #26 TEX-E	Wind bifilar in one layer
6	Insulate			1	Mylar Tape	
7	Pri Bias	5	6	7	#26 TEX-E	Spread evenly in one layer
8	Insulate			3	Mylar Tape	

Hipot: 3KV from primary to secondary for 1 minute.





Bill of Materials

DesignatorDescriptionValueManufacturerManufacturer Part NumberDS, D10DiodeON SemiconductorMRA4007TD1, D2, D3, D6DiodeON SemiconductorMKA4007TD6Ultrafast diodeON SemiconductorMMS160D7Ultrafast diodeMicro CommercialESIM-TPD9Signal diodeNot FittedON SemiconductorMMSD448AD11, 12, 13Signal diodeNot FittedON SemiconductorMMSD448AD8UFR diodeInput transientON SemiconductorMMSD448AZ4Zaner diode15VON SemiconductorMMSD448AZ4Zaner diodeNot FittedInput transientON SemiconductorMMSD448AZ4Zaner diodeNot FittedInput transientON SemiconductorMMSD448AZ4Zaner diodeNot FittedInput transientInput transientInput transientZ4Zaner diodeNot FittedInput transientInput transientZ4Zaner diodeNot FittedInput transientInput transientZ4Zaner diodeNot FittedInput transientInput transientZ5Zaner diodeNot FittedInput transient		Bill of materials						
D1, D2, D3, D6 Ubice ON Semiconductor IN5406 D6 Ultrafast cliode More Commercial ESIM TP D9 Signal diode Not Fitted ON Semiconductor MMSD4148A D11, 12, 13 Signal diode Input transient option ON Semiconductor MMSD4148A 21 TVS option ON Semiconductor MMSD4148A 22 Zener diode Not Fitted - - 23 Zener diode Not Fitted - - 24 Zener diode Not Fitted - - 25 Zener diode Not Fitted - - 26 Jumper #26 bus wire - - 27 Zener diode Not Fitted - - 27 Zener diode Not Fitted - - 27 BJT 60V, 500 mA ON Semiconductor MBZ04(TIG 28 BJT 100V, 4A ON Semiconductor MB2436 29 Dual amp + zener - - - 27 Y cap 2.2 nF, 1kV ON Semiconductor MD243G 28 Dual amp + zener - - - 22.2 nF, 1kV 0.22 kV	Designator	Description	Value	Manufacturer	Manufacturer Part Number			
D4DiodeON Semiconductor11/54/06D6Ultratest diodeON SemiconductorMURS160D7Ultratest diodeNot Fitted-D8Signal diodeNot Fitted-D8UPR diodeInput transientON SemiconductorMMSD4148AD8UPR diode15VON SemiconductorMMSD4148AZ1TVSoption1.5KE440A1.5KE440AZ42zener diode18VON SemiconductorMMSZ545BZ3Zener diodeNot FittedC4Zener diodeNot FittedC5Jumper#28 bus wireC7Jumper#28 bus wireC4BJT60V, 500 mAON SemiconductorMMSZ548BC2Zanar diodeNot FittedC4BJT100V, 4AON SemiconductorMMBTA0EL11GQ6BJTNot FittedQ1PFC controllerVac22 nF, 1kVQ2QD cocupierVacEvox Rifa/Kemet or EPCOSQ2Y2 cap2.2 nF, 1kVON SemiconductorMUE214220 nP271HE22M250AQ3Dual amp + zener0.1 uF, 50VTDKC3216X7R2A104KC3Polyprop. Film68 to 100 nF, 50VTDKC3216X7R2A104KC4eramic cap0.1 uF, 50VTDKC3216X7R2A104KC28, C33ceramic cap1.0 uF, 50VTDKC3216X7R2A104KC4eramic cap1		Diode		ON Semiconductor	MRA4007T			
D7Uttrafast diodeNot FittedMicro CommercialES1M-TPD9Signal diodeNot FittedON SemiconductorMMSD4149AD8UFR diodeinput transientON SemiconductorMMSD4149AZ1TVSZener diode16VON SemiconductorMMSD4149AZ4Zener diode16VON SemiconductorMMSD5248BZ5Zener diodeNot FittedZ3Zener diode118VON SemiconductorMMS25248BZ2Zaner diode114, 800VInfineonSPP11N80C3Q1Mosfet11A, 800VInfineonSPP11N80C3Q2Q3BJT10V, 4AON SemiconductorMME146L11GQ4BJT10V, 4AON SemiconductorMD243GQ1PFC controller0.47 uF, 277V3 capsV3cQ2X capsV3cVacEvox Rila/Kemet or EPCOSPHE840MB6470MB16R17 or B32922C3474MQ3Polytop, Film0.22 uF, 1kVVishayPHE21422M or 22116E3240204Q4eeramic cap0.1 uF, 50VTDKC3216X7R2A104KC3Polytop, Film0.22 uF, 1kVVishayVishay2222 fileX7R2J104KC4ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC4ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC4ceramic cap1.0 F, 50VTDKC3216X7R2A104KC4ceramic cap1.0 F, 50VTDKC3216C7R2A104KC4ceramic cap1.	D4							
D9 D11, 12, 13 Bignal diode B8Not Fitted··D11, 12, 13 B8Signal diode UFR diode UFR diodeNot FittedON SemiconductorMMSD4148A 		Ultrafast diode						
D11, 12, 13 D8Signal diode UFR diodeInput transient optionON SemiconductorMMSD2148A MURH860CTGZ1TVS Zener diode16VON Semiconductor1.5KE440AZ4Zener diode18VON SemiconductorMMSZ5245BZ5Zener diodeNot FittedC3Zener diodeNot FittedC4Jumper#26 bus wireC7Jumper#20 bus wireC1Mosfet11A, 800VInfineonSPP11N80C3C2 G3BJTF0V, 500 mAON SemiconductorMMSTA0L11GC4BJTNot FittedC4BJT100V, 4AON SemiconductorMJD243GU1PFC controllerON SemiconductorMJD243GU2OptocouplerON SemiconductorNL14817 or SFH6156A-4U3Dual amp + zeneC7Disc cap400VTDKC3216X7R2J104KC33Polynop, Film0.224F (630V)0N SemiconductorPHE840MB6470MB16R17 or B3292C3474MC47Disc cap400VTDKC3216X7R2J104KC45c33ceramic cap0.1 uF, 100VTDKC3216X7R2J104KC45ceramic cap0.1 uF, 100VTDKC3216X7R2J104KC47Disc cap1.0 uF, 150VTDKC3216X7R2J104KC47ceramic cap0.1 uF, 100VTDKC3216X7R2J104KC47ceramic cap0.1 uF, 100VCKC				Micro Commercial	ES1M-TP			
