

Dynamic Model of High Dielectric Constant Type Chip Monolithic Ceramic Capacitors and Power Inductors



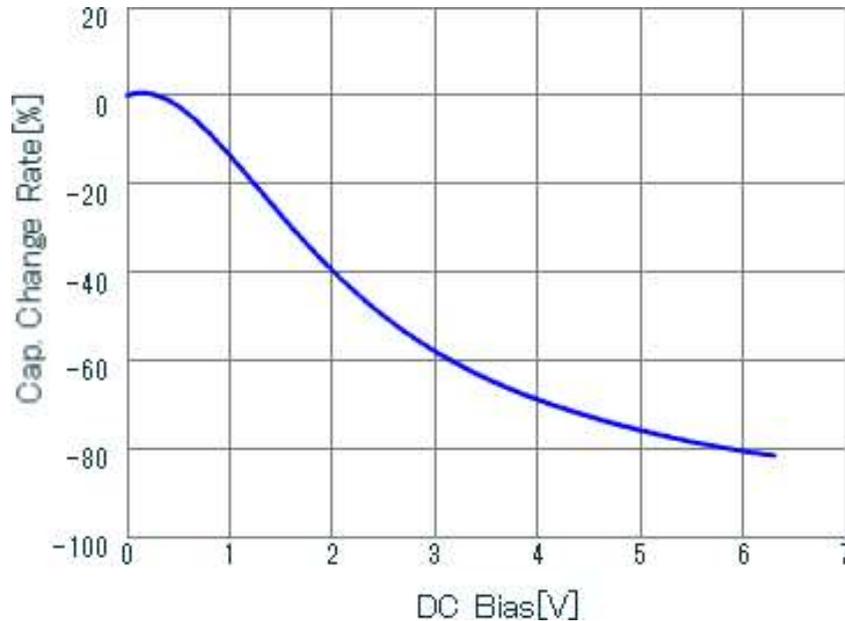
v1.02 2025/4

High Dielectric Constant Type Chip Monolithic Ceramic Capacitors

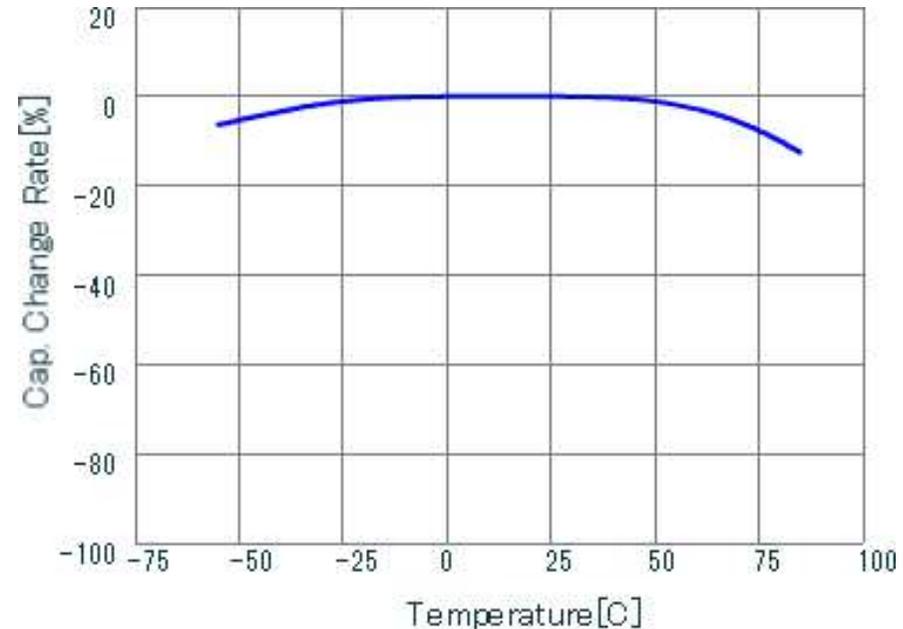
Change of Capacitance by DC Bias/Temperature in High Dielectric Constant Type MLCC (1/2)



