

TPS7H1101A-SP WCA Model User's Guide

This user guide is intended to demonstrate use of the Pspice model for the TPS7H1101A-SP low-dropout linear regulator. Instructions on how to import the unencrypted model netlist into Cadence Pspice® are also provided. The first half of the guide outlines the modeled parameters and the second half of the guide addresses how to simulate the modeled parameters.

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1 TPS7H1101A-SP Model Specification

The netlist file (TPS7H1101A-SP.lib) contains the spice model of the device TPS7H1101A-SP. The model is intended for following types of simulation:

- Frequency response (Phase Margin, Phase Margin Crossover)
- Transient response
- DC simulations for parameters like reference voltage, load regulation, etc.

Monte Carlo analysis models device variation for the following parameters:

- **tol_gmps** – The tolerance (%) of the power stage gain.
- **tol_vref** – The tolerance (%) of reference voltage.

The default tolerance values are set based on design simulations. The user has flexibility to change these values.

Environmental parameters:

- **TID** – Total Ionizing Dose exposure (krad) can be modeled from 0 to 100 krad.
- **Temperature** – Temperature (°C) can be modeled from –55°C to 125°C.

2 Default Parameters

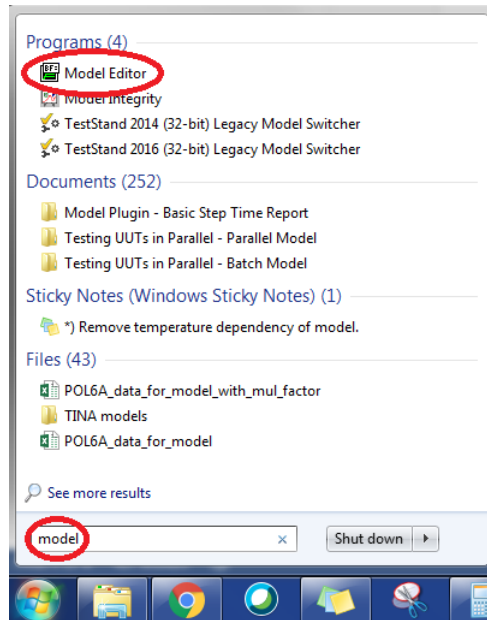
- **tol_vref** – Reference voltage tolerance (%) : 0.41
- **tol_gmps** – Power stage gain tolerance (%) : 4.28
- **TID** – Radiation exposure (krad) : 0

3 Example of using model with Cadence Pspice (17.2.0)

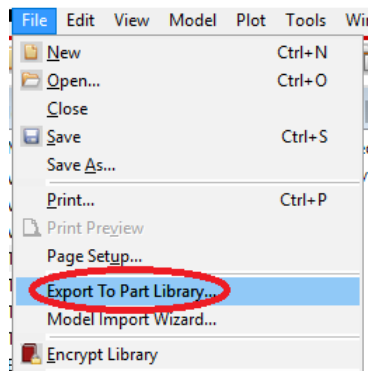
3.1 Creating a part from the netlist file

In order to run a simulation, the netlist file must be used to create a part that can be used in the schematic.

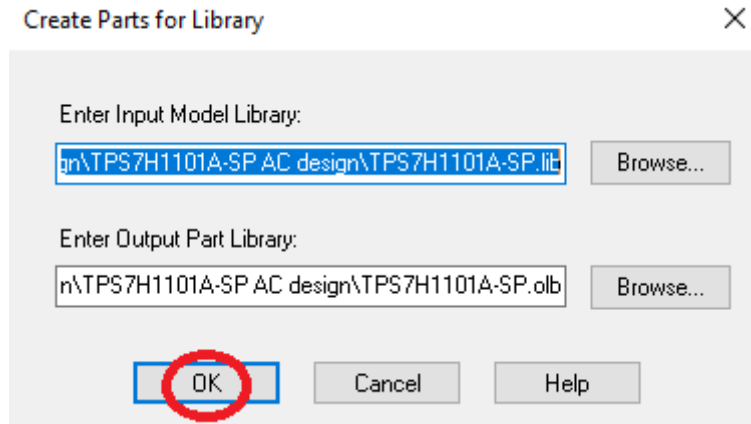
1. First, open the "Model Editor" application.



2. Then select *File* → *Open* and choose the netlist file (*.lib).
3. Once the netlist opens, select *File* → *Export to Part Library...*



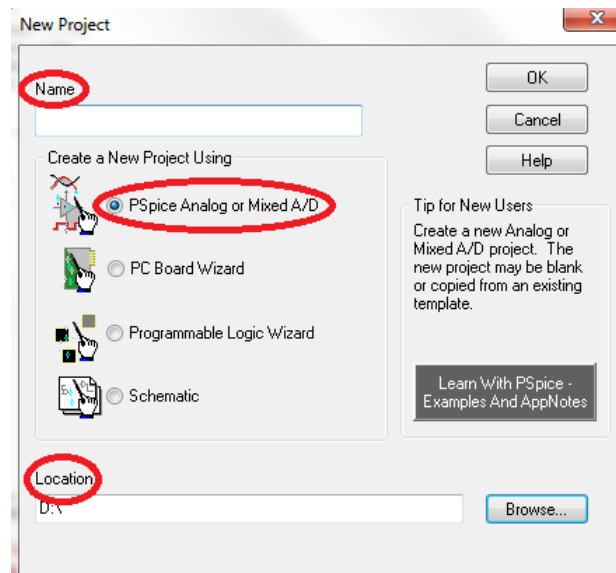
4. The *Create Parts for Library* dialogue box will open. Click "OK" to generate the part library in the default location. This will create a ****.olb* file with the same name and location as the netlist file.



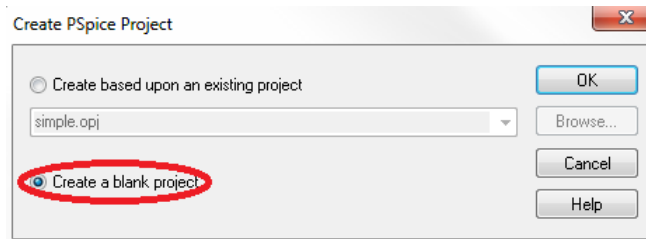
3.2 Steps to create project in Capture®

The following steps explain the procedure for creating a project in Capture and adding the part created from the netlist:

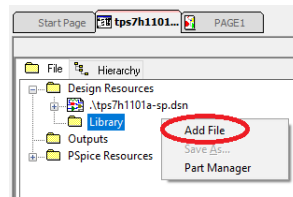
1. Open the Capture application from Cadence - v17.2.0 or above.
2. Click on *File* → *New* → *Project*.
3. Enter a project name and location, choose *PSpice Analog or Mixed A/D* from the options, and click "OK".



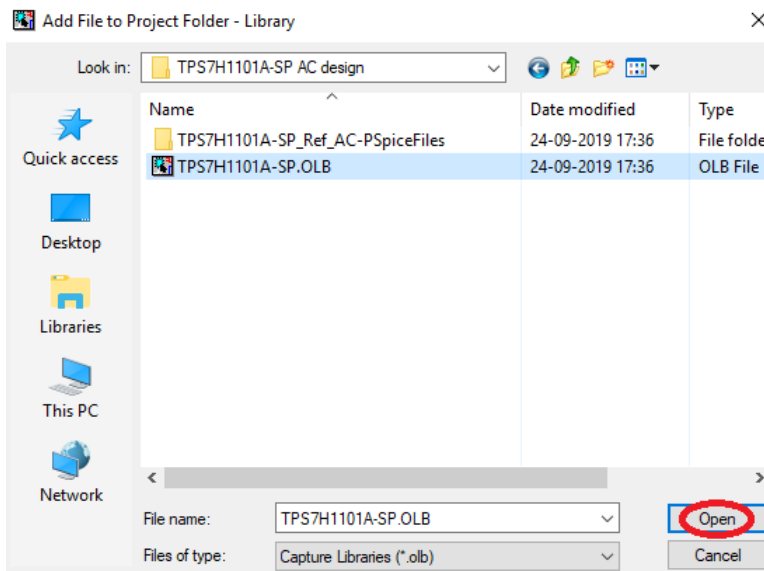
- Once the *Create PSpice Project* dialogue box opens, select the "Create a blank project" option and click "OK".



