Dynamic Model of Power Inductors

v1.01 2015/6

Necessity of a Dynamic Model

Q. Why is a dynamic model required?

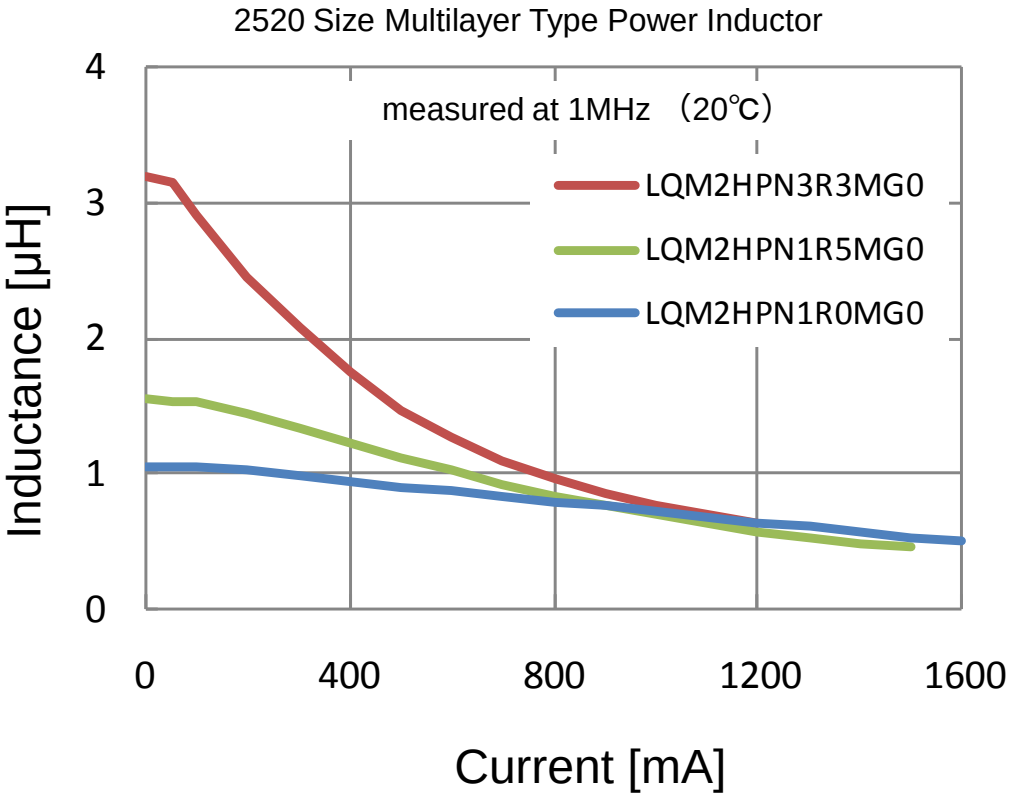
A. In a static model, the simulation results that reflect the inductance which changes in real time cannot be acquired.

In a circuit where a power inductor is used, the current which flows into the power inductor is not constant.

II

The inductance value is not constant during operation.

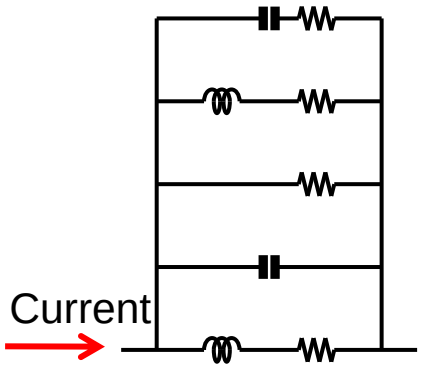
Example of Power Inductor Current - Inductance Characteristics



=> In ferrite based power inductors, when a large current flows through, since the ferrite approaches magnetic saturation, the permeability decreases during the process. The inductance also decreases because the inductance is proportional to the permeability. The above figure shows the characteristics (DC superposition characteristics) when a direct current flows through a power inductor.

