



ON Semiconductor

High Efficiency, Low Standby PFC Adapter

Device	Application	Input Voltage	Output Power	Topology	I/O Isolation
NCP1616	Adapter	85 to 265 Vac	Up to 120 W	Boost PFC	Non-isolated

	Output Specification
Output Voltage	400 Vdc nominal
Nominal Current	300 mA
Full Load Efficiency	> 94 %
Min Current	Zero

Circuit Description

The NCP1616 is a high voltage PFC controller designed to drive boost PFC stages based on an innovative Current Controlled Frequency Foldback (CCFF) method. In this mode, the circuit classically operates in critical conduction mode (CrM) when the inductor current exceeds a programmable value. When the current is below this preset level, the NCP1616 linearly decays the frequency down to a minimum of about 26 kHz when the input current is zero. CCFF maximizes the efficiency at both nominal and light load. In particular, the standby losses are reduced to a minimum. An innovative circuitry allows near-unity power factor even when the switching frequency is reduced.

The integrated high voltage startup circuit eliminates the need for external startup components and consumes negligible power during normal operation. Housed in a SOIC-9 package, the NCP1616 incorporates the features necessary for robust and compact PFC stages, with few external components.

Key Features

- High Voltage Startup Circuit with Integrated Brownout Detection
- Critical Conduction Mode (CrM)
- Novel CCFF Based Control Scheme Maximizes Efficiency Across Line and Load
- Valley Switching for Improved Efficiency
- Skip Mode Near the Line Zero Crossing
- Fast Line / Load Transient Compensation
- Input Voltage Range Detection
- Integrated Input X2 Capacitor Discharge Circuitry and Standby Mode Enable Very Low Standby Power Applications
- Input to Force Controller into Standby Mode
- High Drive Capability: -500 mA/+800 mA
- Wide VCC Range: from 9.5 V to 28 V

