ON Semiconductor

Design Note – DN06019/D

DC-DC 30 W, 12 Vin, 28 Vout

Device	Application	Input Voltage	Output Power	Topology	I/O Isolation
iNID	**Telecom**	**10-18 Vdc**	**28 Watt 28 Vdc**	**FAC**	**EN61000**

Other Specifications

	Output 1	Output 2	Output 3	Output 4
Output Voltage	28 V	N/A	N/A	N/A
Ripple	20 mV	N/A	N/A	N/A
Nominal Current	N/A	N/A	N/A	N/A
Max Current	1	N/A	N/A	N/A
Min Current	N/A	N/A	N/A	N/A

PFC (Yes/No)	NO
Minimum Efficiency	92% Target
Inrush Limiting / Fuse	N/A
Operating Temp. Range	-40ºC to 85ºC
Cooling Method/Supply Orientation	Case convection
Signal Level Control	N/A

Others	

Circuit Description

Isolated 30 watt DC-DC supply.

Application: Telecom equipment.

- Input range: 10.5 Vdc minimum 18 Vdc maximum.
- Single output: 28 Vdc 1 A.
- Targeted 92% efficiency.
- Thermal shutdown (for safety).
- Output short circuit protection with auto restart.
- The internal UV/OV feature will be set for 10-18 Vdc range to assure that it starts up with a minimum of 10.5 Vdc input
- Operating temperature: -40 C to +85 C.
- Recommended Input filter is included.
- P-channel used for the MosFet clamp to eliminate a gate drive transformer and reduce cost.

Key Features

Utilizes the new NCP1562A with these features:

- High efficiency FAC PWM.
- FAC with soft-start, soft-stop.
- Cycle by cycle current limit.
- Cycle skip for over current limit condition.
- Voltage Mode with input voltage feed forward.
- Duty cycle maximum of 67%
- Programmable maximum volt-second product.
- Fixed frequency operation within the 400 kHz band.
- Full 28 watt rating over temperature.
- OCP protection for output power.
- Compliant to EMI/RFI/ESD regulations.

ANALYSIS:

This project has the requirement to operate at high efficiency. A converter that is designed to approach 92% efficiency justifies the added parts count for the active clamp, quasi-resonant circuit or other means to recirculate the magnetizing energy of the transformer..

The synchronous rectifiers do not gain efficiency in this application. The higher 28 Vdc output requires 200 volt rectifiers. Typical MosFets would require an on resistance better than 125 mOhm to be equivalent to the ultra fast silicon rectifiers. The additional gate drives for the SDSR operation would further add to the cost and detracts from efficiency.

All the ON Semi NCP1xxx families of controllers are rated for -40°C to +125°C operation. The electrolytic capacitors selected on the bill of materials have been selected to provide extended temperature operation.

EXCEL DESIGN TOOL:

The NCP1652 DT is provided to illustrate the design methods. The magnetic elements are listed in the BOM and commercially available. The schematic and BOM shown on the following sheets are specific to this design and use the spread sheet design tool to obtain the initial values and requirements.