- A new project will be created and the project window will open. Click on the tab with the same name as your project, then right click on the *Library* folder and select "Add File".



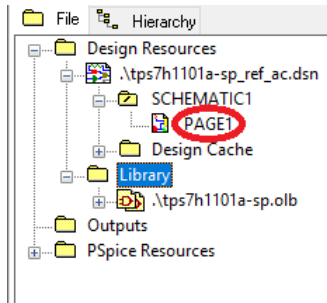
- Choose the ****.olb* file that was previously created, add it to the dialogue box, and click "Open". This will add the part symbol to the project.



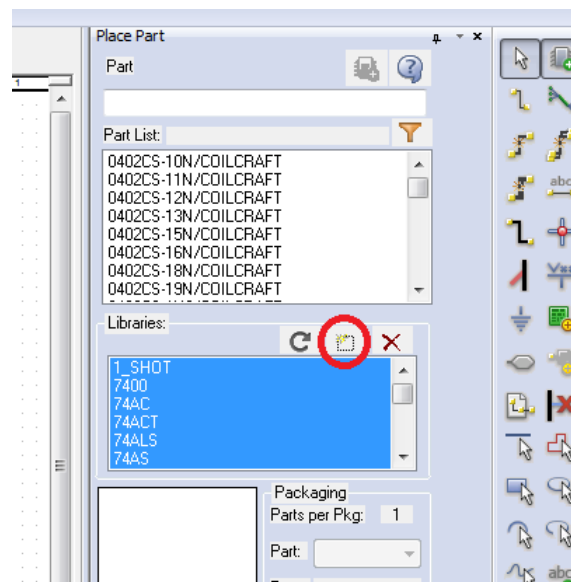
3.3 Creating the schematic in Capture

The following steps explain the procedure for developing a schematic in Capture using the part created from the netlist:

1. Open *PAGE1* under the *SCHEMATIC1* folder below the *.dsn* file.

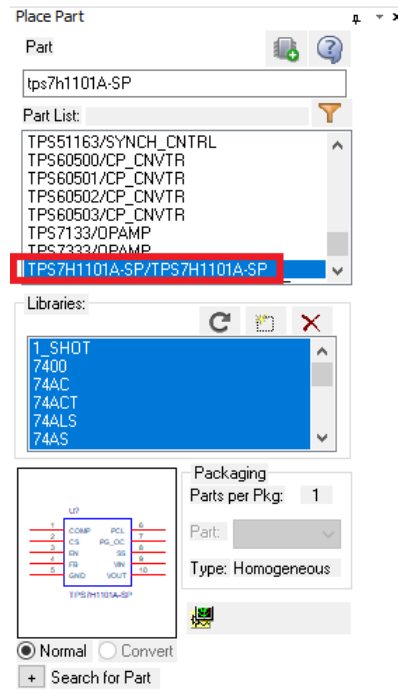


2. Select *Place* → *Part* to open the *Place Part* window. Click on the square icon shown in the following image to add libraries to the project.

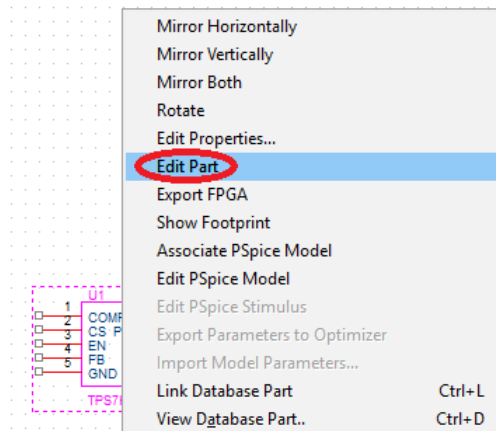


3. Select all default library files of PSPICE from installation directory and click "Open". (Default Location: "C:\Cadence\SPB_17.2\tools\capture\library\pspice") Note: This step can be omitted if the default libraries have already been added to Capture.

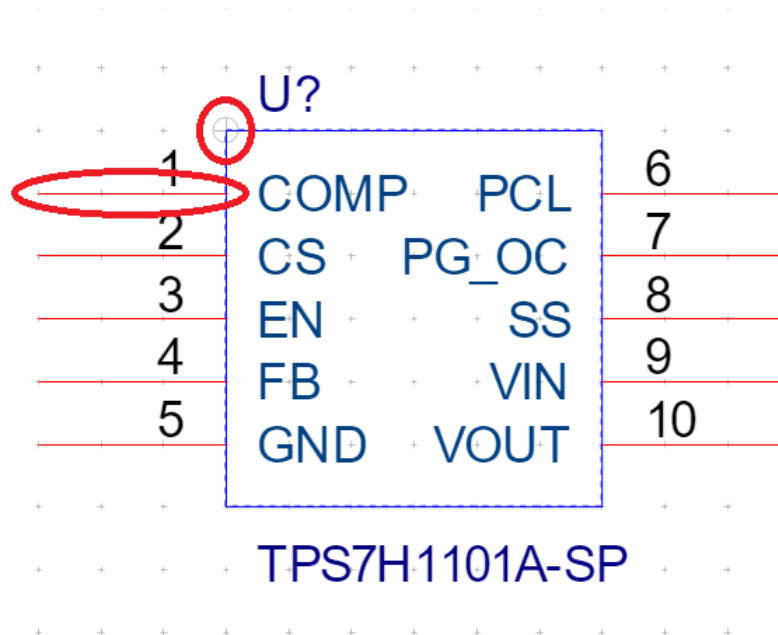
- In the *Part* search box, type “TPS7H1101A-SP” and select the model.



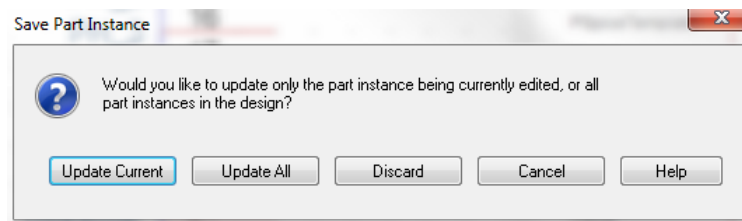
- Double click on the part in the *Part List* window and place it by left clicking the cursor while on PAGE1. Once the part is placed, the symbol can be edited by selecting the part, right clicking, and choosing "Edit Part".



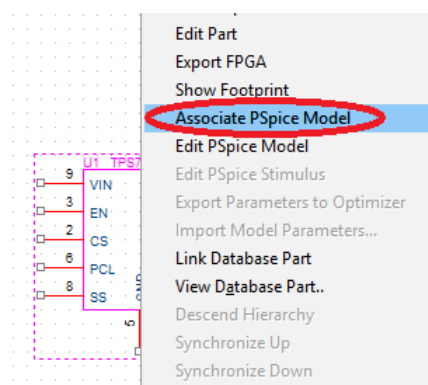
- The part can be resized and pins can be relocated to more convenient positions by clicking and dragging them.



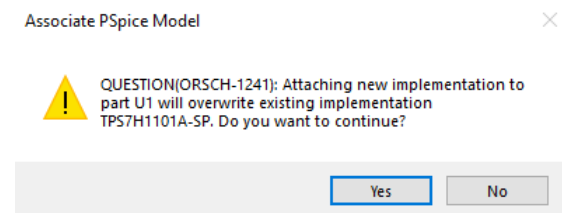
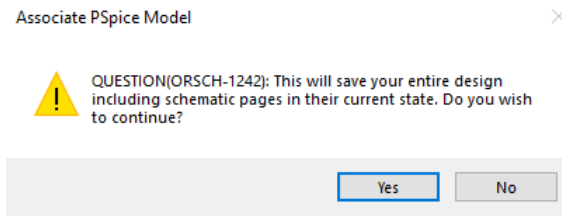
- After editing the part, close the tab to save changes. Choose "Update Current" in the pop-up.