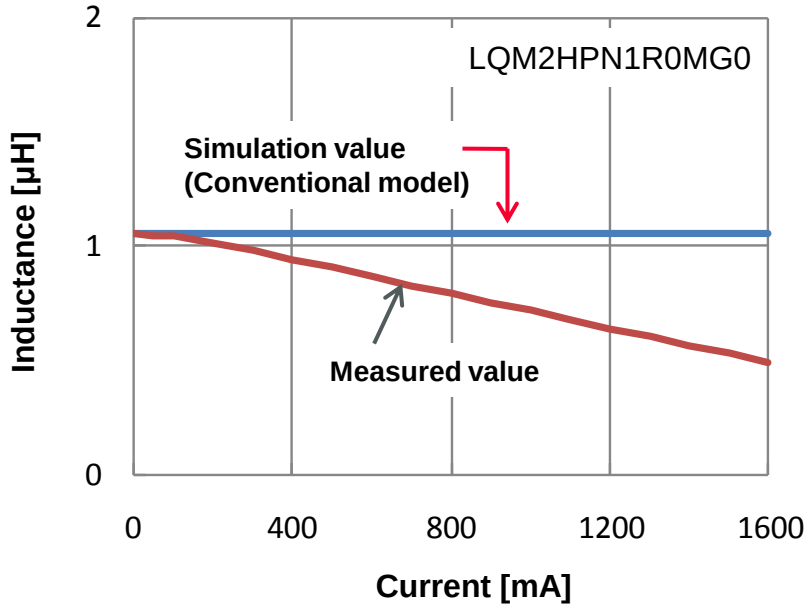
Comparison between Murata's Conventional Models and Actual Measurement Value

(1) Murata‘s conventional equivalent circuit model of an inductor (Example)



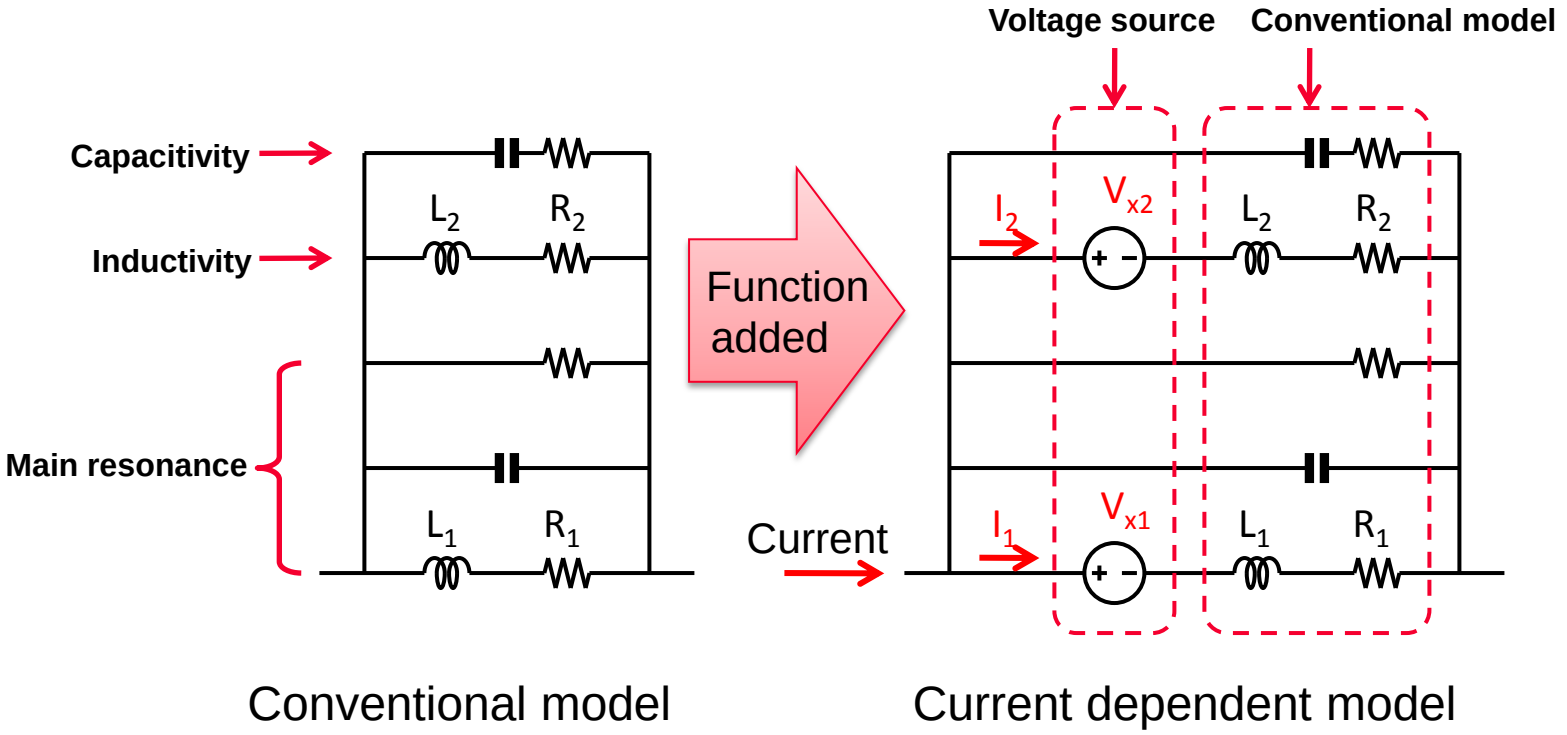
=> Even when the current changes, the constant of each component does not change (DC superposition characteristics are not reflected)

