



ON Semiconductor

DN05126/D

Design Note – DN05126/D

# High-Efficiency QR Flyback Adapter with USB-PD / Type-C Output Utilizing NCP1342

Device	Application	Input Voltage	Output Power	Topology	I/O Isolation
NCP1342AMDCC NCP43080D	USB-PD Adapter	90 to 265 Vac	60 W Nominal	Quasi-Resonant Flyback	Isolated

Output Specification	
Output Voltage	5/9/15/20 Vdc USB-PD/Type-C
Nominal Current	3 A Max
No Load Standby	< 50 mW at 115/230 Vac

## Circuit Description

The NCP1342 is a highly-integrated quasi-resonant flyback controller suitable for designing high-performance off-line power converters. With an integrated active X2 capacitor discharge feature, the NCP1342 enables no-load power consumption below 70 mW.

The quasi-resonant operating mode features a proprietary valley-lockout circuitry ensuring stable valley switching down the 6<sup>th</sup> valley. After the 6<sup>th</sup> valley the controller transitions to a frequency foldback mode to reduce switching losses in lighter load conditions.

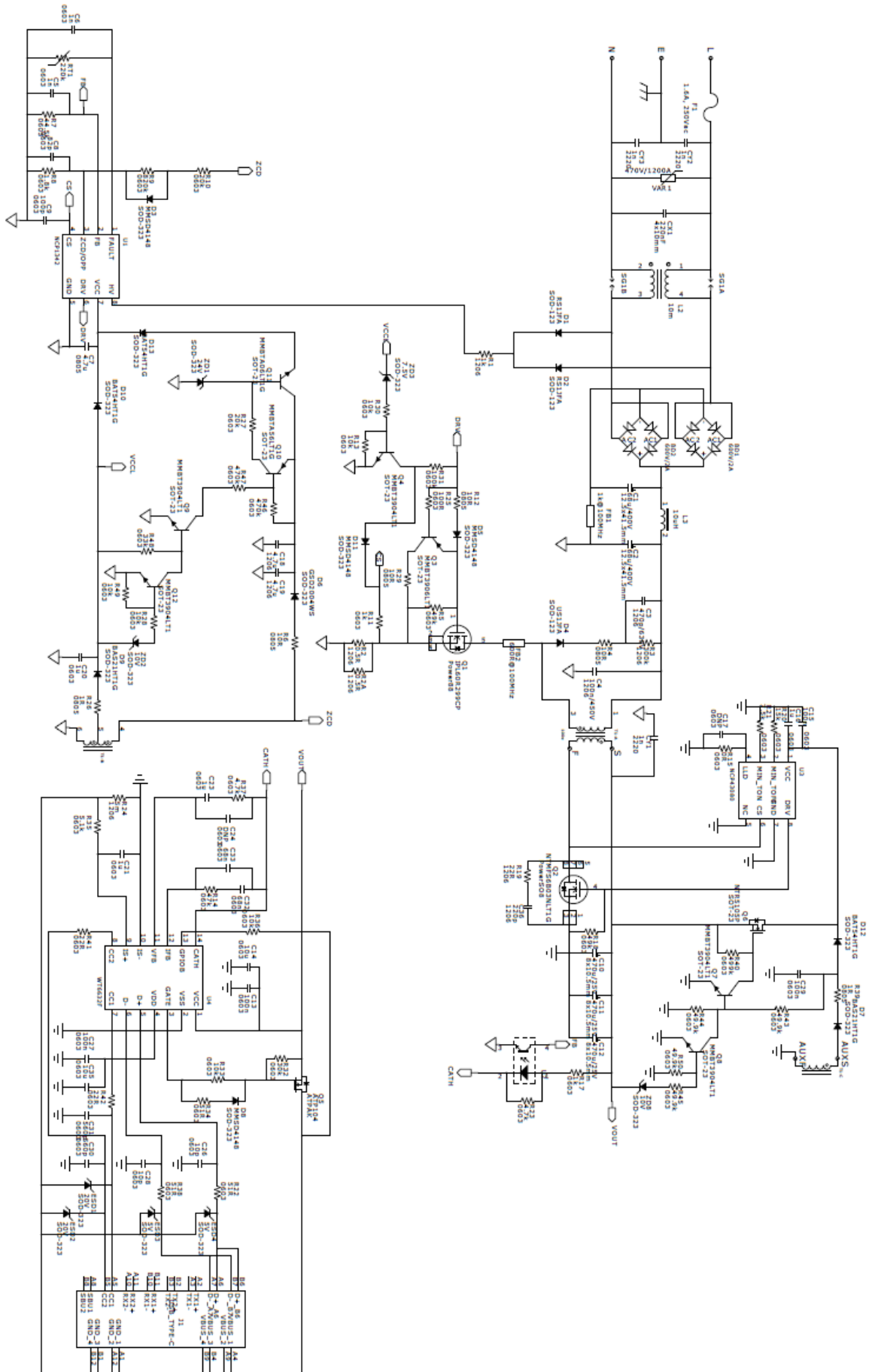
Secondary side synchronous rectification (SR) is implemented with the NCP43080 for optimized efficiency across all operating modes. The NCP43080 features precise zero current turn off and 12 ns turn-off delay from current sense to the driver allowing for the optimal SR conduction period in quasi-resonant mode. The light load detection (LLD) feature modulates the drive voltage as the load decreases and shuts down the driver for optimal light and no-load performance.

Separate output voltage detection circuits adjust the skip threshold and provide V<sub>CC</sub> management to both the NCP1342 and the NCP43080.

