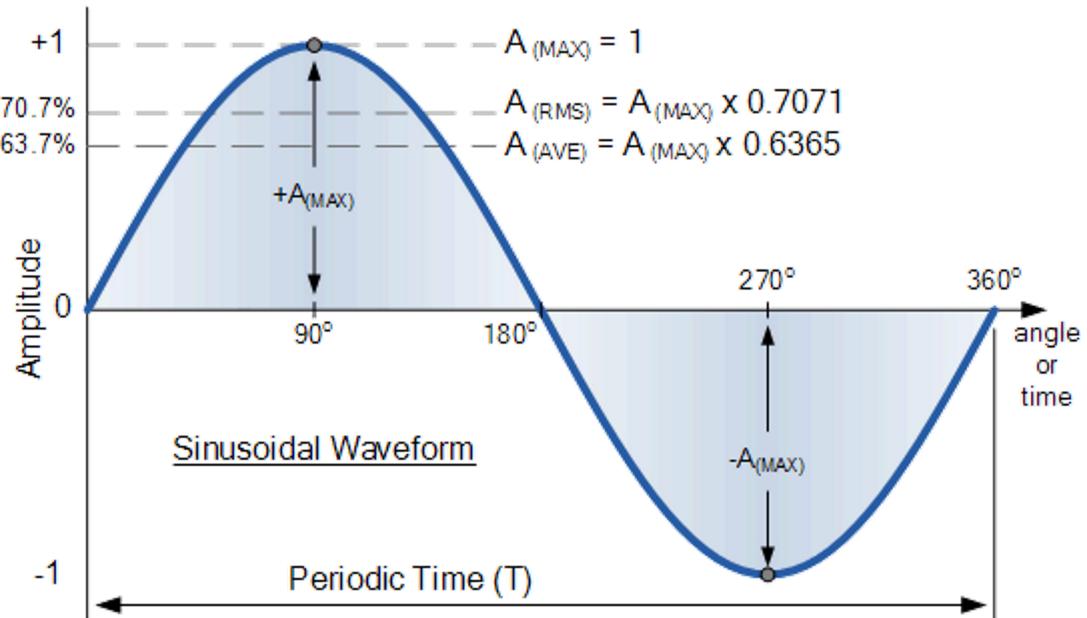


Overview

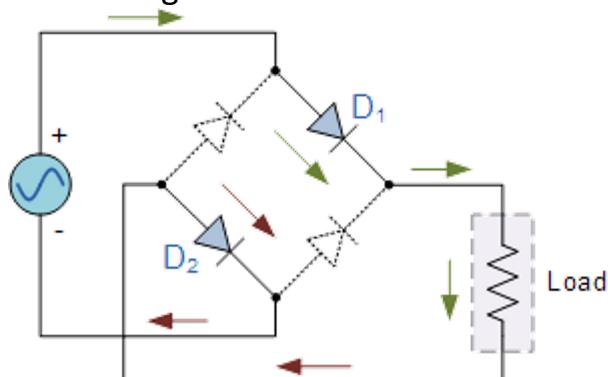
- Requirements
 - Voltage Output- 12VDC
 - Current Output- 1.4A
 - Power Output- 16.8W
 - Voltage Input- 85VAC - 265VAC
 - Topology- Fly-back
- Block Diagram
 - TBD

Rectifier Section

- AC Voltage Level Definition



- Basic Structure Bridge Rectifier



- $V_{in(rms)} = (85VAC - 265VAC)$
- Peak Inverse Voltage(PIV)
 - $PIV = V_m = \sqrt{2} \times V_{rms(max)} = \sqrt{2} \times 265VAC = 374.76V$
- $V_{out} = 12V$
- $I_{out} = 1.4A$
- Efficiency(η)= 0.8 (80%) (Based on Controller)
- $P_{out} = 16.8W$
- $P_{in} = \frac{P_{out}}{n}$
- $P_{in} = \frac{16.8W}{0.8} = 21W$
- $V_{in(min)} = \sqrt{2} \times V_{rms(max)} = \sqrt{2} \times 85 = 120V$

$$\bullet \quad I_{in(max)} = \frac{P_{in}}{V_{in(min)}} = \frac{21W}{120V} = 175mA$$

- Reverse Voltage rating of diode > PIV
- Current Rating of Diode > $I_{in(max)}$