(2) Comparison between conventional model and actual measurement value



=> The DC superposition characteristics are not reflected in the (1) conventional model.

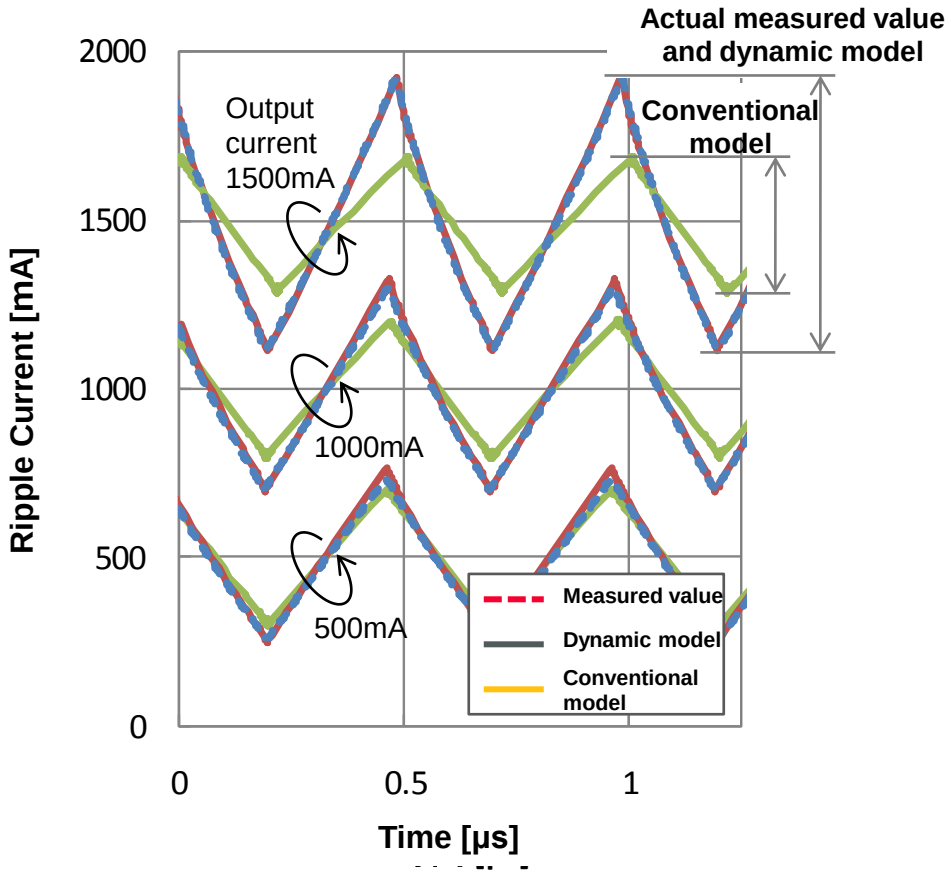
Proposal of Current Dependent Model (Dynamic Model)



=> Adding current dependency to several components of a conventional model, realized a dynamic model which responds to the change of inductance along with the change of the real time current.