## Key Features

- High-Voltage Startup Circuit with Active Input Filter Capacitor Discharge and Brownout Detection for Reduced Standby Power
- Valley Switching Operation to 6<sup>th</sup> valley with Valley-Lockout for Stable Operation
- Frequency Foldback with 25 kHz Minimum Frequency Clamp
- Minimized Current Consumption for No Load Power Below 50 mW at 115/230 Vac.
- Frequency Jitter for Reduced EMI Signature
- Fault Input for Severe Fault Conditions, NTC Compatible (Latch and Auto-Recovery Options)
- Adjustable Maximum Frequency Clamp

# DN05126/D Circuit Schematic



# DN05126/D

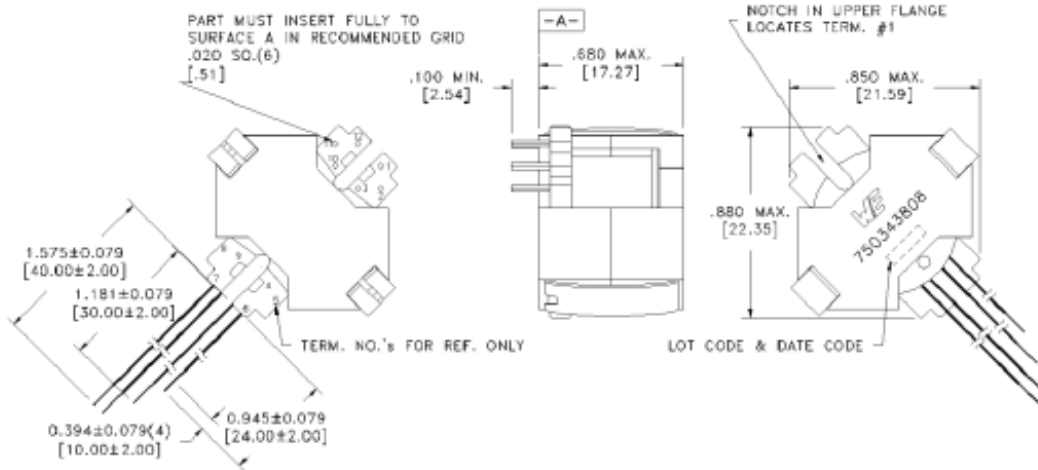
## Magnetics Design – Flyback Transformer NCP1342

more than you expect

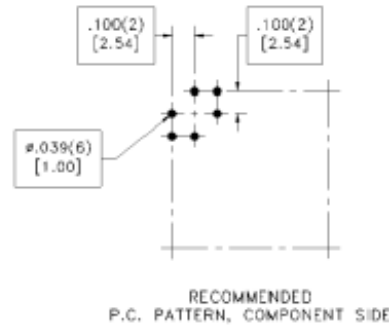
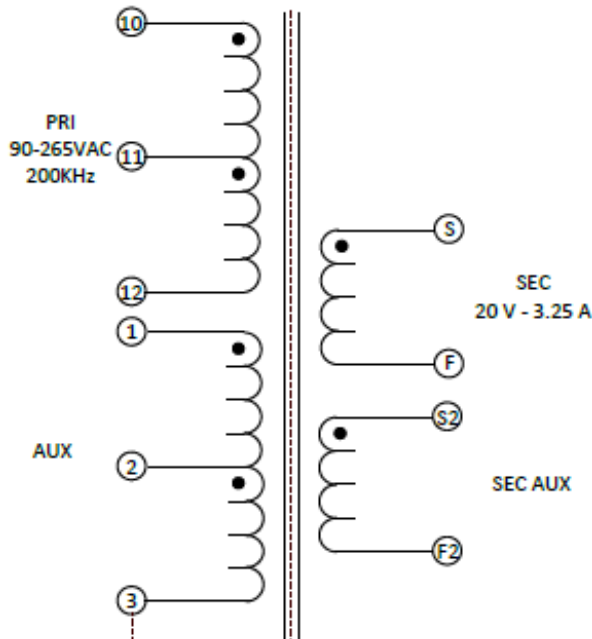


### ELECTRICAL SPECIFICATIONS @ 25° C unless otherwise noted:

PARAMETER	TEST CONDITIONS	VALUE
D.C. RESISTANCE	10-12	@20°C 0.220 ohms max.
D.C. RESISTANCE	1-2	@20°C 0.300 ohms max.
D.C. RESISTANCE	2-3	@20°C 0.170 ohms max.
D.C. RESISTANCE	S-F	@20°C 0.030 ohms max.
D.C. RESISTANCE	S2-F2	@20°C 0.150 ohms max.
INDUCTANCE	10-12	10kHz, 100mV, Ls 300.00µH ±10%
LEAKAGE INDUCTANCE	10-12	tie(1thru3+s+f+s2+f2), 100kHz, 100mV, Ls 4.5µH max.
DIELECTRIC	10-S	tie(1+12,S+S2), 3750VAC, 1 second 3000VAC, 1 minute
DIELECTRIC	S-CORE	tie(S+S2), 3750VAC, 1 second 3000VAC, 1 minute
URNS RATIO		(10-12):(1-2) 3.6:1, ±1%
URNS RATIO		(10-12):(2-3) 7.2:1, ±1%
URNS RATIO		(10-12):(S-F) 6:1, ±1%
URNS RATIO		(10-12):(S2-F2)

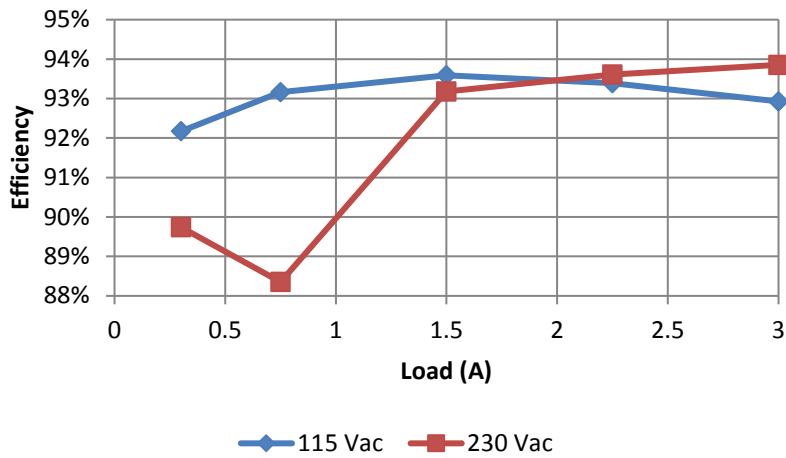


Flying wire starts at bottom, long is S2, short is S, finishes at top, long is F2, short is F.