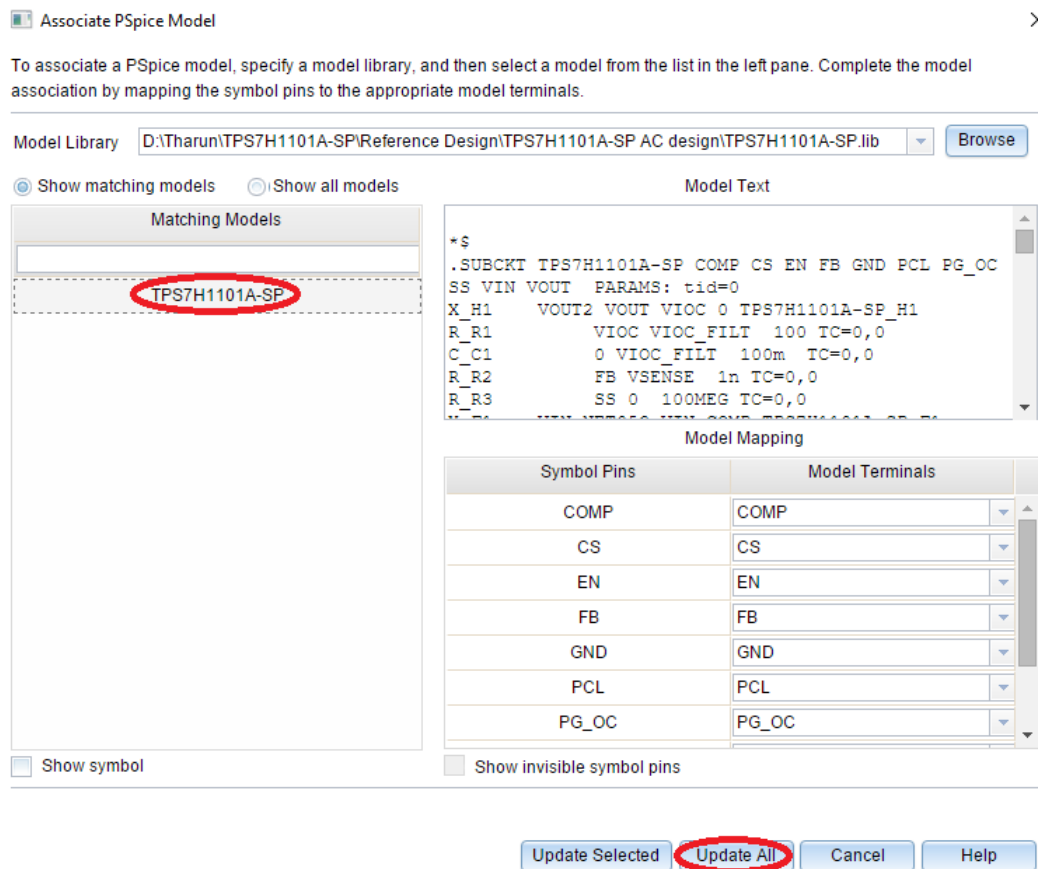
- Now, the part must be associated with the netlist. Select the part, right click, and choose "Associate Pspice Model".



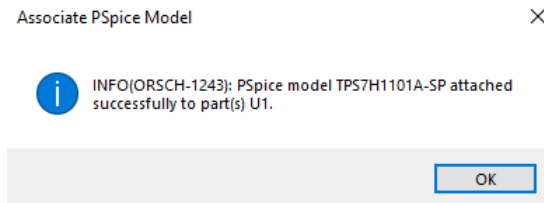
9. Two pop-ups will appear to confirm the operation. Click "Yes" for both.



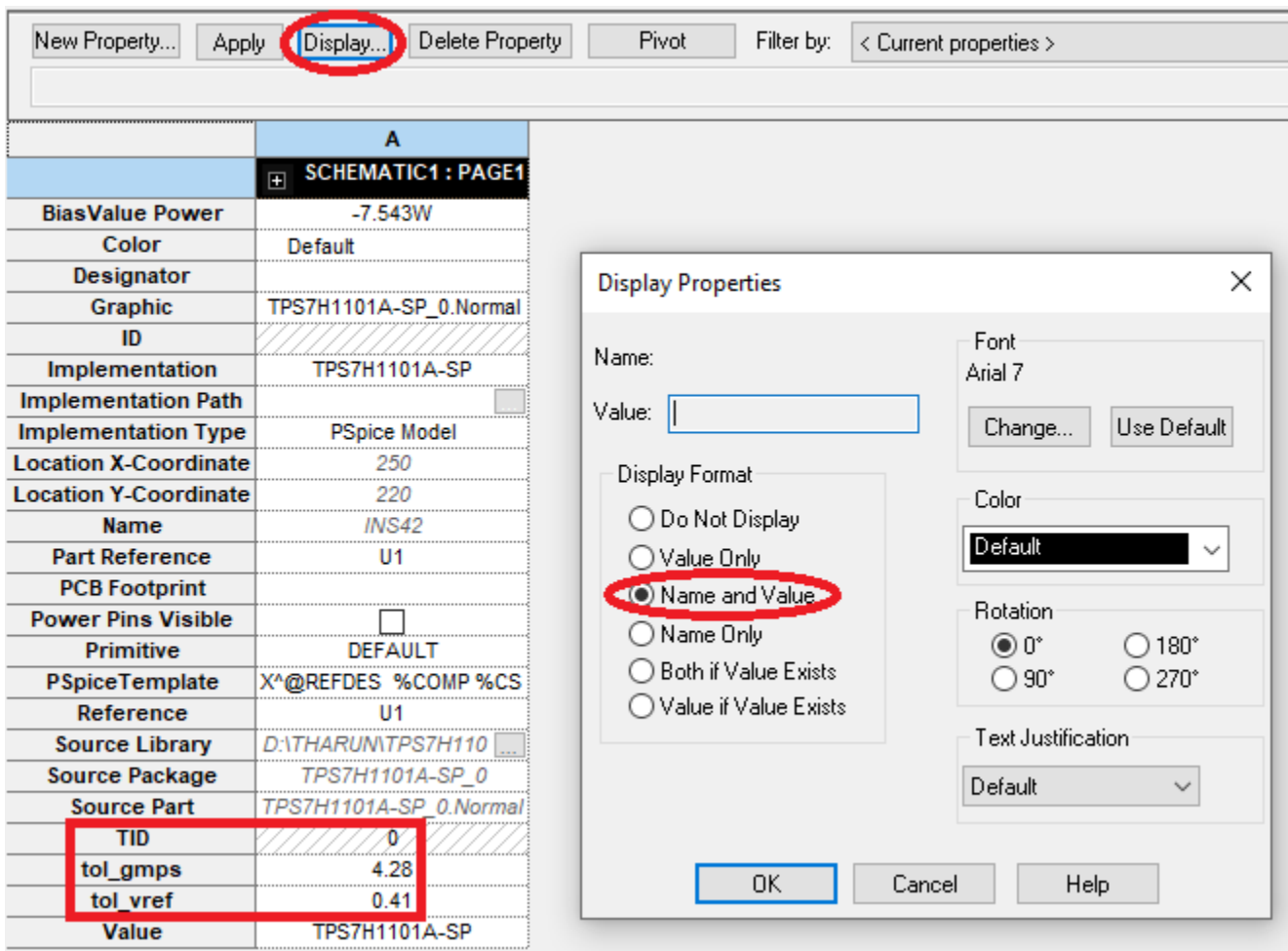
10. In the *Associate Pspice Model* dialogue box, choose the netlist file (*.lib), select the model, and click "Update All".



11. A pop-up will appear with a successful update message. Click "Ok".



12. The model contains multiple controllable parameters which can be varied to analyze the model functionality. The default values for these parameters can be found in [Section 2](#).
13. Displaying these parameters on the schematic next to the part will make it easier to view and alter their values. Start by double clicking the part to open the window shown below. Select all the highlighted parameters and then click "Display". In the pop-up, select "Name and Value" and click "OK".