Example:
Capacitance change rate - DC bias characteristic



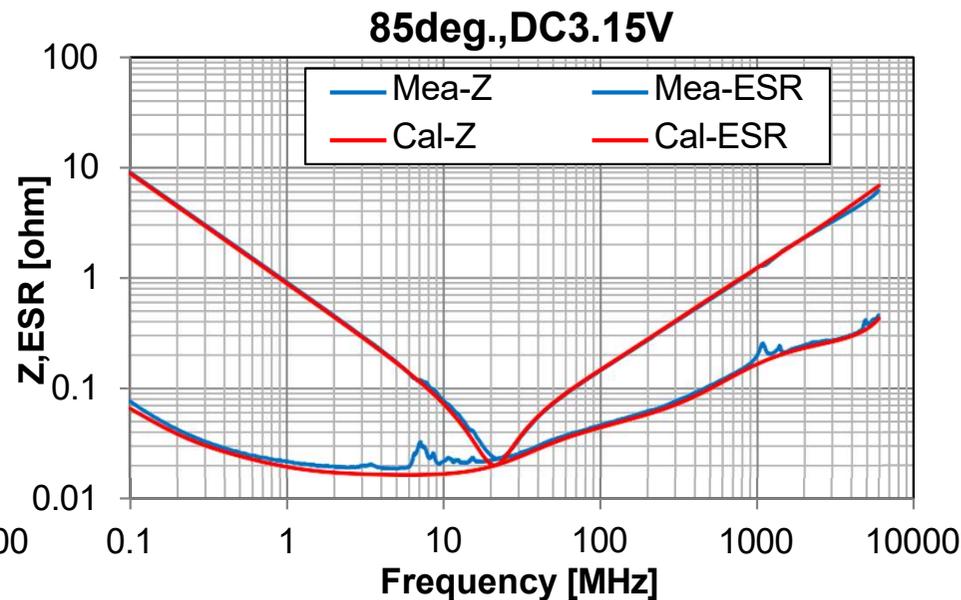
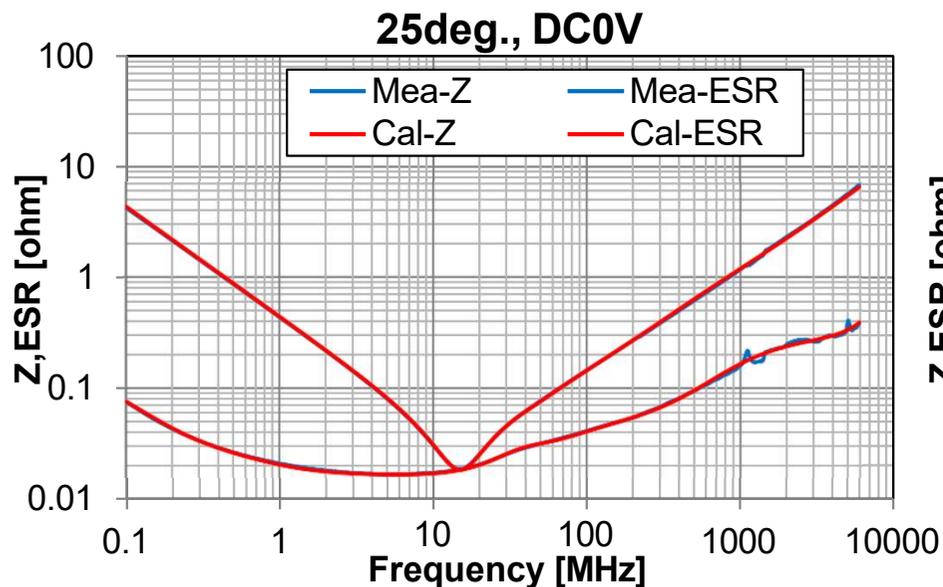
Example:
Capacitance change rate - Temperature characteristic



MLCC: 0603 size / R6 Temp. characteristic / 0.47 uF / rated 6.3V

=> As shown in the above figure, the capacitance of the high dielectric constant type monolithic ceramic capacitor (MLCC) changes with the DC bias and temperature. Accordingly in the circuit design, there were cases where a deviation occurred between the simulation results and the actual measured value.