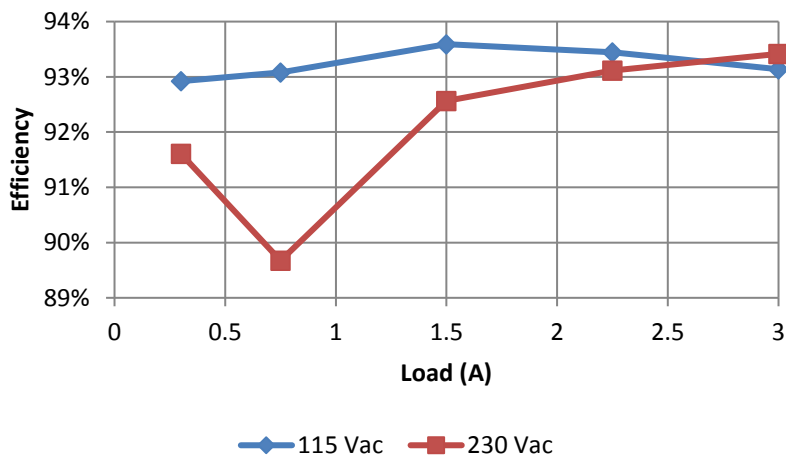
Efficiency vs. Load Over Output Range

Efficiency vs. Load - 20V



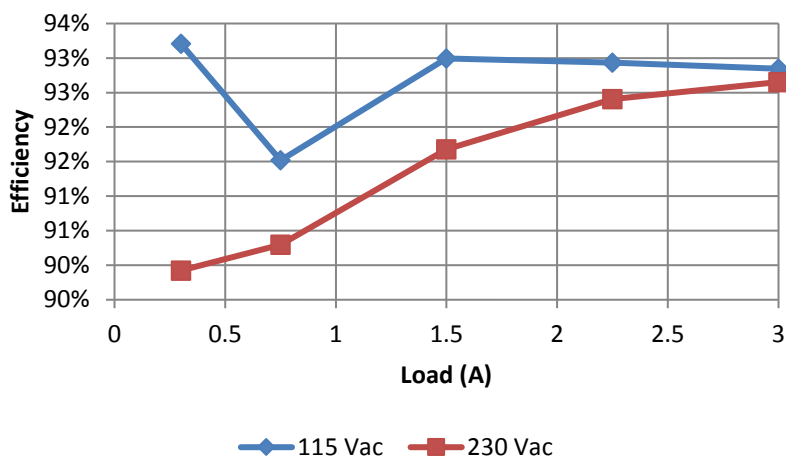
20V Output			
Input (Vac)	Load (%)	Efficiency (%)	Average (%)
115	100	92.9	93.3
	75	93.4	
	50	93.6	
	25	93.2	
	10	92.2	
230	100	93.9	92.2
	75	93.6	
	50	93.2	
	25	88.4	
	10	89.7	

Efficiency vs. Load - 15V



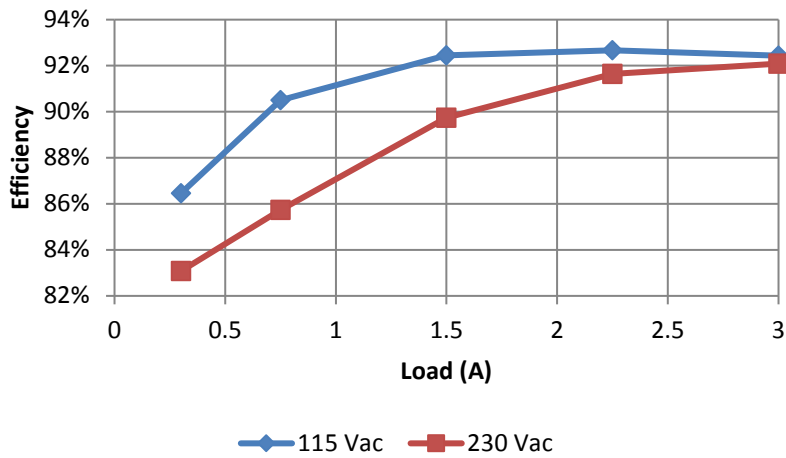
15V Output			
Input (Vac)	Load (%)	Efficiency (%)	Average (%)
115	100	93.1	93.3
	75	93.4	
	50	93.6	
	25	93.1	
	10	92.9	
230	100	93.4	92.2
	75	93.1	
	50	92.6	
	25	89.7	
	10	91.6	

Efficiency vs. Load - 12V



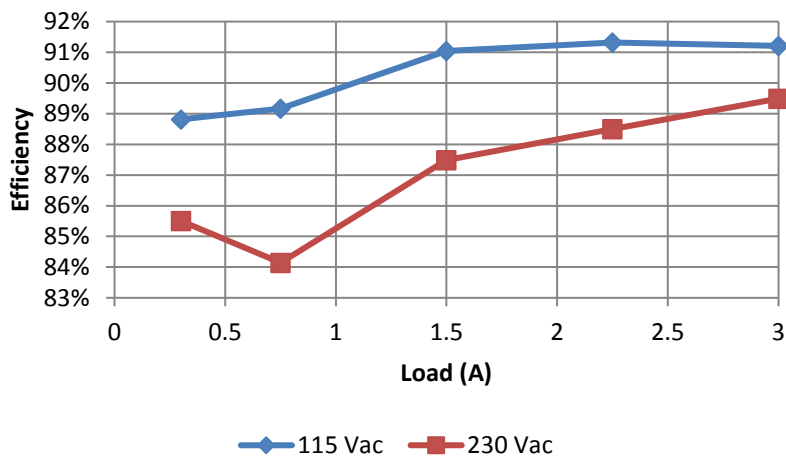
12V Output			
Input (Vac)	Load (%)	Efficiency (%)	Average (%)
115	100	92.8	92.6
	75	92.9	
	50	93.0	
	25	91.5	
	10	93.2	
230	100	92.7	91.8
	75	92.4	
	50	91.7	
	25	90.3	
	10	89.9	

### Efficiency vs. Load - 9V



9V Output			
Input (Vac)	Load (%)	Efficiency (%)	Average (%)
115	100	92.4	92.0
	75	92.7	
	50	92.5	
	25	90.5	
	10	86.5	
230	100	92.1	89.8
	75	91.6	
	50	89.7	
	25	85.7	
	10	83.1	

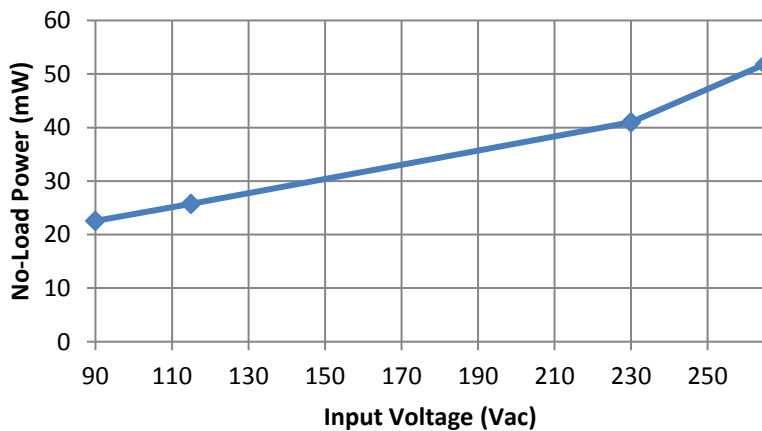
### Efficiency vs. Load - 5V



5V Output			
Input (Vac)	Load (%)	Efficiency (%)	Average (%)
115	100	91.2	90.7
	75	91.3	
	50	91.0	
	25	89.2	
	10	88.8	
230	100	89.5	87.4
	75	88.5	
	50	87.5	
	25	84.1	
	10	85.5	