D8UFR diode Input transient optionON SemiconductorMURH860CTGZ1TVSoption1.5KE440AZ4Zener diode15VON Semiconductor1.5KE440AZ3Zener diodeNot FittedZ3Zener diodeNot FittedC4Zener diodeNot FittedC5Jumper#26 bus wireC6Jumper#26 bus wireC7Jumper#26 bus wireC41Mosfet11A, 800VInfineonSPP11N80C3C6BJTNot FittedC6BJTNot FittedC6BJTNot FittedC7Optocoupler100V, 4AON SemiconductorNUD243GU1PFC controllerVacON SemiconductorNCL30001U2OptocouplerVacEvox Rifa/Kemet or EPOCPHE840MB6470MB16R17 or B329223474MC27Y cap2.2 nF, f.VEvox Rifa/Kemet or EPOCPHE271Y422MC50AC27V cap0.1 uF, 50VTDKC3216X7R2A104KC15, 16, 25,ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC28, C29ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC28, C30ceramic cap1.0 uF, 50VVishayV11206A471JXACW1BCC15, 16, 25,ceramic cap1.0 uF, 50VKernetC1206C61KSACTUC16ceramic cap1.0 uF, 50V<		•	Not Fitted	-	-			
Input transient Z4 Input transient opion Input transient opion Input transient opion Input transient opion Input transient opion Z4 Zener diode Not Fitted - - - Z5 Zener diode Not Fitted - - - Z1 Zener diode Not Fitted - - - Z1 Zener diode Not Fitted - - - Q1 Mosfet 11A, 800V Infineon SPP11N80C3 - Q2, Q3 BJT Not Fitted - - - - Q4 BJT Not Fitted - - - - - Q4 BJT Not Fitted - - - - NCL3001 NLD243G NL	D11, 12, 13	Signal diode		ON Semiconductor	MMSD4148A			
21 TVS option 1.5V ON Semiconductor MMSZ5245B 23 Zener diode 16V ON Semiconductor MMSZ5248B 23 Zener diode 16V ON Semiconductor MMSZ5248B 24 Zener diode No Filted - - 05 Jumper #26 bus wire - - 04 Mosfet 11A, 800V Infineon SPP11N80C3 06 BJT 60V, 500 mA ON Semiconductor MMBTA06LT16 06 BJT 100V, 4A ON Semiconductor MJD243G 01 PFC controller - - 02 Optocoupler - - 04 BJT 100V, 4A ON Semiconductor MJD243G 03 Dual amp + zener - - - 04 BJT 0.27 µF, 277 V2 cap 2.2 nF, 1kV ON Semiconductor ML3040H516R17 or B32922C3474M C27 Y2 cap 2.2 nF, 1kV DVEW RiA/Kemet or EPCOS Evox Rifa/Kemet or EPC	D8	UFR diode		ON Semiconductor	MURH860CTG			
Z4 Zener diode Not Fitted ON Semiconductor MMSZ52458 Z5 Zener diode Not Fitted ON Semiconductor MMSZ52488 Z2 Zener diode Not Fitted ON Semiconductor MMSZ52488 Z6 Jumper #20 bus wire - - Q1 Mosfet 11A, 800V Infineon SPP11N80C3 Q2, Q3 BJT 60V, 500 mA ON Semiconductor MID243G Q4 BJT Not Fitted ON Semiconductor MID243G Q4 BJT 100V, 4A ON Semiconductor NCI30001 Q2 Optocoupler ON Semiconductor NCI30001 Q3 Dalat amp + zener ON Semiconductor NCI3002 Q4 Polyprop. Film 0.22 µF, 1kV Evox Rifa/Kemet or EPCOS PME840MB6470MB16R17 or B32922C3474M C3 Polyprop. Film 0.22 µF, 1kV TDK G3216X7R2A104K C47 V2 cap 2.2 nF, 1kV TDK G3216X7R2A104K C43 ceramic cap 0.1 uF, 50V	-	-						
Z5 Zener diode Not Fitted - MMSZ5248B Z3 Zoner diode 18V ON Semiconductor MMSZ5248B Z4 Zener diode Mot Fitted - - G5 Jumper #26 bus wire - - G6 Jumper #20 bus wire - - G1 Mostet 11A, 800V Infineon SPP11N80C3 G6 BJT Kor Fitted - - G6 BJT 100V, 4A ON Semiconductor MMBTA0ELTG U1 PFC controller ON Semiconductor MICL30001 NCL3001 U2 Optocoupler ON Semiconductor NCS1002 NCS1002 C17 V cap 2.2 nF, 1kV Evox Rfla/Kemet or EPCOS PHE840MB6470MB16R17 or B32922C3474M C26 Polyprop. Film 0.22 LP f. 1kV Evox Rfla/Kemet or EPCOS PME2012M or P271H222M or P271H222M220								
23Zener diode18VON SemiconductorMMSZ5248B22Zener diodeNot Fitted05Jumper#20 bus wire07Jumper#20 bus wire01Mosfet11A, 800VInfineonSPP11N80C302, 03BJTNot Fitted06BJTNot Fitted06BJT100V, 4AON SemiconductorMMBTA0ELTIG04BJT100V, 4AON SemiconductorNCL30001102OptocouplerON SemiconductorNCL30001103Dual amp + zenerON SemiconductorNCS1002C1, C2X caps2.2 nF, 1kVEvox Rifa/Kemet or EPCOSPHE840MB6470MB16R1 or B32922C3474MC27Y2 cap2.2 nF, 1kVEvox Rifa/KemetPME271Y422M or P271HE222M250AC3Polyrop, Film0.2 UF (630V)Vishay2223 33 20224C4ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC28, C30ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC28, C34ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC4ceramic cap1.0 uF, 25VTDKC3216X7R2A104KC31ceramic cap1.0 uF, 50VVishayVU1206471JXACW1BCC4ceramic cap1.0 uF, 50VVishayVU1206471JXACW1BCC5ceramic cap1.0 uF, 50VTDKC3216X7R2A104KC32ceramic				ON Semiconductor				