Controller Selection

- Controller Selection

UCC28701DBVT

From <<https://www.mouser.in/ProductDetail/595-UCC28701DBVT>>

- Max Duty Cycle

$$\bullet D_{MAX} = 1 - \left(\frac{T_R}{2} \times f_{MAX} \right) - D_{MAGCC}$$

- $\frac{T_R}{2} = 1\mu S$ (given in data sheet)
- $f_{max} = 100KHz$ (assumed)
- $D_{MAGCC} = 0.425$ (given in data sheet)
- $D_{max} = 1 - (1\mu S \times 100KHz) - 0.425 = 1 - 0.1 - 0.425 = 0.48$

- Max Primary to secondary ratio(N_{PS})

$$\bullet N_{PS(max)} = \frac{D_{MAX} \times V_{BULK(min)}}{D_{MAGCC} \times (V_{OCV} + V_F + V_{OCBC})}$$

- $V_{OCV} = 12V$
- $V_F = 0.9V$
- $V_{OCBC} = 16mV$ (Cable compensation drop)
- $V_{BULK(min)} = 120V$
- $N_{PS(max)} = \frac{0.47 \times 120V}{0.425 \times (12 + 0.9 + 0.016)} = 10.27$
- $N_{PS} = 10$ (selected below $N_{PS(max)}$)

- Primary Inductance

$$\bullet R_{CS} = \frac{V_{CCR} \times N_{PS}}{2I_{OCC}} \times n_{XFMR}$$

- $V_{CCR} = 0.319V$ (given in data sheet)
- $\eta = 0.9$ (Transformer Efficiency given in data sheet)
- $I_{OCC} = 1.4A$

- $R_{CS} = \frac{0.319V \times 10 \times 0.9}{2 \times 1.4A} = 1.03\Omega$
- $R_{CS} = 1.05 \Omega$ selected

- $I_{PP(max)} = \frac{V_{CST(max)}}{R_{CS}}$
- $V_{CST(max)} = 0.75V$
- $I_{PP(max)} = \frac{0.75V}{1.05} = 0.714A$

- $L_P = \frac{2(V_{OCV} + V_F + V_{OCBC}) \times I_{OCC}}{\eta_{XFMR} \times I_{PP(max)}^2 \times f_{MAX}}$
- $V_{OCV} = 12V$
- $V_F = 0.9V$
- $V_{OCBC} = 0.016V$
- $I_{OCC} = 1.4A$
- $\eta = 0.9$ (Transformer Efficiency given in data sheet)
- $f_{max} = 100KHz$ (assumed)
- $I_{PP(max)} = 0.714A$
- $L_P = \frac{2 \times (12 + 0.9 + 0.016) \times 1.4}{0.9 \times 0.714^2 \times 100K} = 788.219\mu H$

- Secondary Winding to Auxiliary winding

- $N_{AS} = \frac{V_{DD(off)} + V_{FA}}{V_{OCC} + V_F}$
- $V_{DD(off)} = 8.1V$
- $V_{FA} = 0.9V$
- $V_{OCC} = 11.75V$
- $V_F = 0.9V$
- $N_{AS} = \frac{8.1 + 0.9}{11.75 + 0.9} = 0.71$
- $N_{AS} = 1.167$ (due to purchased transformer)

- MOSFET Drain to Source Voltage Rating

- $V_{DS(max)} = V_{in(max)} \times \sqrt{2} + (V_{OCV} + V_F + V_{OCBC}) \times N_{PS} + (V_{OCV} \times N_{PS} \times 2)$
- $V_{DS(max)} = 375 + 12.916 \times 10 + (12 \times 10 \times 2) = 745V$

- Output Capacitor

- $C_{OUT} = \frac{I_{TRAN} \left(\frac{1}{f_{SW(min)}} + 150 \mu s \right)}{V_{O\Delta}}$
- $I_{TRAN} = 0.5A$
- $f_{SW(min)} = 950Hz$
- $V_{O\Delta} = 0.9V$
- $C_{OUT} = \frac{0.5(\frac{1}{950} + 150\mu s)}{0.9} = 668\mu F$
- $C_{OUT} = 270\mu F \times 3 = 810\mu F$

- Load Resistance

- $R_{PL} = \frac{V_{OCV}^2}{P_{SB_CONV} - 2.5 mW}$
- $V_{OCV} = 12V$
- $P_{SB-CONV} = 30mW$
- $R_{PL} = \frac{12^2}{30 - 2.5} = 5.236k\Omega$