A	
+ SCHEMATIC1 : PAGE1	
BiasValue Power	-7.543W
Color	Default
Designator	
Graphic	TPS7H1101A-SP_0.Normal
ID	
Implementation	TPS7H1101A-SP
Implementation Path	
Implementation Type	PSpice Model
Location X-Coordinate	250
Location Y-Coordinate	220
Name	INS42
Part Reference	U1
PCB Footprint	
Power Pins Visible	<input type="checkbox"/>
Primitive	DEFAULT
PSpiceTemplate	X*@REFDES %COMP %CS
Reference	U1
Source Library	D:\THARUN\TPS7H110
Source Package	TPS7H1101A-SP_0
Source Part	TPS7H1101A-SP_0.Normal
TID	0
tol_gmps	4.28
tol_vref	0.41
Value	TPS7H1101A-SP

14. There are slight differences between the reference designs used for transient analysis and frequency analysis. Add the remaining components to complete the schematic as shown in Figure 1 or Figure 2 according to which analysis you wish to perform.

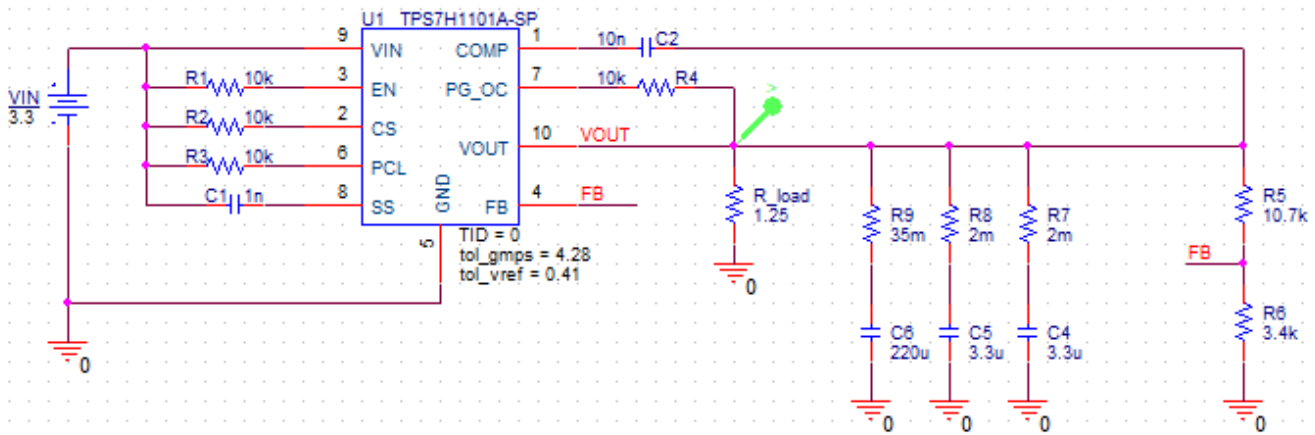


Figure 1. Transient Analysis Schematic

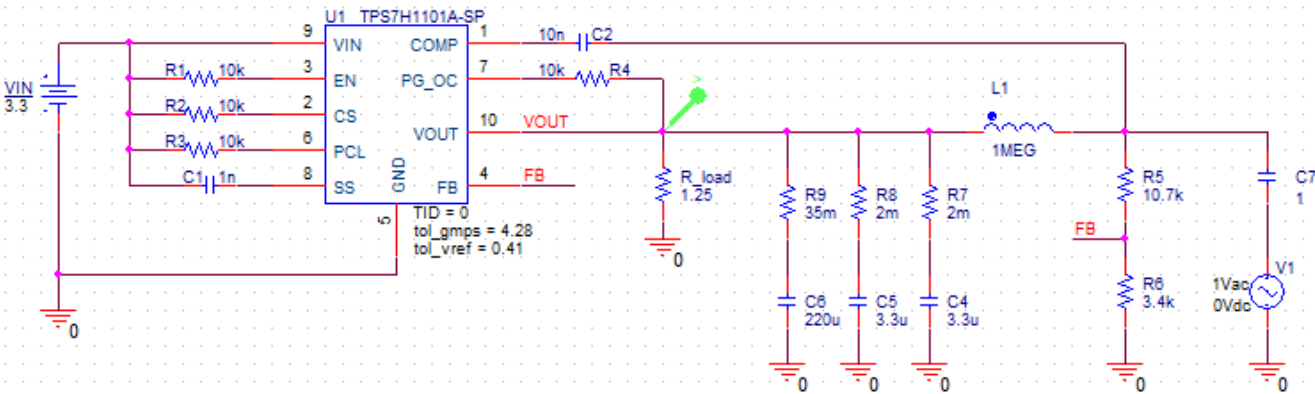
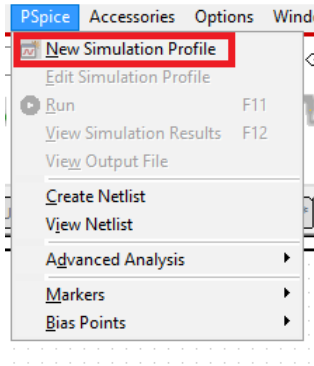


Figure 2. Frequency Analysis Schematic

4 Simulation of the TPS7H1101A-SP model

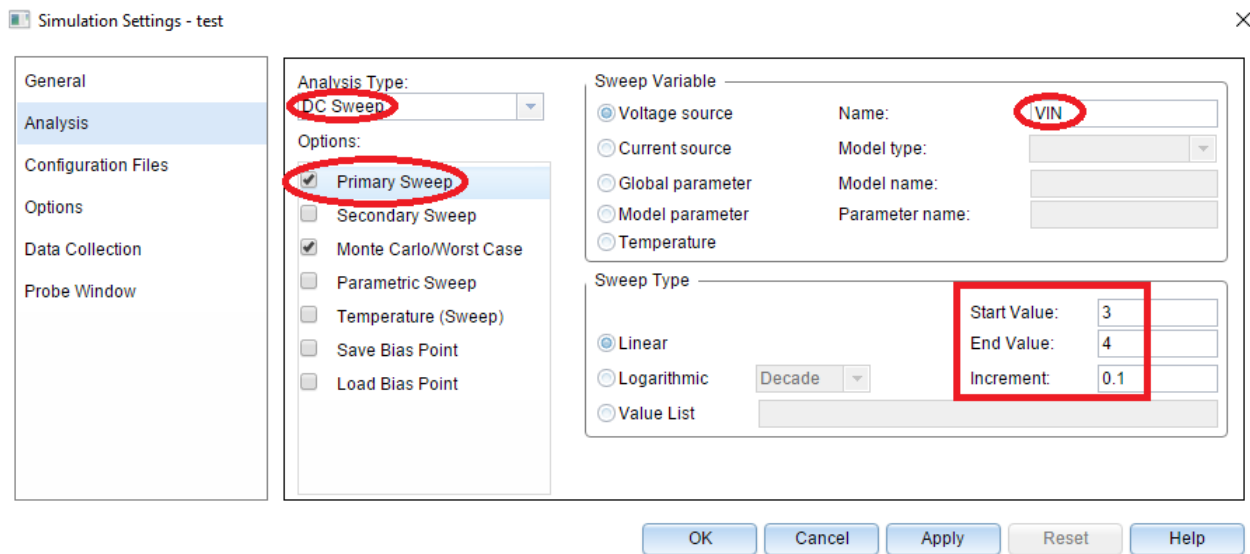
4.1 Monte Carlo analysis of output voltage