Z2 Zener diode Not Fitted - - Q5 Jumper #Z6 bus wire - - Q1 Mosfet 114,800V Infineon SPP11N80C3 Q1 Mosfet 114,800V ON Semiconductor MMBTA06LTIG Q6 BJT Not Fitted - - Q4 BJT 100V,4A ON Semiconductor MJD243G Q1 PFC controller ON Semiconductor MJD243G Q1 PFC controller ON Semiconductor MJCL30001 U2 Optocoupler ON Semiconductor NCL3001 U3 Dual amp + zener O.47 uF,277 Vac Evox Rifa/Kemet or EPCOS PHE840MB6470MB16R17 or B32922C3474M C27 Y2 cap 2.2 nF,1kV Evox Rifa/Kemet or EPCOS PHE840MB6470MB16R17 or B32922C3474M C15, 62, 52, C26 ceramic cap 0.1 uF, 50V TDK C3216X7R2A104K C15, 62, 52, C24 ceramic cap 0.1 uF, 100V TDK C3216X7R2A104K C33 ceramic cap 0.1 uF, 100V				-				
Q5Jumper#26 bus wire-Q7Jumper#20 bus wire-Q1Mosfet11A, 800VInfineonSPP11N80C3Q2, Q3BJT60V, 500 mAON SemiconductorMMBTA06LT1GQ6BJTNot FittedQ6BJT100V, 4AON SemiconductorMD243GQ1PFC controller100V, 4AON SemiconductorMD243GU1PFC controller0.47 UF, 277VacON SemiconductorNCS1002U2Optocoupler0.47 UF, 277VacEvox Rifa/Kemet or EPCOSPHE840MB6470MB16R17 or B32922C3474MC27Y2 cap2.2 nF, 1kVEvox Rifa/Kemet or EPCOSEvox Rifa/Kemet or EPCOSPHE840MB6470MB16R17 or B32922C3474MC33Polyprop. Film0.22UF (630V)68 to 100 nF,02222 83 20224C33ceramic cap0.1 uF, 100VTDKC3216X7R2A104KC44ceramic cap0.1 uF, 100VTDKC3216X7R2A104KC43ceramic cap1.0 uF, 25VTDKC3216X7R2A104KC43ceramic cap1.0 uF, 25VTDKC3216X7R2A104KC410ceramic cap1.0 uF, 55VTDKC3216X7R2A104KC410ceramic cap680 pF, 50VKemetC1206C681K5GACTUC14ceramic cap1.0 uF, 55VTDKC3216C0G2A103JC34ceramic cap1.0 uF, 55VUCCESMG300ELL2X1MACV1BCC4electrolytic cap1.0 uF, 55VUCCESMG300ELL21MME11DC5 <t< td=""><td></td><td></td><td></td><td>ON Semiconductor</td><td>MMSZ5248B</td></t<>				ON Semiconductor	MMSZ5248B			
Q7 Jumper #20 bus wire - - Q1 Mosfet 114, 800V Infineon SPP11N80C3 Q2, Q3 BJT Not Fitted ON Semiconductor MMBTA08LT1G Q6 BJT Not Fitted ON Semiconductor MJD243G Q4 BJT 100V, 4A ON Semiconductor NLD243G Q1 PFC controller ON Semiconductor NLD243G Q3 Dual amp + zener O.47 uF, 277 ON Semiconductor NCS1002 C1, C2 X caps Vac Evox Rifa/Kemet or EPCOS PHE840MB6470MB16R17 or B32922C3474M C3 Polyprop. Film 0.22u F, fs/W Vishay 2222 383 20224 C3 Polyprop. Film 0.22u F (630V) Vishay 2222 383 20224 C47 Dis cap 0.1 uF, 50V TDK C3216X7R2A104K C45, 16, 25, C26 ceramic cap 0.1 uF, 50V TDK C3216X7R2A104K C43, C24 ceramic cap 0.1 uF, 50V TDK C3216X7R2A104K C43 ceramic cap				-	-			
Q1 Q2,Q3Mosfet BJT11A, 800V 60V, 500 mAInfineon ON SemiconductorSPP11N80C3 MMBTA06LT1GQ6 Q4BJTNot FittedQ4BJT100V, 4AON Semiconductor VishayMJD243G H11A817 or SFH6156A-4U1PFC controllerON SemiconductorNC130001U2OptocouplerVishayH11A817 or SFH6156A-4U3Dual amp + zenerON SemiconductorNCS1002C1, C2X capsVacEvox Rifa/Kemet or EPCOSPHE840MB6470MB16R17 or B32922C3474MC27Y2 cap2.2 nF, 1kVEvox Rifa/Kemet or EPCOSPHE840MB6470MB16R17 or B32922C3474MC33Polyprop, Film0.22 uF (630V)Vishay2222 383 20224C47Disc cap0.1 uF, 50VTDKFK22X7R2J104KC15, 16, 25, C26, C29ceramic cap0.1 uF, 50VTDKC3216X7R1H105KC28, C33ceramic cap0.1 uF, 100VTDKC3216X7R1H105KC19ceramic cap1.0 uF, 50VTDKC3216X7R1H105KC19ceramic cap1.0 uF, 50VVishayV/J1206A471,JXACW1BCC9ceramic cap1.0 nF, 50VKemetC1206C081K5GACTUC13, C14, C17, C32ceramic cap1.0 nF, 50VTDKC3216CC0G2A103JC14, C17, C32ceramic cap1.0 nF, 50VTDKC3216CC0G2A103JC14, C17, C32ceramic cap1.0 nF, 50VTDKC3216CC0G2A103JC14, C17, C32ceramic cap3.0 n, 50VTDKC3216CC0G1H333J<				-	-			
Q2, Q3 BJT 60V, 500 mA ON Semiconductor MMBTA06LT1G Q6 BJT Not Fitted				-	-			