Change of Capacitance by DC Bias/Temperature in High Dielectric Constant Type MLCC (2/2)



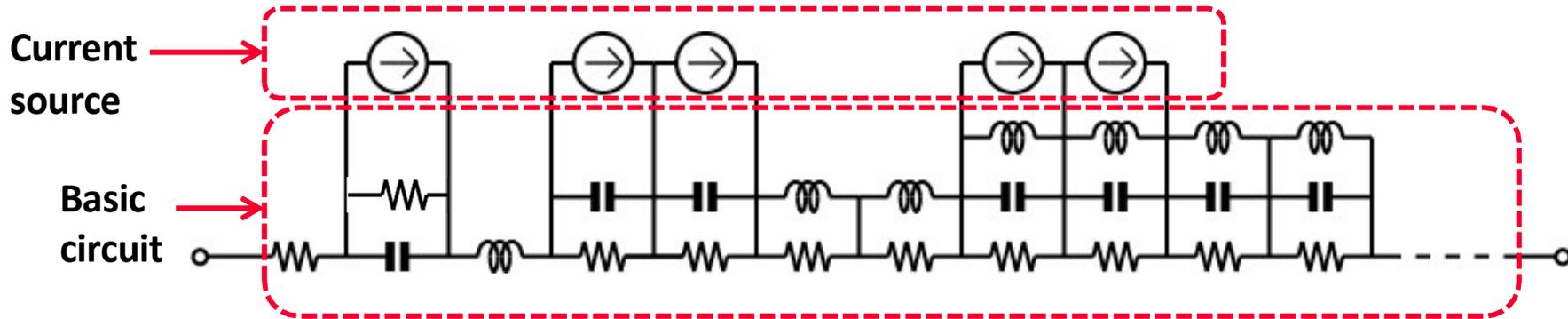
0603 size / R6 Temp. characteristic / 0.47 uF /
rated 6.3V

Red line: Calculated Value (Cal);
Blue line: Actual Measured Value (Mea)

=> In order to reduce the deviation between the simulation and the actual measured value, Murata provides a SPICE model in which the DC bias and temperature can be specified as 1 condition in our design support tool "SimSurfing".

The figure on the upper left shows the comparison between the calculated value and the actual measured value of Z and ESR acquired from the SPICE model in the conditions of DC bias 0V/room temperature, and the figure on the upper right shows the values acquired from the SPICE model in which the conditions of DC bias/temperature are reflected. Both graphs show similar results.

Dynamic Model in High Dielectric Constant Type MLCC

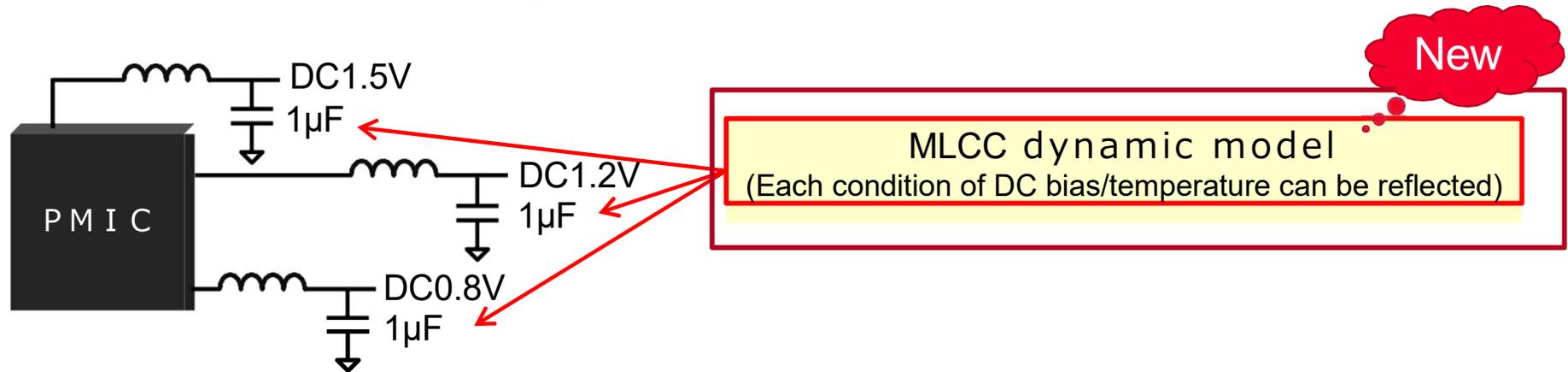


Example of SPICE model in which DC bias dependency and temperature dependency are reflected