1. Create a new simulation profile by clicking on *PSpice* → *New Simulation Profile* and give it a name.

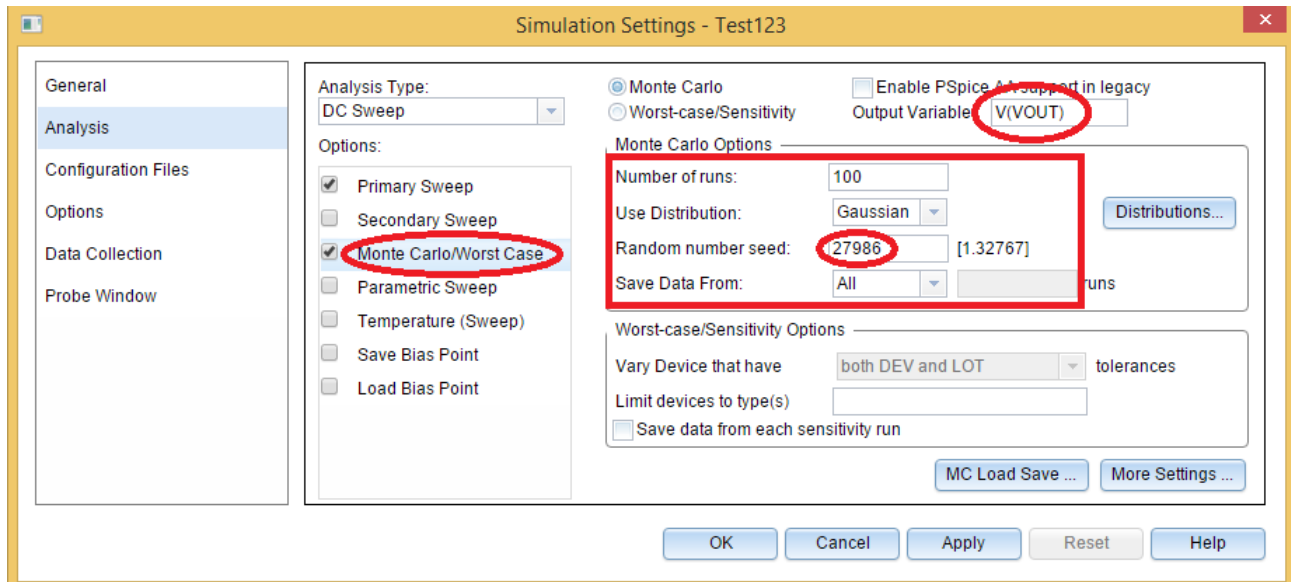


2. Use the following information to set the simulation parameters:

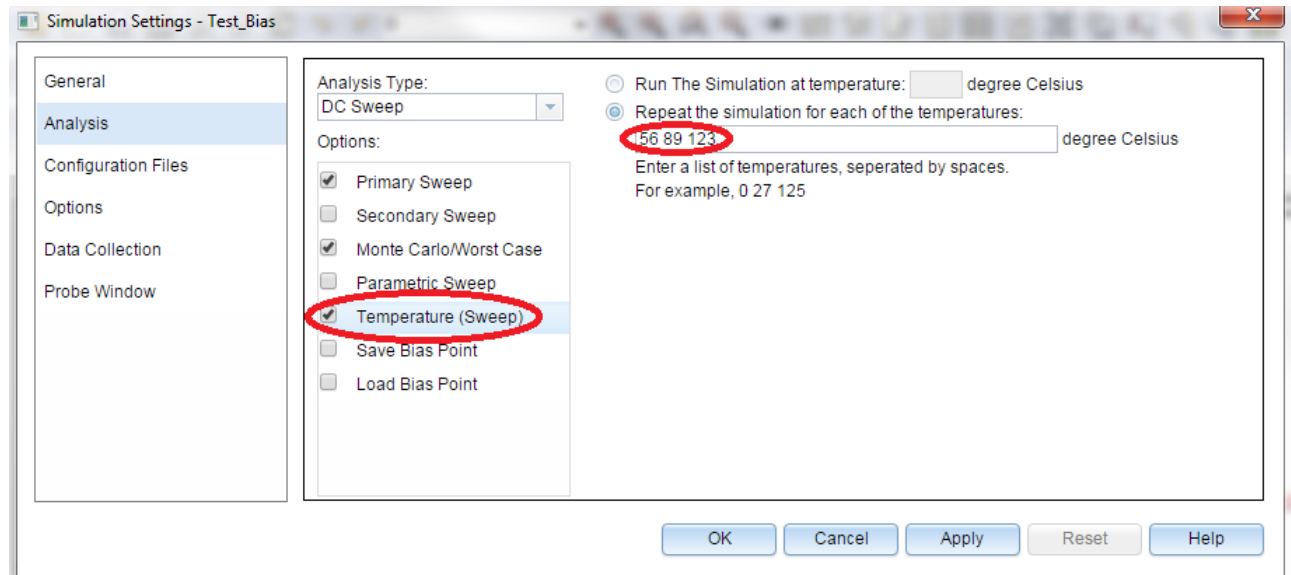
- **Analysis Type** – DC-Sweep
- **Primary Sweep** – VIN (Input Voltage) from 3 V to 4 V



- **Monte Carlo** – 100 runs with Gaussian distribution
- **Output Variable** – V(VOUT) - Output voltage

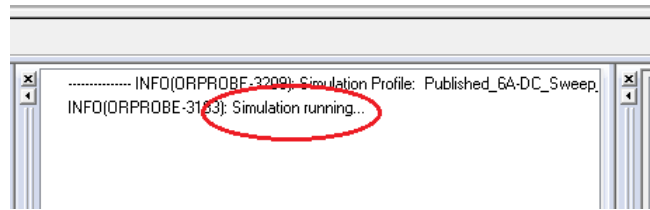


3. Set the random seed number for Monte Carlo within the range shown to the right of the entry box.
4. If desired, the simulation can be performed at various temperatures by selecting temperature sweep in the simulation profile and setting the temperature values in ascending order.

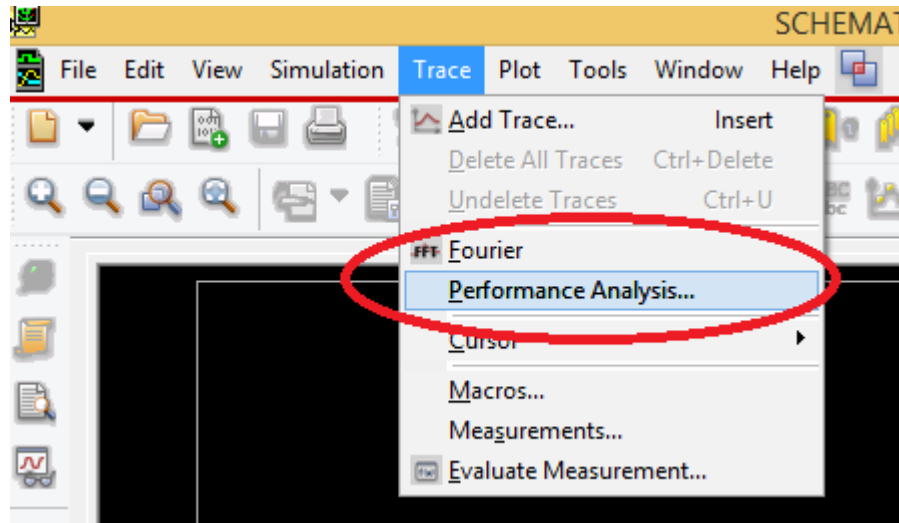


5. Click "OK" to finish creating the simulation profile and then run the simulation by pressing F11 or *PSpice* → *Run*.

6. Wait for the simulation completion in the console window of AMS Simulator.



7. The output window comes up once the simulation is completed.
8. Select *Trace* → *Performance Analysis*. A pop-up will appear, click "OK".



9. Right click on the plot area and click on "Add Trace".

- Copy the expression **Max(V(VOUT))** into the *Trace Expression* and click "OK". This will generate a histogram showing the statistical variation in maximum output voltage of the simulations. The mean, sigma, min, max, etc. are displayed at the bottom of the window.