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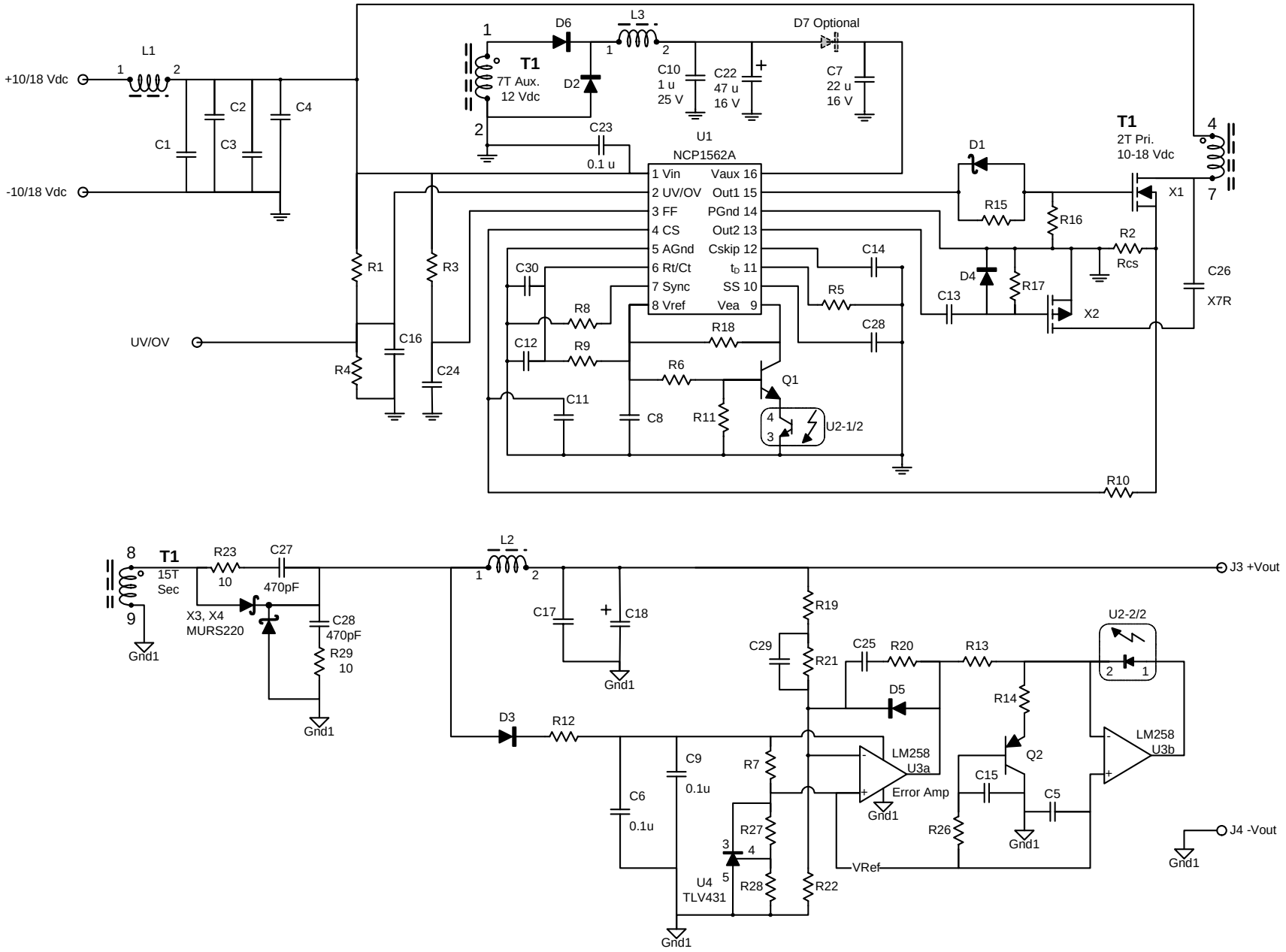
DN06019/D
Schematic[1]



REV.
A

DN06019/D
Bill Of Materials[2]