O6BJTNot FittedOQ4BJT100V, 4AON SemiconductorMJD243GQ4BJT10V, 4AON SemiconductorNCL30001U2OptocouplerDual amp + zenerON SemiconductorH11A817 or SFH6156A-4U3Dual amp + zener0A7 uF, 277ON SemiconductorNCS1002C1, C2X caps2.2 nF, 1kVEvox Rifa/Kemet or EPCOSPHE840MB6470MB16R17 or B32922C3474MC27Y2 cap2.2 nF, 1kVEvox Rifa/Kemet or EPCOSPHE840MB6470MB16R17 or B32922C3474MC3Polyprop. Film0.22uF (630V)Vishay2222 383 20224C3Polyprop. Film0.22uF (630V)Vishay2222 383 20224C4Disc cap0.1 uF, 50VTDKFK22X7R2J104KC55, C26, C29ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC23, C24ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC24, C24ceramic cap1.0 uF, 25VTDKC3216X7R2A104KC12ceramic cap1.0 uF, 50VVishayVJ1206A471JXACW1BCC12ceramic cap1.0 nF, 50VVishayVJ1206A471JXACW1BCC13ceramic cap1.0 nF, 50VTDKC3216CO21103JC14, C17,caramic cap1.0 nF, 50VTDKC3216CO24103JC31ceramic cap1.0 nF, 50VTDKC3216CO24103JC31ceramic cap3.0 nF, 50VTDKC3216CO24103JC31ceramic cap3.0 nF, 50VUCCESMG3050ELL101MF11D								
Q4BJT PFC controller100V, 4AON Semiconductor ON SemiconductorMJD243G NCL30001U2Optocoupler Dual amp + zener0.47 uF, 277 VacON SemiconductorNCL30001U3Dual amp + zener0.47 uF, 277 VacVacPhese SemiconductorPHEs40MB6470MB16R17 or B32922C3474MC1, C2X caps2.2 nF, 1kV 0.22UF (630V)Evox Rifa/Kemet or EPCOS VishayPHEs40MB6470MB16R17 or B32922C3474MC3Polyprop. Film0.22UF (630V) 68 to 100 nF, 68 to 100 nF,TDKFK22X7R2J104KC15, 16, 25, C26, C29ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC23, C24ceramic cap0.1 uF, 100V 1 nF, 16VTDKC3216X7R2A104KC28, C30ceramic cap1.0 uF, 25VTDKC3216X7R2A104KC19ceramic cap1.0 uF, 25VTDKC3216X7R2A104KC19ceramic cap1.0 nF, 50VTDKC1206C681K5GACTUC10, C18, C31ceramic cap1.0 nF, 50VKemetC1206C681K5GACTUC11electrolytic cap10 nF, 50VTDKC3216CCG2A103JC13ceramic cap10 nF, 50VTDKC3216CCG2A103JC13ceramic cap10 nF, 50VUCCESMG350ELL101MF11DC14electrolytic cap10 nF, 50VUCCESMG350ELL101MF11DC13ceramic cap10 nF, 50VUCCESMG350ELL101MF11DC14electrolytic cap220 uF, 53VUCCESMG350ELL101MF11DC31ceramic cap10 nF, 50V<				ON Semiconductor	MMBTA06LT1G			
U1PFC controller OptoccuplerON SemiconductorNCL30001U2Optoccupler Dual amp + zener0.47 uF, 277 VacON SemiconductorH11A817 or SFH6156A-4 NCS1002C1, C2X caps0.47 uF, 277 VacEvox Rifa/Kemet or EPCOS Evox Rifa/KemetPHE840MB6470MB16R17 or B32922C3474M PME271Y422M or P271HE22MC50AC3Polyprop. Film0.22uF (630V) 68 to 100 nF, 400VEvox Rifa/Kemet VishayPHE271Y422M or P271HE22M250A 2222 383 20224C45, 16, 25, C26, C29ceramic cap0.1 uF, 50VTDKFK22X7R2J104KC15, 16, 25, C28, C33ceramic cap0.1 uF, 100VTDKC3216X7R2A104KC23, C24ceramic cap0.1 uF, 100VTDKC3216X7R2A104KC28, C30ceramic cap1.0 uF, 25VTDKC3216X7R2A104KC19ceramic cap1.0 uF, 25VTDKC1206C681K5GACTUC10, C18, C31ceramic cap1 nF, 10VKemetC1206C681K5GACTUC31ceramic cap1 nF, 50VVishayV/J1206A71JX4CW1BCC31ceramic cap1 nF, 50VTDKC3216CC02A103JC31ceramic cap1 nF, 50VTDKC3216CC02A103JC31ceramic cap1 nF, 50VTDKC3216CC02A103JC31ceramic cap10 nF, 50VTDKC3216CC02A103JC31ceramic cap3 3 nF, 50VTDKC3216CC02A103JC33ceramic cap10 nF, 50VUCCESMG350ELL101MF11DC11electrolytic cap220 UF, 50VUCC				-	-			
U2 U3Optocoupler Dual amp + zenerVishay ON SemiconductorH11A817 or SFH6156A-4 NCS1002C1, C2X caps0.47 uF, 277 VacEvox Rifa/Kemet or EPCOS Evox Rifa/Kemet or EPCOS Evox Rifa/KemetPHE840MB6470MB16R17 or B32922C3474M PME271Y422M or P271HE222M250AC3Polyprop. Film0.22uF (630V) O12uF (630V)Evox Rifa/Kemet or EPCOS Evox Rifa/KemetPHE840MB6470MB16R17 or B32922C3474M PME271Y422M or P271HE222M250AC3Polyprop. Film0.22uF (630V) O10 PCVishay2222 383 20224C4Ceramic cap0.1 uF, 50VTDKFK22X7R2J104KC28, C33ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC28, C34ceramic cap0.1 uF, 100VTDKC3216X7R2A104KC28, C30ceramic cap1.0 uF, 25VTDKC3216X7R2A104KC28, C34ceramic cap0.1 uF, 100VTDKC445-B3AD102KYNNC12ceramic cap470 pF, 50VVishayVJ1206A471JXACW1BCC9ceramic cap680 pF, 50VKemetC1206C681K5GACTUC14, C17, C32ceramic cap10 nF, 50VTDKC3216COG2A103JC13ceramic cap10 nF, 50VTDKC3216COG2A103JC13ceramic cap10 nF, 50VTDKC3216COG2A103JC13ceramic cap10 nF, 50VTDKC3216COG2A103JC14electrolytic cap20 uF, 50VUCCESMG350ELL101MF11DC6electrolytic cap20 uF, 50VUCCESMG500ELL21MJC5SC20, 21, 22elect		BJT	100V, 4A					