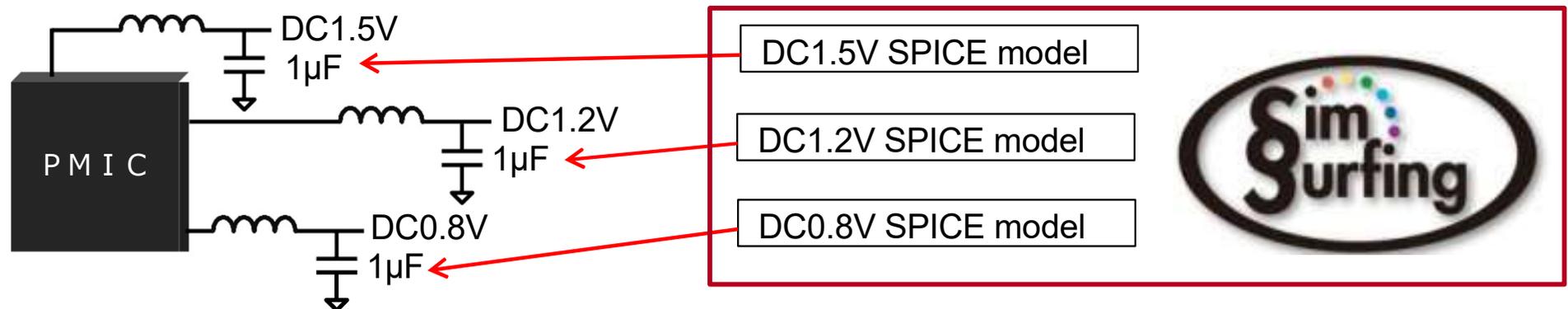
=> This SPICE model realized a dynamic model that corresponds to the changes of the DC bias and temperature, by adding the dependency of DC bias and temperature to several components in a basic equivalent circuit model.

Merits of using Dynamic Models

©When a dynamic model is used (SPICE model with DC bias automatic setting / specifiable temperature)
Using the following circuit as an example, the characteristics according to the DC bias voltage applied to each capacitor under certain operating temperature environments **can be simulated in one model.**



<Reference> When a SPICE model downloaded from myMurata "SimSurfing" is used The SPICE model will be downloaded by model where each DC bias/temperature is set. When performing the same simulation as the above, **it is necessary to prepare models set with three different types of DC bias.**





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

- Analog Devices LTspice™
<https://www.murata.com/en-us/tool/data/librarydata/library-ltspice>
- ANSYS™ Electronics Desktop
<https://www.murata.com/en-us/tool/data/librarydata/library-ansys>
- Cadence™ OrCAD Capture
<https://www.murata.com/en-us/tool/data/librarydata/library-orcad>
- Cadence™ PSpice
<https://www.murata.com/en-us/tool/data/librarydata/library-pspice>
- Cadence™ Spectre
<https://www.murata.com/en-us/tool/data/librarydata/library-spectre>
- Keysight PathWave ADS
<https://www.murata.com/en-us /tool/data/librarydata/library-keysight2>
- Simetrix Technologies SIMetrix/SIMPLIS™
<https://www.murata.com/en-us/tool/data/librarydata/library-simetrix>
- Synopsys HSPICE™
<http://www.murata.com/en-us/tool/library/hspice>

[Contained Products]

MLCC : All series

※LTspice is a registered trademark or trademark of Analog Devices, Inc.

※Cadence is a registered trademark or trademark of Cadence Design Systems, Inc.

※Simetrix/SIMPLIS are registered trademarks or trademarks of Simetrix Technologies Inc.

※HSPICE is a registered trademark or trademark of Synopsys, Inc.

Usage Example of Dynamic Models of Murata's MLCC *muRata* - LTspice™ -

INNOVATOR IN ELECTRONICS



■ 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\LTCspice\lib\sym\murata_MLCC

■ Encrypted nonlinear SPICE file (Ext.mod)