Comparison between Dynamic Model and Actual Measurement Value (1/2)

Example of verification: Comparison of the ripple current in a DC-DC converter



=> In a conventional model, since the current dependent characteristics of an inductor are not reflected, the simulation results deviate from the measured value.
On the other hand, in a dynamic model, results close to the actual measured value could be acquired.

Comparison between Dynamic Model and Actual Measurement Value (2/2)

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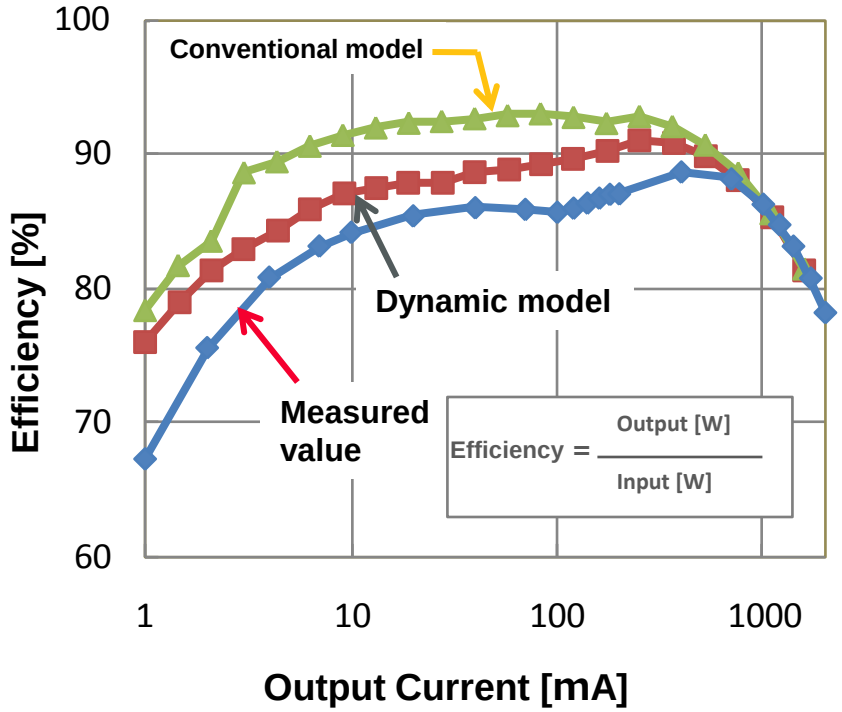
Example of verification: Comparison of the power supply efficiency in a DC-DC converter



=> In the simulation by a dynamic model, results closer to the actual measured value could be acquired.

* Since there are factors other than the dynamic model of an inductor, the simulation and actual measured value do not conform completely.

Downloading of Dynamic Models of Murata's Inductors

This model is released in the Library of Murata's Web site.

- Cadence® PSpice®
  http://www.murata.com/en-global/tool/library/pspice

- Cadence® Spectre®
  http://www.murata.com/en-global/tool/library/spectre

- Synopsys HSPICE®
  http://www.murata.com/en-global/tool/library/hspice

- Linear Technology LTspice®
  http://www.murata.com/en-global/tool/library/ltspice

[Contained Products]
Power inductor: LQMxxP Series, etc.

