

AN-6006

FAN5068 / FAN5078 / FAN5078D3

Component Calculation and Simulation Tools

Background / Overview

To simplify designs using the FAN5068 / FAN5078 / FAN5078D3 DDR/ACPI control IC, Fairchild provides:

- An Excel workbook to calculate recommended external component values
- A continuous time behavioral model of the modulator that runs in PSPICE A/D v 9.1 or above. The model is small enough to run under Cadence's Orcad Lite Edition (includes Orcad Capture and PSPICE A/D), which can be ordered on CD at <http://www.ema-eda.com/products/Default.aspx> or downloaded from: <http://www.orcad.com/download.orcaddemo.aspx>.
Note: These links have been verified as of this publication date, but may change over time.

Information on the FAN5068 or FAN5078/ FAN5078D3, including the datasheets, can be found respectively on:

<http://www.fairchildsemi.com/pf/FA/FAN5068.html>
<http://www.fairchildsemi.com/pf/FA/FAN5078.html>
<http://www.fairchildsemi.com/pf/FA/FAN5078D3.html>

This package of design aids (including this document) can be downloaded from:

<http://www.fairchildsemi.com/collateral/AN-6006.zip>.

To install, copy AN-6006.ZIP to an empty folder (e.g. "FAN5068Design"), then unzip / extract AN-6006.ZIP into that folder.

Recommended Design Procedure

1. Use the spreadsheet (FAN5068 Family Design Calculation Aid.xls) to calculate the output filter using the "Output Filter" tab.
2. Use the "Main Sheet" tab of the spreadsheet to calculate the other component values once you have selected the output L and C.
3. Use the "Compensation" tab to design the compensation network.
4. Input the selected values into the PSPICE model. Generate a bode plot by simulating with the "application circuit-ac sweep" simulation profile. Make sure to simulate over the corners of V_{IN} and I_{OUT} for the application.
5. Once you are satisfied with the small signal stability, view the transient response by simulating using the "application circuit-transient response" simulation profile. Be sure to follow the instructions at the bottom of the Application Circuit, Page 1 sheet for resetting RLOAD before simulating transient response.

Design Calculation Spreadsheet: FAN5068 Family Design calculation aid.xls

For instructions on the use of this spreadsheet, see the "Instructions" tab of the spreadsheet.

Macro Security Note:

FAN5068 Family Design calculation aid.xls uses macros extensively. For the spreadsheet to operate properly, check the "Always trust macros from this source" box if a security warning appears, and click the **Enable Macros** button.

This is only required the first time you run a Fairchild spreadsheet tool with macros.

PSPICE Simulation Model

The PWM modulators of the FAN5068, FAN5078, and FAN5078D3 are identical; the FAN5068 model works for all part types.

The simulation model is a sampled data continuous time model, which is adapted from Ray Ridley and Dennis Feucht's modeling work for current mode controllers^{i,iii,v}. It is set up to provide a bode plot where the red trace is phase margin (in degrees) and the green trace is gain (in dB). For stable response, Fairchild recommends at least 45° of phase margin when the gain crosses 0dB. The model also provides transient response using a pulsed current source (I1) as the load. The IC's error-amp behavioral model is based on Ray Kendall's Macromodelling article in EDN.^{vii}

1. To run the model, start Capture (9.1 or higher).
2. Open FAN5068.opj (this is the "project" file for Capture).
3. Double-click on Page 1 under .\fan5068.dsn\Application Circuit.