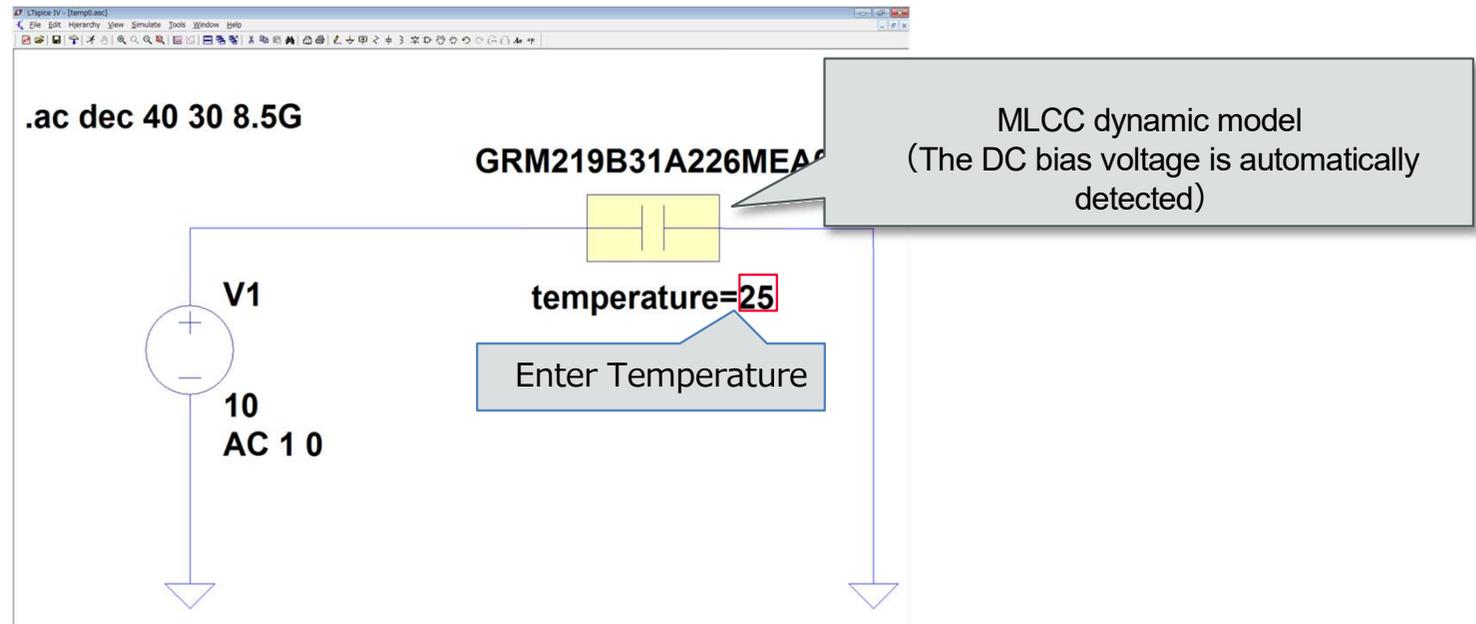
Directly save the mod file after the "sub" folder in the folder where LTspice is installed.

Example) C:\Program Files (x86)\LTC\LTCspice\lib\sub

* The mod file in the same folder as the circuit (e.g.: test1.asc) of the reference source can also be saved.

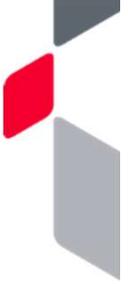
* When saving the file to other folders, use the command ".inc" to refer to a folder.