- Programming Resistance

- $R_{S1} = \frac{V_{IN(run)} \times \sqrt{2}}{N_{PA} \times I_{VSL(run)}}$
- $V_{IN(run)} = 70V$
- $N_{PA} = 8.57$
- $I_{VSL(run)} = 220\mu A$
- $R_{S1} = \frac{70 \times \sqrt{2}}{8.57 \times 220\mu} = 52.5k\Omega$

- $R_{S2} = \frac{R_{S1} \times V_{VSR}}{N_{AS} \times (V_{OCV} + V_F) - V_{VSR}}$
- $N_{AS} = 1.167$
- $V_{OCV} = 12V$
- $V_F = 0.9V$
- $V_{VSR} = 4.05V$
- $R_{S2} = \frac{52.5k \times 4.05}{1.167 \times (12 + 0.9) - 4.05} = 19.3K\Omega$

- $R_{LC} = \frac{K_{LC} \times R_{S1} \times R_{CS} \times T_D \times N_{PA}}{L_P}$
 - $K_{LC} = 25$ (in data sheet)
 - $T_D = 40nS$ (MOSFET turn off delay time) + $50nS = 90nS$
 - $N_{PA} = 8.57$
 - $L_P = 750\mu H$
 - $R_{LC} = \frac{25 \times 52.5k \times 1.05 \times 90n \times 8.57}{750\mu} = 1.41k\Omega$

Transformer Details

05 October 2022 07:57 AM

Flyback Discontinuous Mode

PARAMETERS

Input

V_{in,min} 120 V V_{in,max} 375 V

Output 1

V_{out} 12 V I_{out} 1 A V_f 0.9 V

Output 2

Output 3

Auxiliary

V_{out} 10 V I_{out} 20 mA V_f 0.9 V

PWM Controller

TI ▾ P/N UCC28701

f_{sw} 100 kHz I_{peak,max} 2.14 A

DC_{min} 10 % DC_{max} 99 %

MOSFET Switch

V_{dss} 800 V R_{dson} 0.7 Ω

Derating 80 %

C UPDATE D DETAILS

Filters: Status = Active

Order Code	Series	S...	Packa...	L _{pri}	I _{sat}	Turns Ratio	L _{leakage}	Isolati...	V _T	Mount...	Length	Wid...
750813134	MID-OLLT	EE16/7/5	600 μH	1.03 A	8:1:1:1,286	15.0 μH	R	4.50 kV	TH	18.0 mm		
7508110101	MID-OLPI	EE16/8/5	1.07 mH	598 mA	15:1:1:714	25.0 μH	R	4.50 kV	TH	20.3 mm		
750312495	MID-OLON	EE20/10/6	750 μH	776 mA	10:1:1:167	12.0 μH	F	3.00 kV	TH	23.0 mm		
750811248	MID-OLLT	ER28/14	300 μH	3.22 A	4:1:1	3.60 μH	R	4.50 kV	TH	31.0 mm		
750811330	MID-OLLT	ETD34	300 μH	3.51 A	6:1:1	3.50 μH	R	4.50 kV	TH	39.6 mm		

Click and type or drop an Order Code here

ADD MORE

Current Waveform

Current

Duty Cycle

Schematic

Input

Output 1

auxiliary

1 3 5 6 8 9

3D Viewer

Resistor Sizing

MOSFET- NX7002AK,215

$$V_{th(max)} = 2.1V \text{ (MOSFET threshold voltage)}$$

$$V_{dd} = 5V$$

$$I_p = 0.5A$$

$$V_R = V_{dd} - V_{th} = 5 - 2.1 = 2.9V$$

$$R_s = \frac{V_R}{I_P} = \frac{2.9}{0.25} = 11.6\Omega$$

$V_{th(min)} = 1.1V$ (MOSFET threshold voltage)

$$V_{dd} = 5V$$

$$I_p = 0.5A$$

$$V_R = V_{dd} - V_{th} = 5 - 1.1 = 3.9V$$

$$R_s = \frac{V_R}{I_P} = \frac{3.9}{0.25} = 15.6\Omega$$

$V_{th(typ)} = 1.6V$ (MOSFET threshold voltage)

$$V_{dd} = 5V$$

$$I_p = 0.5A$$

$$V_R = V_{dd} - V_{th} = 5 - 1.6 = 3.4V$$

$$R_s = \frac{V_R}{I_P} = \frac{3.4}{0.25} = 13.6\Omega$$

$$R_s = 13.5\Omega \text{ (selected)}$$