Ref Des	Est. Cost	Value	Tol.	Description			FootPrint SMT EIA	Mfgr.	Mfgr. Part Number	Sub. allowed?	Pb Free?
C_											
C_1		*2.2 uF*	±20%	Cap, Ceramic	X7R	100 V	1812	TDK	C4532X7R2A225M	Yes	Yes
C_2		*2.2 uF*	±20%	Cap, Ceramic	X7R	100 V	1812	TDK	C4532X7R2A225M	Yes	Yes
C_3		*2.2 uF*	±20%	Cap, Ceramic	X7R	100 V	1812	TDK	C4532X7R2A225M	Yes	Yes
C_4		*2.2 uF*	±20%	Cap, Ceramic	X7R	100 V	1812	TDK	C4532X7R2A225M	Yes	Yes
C_5		*1,000 pF*	±5%	Cap, Ceramic	C06	50 V	0805	Vishay	VJ0805A102JXAAT	Yes	Yes
C_6		*0.1 uF*	±10%	Cap, Ceramic	Y5V	50 V	0805	Vishay	VJ0805Y104KXAAT	Yes	Yes
C_7		22 uF	±20%	Cap, Ceramic	X5R	16 V	1812	TDK	C4532X5R1C226M	Yes	Yes
C_8		*0.1 uF*	±10%	Cap, Ceramic	Y5V	50 V	0805	Vishay	VJ0805Y104KXAAT	Yes	Yes
C_9		*0.1 uF*	±10%	Cap, Ceramic	Y5V	50 V	0805	Vishay	VJ0805Y104KXAAT	Yes	Yes
C10		1 uF	±20%	Cap, Ceramic	X7R	25 V	1210	TDK	C3216X7R1E105M	Yes	Yes
C11		*330 pF*	±5%	Cap, Ceramic	C0G	50 V	0805	Vishay	VJ0805A331JXAAT	Yes	Yes
C12		330 pF	±5%	Cap, Ceramic	C0G	50 V	0805	Vishay	VJ0805A331JXAAT	Yes	Yes
C13		0.010 uF	±10%	Cap, Ceramic	Y5V	50 V	0805	Vishay	VJ0805Y103KXAAT	Yes	Yes
C14		*3,300 pF*	±10%	Cap, Ceramic	Y5V	50 V	0805	Vishay	VJ0805Y332KXAAT	Yes	Yes
C15		*(1.7) 2.2 uF*	±20%	Cap, Ceramic	X5R	16 V	0805	TDK	C2012X5R1C225K	Yes	Yes
C16		*0.01 uF*	±10%	Cap, Ceramic	Y5V	50 V	0805	Vishay	VJ0805Y103KXAAT	Yes	Yes
C17		*15 uF*	±20%	Cap, Ceramic	X5R	16 V	1210	TDK	C3225X5R1C156M	Yes	Yes
C18		*33 uF*	±20%	Cap, Elect.	Tant.	16 V	7343-20	Kemet	T520V336M016ATE045	Yes	Yes
C19		none									
C20		none									
C21		none									
C22		47 uF	±10%	Cap, Elect.	Tant.	16 V	"C"	Vishay	595D476X9016C2T	Yes	Yes
C23		*0.1 uF*	±10%	Cap, Ceramic	X7R	100 V	1210	TDK	C3216X7R2A104K	Yes	Yes
C24		*150 pF*	±5%	Cap, Ceramic	C0G	50 V	0805	Vishay	VJ0805A151JXAAT	Yes	Yes
C25		*0.047 uF*	±10%	Cap, Ceramic	Y5V	25 V	0805	Vishay	VJ0805Y473KXXAT	Yes	Yes
C26		*0.0047 uF*	±20%	Cap, Ceramic	X7R	630 V	1210	TDK	C3216X7R2J472M	Yes	Yes
C27		*2,200 pF*	±10%	Cap, Ceramic	X7R	2 kV	1812	TDK	C4532X7R3D222K	Yes	Yes
C28		*0.047 uF*	±10%	Cap, Ceramic	Y5V	50 V	0805	Vishay	VJ0805Y473KXAAT	Yes	Yes
C29		*4,700 pF*	±5%	Cap, Ceramic	C0G	50 V	0805	Vishay	VJ0805A472JXAAT	Yes	Yes
C30		*30 pF*	±5%	Cap, Ceramic	C0G	50 V	0805	Vishay	VJ0805A300JXAAT	Yes	Yes
C31		none									
C32		470 pF	±10%	Cap, Ceramic	X7R	50 V	0805	Vishay	VJ0805Y471KXAAT	Yes	Yes
C33		470 pF	±10%	Cap, Ceramic	X7R	50 V	0805	Vishay	VJ0805Y471KXAAT	Yes	Yes
D_											