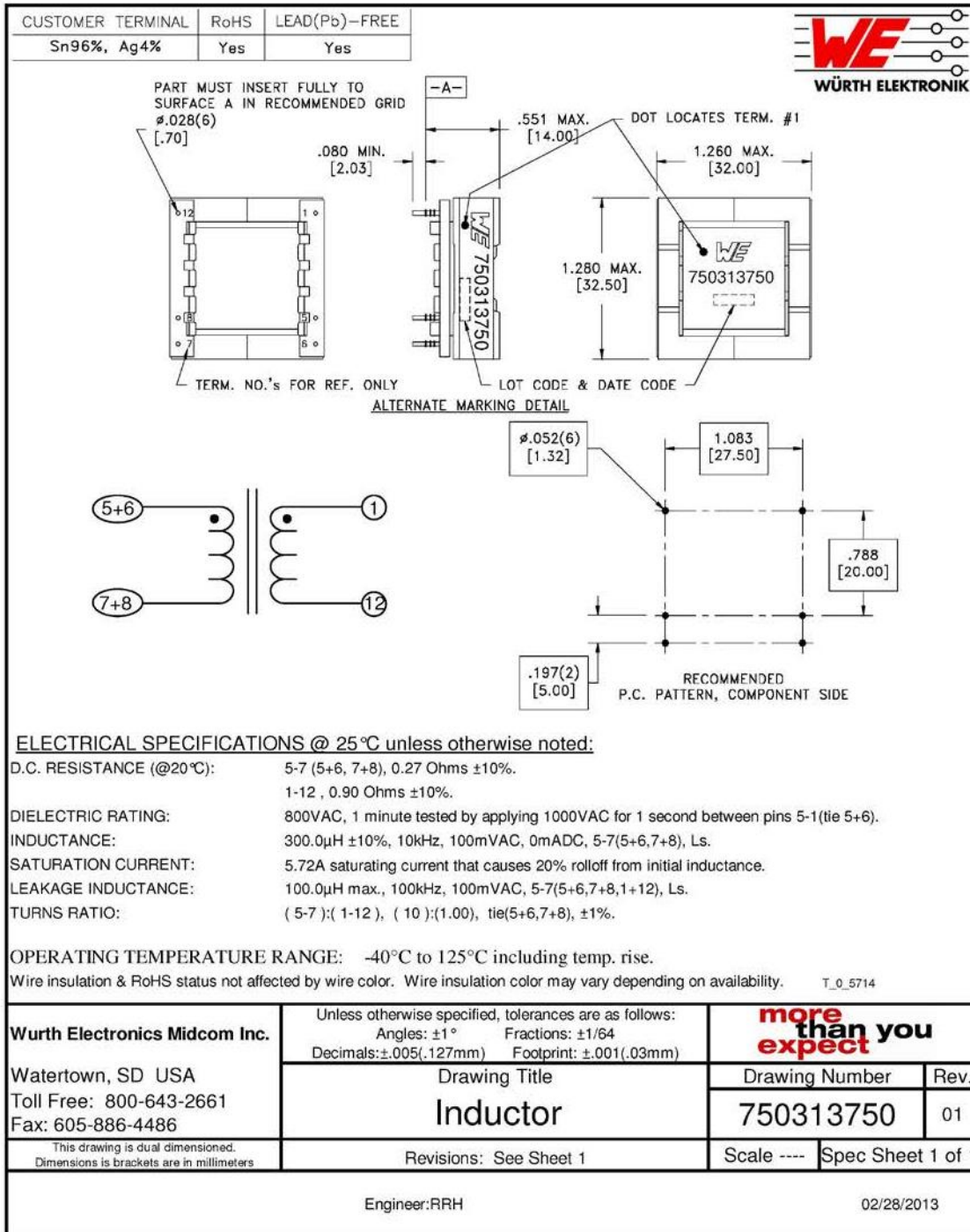
Safety Features

- Soft Overvoltage Protection
- Line Overvoltage Protection
- Bulk Undervoltage Protection
- Overcurrent Protection
- Open Pin Protection for FB and STDBY/FAULT Pins
- Internal Thermal Shutdown
- Latch Input for OVP
- Bypass/Boost Diode Short Circuit Protection
- Open Ground Pin Protection



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Efficiency and Power Factor

Vac (V)	Pin (W)	Iout (A)	Vout (V)	Pout (W)	Efficiency (%)	Power Factor
85	31.3	0.073	397.9	29.047	92.802	0.9741
85	62.542	0.148	397.8	58.874	94.135	0.9878
85	93.93	0.223	397.8	88.709	94.442	0.9925
85	125.652	0.298	397.7	118.515	94.32	0.9941
115	31.554	0.073	397.9	29.047	92.055	0.967
115	62.236	0.147	397.9	58.491	93.983	0.9819
115	93.125	0.223	397.8	88.709	95.258	0.9883
115	124.41	0.298	397.8	118.544	95.285	0.9916
230	29.818	0.072	397.8	28.642	96.056	0.889
230	61.95	0.147	397.6	58.447	94.345	0.963
230	91.858	0.222	397.6	88.267	96.091	0.975
230	122.324	0.298	397.7	118.515	96.886	0.981
265	29.682	0.072	397.8	28.642	96.496	0.832
265	61.162	0.147	397.8	58.477	95.61	0.9352
265	91.888	0.222	397.7	88.289	96.083	0.9682
265	121.958	0.297	397.7	118.117	96.851	0.9763