U3Dual amp + zener0.4ON SemiconductorNCS1002C1, C2X caps0.47 uF, 277 VacEvox Rifa/Kemet or EPCOS Evox Rifa/KemetPHE840MB6470MB16R17 or B32922C3474M PME271Y422M or P271HE222M250AC3Polyprop. Film0.22 uF (630V) 68 to 100 nF, 68 to 100 nF, 68 to 100 nF, 68 to 100 nF, 2626, C29TDKFK22X7R2J104KC15, 16, 25, C26, C29ceramic cap0.1 uF, 50VTDKFK22X7R2J104KC23, C24ceramic cap0.1 uF, 100VTDKC3216X7R2A104KC23, C24ceramic cap0.1 uF, 100VTDKC3216X7R2A104KC28, C30ceramic cap1.0 uF, 25VTDKC3216X7R2A104KC12ceramic cap1.0 uF, 50VTDKC3216X7R1H106KC12ceramic cap1.0 uF, 50VVishayVJ1206A471JXACW1BCC9ceramic cap680 pF, 50VKemetC1206C681K5GACTUC14, C17, C32ceramic cap1.0 nF, 50VTDKC3216C022A103JC13ceramic cap1.0 nF, 50VTDKC3216C02A103JC14electrolytic cap1.0 nF, 50VTDKC3216C02A103JC13ceramic cap1.0 nF, 50VTDKC3216C02A103JC14electrolytic cap1.0 uF, 55VUCCESMG350EL101MF11DC11electrolytic cap2.20 uF, 63VNichiconUPV1J222MHDC6electrolytic cap2.20 uF, 63VNichiconG47-UV12W220MHDC6electrolytic cap2.20 uF, 63VNichiconG47-UV1222MHDC6		PFC controller		ON Semiconductor				
C1, C2 C27 C3X caps Y2 cap Polyprop. Film0.47 uF, 277 Vac C2 2.2 nF, 1kVEvox Rifa/Kemet or EPCOS Evox Rifa/Kemet VishayPHE840MB6470MB16R17 or B32922C3474M PME271Y422M or P271HE222M250A 2222 383 20224C3Polyprop. Film0.22uF (630V) 68 to 100 nF, 400VEvox Rifa/Kemet VishayPME271Y422M or P271HE222M250A 2222 383 20224C7Disc cap0.1 uF, 50VTDKFK22X7R2J104KC8, C33ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC23, C24ceramic cap0.1 uF, 16VTDKC3216X7R2A104KC28, C30ceramic cap1.0 uF, 25VTDKC3216X7R2A104KC428, C30ceramic cap1.0 uF, 50VTDKC3216X7R2A104KC19ceramic cap1.0 uF, 50VTDKC445-B3AD102KYNNC12ceramic cap470 pF, 50VVishayVJ1206A471JXACW1BCC31ceramic cap680 pF, 50VKemetC1206C012K1RACTUC14, C17, C32ceramic cap10 nF, 50VTDKC3216COG2A103JC13ceramic cap10 nF, 50VTDKC3216COG41333JC5electrolytic cap100 uF, 35VUCCESMG350ELL47IME11DC6electrolytic cap220 uF, 63VNichiconUPW1J222MHDC4electrolytic cap220 uF, 63VNichicon647-UVY2W220MHDC340.25W resistor2.2 uF, 450VNichiconG2316X7R2A104KC340.25W resistor2.2 kNishayNichiconMC1206C122KTR2A104K	U2	Optocoupler		Vishay	H11A817 or SFH6156A-4			
C1, C2 X caps Vac Evox Rifa/Kemet or EPCOS PHE840MB6470MB16R17 or B32922C3474M C27 Y2 cap 2.2 nF, 1kV Evox Rifa/Kemet PME271Y422M or P271HE222M250A C3 Polyprop. Film 0.22uF (630V) Vishay 2222 383 20224 C7 Disc cap 400V TDK FK22X7R2J104K C15, 16, 25, C26, C29 ceramic cap 0.1 uF, 50V TDK C3216X7R2A104K C23, C24 ceramic cap 0.1 uF, 100V TDK C3216X7R2A104K C28, C30 ceramic cap 1.0 uF, 25V TDK C3216X7R2A104K C19 ceramic cap 1.0 uF, 55V VV vishay VJ1206A471JXACW1BC C9 ceramic cap 470 pF, 50V Vishay VJ1206A471JXACW1BC C14, C17, C31 ceramic cap 1 nF, 10V Kemet C1206C102K1RACTU C14, C17, C33 ceramic cap 1 nF, 50V TDK C3216COG2A103J C13 ceramic cap 1 nF, 50V TDK C3216COG2A103J C31 C34 ceramic cap	U3	Dual amp + zener		ON Semiconductor	NCS1002			
C27 Y2 cap Polyprop. Film 2.2 n F, 1kV 0.22u F (630V) 0.22u F (630V) Evox Rifa/Kemet Vishay PME271Y422M or P271HE222M250A C3 Polyprop. Film 0.22u F (630V) 8 to 100 n F, 0 to cap Evox Rifa/Kemet Vishay PME271Y422M or P271HE222M250A C7 Disc cap 400V TDK FK22X7R2J104K C15, 16, 25, C26, C29 ceramic cap 0.1 u F, 50V TDK C3216X7R2A104K C32, C24 ceramic cap 0.1 u F, 100V TDK C3216X7R2A104K C28, C30 ceramic cap 0.1 u F, 100V TDK C3216X7R2A104K C19 ceramic cap 1.0 u F, 25V TDK C3216X7R1H105K C19 ceramic cap 680 pF, 50V Vishay VJ1206A471JXACW1BC C9 ceramic cap 680 pF, 50V Kemet C1206C102K1RACTU C14, C17, C32 ceramic cap 10 n F, 50V TDK C3216COG2A103J C13 ceramic cap 10 n F, 50V TDK C3216COG2A103J C31 ceramic cap 10 n G, 35V UCC ESMG350ELL101MF11D C41 electro								
C3 Polyprop. Film 0.22uF (630V) 68 to 100 nF, 400V Vishay 2222 383 20224 C7 Disc cap 400V TDK FK22X7R2J104K C15, 16, 25, C26, C29 ceramic cap 0.1 uF, 50V TDK C3216X7R2A104K C8, C33 ceramic cap 0.1 uF, 100V TDK C3216X7R2A104K C23, C24 ceramic cap 0.1 uF, 100V TDK C3216X7R2A104K C28, C30 ceramic cap 1.0 uF, 25V TDK C3216X7R2A104K C12 ceramic disc cap 1.0 uF, 50V VIShay VJ1206A471JXACW1BC C9 ceramic cap 470 pF, 50V Vishay VJ1206A471JXACW1BC C9 ceramic cap 680 pF, 50V Kemet C1206C102K1RACTU C14, C17, caramic cap 1 nF, 100V Kemet C1206C102K1RACTU C14, C17, caramic cap 33 nF, 50V TDK C3216COG2A103J C5 electrolytic cap 10 nF, 50V TDK C3216COG1H333J C5 electrolytic cap 220 uF, 50V UCC ESMG3050ELL21MJC5S <td></td> <td>-</td> <td></td> <td></td> <td></td>		-						