D1		*MBRM120E*		Diode, Schottky	20 V	1 A	DO-216AA	ON Semi	MBRM120ET1G	Yes	Yes
D2		*MMSD914*		Diode, GP	100 V	100 V	SOT-23	ON Semi	MMSD914T1G	Yes	Yes
D3		*MMSD914*		Diode, GP	100 V	100 V	SOT-23	ON Semi	MMSD914T1G	Yes	Yes
D4		*MMSD914*		Diode, GP	100 V	100 V	SOT-23	ON Semi	MMSD914T1G	Yes	Yes
D5		*MMSD914*		Diode, GP	100 V	100 V	SOT-23	ON Semi	MMSD914T1G	Yes	Yes
D6		*MMSD914*		Diode, GP	100 V	100 V	SOT-23	ON Semi	MMSD914T1G	Yes	Yes
D7		*MMSD914*		Diode, GP	100 V	100 V	SOT-23	ON Semi	MMSD914T1G	Yes	Yes
L_											
L1		*1.5 uH*	±20%	Inductor	Input	4.5 A	DS3316	Coilcraft	DS3316P-152	Yes	Yes
L2		*50 uH*	±20%	Inductor	Output	5.0 A		Payton	Half size of 51666	Yes	Yes
L3		*1000 uH*	±20%	Inductor	Aux	80 mA	DO1606	Coilcraft	DO1606T-105	Yes	Yes
Q_											
Q_1		BC817-25	GP	Transistor, NPN	45 V	500 mA	SOT-23	ON Semi	BC817-25LT1G	Yes	Yes
Q_2		BC807-25	GP	Transistor, PNP	45 V	500 mA	SOT-23	ON Semi	BC807-25LT1G	Yes	Yes
R_											
R_1		*1.05 Meg*	±1%	Res, Thick Film	0.13 W	±100ppm/K	0805	Vishay	CRCW08051M05FKEA	Yes	Yes
R_2		0.040	±1%	Res, Thick Film	3.00W	±100ppm/K	3WLF	IRC	LRC-LRF3WLF-01-R040-F	Yes	Yes
R_3		*75.0 k*	±1%	Res, Thick Film	0.25 W	±100ppm/K	1206	Vishay	CRCW120675K0FKEA	Yes	Yes
R_4		*162.0 k*	±1%	Res, Thick Film	0.13 W	±100ppm/K	0805	Vishay	CRCW0805162KFKEA	Yes	Yes
R_5		44.2 k	±1%	Res, Thick Film	0.13 W	±100ppm/K	0805	Vishay	CRCW080544K2FKEA	Yes	Yes
R_6		*12.1k*	±1%	Res, Thick Film	0.13 W	±100ppm/K	0805	Vishay	CRCW080512K1FKEA	Yes	Yes
R_7		22.1 k	±1%	Res, Thick Film	0.13 W	±100ppm/K	0805	Vishay	CRCW080522K1FKEA	Yes	Yes
R_8		*20 k*	±1%	Res, Thick Film	0.13 W	±100ppm/K	0805	Vishay	CRCW080520K0FKEA	Yes	Yes
R_9		*12.4 k*	±1%	Res, Thick Film	0.13 W	±100ppm/K	0805	Vishay	CRCW080512K4FKEA	Yes	Yes
R10		100	±1%	Res, Thick Film	0.13 W	±100ppm/K	0805	Vishay	CRCW0805100RFKEA	Yes	Yes
R11		*5.11k*	±1%	Res, Thick Film	0.13 W	±100ppm/K	0805	Vishay	CRCW08055K11FKEA	Yes	Yes
R12		49.9	±1%	Res, Thick Film	0.13 W	±100ppm/K	0805	Vishay	CRCW080549R9FKEA	Yes	Yes
R13		*249*	±1%	Res, Thick Film	0.13 W	±100ppm/K	0805	Vishay	CRCW0805249RFKEA	Yes	Yes
R14		*20 k*	±1%	Res, Thick Film	0.13 W	±100ppm/K	0805	Vishay	CRCW080520K0FKEA	Yes	Yes
R15		4.75	±1%	Res, Thick Film	0.25 W	±100ppm/K	1206	Vishay	CRCW12064R75FKEA	Yes	Yes
R16		*10 k*	±1%	Res, Thick Film	0.13 W	±100ppm/K	0805	Vishay	CRCW080510K0FKEA	Yes	Yes
R17		*10 k*	±1%	Res, Thick Film	0.13 W	±100ppm/K	0805	Vishay	CRCW080510K0FKEA	Yes	Yes
R18		*2.49 k*	±1%	Res, Thick Film	0.13 W	±100ppm/K	0805	Vishay	CRCW08052K49FKEA	Yes	Yes
R19		*750*	±1%	Res, Thick Film	0.25 W	±100ppm/K	1206	Vishay	CRCW1206750RFKEA	Yes	Yes
R20		*750*	±1%	Res, Thick Film	0.13 W	±100ppm/K	0805	Vishay	CRCW1206750RFKEA	Yes	Yes
R21		*15.0 k*	±1%	Res, Thick Film	0.13 W	±100ppm/K	0805	Vishay	CRCW080515K0FKEA	Yes	Yes
R22		*1.82 k*	±1%	Res, Thick Film	0.13 W	±100ppm/K	0805	Vishay	CRCW08051K82FKEA	Yes	Yes
R23		10	±5%	Res, Thick Film	0.25 W	±100ppm/K	1206	Vishay	CRCW120610RJKTA	Yes	Yes
R24		none									
R25		none									