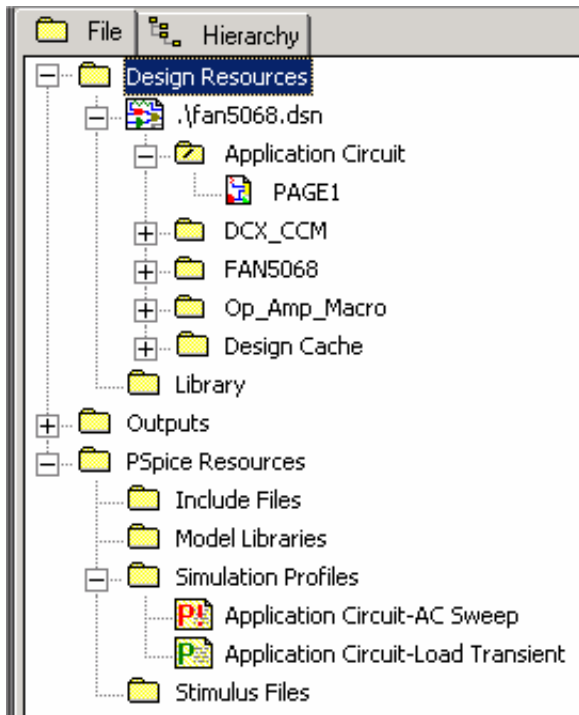


Figure 1. FAN5068.OPJ project

Note: The parameters for this model are entered in the "Parameters" block in the lower left of the schematic; there should be no need to edit the schematic itself.

4. Double-click on any parameter in that block to set the values in the schematic.
5. Once the schematic is set up, press the F11 (function key) to display the bode plot.
6. To choose between bode plot (AC small signal) and transient response, go to the project window and right-click the appropriate model. If you are simulating for transient response, be sure to set up RLOAD. If you skip this step, the inductor current [I(L1)] trace is much higher (probably beyond the Y axis limit) than the pulse load current [I(I1)].
7. Alternately, from the schematic view, select the type of simulation profile from the drop-down box.

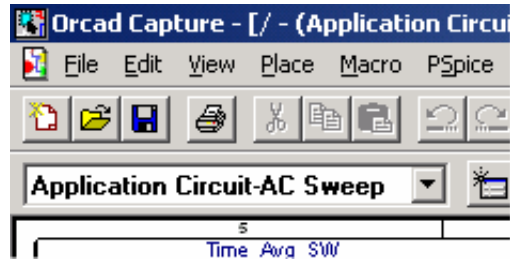


Figure 2. Simulation profile select drop-down

Troubleshooting the Plot Window

Some older versions of PSPICE may not automatically load the probe settings (which are contained in the *.prb files). These settings define the XY axis settings, trace colors, and signals displayed. If you run a simulation and the probe window has no trace, add a trace and input the expressions for the signals to plot:

Gain: $DB(V(Out)/V(Sig))$ **Phase:** $P(V(Out)/V(Sig))$

Copy and paste these expressions into the add trace window as shown below. The schematic contains the expressions for the bode plot in the lower right hand corner.

