EBNCP1200/D

How to Use the Spreadsheet "NCP1200 Discont.xls"

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ENGINEERING BULLETIN

This short note describes the necessary steps to efficiently use the NCP1200 design aid file: "NCP1200 Discont.xls".

Symbol	Cell in Spreadsheet	Explanation	Remarks
V_{max}	B4	Maximum AC Input Voltage in volt	
V_{min}	B5	Minimum AC Input Voltage in volt	
F_{line}	B6	AC Line Frequency in Hz	
V_o	B11	Output Voltage in volt	
I_o	B12	Maximum Output Current in ampere	
h	B13	Efficiency in %	Assume 80% if unknown
V_{bd}	B14	Power MOSFET breakdown voltage in volt	
V_d	B16	Diode voltage drop in volt	Assume 1.0 V if an ultra–fast diode is used or 0.8 V if a Schottky diode is used

Step 1: Input System Parameters

The first step in power supply design is to understand the system requirements. The following parameters have to be entered into the spreadsheet.

Step 2: Enter Capacitance of Input Filter Capacitor C_{in}

Enter the capacitance value of the input filter capacitor into cell B39 in mF. A recommended capacitance value is shown in cell B38.

Step 3: Determine Primary Inductance

A list box is shown in the spreadsheet which labelled as "Selected Device" – Cell G12. Choose a device which you plan to use from the list. NCP1200 is offered in 40 KHz, 60 KHz and 100 KHz versions. Then the user can set the primary inductance by inputting a value in cell B32. A recommended L_p is shown in cell B31 for the user reference. Depending on the application, the choice of Lp can have a significant noise impact during NCP1200 skip cycle operation. Low Lp implies high peak currents (with possible noise problems in standby) while a high Lp implies low peak current (less noise problems) but possibly a higher leakage inductance. A trade–off has thus to be found between all the design requirements.

Step 4: Enter Current Density Allowed for the Transformer

The wire size of a transformer has to be chosen suitably to avoid excessive copper loss and heat dissipation. The current density of the wire selected should be in the range of 3 ~ 5 A/mm^2 for natural cooling system and current density can be increased to 4 ~ 7 A/mm^2 for fan cooled system. This value should be entered into cell B55.

Step 5: Determine Maximum Wire Size

Select the maximum wire size for the transformer in the list box in cell G53. The program will limit itself in choosing which wire size for primary and secondary winding with this information.

Step 6: Enter Flux Density Safety Factor

Flux density safety factor determines the magnetizing level of the transformer core, it should in the range from 0.3 to 0.5 Tesla. Enter this value in cell B58.

Step 7: Enter Bobbin Usage Factor

In a transformer bobbin, not all cross sectional area is available to accommodate the windings. A bobbin usage factor is introduced to account for area occupied by margin, insulation tape and waste space between wires. It should be in the range from 0.3 to 0.5. Enter this value in cell B59.

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Step 8: Enter Magnetic Core and Bobbin Data

Before we can proceed further, we must have the information of different magnetic cores and bobbins ready. Recommended core types are EE, EI, EF and ETD made of material that can work in the selected switching frequency without excessive hysteresis loss, e.g. N67 from Epcos (Siemens) and PC40 from TDK. The worksheet allows user to input properties of 5 material simultaneously. From the data book of the magnetics, locate the following date and enter into cell B61 to F64.

Symbol	Cell in Spreadsheet	Explanation	Remarks
Core Name	B61–F61	Name of the magnetic core	Optional data, not for calculation For identification purpose only
Ae	B62–F62	Effective area of the magnetic core in mm^2	Property of the magnetic core
Bsat	B63–F63	Saturation magnetic flux density at 25°C in Tesla	Property of the magnetic material
Aw	B64–F64	Bobbin window area in mm^2	Property of the bobbin, some vendors provide several bobbins for one magnetic core

Step 9: Enter $R_{DS(on)}$ of the Power MOSFET

The spreadsheet provides additional information on maximum conduction loss of the power MOSFET. Enter maximum $R_{DS(on)}$ (usually @T_j = 100°C) of the selected power MOSFET in cell B34, maximum conduction loss is shown in cell B35.

Step 10: Determine the Sensing Resistor

It is normal for a transformer to have 10% tolerance in its primary inductance. Enter the percentage tolerance in cell B82. The spreadsheet uses the lowest primary inductance and lowest switching frequency to compute worst case primary peak current. Maximum allowable sensing resistance is calculated based on this information and it is shown in cell B86. Select a sensing resistor with value lower than B86 and enter into B87. Please pick a value within the E24 series for easier selection: 0.56 Ω, 0.68 Ω, 0.82 Ω, 1.0 Ω, 1.2 Ω, 1.5 Ω, 1.8 Ω, 2.2 Ω, 2.7 Ω, 3.3 Ω, 3.9 Ω, 4.7 Ω.

Step 11: Final Review

Before finalizing on the design, one has to review the calculation results.

a. Maximum turn on duty, D_{max}:
   D_{max} (cell B25) should be kept below the maximum turn on duty of NCP1200. Referring to NCP1200 data sheet, typical $D_{(max)}$ is at 80%. However, it is not realistic to push D_{max} to the limit of the control IC because the secondary peak current will be very high and there is no room for transient response. Ideally D_{max} should be kept at 40% to 60% so that there is reasonable balance on primary and secondary ripple current. Decrease L_p if D_{max} is too high.
b. Maximum voltage across power switch circuit, $V_{pwr\_sw(max)}$:
   Make sure that this value (cell B23) does not exceed power MOSFET breakdown voltage. Decrease L_p if $V_{pwr\_sw(max)}$ is too high. In fact, we must have headroom to cater for voltage spike generated by the leakage inductance of the transformer.
c. Magnetic flux density during start–up, B_{init}:
   To avoid magnetic saturation during start–up, B_{init} (cell B88) should be kept below 70% of B_{sat}. If B_{init} is too high, first attempt to reduce B_{init} should be by increasing the value of the sensing resistor R_{sense}. If R_{sense} is already very close to its allowable maximum value, try lowering the value of flux density safety factor (cell B58). This may force you to change to a bigger magnetic core.

Step 12: Reading Results

Results are summarized in the Results page. Select magnetic core/bobbin set to use by list box in cell G6. User should take note whether cell C11 is showing “OK” or “not OK”. Cell showing “OK” implies that the corresponding magnetic core/bobbin set is big enough to accommodate all windings. The information is for reference only, consult your transformer vendor for a conclusive answer.

Notes

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