R26		*20.0 k*	±1%	Res, Thick Film	0.13 W	±100ppm/K	0805	Vishay	CRCW080520K0FKEA	Yes	Yes
R27		*6.04 k*	±1%	Res, Thick Film	0.13 W	±100ppm/K	0805	Vishay	CRCW08056K04FKEA	Yes	Yes
R28		*1.24 k*	±1%	Res, Thick Film	0.13 W	±100ppm/K	0805	Vishay	CRCW08051K24FKEA	Yes	Yes
R29		10.0	±5%	Res, Thick Film	0.25 W	±100ppm/K	1206	Vishay	CRCW120610RJKTA	Yes	Yes
R30		*750*	±1%	Res, Thick Film	0.13 W	±100ppm/K	0805	Vishay	CRCW1206750RFKEA	Yes	Yes
T_											
T1		48 Watt 197 uH (Pri)		Transformer, 6T/7T/7T	18-72 Vdc	4 A, 12 V out 12 Vaux.		Payton	Half size of 51665	Yes	Yes
U_											
U_1		NCP1562A		IC, FAC Controller			SO-16	ON Semi	NCP1562ADTBR2G	No	Yes
U_2		100% CTR	±50%	IC, Opto-coupler				NEC	PS2703	Yes	Yes
U_3		LM258		IC, OpAmp	Dual		SO-8	ON Semi	LM258DG	Yes	Yes
U_4		1.25 Vref		IC, Voltage Reference			TSOP-5	ON Semi	TLV431ASNT1G	Yes	Yes
X_											
X_1		HUF76629 D3S		MosFet, N-ch	150 V	21 A 0.066 Rdson	DPAK	FC/Vishay	FDD2582 (*SUD25N15-52)	Yes	Yes
X_2		IRF6217		MosFet, P-ch	150 V	0.7 A 2.4 Rdson	SO-8	IR	IRF6217PBF	Yes	Yes
X_3		MUR1610CT		MosFet, N-ch	30 V	104 A 0.004 Rdson	TO-220AB	ON Semi	NTMFS4835NT1G	Yes	Yes

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