### No-Load Power Consumption – 5V Only

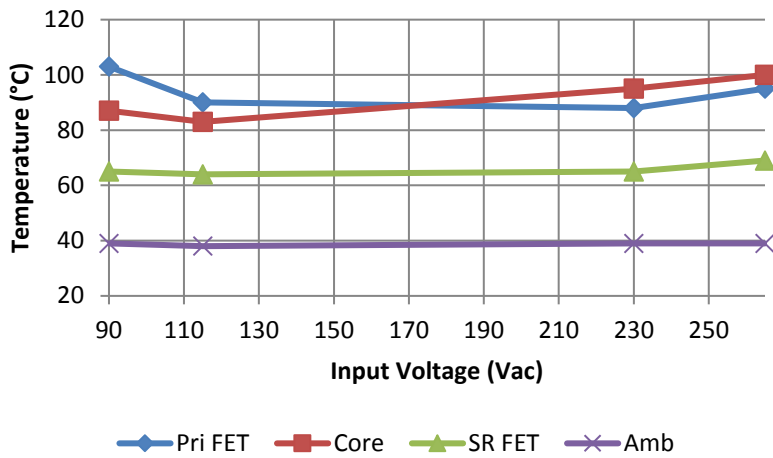
#### No-Load Power vs Input Voltage



Input (Vac)	Power Dissipation (mW)
90	23
115	26
230	41
265	52

### Full Load Thermal Performance

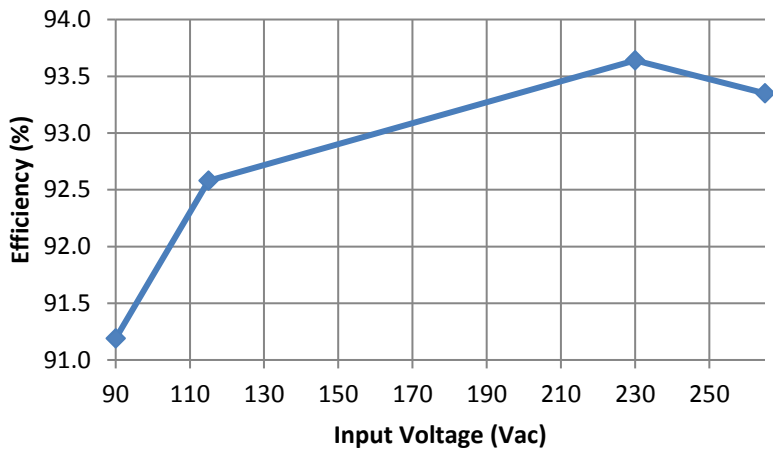
#### Temperature vs. Input Voltage



Input (Vac)	Pri FET (°C)	Core (°C)	SR FET (°C)	Amb (°C)
90	103	87	65	39
115	90	83	64	38
230	88	95	65	39
265	95	100	69	39