C7Disc cap68 to 100 nF, 400VTDKFK22X7R2J104KC15, 16, 25, C26, C29ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC23, C24ceramic cap0.1 uF, 100VTDKC3216X7R2A104KC23, C24ceramic cap0.1 uF, 100VTDKC3216X7R2A104KC28, C30ceramic cap1.0 uF, 25VTDKC3216X7R2A104KC19ceramic disc cap1 nF, 1 kVTDKC445-B3AD102KYNNC12ceramic cap470 pF, 50VVishayVJ1206A471JXACW1BCC9ceramic cap680 pF, 50VKemetC1206C681K5GACTUC10, C18, C31ceramic cap1 nF, 100VKemetC1206C102K1RACTUC14, C17, C32ceramic cap1 nF, 50VTDKC3216COG2A103JC13ceramic cap1 0 nF, 50VTDKC3216COG2A103JC13ceramic cap10 nF, 50VTDKC3216COG2A103JC13ceramic cap10 nF, 50VTDKC3216COG2A103JC14, C17, C32ceramic cap100 uF, 35VUCCESMG350ELL101MF11DC11electrolytic cap220 uF, 50VUCCESMG350ELL4R7ME11DC6electrolytic cap220 uF, 50VUCCESMG350ELL4R7ME10DC4electrolytic cap220 uF, 50VNichicon647-UVY2W220MHDC35ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC340.25W resistor0.2 ohmsRohm SemiconductorMCR18EZHFLR200R40.5W resistor2.2KVishay<								
C7 Disc cap 400V TDK FK22X7R2J104K C15, 16, 25, C26, C29 ceramic cap 0.1 uF, 50V TDK C3216X7R2A104K C8, C33 ceramic cap Not Fitted - - C23, C24 ceramic cap 0.1 uF, 100V TDK C3216X7R2A104K C28, C30 ceramic cap 1.0 uF, 25V TDK C3216X7R2A104K C19 ceramic cap 1.0 uF, 25V TDK C3216X7R1H105K C12 ceramic cap 1 nF, 1 kV TDK C445-B3AD102KYNN C12 ceramic cap 470 pF, 50V Vishay VJ1206A471JXACW1BC C9 ceramic cap 1 nF, 10V Kemet C1206C681K5GACTU C14, C17, 6 7 7 7 7 C32 ceramic cap 1 nF, 50V TDK C3216COG2A103J 7 C14, C17, ceramic cap 3 n F, 50V TDK C3216COG2A103J 7 C32 ceramic cap 1 0 n F, 50V TDK C3216COG21H333J 7	C3	Polyprop. Film		Vishay	2222 383 20224			
C26, C29Ceramic capNot Fitted-C8, C33ceramic cap0.1 uF, 100VTDKC3216X7R2A104KC23, C24ceramic cap1.0 uF, 25VTDKC3216X7R1H105KC19ceramic cap1.0 uF, 25VTDKC3216X7R1H105KC12ceramic cap470 pF, 50VVishayVJ1206A471JXACW1BCC9ceramic cap680 pF, 50VKemetC1206C681K5GACTUC10, C18,ceramic cap1 nF, 100VKemetC1206C102K1RACTUC14, C17,cap10 nF, 50VTDKC3216COG2A103JC32ceramic cap10 nF, 50VTDKC3216COG2A103JC13ceramic cap33 nF, 50VTDKC3216COG2A103JC5electrolytic cap100 uF, 35VUCCESMG350ELL101MF11DC11electrolytic cap100 uF, 50VUCCESMG350ELL21MNE11DC6electrolytic cap220 uF, 50VUCCESMG500ELL221MJC5SC20, 21, 22electrolytic cap220 uF, 63VNichiconUPV1J222MHDC4electrolytic cap22 uF, 450VNichicon647-UVY2W220MHDC35ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC340.25W resistor0.2 ohmsRohm SemiconductorMCR18EZHFLR200R40.5W resistor2.2KVishayNFR25H0002201JR500	C7	Disc cap		TDK	FK22X7R2J104K			
C23, C24 ceramic cap 0.1 uF, 100V TDK C3216X7R2A104K C28, C30 ceramic cap 1.0 uF, 25V TDK C3216X7R1H105K C19 ceramic disc cap 1 nF, 1 kV TDK CK45-B3AD102KYNN C12 ceramic cap 470 pF, 50V Vishay VJ1206A471JXACW1BC C9 ceramic cap 680 pF, 50V Kemet C1206C681K5GACTU C10, C18, ceramic cap 1 nF, 100V Kemet C1206C102K1RACTU C14, C17, ceramic cap 1 nF, 50V TDK C3216COG2A103J C32 ceramic cap 10 nF, 50V TDK C3216COG2A103J C13 ceramic cap 33 nF, 50V TDK C3216COG2A103J C5 electrolytic cap 100 uF, 35V UCC ESMG350ELL101MF11D C11 electrolytic cap 220 uF, 50V UCC ESMG500ELL221MJC5S C20, 21, 22 electrolytic cap 220 uF, 63V Nichicon UPW1J222MHD C4 electrolytic cap 22 uF, 450V Nichicon 647-UVY2W220MHD		ceramic cap	0.1 uF, 50V	TDK	C3216X7R2A104K			
C28, C30 ceramic cap 1.0 uF, 25V TDK C3216X7R1H105K C19 ceramic disc cap 1 nF, 1 kV TDK CK45-B3AD102KYNN C12 ceramic cap 470 pF, 50V Vishay VJ1206A471JXACW1BC C9 ceramic cap 680 pF, 50V Kemet C1206C681K5GACTU C10, C18, - - - - C31 ceramic cap 1 nF, 100V Kemet C1206C102K1RACTU C14, C17, - - - - - C32 ceramic cap 10 nF, 50V TDK C3216COG2A103J - C13 ceramic cap 33 nF, 50V TDK C3216COG2A103J - C5 electrolytic cap 100 uF, 35V UCC ESMG350ELL101MF11D C11 electrolytic cap 220 uF, 50V UCC ESMG500ELL221MJC5S C20, 21, 22 electrolytic cap 220 uF, 63V Nichicon 047-UVY2W220MHD C35 ceramic cap 0.1 uF, 50V TDK C3216X7R2A104K C34	C8, C33	ceramic cap	Not Fitted	-	-			