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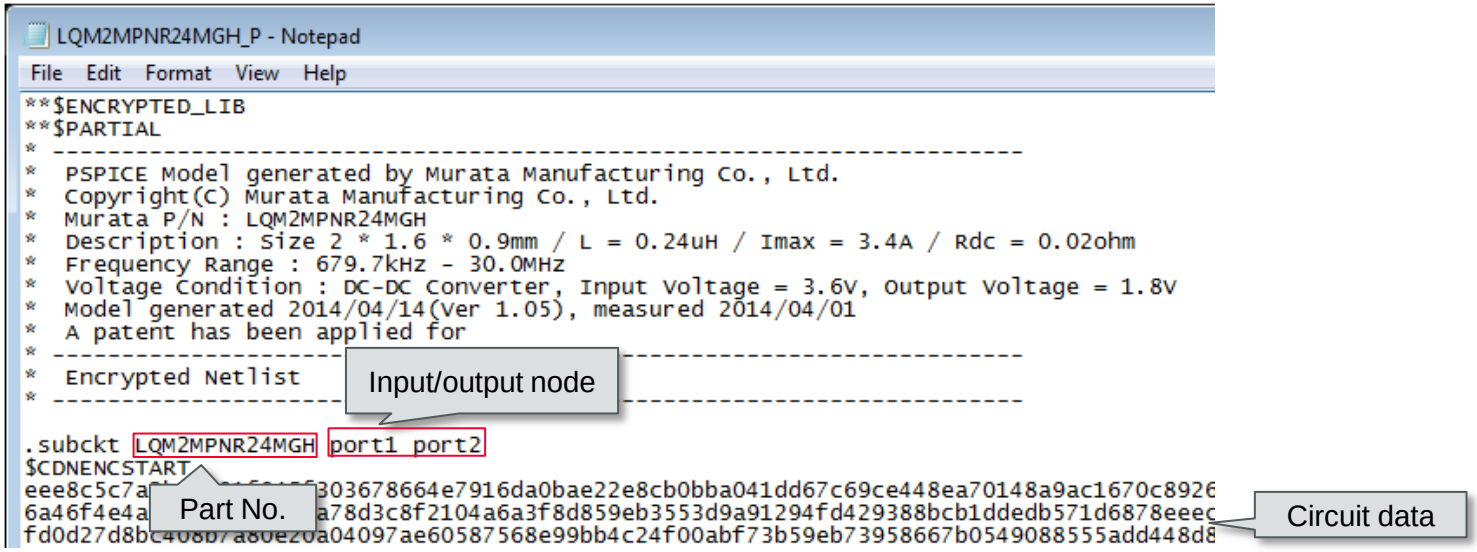
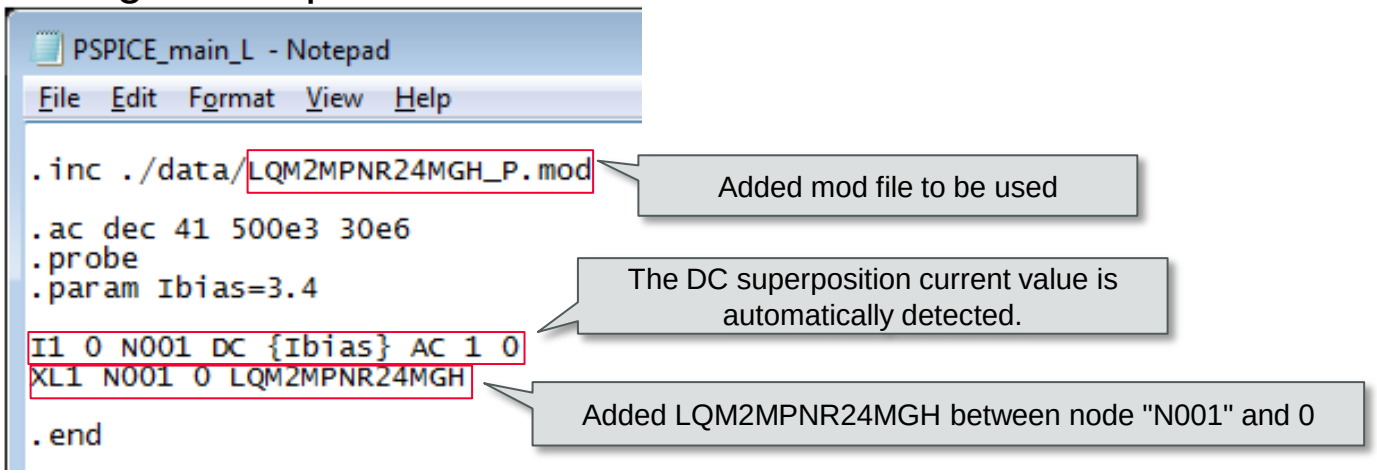
* HSPICE is a registered trademark or trademark of Synopsys, Inc. in the United States and other countries.
* LTspice is a registered trademark or trademark of Linear Technology Corporation in the United States and other countries.