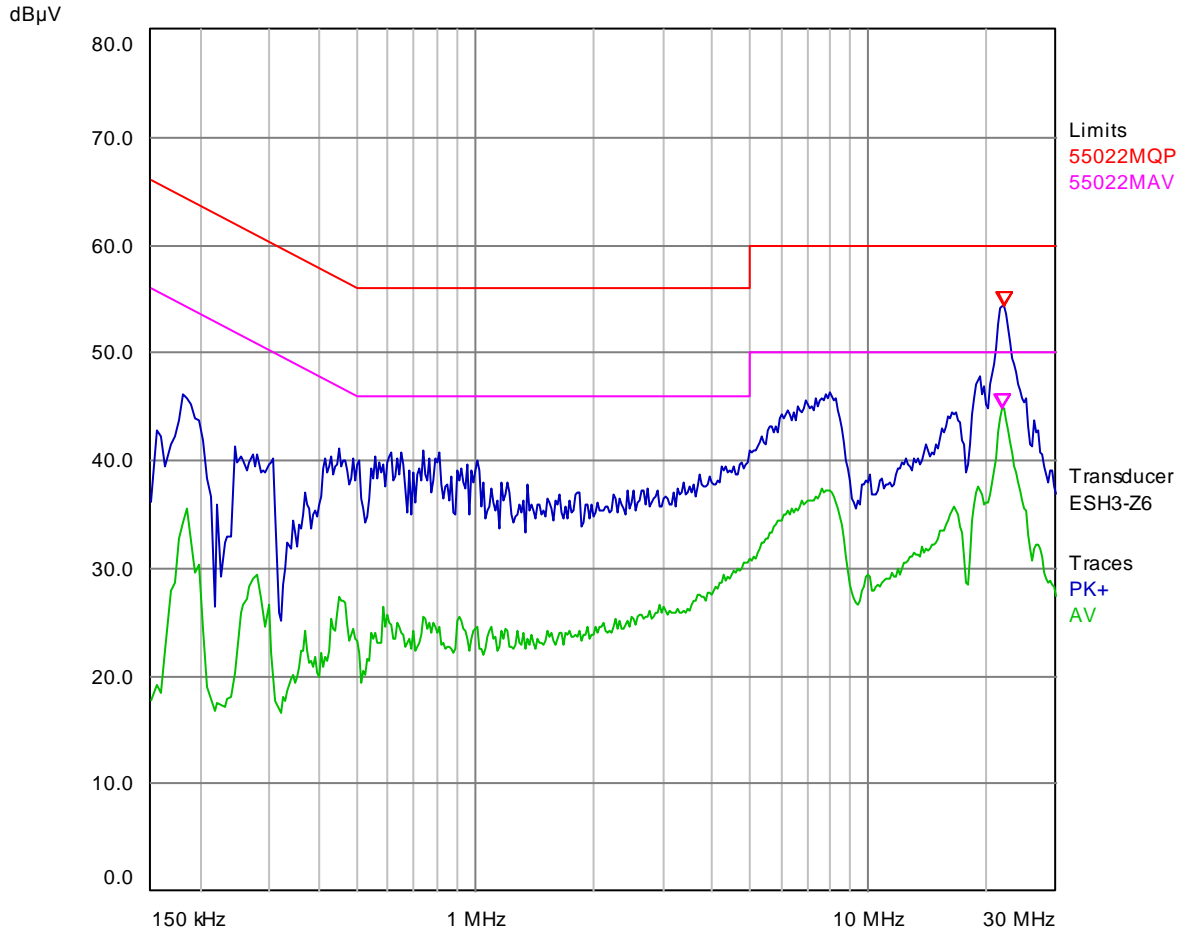
### Full Load Efficiency

#### Efficiency vs Input Voltage



Input (Vac)	Efficiency (%)
90	91.2
115	92.6
230	93.6
265	93.4

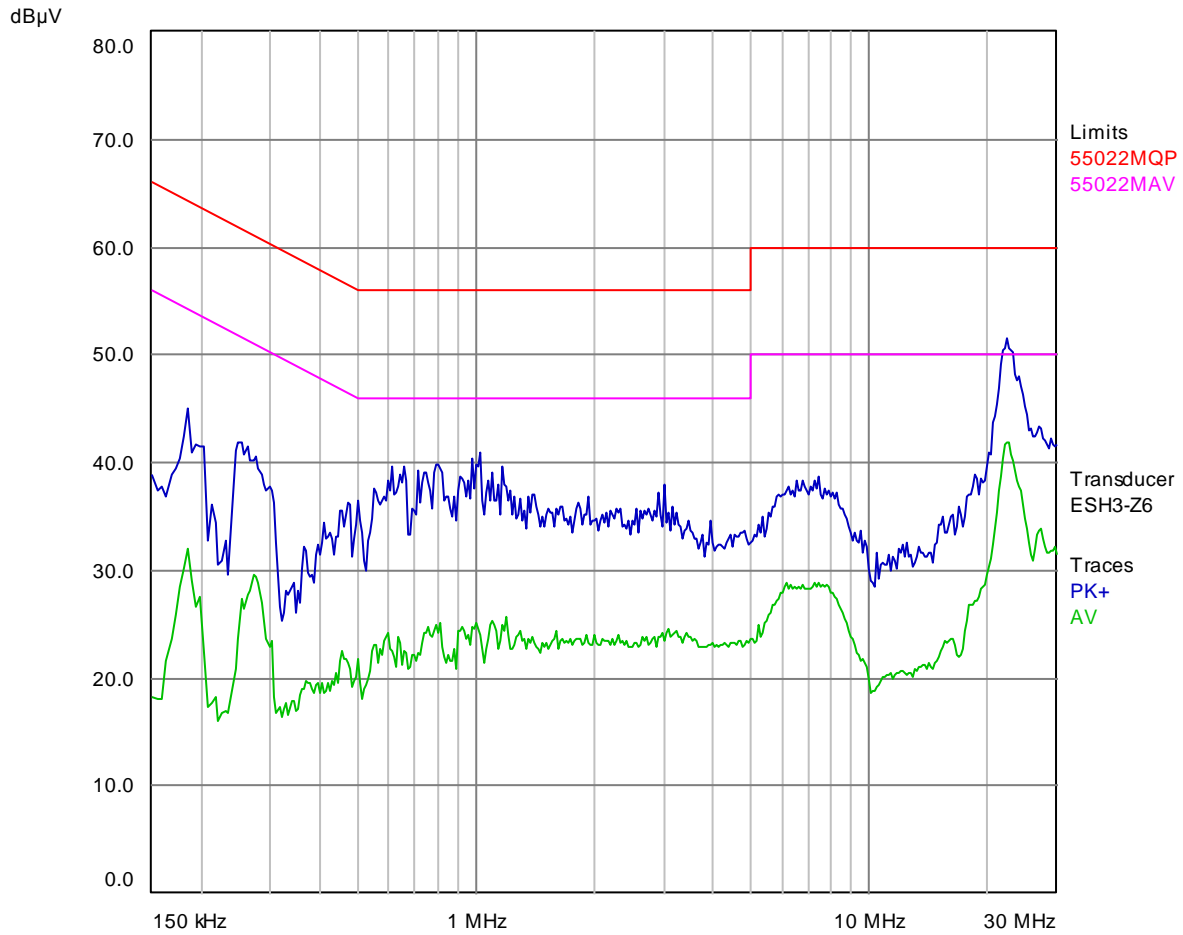
EMI Performance



120 Vac – 60W Load – Line

Trace	Frequency (MHz)	Level (dBµV)	Limit (dBµV)	Delta Limit (dBµV)
AV	21.9525	44.86	50.00	-5.14
PK+	22.0875	54.38	60.00	-5.62

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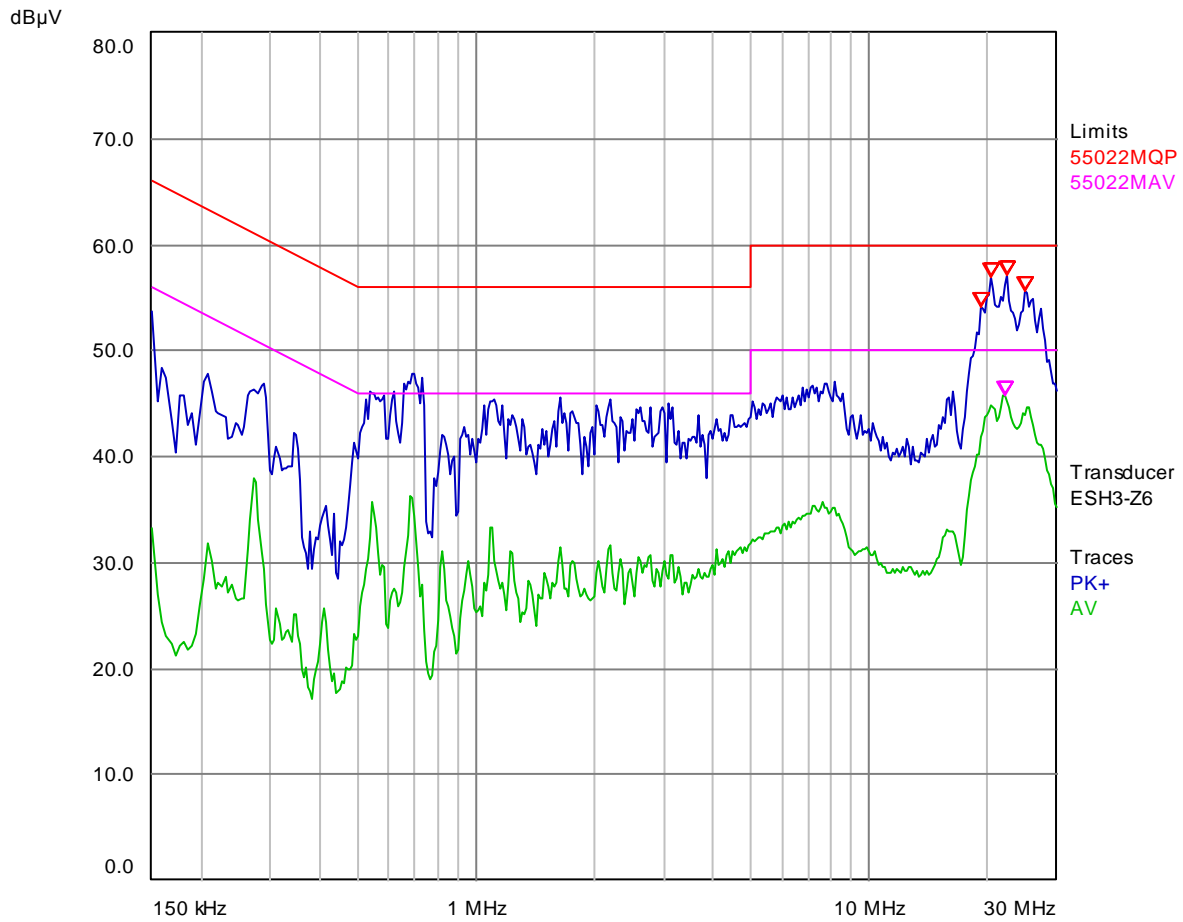