C19ceramic disc cap1 nF, 1 kVTDKCK45-B3AD102KYNNC12ceramic cap470 pF, 50VVishayVJ1206A471JXACW1BCC9ceramic cap680 pF, 50VKemetC1206C681K5GACTUC10, C18,ceramic cap1 nF, 100VKemetC1206C102K1RACTUC14, C17,ceramic cap10 nF, 50VTDKC3216COG2A103JC32ceramic cap10 nF, 50VTDKC3216COG2A103JC13ceramic cap33 nF, 50VTDKC3216COG1H333JC5electrolytic cap100 uF, 35VUCCESMG350ELL101MF11DC11electrolytic cap4.7 uF, 25VUCCESMG250ELL4R7ME11DC6electrolytic cap220 uF, 63VNichiconUPW1J222MHDC4electrolytic cap220 uF, 63VNichicon647-UVY2W220MHDC35ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC340.25W resistor0.2 ohmsRohm SemiconductorMCR18EZHFLR200R40.5W resistor2.2KVishayNFR25H0002201JR500	C23, C24	ceramic cap	0.1 uF, 100V	TDK	C3216X7R2A104K			
C12 C9 C10, C18, C31ceramic cap470 pF, 50V 680 pF, 50VVishay KemetVJ1206A471JXACW1BC C1206C681K5GACTUC10, C18, C31 C14, C17, C32ceramic cap1 nF, 100VKemetC1206C102K1RACTUC14, C17, C32ceramic cap10 nF, 50VTDKC3216COG2A103JC13 C5 electrolytic cap100 uF, 35VUCCESMG350ELL101MF11DC11 C61 electrolytic cap4.7 uF, 25VUCCESMG250ELL4R7ME11DC6 C20, 21, 22electrolytic cap220 uF, 63VNichiconUPW1J222MHDC4 C35 ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC34 R40.25W resistor0.2 ohmsRohm SemiconductorMCR18EZHFLR200R40.5W resistor2.2KVishayNF25H0002201JR500	C28, C30	ceramic cap	1.0 uF, 25V	TDK	C3216X7R1H105K			
C9 C10, C18, C31 C14, C17, C32ceramic cap680 pF, 50VKemetC1206C681K5GACTUC14, C17, C32 C13ceramic cap1 nF, 100VKemetC1206C102K1RACTUC13 C5 C6 electrolytic cap10 nF, 50VTDKC3216COG2A103JC5 C6 C6 electrolytic cap100 uF, 35VUCCESMG350ELL101MF11DC11 C6 C6 electrolytic cap4.7 uF, 25VUCCESMG250ELL4R7ME11DC6 C20, 21, 22220 uF, 50VUCCESMG500ELL221MJC5SC20, 21, 22 C35electrolytic cap220 uF, 63VNichicon047-UVY2W220MHDC35 C35ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC34 R40.5W resistor0.2 ohmsRohm SemiconductorMCR18EZHFLR200R40.5W resistor2.2KVishayNFR25H0002201JR500	C19	ceramic disc cap	1 nF, 1 kV	TDK	CK45-B3AD102KYNN			
C10, C18, C31 C14, C17, C32ceramic cap1 nF, 100VKemetC1206C102K1RACTUC14, C17, C32ceramic cap10 nF, 50VTDKC3216COG2A103JC13ceramic cap33 nF, 50VTDKC3216COG1H333JC5electrolytic cap100 uF, 35VUCCESMG350ELL101MF11DC11electrolytic cap4.7 uF, 25VUCCESMG250ELL4R7ME11DC6electrolytic cap220 uF, 50VUCCESMG500ELL221MJC5SC20, 21, 22electrolytic cap220 uF, 63VNichicon047-UVY2W220MHDC35ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC340.25W resistor0.2 ohmsRohm SemiconductorMCR18EZHFLR200R40.5W resistor2.2KVishayNFR25H0002201JR500	C12	ceramic cap	470 pF, 50V	Vishay	VJ1206A471JXACW1BC			
C31 C14, C17, C32ceramic cap1 nF, 100VKemetC1206C102K1RACTUC32 C32ceramic cap10 nF, 50VTDKC3216COG2A103JC13 C5 C5electrolytic cap33 nF, 50VTDKC3216COG1H333JC5 C11electrolytic cap100 uF, 35VUCCESMG350ELL101MF11DC11 C6 electrolytic cap4.7 uF, 25VUCCESMG250ELL4R7ME11DC6 celectrolytic cap220 uF, 50VUCCESMG500ELL221MJC5SC20, 21, 22 C35electrolytic cap220 uF, 63VNichiconUPW1J222MHDC4 C35 C35ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC34 R40.25W resistor0.2 ohmsRohm SemiconductorMCR18EZHFLR200R40.5W resistor2.2KVishayNFR25H0002201JR500		ceramic cap	680 pF, 50V	Kemet	C1206C681K5GACTU			
C32 ceramic cap 10 nF, 50V TDK C3216COG2A103J C13 ceramic cap 33 nF, 50V TDK C3216COG1H333J C5 electrolytic cap 100 uF, 35V UCC ESMG350ELL101MF11D C11 electrolytic cap 4.7 uF, 25V UCC ESMG250ELL4R7ME11D C6 electrolytic cap 220 uF, 50V UCC ESMG500ELL221MJC5S C20, 21, 22 electrolytic cap 220 uF, 63V Nichicon UPW1J222MHD C35 ceramic cap 0.1 uF, 50V TDK C3216X7R2A104K C35 ceramic cap 0.1 uF, 50V TDK C3216X7R2A104K C34 0.25W resistor 0.2 ohms Rohm Semiconductor MCR18EZHFLR200 R4 0.5W resistor 2.2K Vishay NFR25H0002201JR500	C31	ceramic cap	1 nF, 100V	Kemet	C1206C102K1RACTU			
C13ceramic cap33 nF, 50VTDKC3216COG1H333JC5electrolytic cap100 uF, 35VUCCESMG350ELL101MF11DC11electrolytic cap4.7 uF, 25VUCCESMG250ELL4R7ME11DC6electrolytic cap220 uF, 50VUCCESMG500ELL221MJC5SC20, 21, 22electrolytic cap220 uF, 63VNichiconUPW1J222MHDC4electrolytic cap22 uF, 450VNichicon647-UVY2W220MHDC35ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC340.25W resistor0.2 ohmsRohm SemiconductorMCR18EZHFLR200R40.5W resistor2.2KVishayNFR25H0002201JR500					C2240000244024			