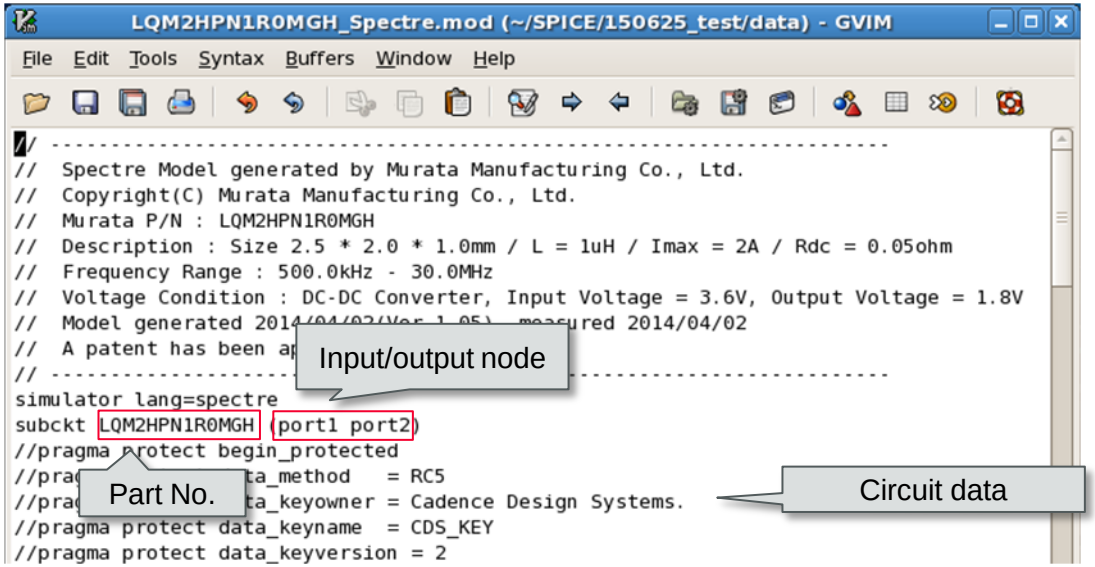
Usage Example of Dynamic Model of Murata's Power Inductor - PSpice® -