## 120 Vac – 60W Load – Neutral

Trace	Frequency (MHz)	Level (dBµV)	Limit (dBµV)	Delta Limit (dBµV)
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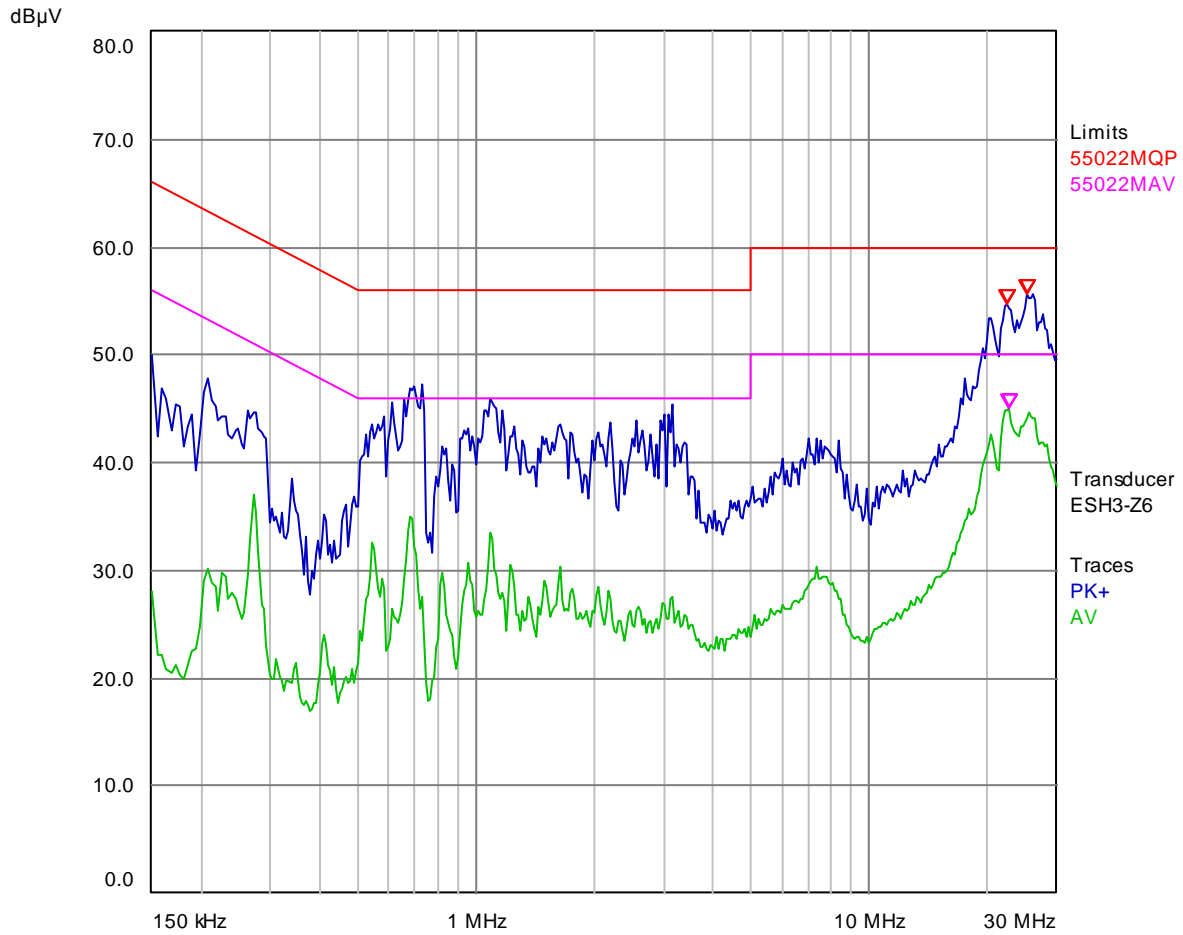
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## 220 Vac – 60W Load – Line

Trace	Frequency (MHz)	Level (dBµV)	Limit (dBµV)	Delta Limit (dBµV)
PK+	22.362	54.69	60.00	-5.31
PK+	25.242	55.67	60.00	-4.33
AV	22.596	45.08	50.00	-4.92
AV	22.029	45.78	50.00	-4.22

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## 220 Vac – 60W Load – Neutral

Trace	Frequency (MHz)	Level (dBµV)	Limit (dBµV)	Delta Limit (dBµV)
PK+	22.362	54.69	60.00	-5.31
PK+	25.242	55.67	60.00	-4.33
AV	22.596	45.08	50.00	-4.92