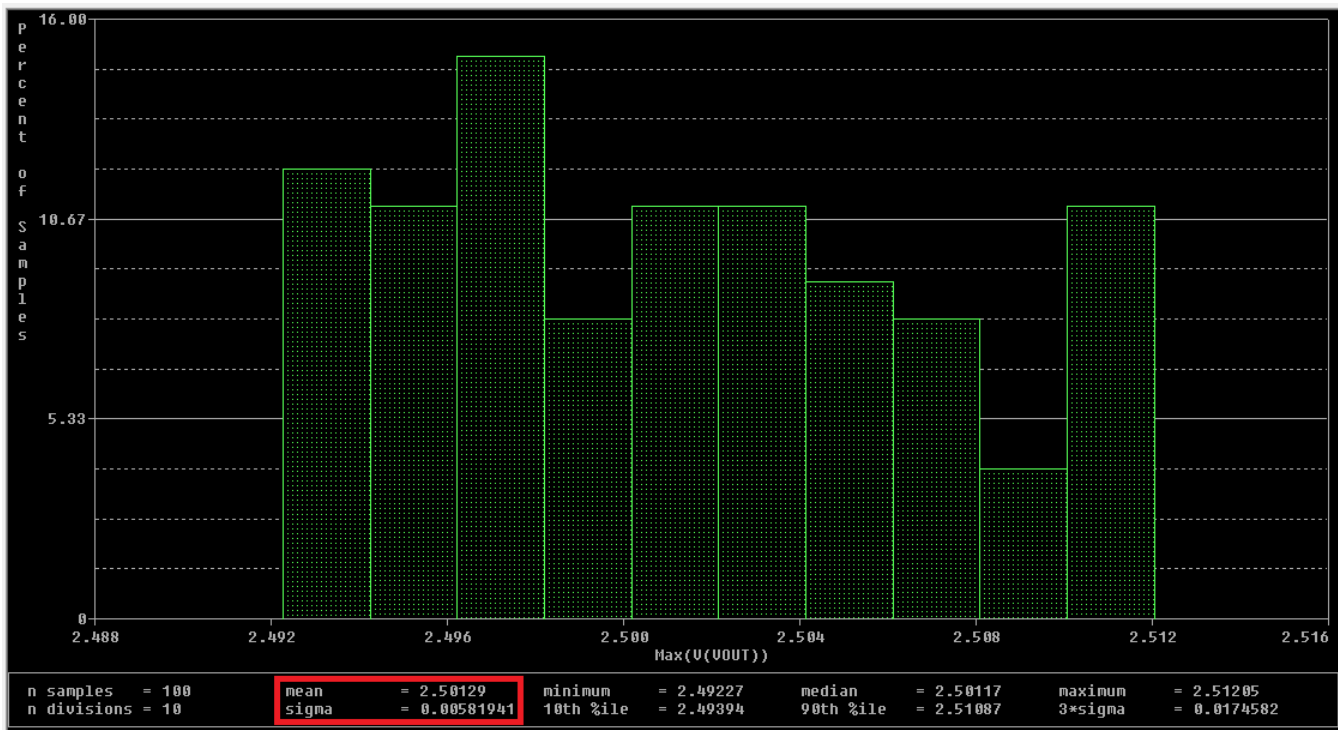
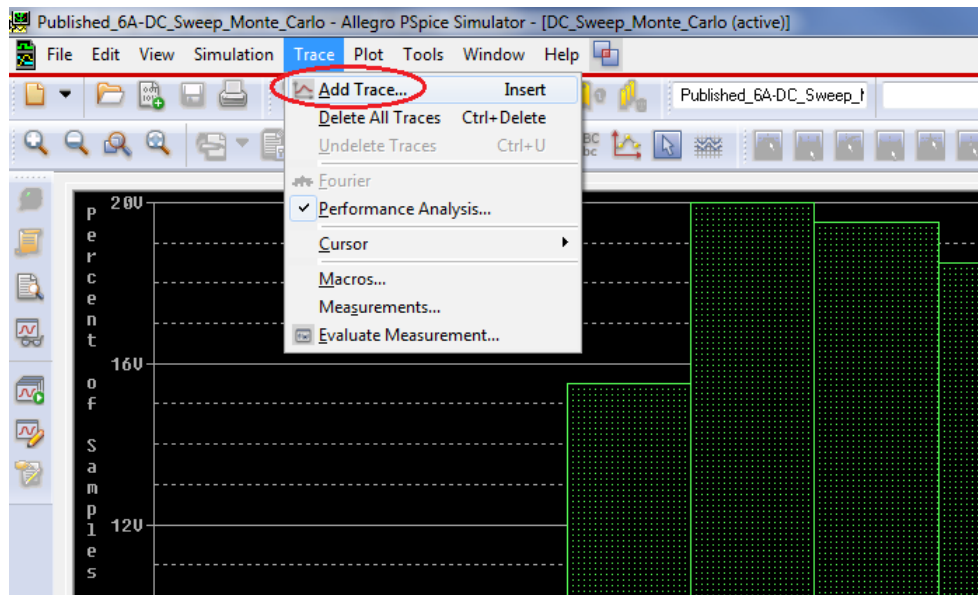
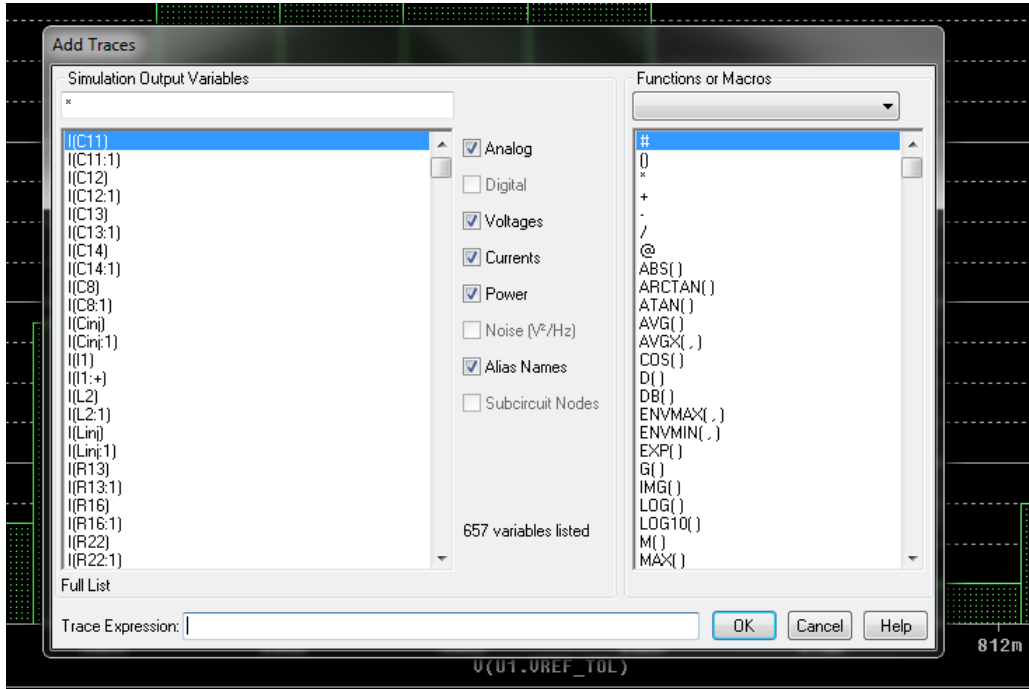


Figure 3. Output Voltage Monte Carlo Histogram

- To analyze other nodes, click on *Trace* → *Add Trace*.

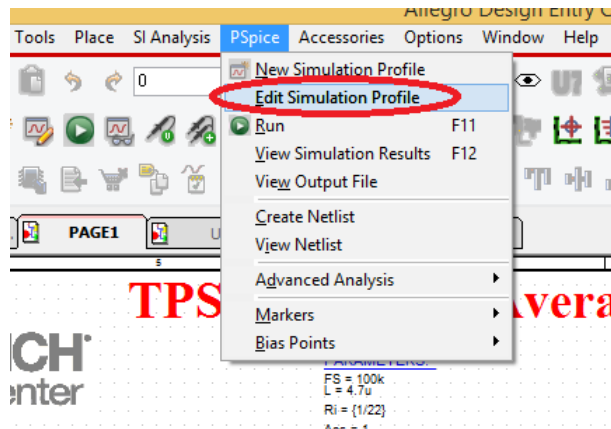


- This will open another pop-up that shows the netlists present in the schematic. Select the desired netlist and click "OK". The histogram will be updated to display the selected node.



