Overview

27 September 2022 06:28 AM

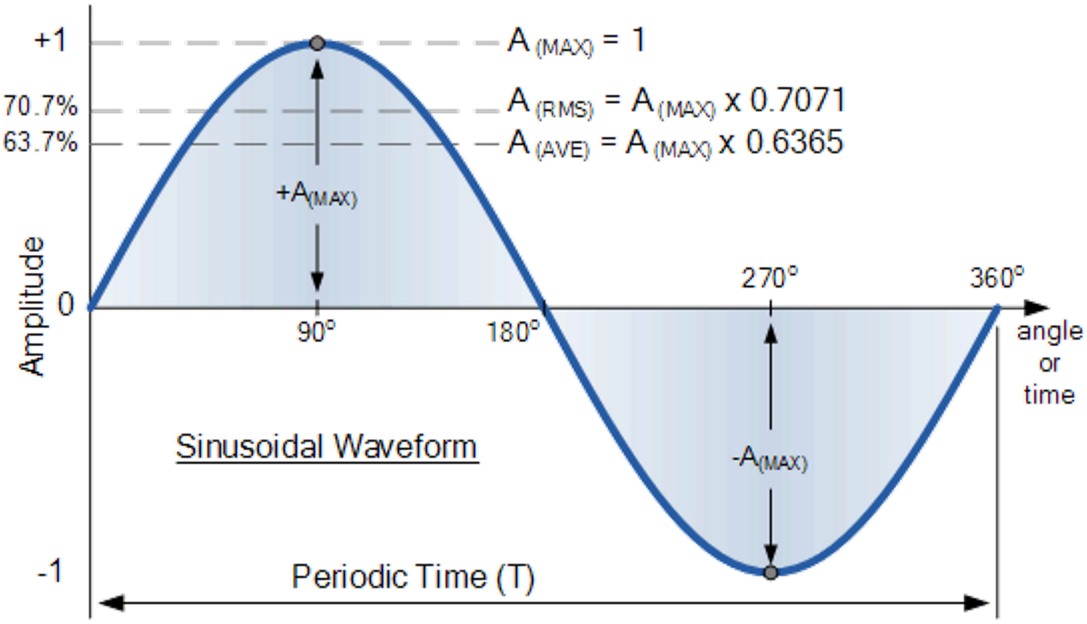
- Requirements
  - Voltage Output- 12VDC
  - Current Output- 1.4A
  - Power Output- 16.8W
  - Voltage Input- 85VAC - 265VAC
  - Topology- Fly-back

- Block Diagram
  - TBD

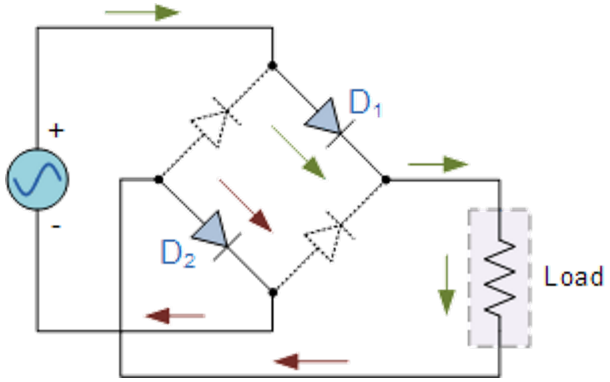
Rectifier Section

01 October 2022 10:18 AM

- 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(n)= 0.8 (80%) (Based on Controller)
- $P_{out} = 16.8W$
- $P_{in} = \frac{P_{out}}{n}$
- $P_{in} = \frac{16.8W}{0.8} = 21W$
- $V_{in(min)} = \sqrt{2} \times V_{rms(max)} = \sqrt{2} \times 85 = 120V$

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

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

Controller Selection

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- Controller Selection

  UCC28701DBVT

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

- Max Duty Cycle
  - $D_{MAX} = 1 - \left(\frac{T_R}{2} \times f_{MAX}\right) - D_{MAGCC}$
  - $\frac{T_r}{2} = 1uS\ (given\ in\ data\ sheet)$
  - $f_{max} = 100KHz\ (assumed)$
  - $D_{MAGCC} = 0.425\ (given\ in\ data\ sheet)$
  - $D_{max} = 1 - (1uS \times 100KHz) - 0.425 = 1 - 0.1 - 0.425 = 0.48$

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

- *Primary Inductance*
  - $R_{CS} = \frac{V_{CCR} \times N_{PS}}{2I_{OCC}} \times \eta_{XFMR}$
  - $V_{CCR} = 0.319V\ (given\ in\ data\ sheet)$
  - $\eta = 0.9\ (Transformer\ Efficiency\ given\ in\ data\ sheet)$
  - $I_{OCC} = 1.4A$