## DN05126/D

## Bill of Materials

Ref	Qty	Description	Value	Footprint	Manufacturer	Manufacturer P/N
T1	1	Flyback Transformer	300uH	RM-8	Würth	750343808
L2	1	Common Mode Choke	10mH	23x13mm	Würth	744823210
L3	1	Axial-Leaded Inductor	10uH	7.8mm	Würth	744732100
CX1	1	Film Capacitor, X2, Radial	330n/305Vac	18x8.5mm	Epcos	B32922D3334K000
C1-2	2	Aluminum Electrolytic Capacitor	68u/400V	12.5mm	Nichicon	UCY2G680MHD
C10-12	3	Aluminum Organic Polymer Capacitor	470u/25V	8mm	Illinois Capacitor	477AVG025MFBJ
C13, C15, C27, C29	4	Ceramic Capacitor	100n/50V	0603	AVX	06035C104K4Z2A
C9	1	Ceramic Capacitor	100p/50V	0603	AVX	06035C101KAT2A
C26, C28	2	Ceramic Capacitor	10p/50V	0603	AVX	06035C100KAT2A
C14	1	Ceramic Capacitor	10u/25V	0603	Murata	GRM188R61E106MA73D
C35	1	Ceramic Capacitor	10u/6.3V	0603	TDK	C1608X7S0J106M080AC
C5-6, C17	3	Ceramic Capacitor	1n/50V	0603	AVX	06035C102K4Z2A
C16, C20	2	Ceramic Capacitor	1u/35V	0603	Murata	GRM188R7YA105KA12D
C21, C23	2	Ceramic Capacitor	1u/50V	0603	AVX	06035C105KAT2A
C30-31	2	Ceramic Capacitor	560p/50V	0603	AVX	06035C561KAT2A
C32-33	2	Ceramic Capacitor	68n/50V	0603	AVX	06035C683K4Z2A
C7	1	Ceramic Capacitor	4.7u/35V	0805	TDK	C2012X7R1V475K125AC
C3	1	Ceramic Capacitor	470p/630V	1206	Yageo	CC1206KKX7RZBB471
C4	1	Ceramic Capacitor	100n/450V	1206	TDK	C3216X7T2W104M160AE
C18-19	2	Ceramic Capacitor	4.7u/100V	1206	AVX	12061Z475KAT2A
C36	1	Ceramic Capacitor	220p/50V	1206	AVX	12065C221KAT2A
CY1-3	3	Ceramic Capacitor, X1/Y2	1n/250Vac	2220	Knowles Syfer	2220JA250102KXTB16
C8, C24	2	Not Installed	-	0603	-	-
R8	1	Chip Resistor	1.8k	0603	Vishay/Dale	CRCW06031K80FKEA
R25	1	Chip Resistor	100R	0603	Vishay/Dale	CRCW0603100RFKEA
R31	1	Chip Resistor	100k	0603	Vishay/Dale	CRCW0603100KFKEB
R13, R20, R28, R30, R33, R36, R49	7	Chip Resistor	10.0k	0603	Vishay/Dale	CRCW060310K0FKEA
R11, R17	2	Chip Resistor	1.00k	0603	Vishay/Dale	CRCW06031K00FKEA
R10, R27	2	Chip Resistor	20.0k	0603	Vishay/Dale	CRCW060320K0FKEA
R41-42	2	Chip Resistor	22R	0603	Vishay/Dale	CRCW060322R0FKEA
R32	1	Chip Resistor	30k	0603	Vishay/Dale	CRCW060330K0FKEA
R48	1	Chip Resistor	33k	0603	Vishay/Dale	CRCW060333K0FKEA
R23, R37	2	Chip Resistor	4.7k	0603	Vishay/Dale	CRCW06034K70FKTA
R7	1	Chip Resistor	44.2k	0603	Vishay/Dale	CRCW060344K2FKEA
R46-47	2	Chip Resistor	470k	0603	Vishay/Dale	CRCW0603470KFKEA
R14	1	Chip Resistor	47k	0603	Vishay/Dale	CRCW060347K0FKEA
R5, R18, R43-45, R50	6	Chip Resistor	49.9k	0603	Vishay/Dale	CRCW060349K9FKEA
R40	1	Chip Resistor	499k	0603	Vishay/Dale	CRCW0603499KFKTA
R35	1	Chip Resistor	5.1k	0603	Vishay/Dale	CRCW06035K10FKEA
R22, R34, R38	3	Chip Resistor	51R	0603	Vishay/Dale	CRCW060351R0FKEA