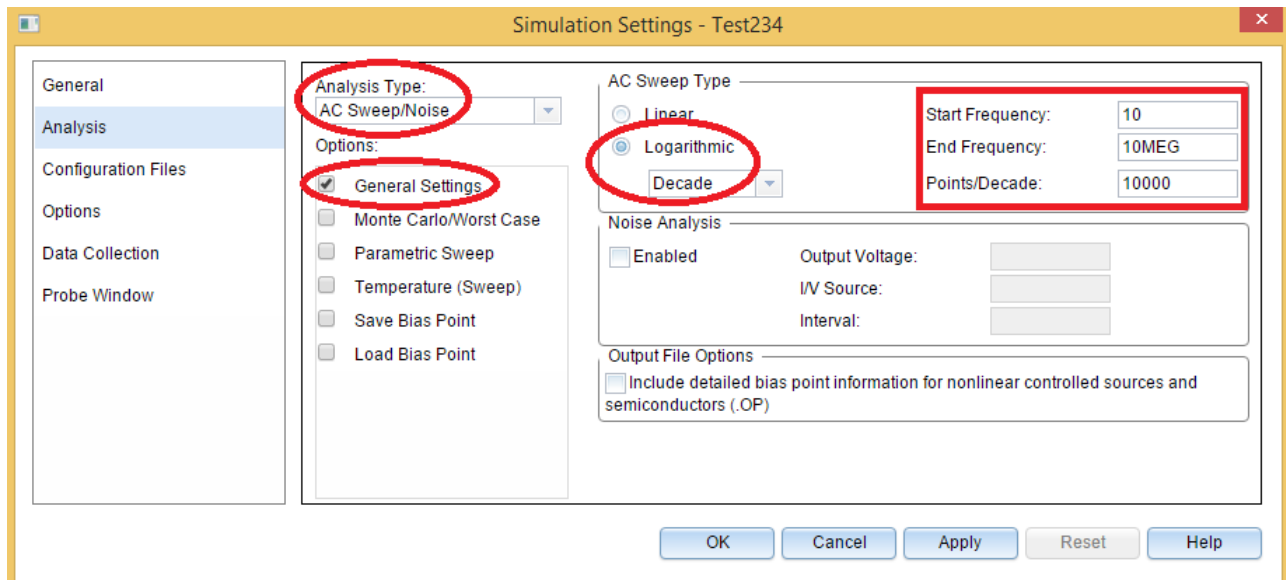
4.2 Performing frequency analysis

- Create a new simulation profile, or edit an existing simulation profile by clicking on *PSpice* → *Edit Simulation Profile*.

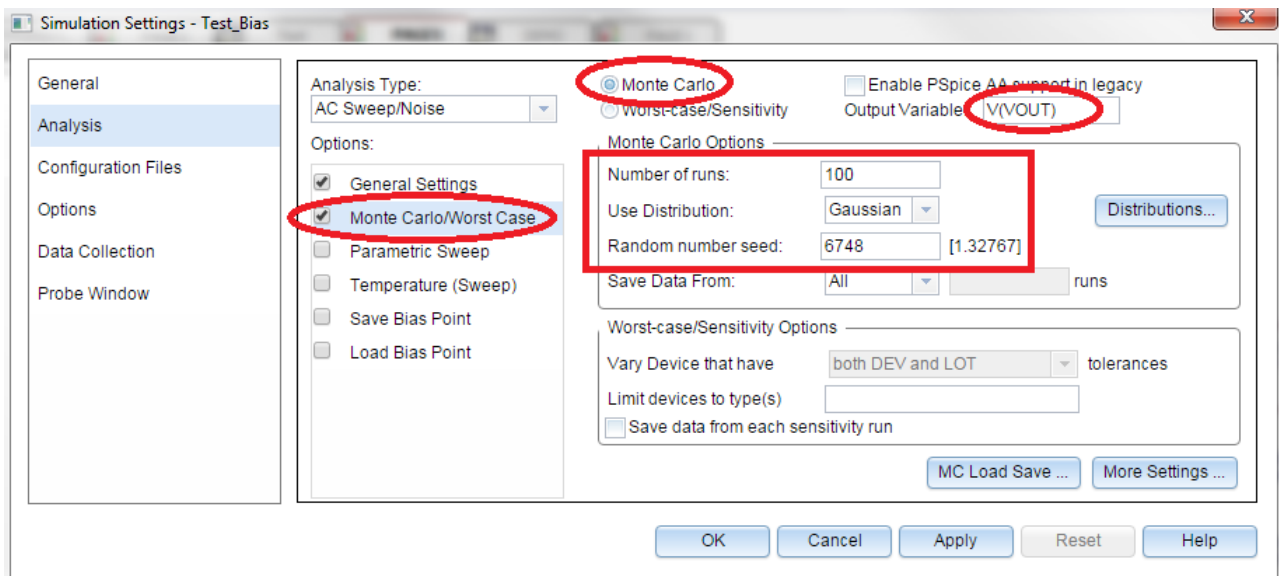


2. Use the following information to set the simulation parameters:

- **Analysis Type** – AC-Sweep
- **General Settings** – Set start and end frequency, number of points per decade, and sweep type

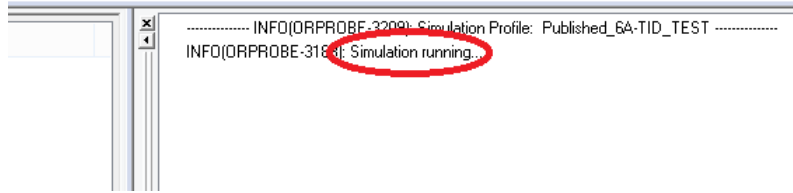


- **Monte Carlo** – 500 runs with Gaussian distribution
- **Output Variable** – V(VOUT) - Output Voltage



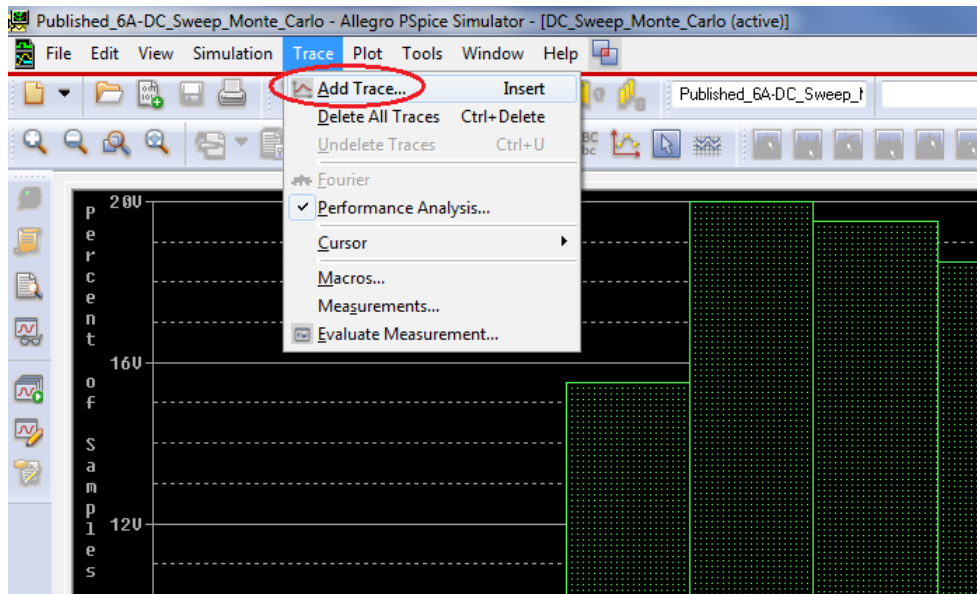
3. Run the Simulation by pressing F11 or *Pspice* → *Run*.