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

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

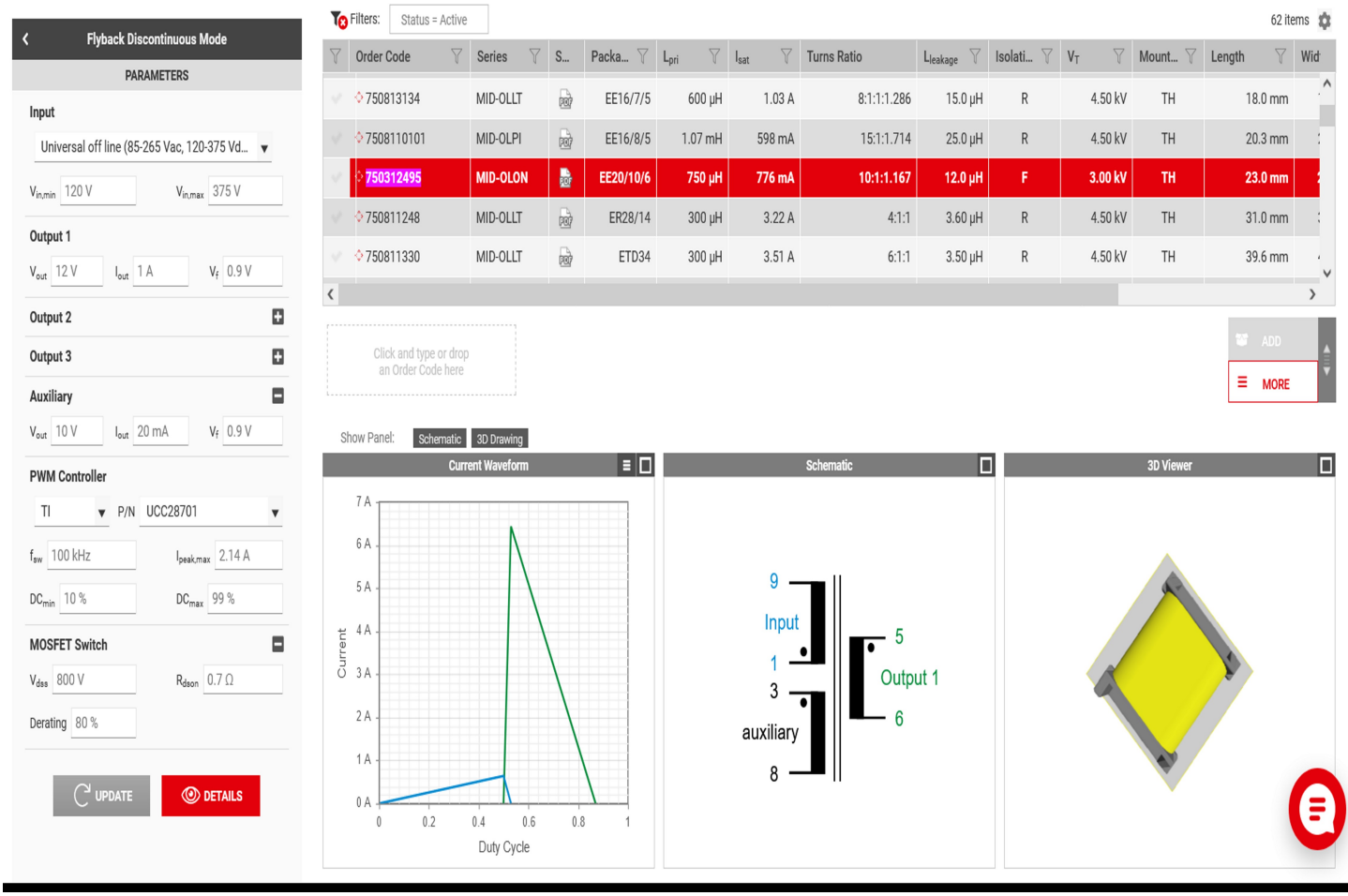
- Load Resistance
  - $$R_{PL} = \frac{V_{OCV}^{\ 2}}{P_{SB\_CONV} - 2.5\,mW}$$
  - $V_{OCV} = 12V$
  - $P_{SB-CONV} = 30mW$
  - $R_{PL} = \frac{12^2}{30 - 2.5} = 5.236k\Omega$

- Programming Resistance
  - $$R_{S1} = \frac{V_{IN(run)} \times \sqrt{2}}{N_{PA} \times I_{VSL(run)}}$$
  - $V_{IN(run)} = 70V$
  - $N_{PA} = 8.57$
  - $I_{VSL(run)} = 220uA$
  - $R_{S1} = \frac{70 \times \sqrt{2}}{8.57 \times 220u} = 52.5k\Omega$
  - $$R_{S2} = \frac{R_{S1} \times V_{VSR}}{N_{AS} \times (V_{OCV} + V_F) - V_{VSR}}$$
  - $N_{AS} = 1.167$
  - $V_{OCV} = 12V$
  - $V_F = 0.9V$
  - $V_{VSR} = 4.05V$
  - $R_{S2} = \frac{52.5k \times 4.05}{1.167 \times (12 + 0.9) - 4.05} = 19.3K\Omega$

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

Transformer Details

05 October 2022 07:57 AM



Resistor Sizing

12 November 2022 12:17 PM

MOSFET- NX7002AK,215

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

$V_{dd} = 5V$

$I_p = 0.5A$

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

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

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

$V_{dd} = 5V$

$I_p = 0.5A$

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

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

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

$V_{dd} = 5V$

$I_p = 0.5A$

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

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

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