C5electrolytic cap100 uF, 35VUCCESMG350ELL101MF11DC11electrolytic cap4.7 uF, 25VUCCESMG250ELL4R7ME11DC6electrolytic cap220 uF, 50VUCCESMG500ELL221MJC5SC20, 21, 22electrolytic cap2200 uF, 63VNichiconUPW1J222MHDC4electrolytic cap22 uF, 450VNichicon647-UVY2W220MHDC35ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC340.25W resistor0.2 ohmsRohm SemiconductorMCR18EZHFLR200R40.5W resistor2.2KVishayNFR25H0002201JR500								
C11electrolytic cap4.7 uF, 25VUCCESMG250ELL4R7ME11DC6electrolytic cap220 uF, 50VUCCESMG500ELL221MJC5SC20, 21, 22electrolytic cap2200 uF, 63VNichiconUPW1J222MHDC4electrolytic cap22 uF, 450VNichicon647-UVY2W220MHDC35ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC340.25W resistor0.2 ohmsRohm SemiconductorMCR18EZHFLR200R40.5W resistor2.2KVishayNFR25H0002201JR500								
C6electrolytic cap220 uF, 50VUCCESMG500ELL221MJC5SC20, 21, 22electrolytic cap2200 uF, 63VNichiconUPW1J222MHDC4electrolytic cap22 uF, 450VNichicon647-UVY2W220MHDC35ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC340.25W resistor0.2 ohmsRohm SemiconductorMCR18EZHFLR200R40.5W resistor2.2KVishayNFR25H0002201JR500								
C20, 21, 22electrolytic cap2200 uF, 63VNichiconUPW1J222MHDC4electrolytic cap22 uF, 450VNichicon647-UVY2W220MHDC35ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC340.25W resistor0.2 ohmsRohm SemiconductorMCR18EZHFLR200R40.5W resistor2.2KVishayNFR25H0002201JR500								
C4electrolytic cap22 uF, 450VNichicon647-UVY2W220MHDC35ceramic cap0.1 uF, 50VTDKC3216X7R2A104KC340.25W resistor0.2 ohmsRohm SemiconductorMCR18EZHFLR200R40.5W resistor2.2KVishayNFR25H0002201JR500								
C35 ceramic cap 0.1 uF, 50V TDK C3216X7R2A104K C34 0.25W resistor 0.2 ohms Rohm Semiconductor MCR18EZHFLR200 R4 0.5W resistor 2.2K Vishay NFR25H0002201JR500								
C340.25W resistor0.2 ohmsRohm SemiconductorMCR18EZHFLR200R40.5W resistor2.2KVishayNFR25H0002201JR500								
R4 0.5W resistor 2.2K Vishay NFR25H0002201JR500	C35	ceramic cap	0.1 uF, 50V	TDK	C3216X7R2A104K			
R4 0.5W resistor 2.2K Vishay NFR25H0002201JR500	C34	0.25W resistor	0.2 ohms	Rohm Semiconductor	MCR18EZHFLR200			

DN05072/D						
R8	0.5W resistor	2K, 0.5W	Vishay	CMF552K0000FHEB		
R2	0.5W resistor	560K	Vishay	HVR3700005603JR500		
R27	0.5W resistor	4.7K	Vishay	CRCW12104K70JNEA		
R24	0.5W resistor	100 ohms	Vishay	CMF50100R00FHEB		
R20, R26	0.5W resistor	0.1 ohms	Ohmite	WNCR10FET		
R26A	1W resistor	0.1 ohms	Vishay/Dale	WSL2512R1000FEA		
R3	3 or 5W resistor	36K to 39K	Ohmite	PR03000203602JAC00		
R23	0.25W resistor	4.7 ohms	Vishay/Dale	CRCW12064R75F		
R5	0.25W resistor	Not Fitted	visitay/Dale			
R38	0.25W resistor	Not Fitted				
R21, 42, 43	0.25W resistor	10 ohms	Vishay/Dale	CRCW120610R0F		
R41	0.25W resistor	Not Fitted	-	-		
R15, R28	0.25W resistor	2.2K	Vishay/Dale	CRCW12062211F		
R13, R28	0.25W resistor	2.2K 2.7K	Vishay/Dale	CRCW12062741F		
R29,R30	0.25W resistor	43.2K	Vishay/Dale	CKGW12002741F		
R25	0.25W resistor	43.2K 20K	Vishay/Dale	CRCW12062002F		
R25 R32	0.25W resistor	20K 68K	-	CRCW12062002F CRCW12066812F		
			Vishay/Dale			
R33 R37	0.25W resistor	6.2K Not Fitted	Vishay/Dale	CRCW12066191F		
	0.25W resistor			-		
R34	0.25W resistor	82K	Vishay/Dale	CRCW12068252F		
R35	0.25W resistor	3.9K	Vishay/Dale	CRCW12063921F		
R14, 22	0.25W resistor	10K	Vishay/Dale	CRCW12061002F		
R39, 40, 44	0.25W resistor	Not Fitted	-			
R13	0.25W resistor	7.32K	Vishay/Dale	CRCW12064322F		
R9	0.25W resistor	30.1K	Vishay/Dale	CRCW12063012F		
R12	0.25W resistor	71.5K	Vishay/Dale	CRCW12067152F		
R17	0.25W resistor	Not Fitted	-	-		
R18	0.25W resistor	49.9K	Vishay/Dale	CRCW12064992F		
R19	0.25W resistor	39.2K	Vishay/Dale	CRCW12063922F		
R16	0.25W resistor	100K	Vishay/Dale	CRCW12061003F		
R10	0.25W resistor	332K	Vishay/Dale	CRCW12063323F		
R6, 7, 11	0.25W resistor	365K	Vishay/Dale	CRCW12063653F		
F1	Fuse	3.15A, 250Vac	Littlefuse	37213150001		
L1A/B	EMI inductor	220uH, 2A	Coilcraft	PCV-0-224-03L		
L2	EMI inductor		Coilcraft	P3220-AL		
74	Flubocketter	50V, 125W	WE-Midcom (Wurth	750214404 BEV 00		
T1	Flyback xfmr	CCM	Electronics)	750314494, REV 00		
J1, J2, J3	I/O connectors		Weidmuller Ohmite	1716020000		
(for Q1, D8)	Heatsink Q1, D8	CONN	Unimite	EA-T220-64E		
HD1	Header	HEADER 2POS	Molex	90120-0122		
		0.1" Two				
		Position				
		Shorting	Sullins Connector			
JMP1	Shorting Jumper	Jumper	Solutions	SPC02SYAN		

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