4. Wait for the simulation completion in the console window of AMS Simulator.

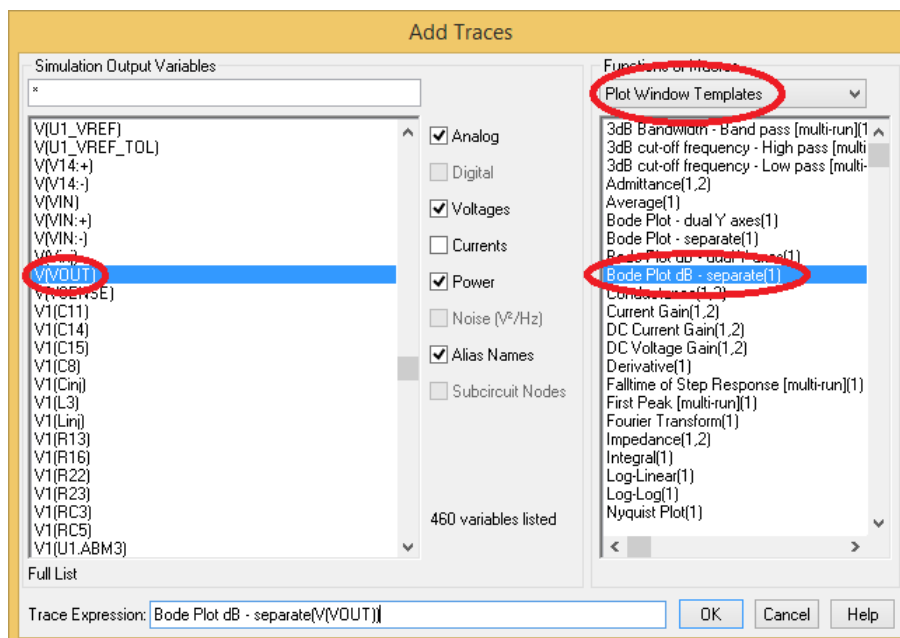


4.2.1 Analyzing frequency response with Bode plot

1. To view the frequency response as Bode plot, click on *Trace* → *Add Trace*.



2. This will open another pop-up with the netlists present in the schematic. Select the following options to get the Bode plot.



3. Use the cursor to evaluate the plot.

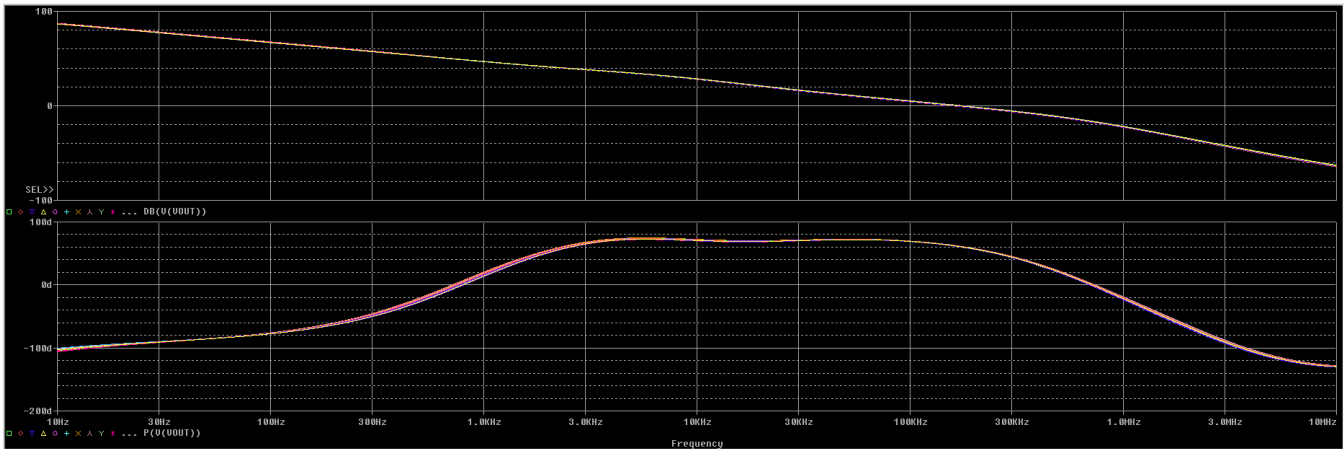
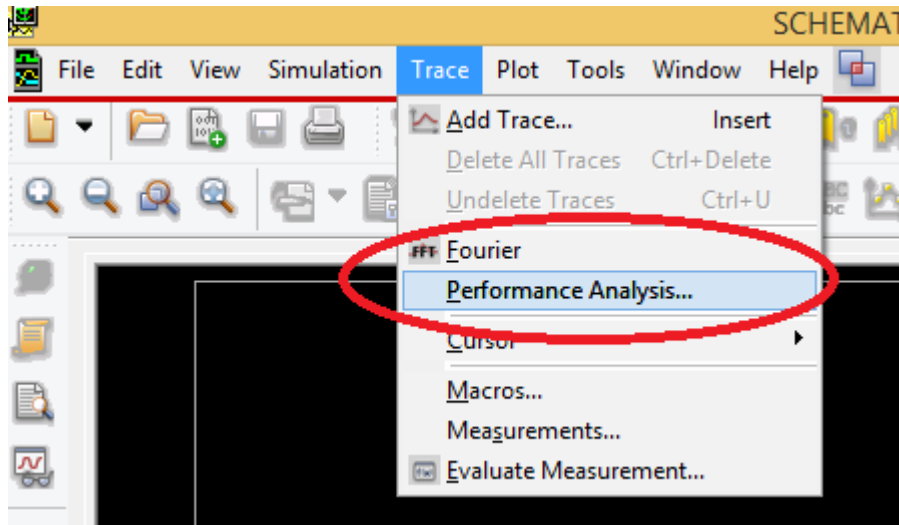


Figure 4. Frequency Response Bode Plot

4.2.2 Analyzing frequency response with histogram

1. Select *Trace* → *Performance Analysis*. A pop-up will appear, click "OK".



2. Right click on the plot area and click on "Add Trace".
3. Copy the expression **PhaseMargin(DB(v(vout)),P(v(vout)))** into the *Trace Expression* field and click "OK". This will generate the histogram for the frequency response as shown in [Figure 5](#).

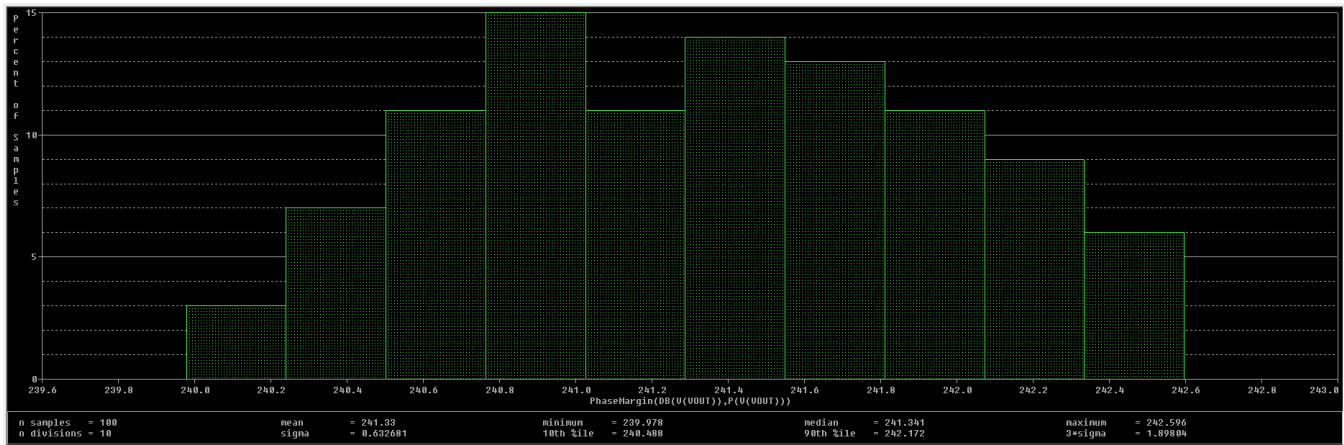


Figure 5. Frequency Response Histogram

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
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 - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
2. *Limited Warranty and Related Remedies/Disclaimers:*
 - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
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 - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGRADATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 Regulatory Notices:

3.1 United States

3.1.1 Notice applicable to EVMs not FCC-Approved:

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。技術適合証明を受けていないものご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

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東京都新宿区西新宿 6 丁目 2 4 番 1 号
西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_02.page
電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_02.page

3.4 European Union

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

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- 4 *EVM Use Restrictions and Warnings:*
 - 4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.
 - 4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.
 - 4.3 *Safety-Related Warnings and Restrictions:*
 - 4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.
 - 4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.
 - 4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.
 5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.
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 - 6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.
 - 6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.
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8.1 *General Limitations.* IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

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