Average Efficiency at 115 Vac: 94.145 %

Average Efficiency at 230 Vac: 95.845 %

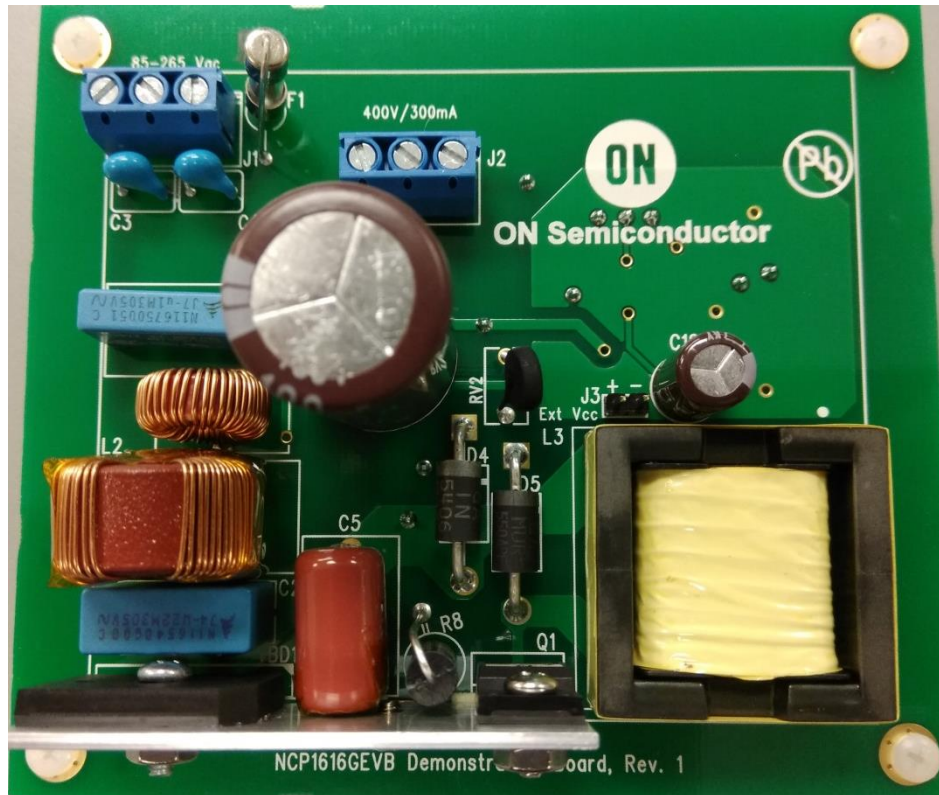
Bill of Materials

Qty	Ref Des	Component Type	Value	Rating	Pkg/Dimensions	P/N	Supplier
1	BD1	Diode Bridge	GBU406	600 V/4 A	18.5 x 22 mm	GBU406	Diodes Incorporated
1	C1	X2	100 nF	305 Vac	5 x 10.5 x 18 mm	B32922C3104M	EPCOS (TDK)
1	C2	X2	220 nF	305 Vac	7 x 12.5 x 18 mm	B32922C3224M	EPCOS (TDK)
1	C3	Y2	1 nF	250 Vac	5 mm	DE2E3KY102MN2AM01F	Murata Electronics North America
1	C4	Y2	1 nF	250 Vac	5 mm	DE2E3KY102MN2AM01F	Murata Electronics North America
1	C5	MKP	470 nF	400 V	15 mm	ECW-F4474JL	Panasonic
1	C6	Electrolytic	100 uF	450 V	18 x 40 mm	EKXG451ELL101MM40S	United Chemi-Con
1	C7	Ceramic	2.2 uF	16 V	C0805W	C2012X7R1C225K125AB	TDK Corporation
1	C8	Ceramic	220 nF	50 V	C0603W	C1608X7R1H224K080AB	TDK Corporation
1	C9	Ceramic	220 nF	50 V	C0603W	C1608X7R1H224K080AB	TDK Corporation
1	C10	Ceramic	15 pF	50 V	C0603W	C1608NP01H150J080AA	TDK Corporation
1	C11	Ceramic	220 nF	50 V	C0603W	C1608X7R1H224K080AB	TDK Corporation
1	C12	Electrolytic	220 uF/50 V	35 V	8 x 15 mm	EKY-350ELL221MH15D	United Chemi-Con
1	C13	Ceramic	10 nF	50 V	C0805W	VJ0805Y103KXACW1BC	Vishay Vitramon
1	C14	Ceramic	1 nF	50 V	C0603W	CGA3E2X7R1H102K080AA	TDK Corporation
1	C16	Ceramic	100 pF	50 V	C0603W	VJ0603Y101KXACW1BC	Vishay Vitramon
1	D1	Rectifier	MRA4007	1000 V/1 A	SMA	MRA4007T3G	ON Semiconductor
1	D2	Rectifier	MRA4007	1000 V/1 A	SMA	MRA4007T3G	ON Semiconductor
1	D3	General Purpose	MMSD4148	100 V/200 mA	SOD-123	MMSD4148T1G	ON Semiconductor
1	D4	Fast Acting	1N5406	600 V/3 A	DO201AD	1N5406G	ON Semiconductor
1	D5	Fast Acting	MUR550	520 V/5 A	DO201AD	MUR550APFG	ON Semiconductor
1	D6	General Purpose	MMSD4148	100 V/200 mA	SOD-123	MMSD4148T1G	ON Semiconductor
1	D7	General Purpose	MMSD4148	100 V/200 mA	SOD-123	MMSD4148T1G	ON Semiconductor