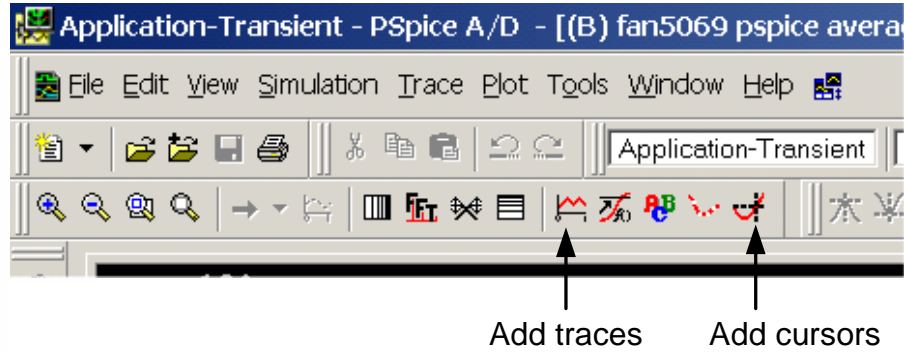


Figure 3. Tips for adjusting probe window settings and adding traces

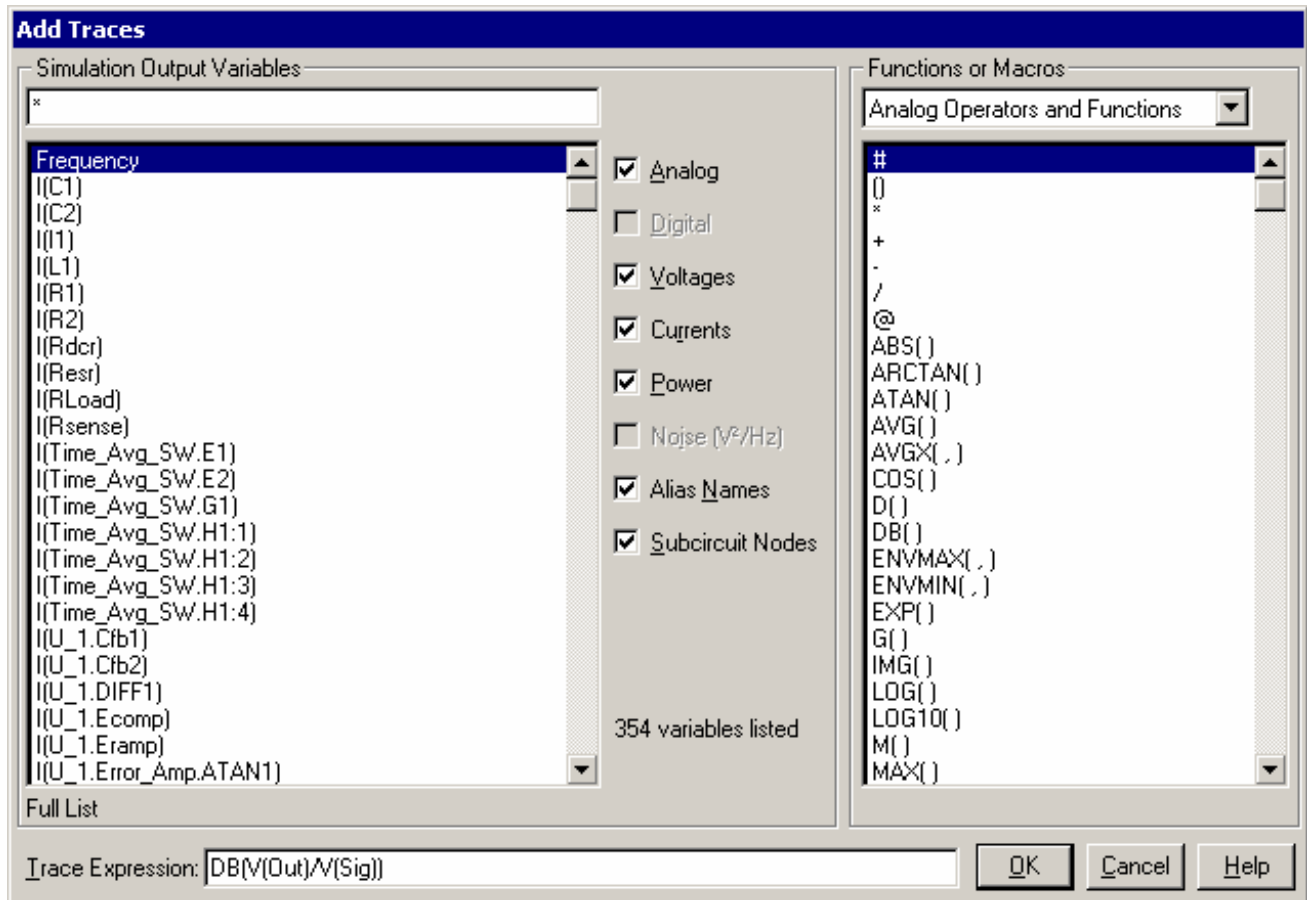


Figure 4. Adding the trace (gain example)

References:

- i Ray Ridley, *An Accurate and Practical Small-Signal Model for Current-Mode Control*, 1999,
<http://www.ridleyengineering.com/downloads/curr.pdf>
- iii Dennis Feucht, *The Tymerski Switch Model*,
<http://www.chipcenter.com/eexpert/dfeucht/dfeucht036.html>
- v Dennis Feucht, *Basic Power Converter Configurations*,
<http://www.chipcenter.com/eexpert/dfeucht/dfeucht037.html>
- vii Ray Kendall, *Modular macromodeling techniques for Spice simulators*, EDN, March 7, 2002,
<http://www.reed-electronics.com/ednmag/contents/images/198891.pdf>

DISCLAIMER

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION, OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS.

LIFE SUPPORT POLICY

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF FAIRCHILD SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body or (b) support or sustain life, and (c) whose failure to perform when properly used in accordance instructions for use provided in the labeling, can be reasonably expected to result in a significant injury of the user.
2. A critical component in any component of a life support, device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.