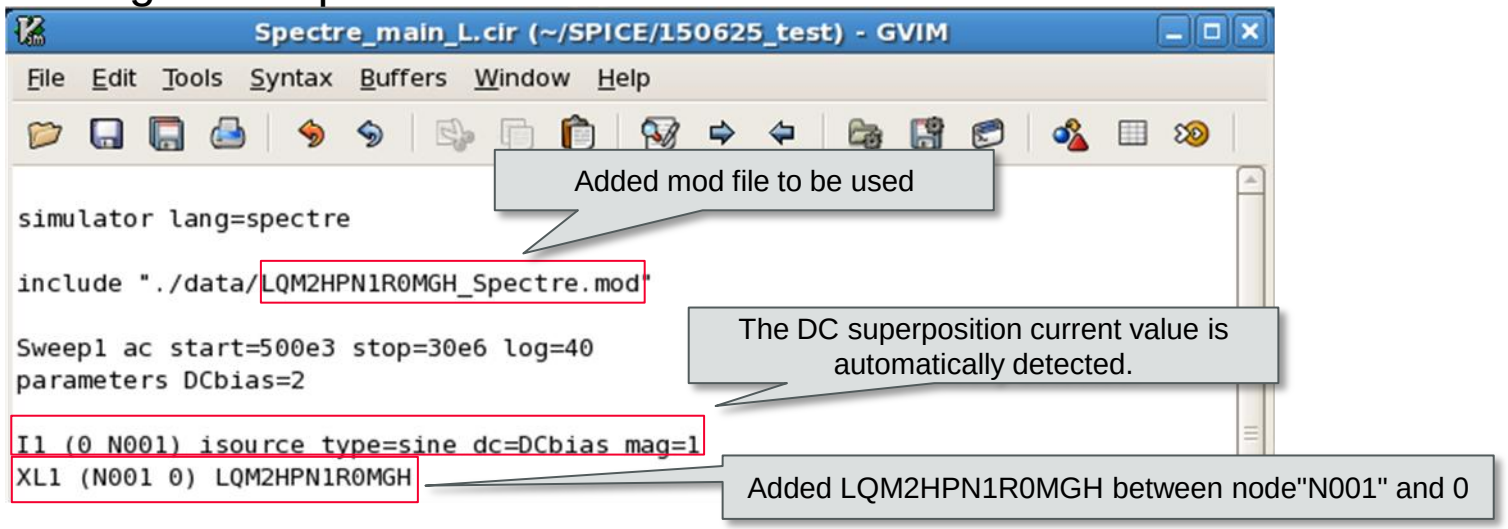
◎Usage Example



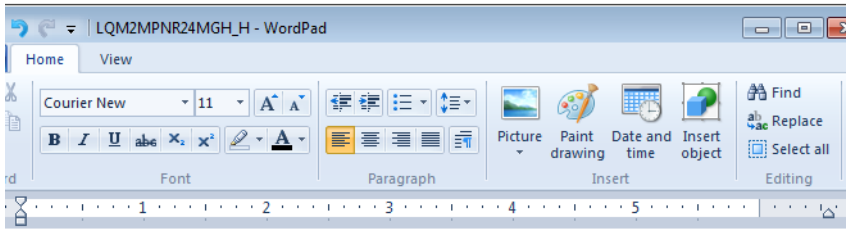
Usage Example of Dynamic Model of Murata's Power Inductor - Spectre® -



◎Usage Example



Usage Example of Dynamic Model of Murata's Power Inductor - HSPICE® -



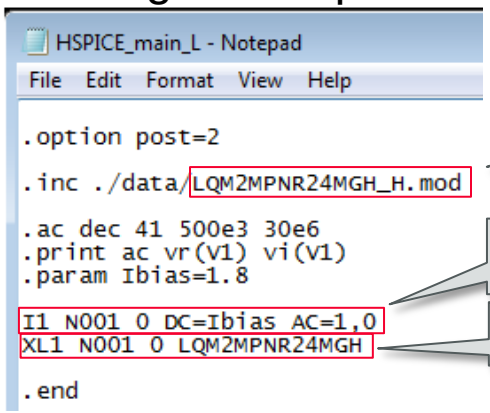

```
*
--------------------------------------------------------------------------
*  HSPICE Model generated by Murata Manufacturing Co., Ltd.
*  Copyright(C) Murata Manufacturing Co., Ltd.
*  Murata P/N : LQM2MPNR24MGH
*  Description : Size 2 * 1.6 * 0.9mm / L = 0.24uH / Imax = 3.4A
/ Rdc = 0.02ohm
*  Frequency Range : 679.7kHz - 30.0MHz
*  Voltage Condition : DC-DC Converter, Input Voltage = 3.6V,
Output Voltage = 1.8V
*  Model generated 2014/04/14(Ver 1.05), measured 2014/04/01
*  A patent has been applied for
*
--------------------------------------------------------------------------
*  Encrypted Netlist
*
--------------------------------------------------------------------------

.subckt LQM2MPNR24MGH port1 port2
.PROT ddl1
A9(8S#Uc(1Y)E-U>9%j;x5I#'%S$b-,(2/E5bVWc'F:9h]Uc:Xj5EJh>(%j)7-
U#/JS:b-I:'%EP$V.c'/25bl+):Fi5h8
```

Part No.

Input/output node

Circuit data

◎Usage Example



Added mod file to be used

The DC superposition current value is automatically detected.

Added LQM2MPNR24MGH between node"N001" and 0

Usage Example of Dynamic Model of Murata's Power Inductor - LTspice® -

■ Symbol file (Ext.asy)

Create and save any folder after the "sym" folder in the folder where LTspice is installed.
Example) C:\Program Files (x86)\LTC\LTspiceIV\lib\sym\murata_Inductor\

■ Encrypted nonlinear SPICE file (Ext.mod)

Directly save the mod file after the "sub" folder in the folder where LTspice is installed.
Example) C:\Program Files (x86)\LTC\LTspiceIV\lib\sub\

* The mod file in the same folder as the circuit (e.g.: test1.asc) of the reference source can also be saved.
* When saving the file to other folders, use the command ".inc" to refer to a folder.

Select the file saved by clicking Edit in Menu → Component