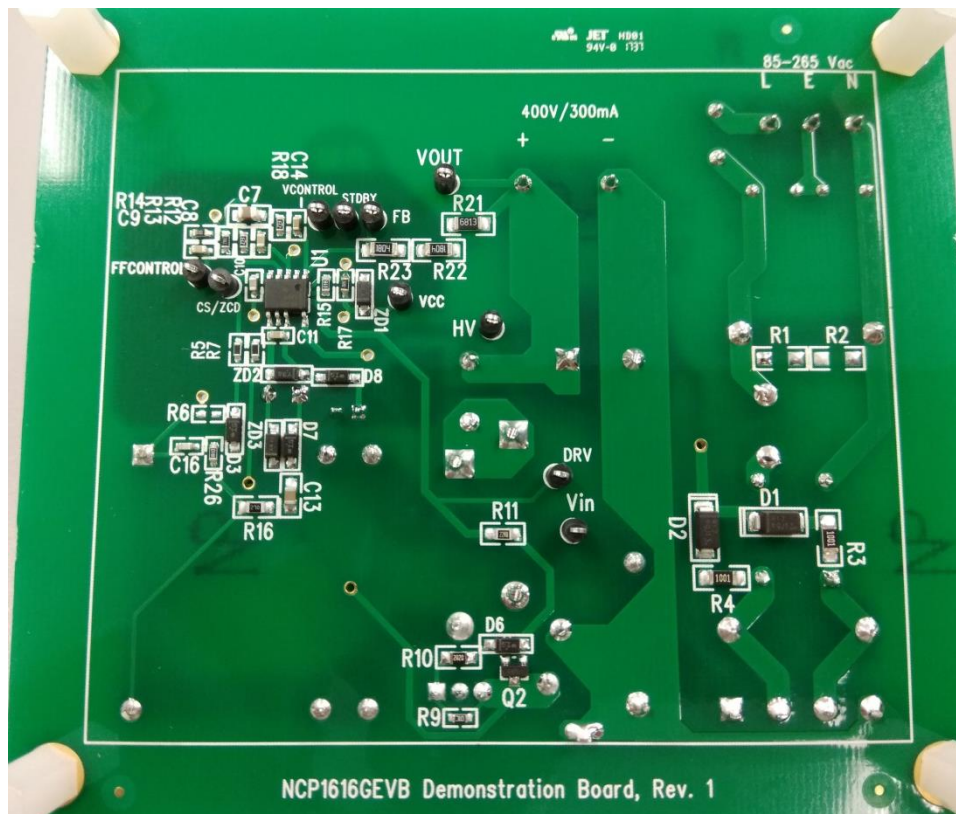
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1	D8	General Purpose	MMSD4148	100 V/200 mA	SOD-123	MMSD4148T1G	ON Semiconductor
1	F1	Fuse	3 A	250 V/3 A	2AG	0224003.HXP	Littelfuse Inc.
1	HS1	Heatsink			Cut to fit		
1	J1	3T Screw Block			5 mm Pitch	OSTTA030161	On Shore Technology Inc.
1	J2	2T Screw Block			10 mm Pitch	ED200/2DS	On Shore Technology Inc.
1	J3	SIP-2P			0.1" Pitch	104351-1	TE Connectivity
1	J5	7_PIN_MOUNTING_HOLE					
1	J6	7_PIN_MOUNTING_HOLE					
1	J7	7_PIN_MOUNTING_HOLE					
1	J8	7_PIN_MOUNTING_HOLE					
1	L1	DM Choke	100 uH		7447021_WURTH	7447021	WURTH
1	L2	CM Choke	10 mH		IND_744823210	744823210	WURTH
1	L3	PFC Transformer	300 uH		EFD-30	750313750	WURTH
1	Q1	HV MOSFET	FCPF22N60NT		TO-220F	FCPF22N60NT	ON Semiconductor
1	Q2	PNP	MMBT589	30 V/1 A	SOT-23	MMBT589LT1G	ON Semiconductor
1	R1	Resistor	Open		R1206W		
1	R2	Resistor	Open		R1206W		
1	R3	Resistor	1 kΩ		R1206W	CRCW12061K00FKEA	Vishay Dale
1	R4	Resistor	1 kΩ		R1206W	CRCW12061K00FKEA	Vishay Dale
1	R5	Resistor	4.7 kΩ		R0603W	CRCW06034K70FKEA	Vishay Dale
1	R6	Resistor	Open		R1206W		
1	R7	Resistor	4.7 kΩ		R0603W	CRCW06034K70FKEA	Vishay Dale
1	R8	Resistor	100 mΩ	3 W		MR3FTR100	Stackpole Electronics Inc.
1	R9	Resistor	10 kΩ		R0603W	CRCW060310K0FKEA	Vishay Dale
1	R10	Resistor	2.2 Ω		R0805W	CRCW08052R20JNEA	Vishay Dale
1	R11	Resistor	22 Ω		R0805W	CRCW080522R0JNEA	Vishay Dale
1	R12	Resistor	27 kΩ		R0603W	CRCW060327K0FKEA	Vishay Dale
1	R13	Resistor	270 kΩ		R0603W	CRCW0603270K0FKEA	Vishay Dale