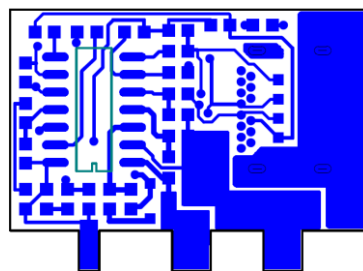
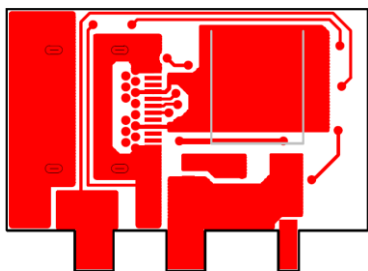
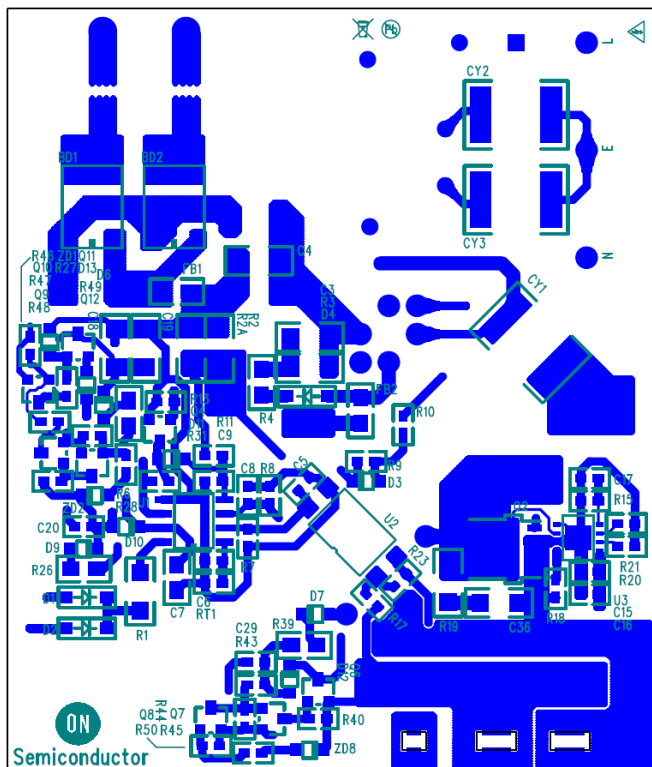
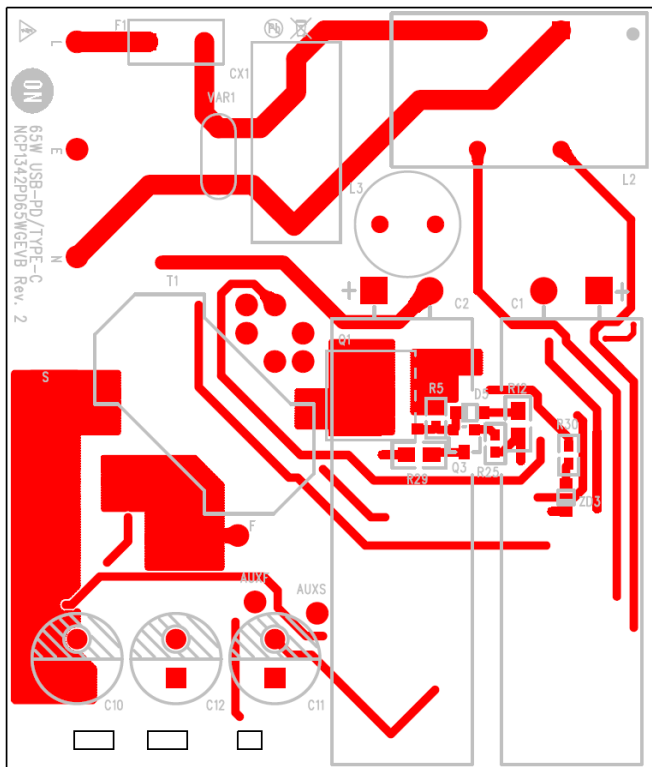
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R21	1	Chip Resistor	7.5k	0603	Vishay/Dale	CRCW06037K50FKEA
R9	1	Chip Resistor	820k	0603	Vishay/Dale	CRCW0603820KFKEA
R15	1	Chip Resistor	91k	0603	Vishay/Dale	CRCW060391K0FKEA
R4, R12, R29	3	Chip Resistor	10.0R	0805	Vishay/Dale	CRCW080510R0FKEA
R6	1	Chip Resistor	7.50R	0805	Vishay/Dale	CRCW08057R50FKEA
R26, R39	2	Chip Resistor	1.00R	0805	Vishay/Dale	CRCW08051R00FKEA
R2, R2A	2	Chip Resistor, 1/2W	0.5R	1206	Stackpole	CSR1206FTR500
R1	1	Chip Resistor	1.00k	1206	Vishay/Dale	CRCW12061K00FKEA
R19	1	Chip Resistor	22R	1206	Vishay/Dale	CRCW120622R0FKEA
R3	1	Chip Resistor	300k	1206	Vishay/Dale	CRCW1206300KFKEA
R24	1	Chip Resistor, 1W	0.005R	1206	Stackpole	CSNL1206FT5L00
RT1	1	NTC Thermistor	220k	0603	Panasonic	ERT-J1VT224FM
VAR1	1	Metal Oxide Varistor	470V/1200A	7mm	Würth	820573011
FB1	1	Ferrite Bead	1k@100MHz	0805	Würth	742792096
FB2	1	Ferrite Bead	600R@100MHz	0805	Würth	742792040
F1	1	Fuse	1.6A/250VAC	Axial Lead	Hollyfuse	20T-016H
ZD1	1	Zener Diode	24V	SOD-323	ON semiconductor	MM3Z24VT1G
ZD2, ZD8	2	Zener Diode	10V	SOD-323	ON semiconductor	MM3Z10VT1G
ZD3	1	Zener Diode	7.5V	SOD-323	ON semiconductor	MM3Z7V5T1G
BD1-2	2	Bridge Rectifier Diode	600V	SMT	Comchip	Z4GP206L-HF
D1-2	2	Fast-Recovery Diode	600V	SOD-123	ON semiconductor	RS1JFA
D3, D5, D7-9, D11	6	General Purpose Switching Diode	250V	SOD-323	ON semiconductor	BAS21HT1G
D4	1	Super-Fast Rectifier Diode	600V	SOD-123	ON semiconductor	US1JFA
D6	1	General Purpose Switching Diode	300V	SOD-323	Vishay	GSD2004WS-E3-08
D10, D12-13	3	Schottky Diode	30V	SOD-323	ON semiconductor	BAT54HT1G
Q1	1	High-Voltage N-Channel Power MOSFET	650V/385mOhm	Power88	Infineon	IPL60R385CPAUMA1
Q2	1	N-Channel Power MOSFET	100V/4.8mOhm	SO-8FL	ON semiconductor	NTMFS6B03NT1G
Q3	1	General Purpose Transistor, PNP	40V	SOT-23	ON semiconductor	MMBT3906LT1
Q4, Q7-9, Q12	5	General Purpose Transistor, NPN	40V	SOT-23	ON semiconductor	MMBT3904LT1
Q5	1	P-Channel Power MOSFET	30V/75A	ATPAK	ON semiconductor	ATP104-TL-H
Q6	1	N-Channel Small-Signal MOSFET	60V	SOT-23	ON semiconductor	NTR5105PT1G
Q10	1	General Purpose Transistor, PNP	80V	SOT-23	ON semiconductor	MMBTA56LT1G
Q11	1	General Purpose Transistor, NPN	80V	SOT-23	ON semiconductor	MMBTA06LT1G
ESD1-4	4	ESD Protection Diode	5V	SOD-323	ON semiconductor	SD05T1G
U1	1	QR Flyback Controller	-	SOIC-8	ON semiconductor	NCP1342AMDCCDR2G
U2	1	Optoisolator	5kV	SMD-4	CEL	PS2513L-1-F3-A

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U3	1	SR Controller	-	DFN-8	ON semiconductor	NCP43080DMNTWG
U4	1	PD3.0/QC3.0 Controller	-	SOIC-14	Weltrend	WT6632F-SG14BWT-S65
J1	1	USB Type-C Connector	-	TH/SMD	Würth	632723300011

Notes: Resistor tolerances are +/- 1% unless noted otherwise  
Capacitor tolerances are +/- 10% unless noted otherwise  
Electrolytic capacitor tolerances are +/- 20% unless noted otherwise

Demo Board



## References

NCP1342-D Datasheet  
NCP43080-D Datasheet

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