1	R14	Resistor	120 kΩ		R0603W	CRCW0603120K0FKEA	Vishay Dale
1	R15	Resistor	1 kΩ		R0603W	CRCW06031K00FKEA	Vishay Dale
1	R16	Resistor	27 Ω		R0805W	CRCW080527R0JNEA	Vishay Dale
1	R17	Resistor	16.9 kΩ		R0603W	CRCW060316K9FKEA	Vishay Dale
1	R18	Resistor	27 kΩ		R0603W	CRCW060327K0FKEA	Vishay Dale
1	R21	Resistor	681 kΩ		R1206W	CRCW1206681KFKEA	Vishay Dale
1	R22	Resistor	1.8 MΩ		R1206W	CRCW12061M80JNEA	Vishay Dale
1	R23	Resistor	1.8 MΩ		R1206W	CRCW12061M80JNEA	Vishay Dale
1	R26	Resistor	1 kΩ		R0603W	CRCW06031K00FKEA	Vishay Dale
1	RV2	NTC	10 Ω		5 mm	B57153S0100M000	EPCOS (TDK)
1	TP1	Test Point	CS/ZCD			5001	Keystone Electronics
1	TP2	Test Point	STBY			5001	Keystone Electronics
1	TP3	Test Point	Vin			5001	Keystone Electronics
1	TP4	Test Point	HV			5001	Keystone Electronics
1	TP5	Test Point	FB			5001	Keystone Electronics
1	TP6	Test Point	VCC			5001	Keystone Electronics
1	TP7	Test Point	FFCONTROL			5001	Keystone Electronics
1	TP8	Test Point	VCONTROL			5001	Keystone Electronics
1	TP9	Test Point	DRV			5001	Keystone Electronics
1	TP10	Test Point	VOOUT			5001	Keystone Electronics
1	U1	PFC Controller	NCP1616		SOIC-9	NCP1616A1DR2G	ON Semiconductor
1	ZD1	Zener	27 V	500 mW	SOD-123	MMSZ27T1G	ON Semiconductor
1	ZD2	Zener	33 V	500 mW	SOD-123	MMSZ33T1G	ON Semiconductor
1	ZD3	Zener	22 V	500 mW	SOD-123	MMSZ22T1G	ON Semiconductor

DN05127/D Demo Board



NCP1616GEVB Top View



NCP1616GEVB Bottom View

References

NCP1616 Datasheet (<http://www.onsemi.com/pub/Collateral/NCP1616-D.PDF>)

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