Select the file saved
by clicking Edit in Menu
→ Component



Usage Example of Dynamic Models of Murata's MLCC *muRata*

- ANSYS™ Electronics Desktop -



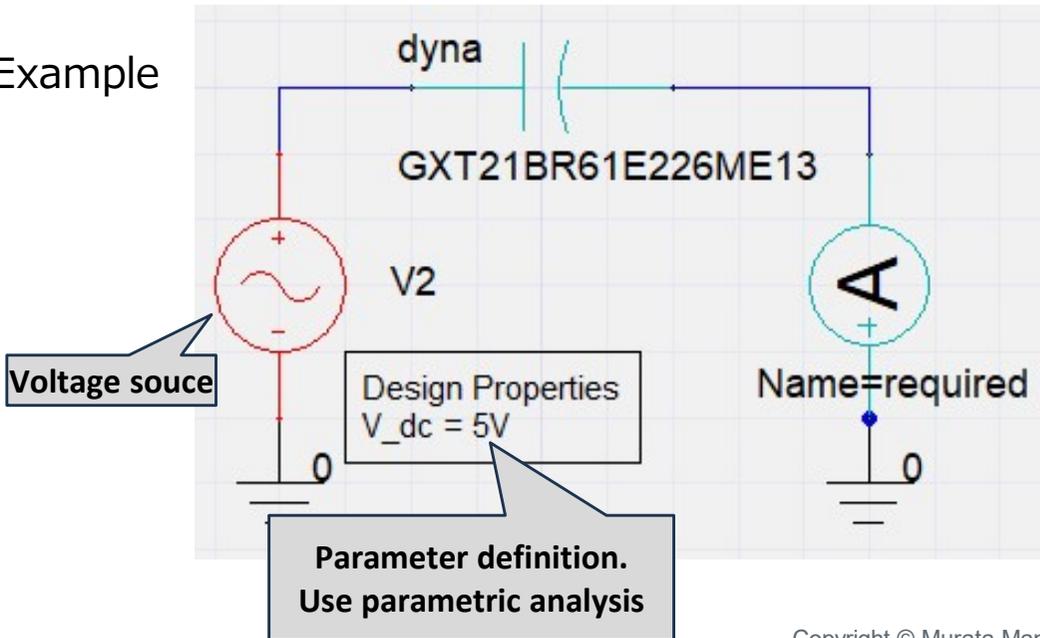
```

*-----↓
* AEDT Model generated by Murata Manufacturing Co., Ltd.↓
* Copyright(C) Murata Manufacturing Co., Ltd.↓
* Description : 2012M(0805)/X5R/22uF/25V (Capacitor)↓
* MURATA P/N : GXT21BR61E226ME13↓
* Property : C = 22 [uF]↓
* Data Generated on Jul 25, 2024↓
*-----↓
* Applicable Conditions:↓
* Frequency Range = 100Hz - 6GHz↓
* Temperature = -55 degC - 85 degC↓
* DC Bias Voltage = 0V - 25V↓
* Small Signal Operation↓
*-----↓
* Encrypted Netlist↓
*-----↓
.subckt GXT21BR61E226ME13 Port1 Port2 PARAMS: temperature=25↓
.protect↓
BeginNexximEncryption↓
6c30235938730388426a62e1f660c41dk+AAJDLXTS14R55FJZIWhjpcGngOZMIx0AvBxHZo0ing4TfIcLsFEDyu2jMAgUAVyE+vUpHcypei440↓
wGf9iD1AF3zrWMORM6pWd83I21o6I9B67vcH2YxpTHwaIueD50suy0rEB4Pjy4IEh1Jd5RwddE1Iza2↓
u5GLNW2+6uBIc5G5wDxcKw+XpICKIrdpYWnm1VEIHDfHWwV7W6g1JebKWjCa4j5QatDB4gu6Taxom+↓
s41nr1ivxX7kDYESZo89kIGLF2RTjaI16/8v2sfpJ12HnTUjLGsGFG+8oMMMK8J7YkYTYTtVQQV++1uI↓
f32ImFKxKmi1PR/TmRaiFon65/N9Iah.IYiH1e2vTPC7sR4NTX87p8MI NSVhkSiubIF1Xe7d+11IlaRv1I↓

```

encrypted netlist

◎ Usage Example



Usage Example of Dynamic Models of Murata's MLCC *muRata*

- OrCAD Capture -



```

lib file
GCD21_nonlin.lib - Xモジュール
ファイル(F) 編集(E) 書式(O) 表示(V) ヘルプ(H)
**$ENCRYPTED_LIB
**$PARTIAL
*-----
* PSPICE Model generated by Murata Manufacturing Co., Ltd.
* Copyright(C) Murata Manufacturing Co., Ltd.
* Description : 2012M(0805)/X7R/47000pF/50V (Capacitor)
* MURATA P/N : GCD21BR71H473KA01
* Property : C = 47000 [pF]
* Data Generated on Jul 25, 2024
*-----
* Applicable Conditions:
* Frequency Range = 100Hz - 6GHz
* Temperature = -55 degC - 125 degC
* DC Bias Voltage = 0V - 50V
* Small Signal Operation
*-----
* I/O node
* Encrypted Netlist
*-----
.subckt GCD21BR71H473KA01_nonlin Port1 Port2 PARAMS: temperature=25
$CDNENSTART_ADVZ
17f62b1fb318c25603aeb85644ae98a5d179ef807807791f6459efacb9d7ffc37a831b146dc0f06bb1ef27E
c5ee9b83eb94b800e457ca6376f082ffc13f324bbc3c07bb05d573f466847dfb35dae9fdd962d0c85dbfda4

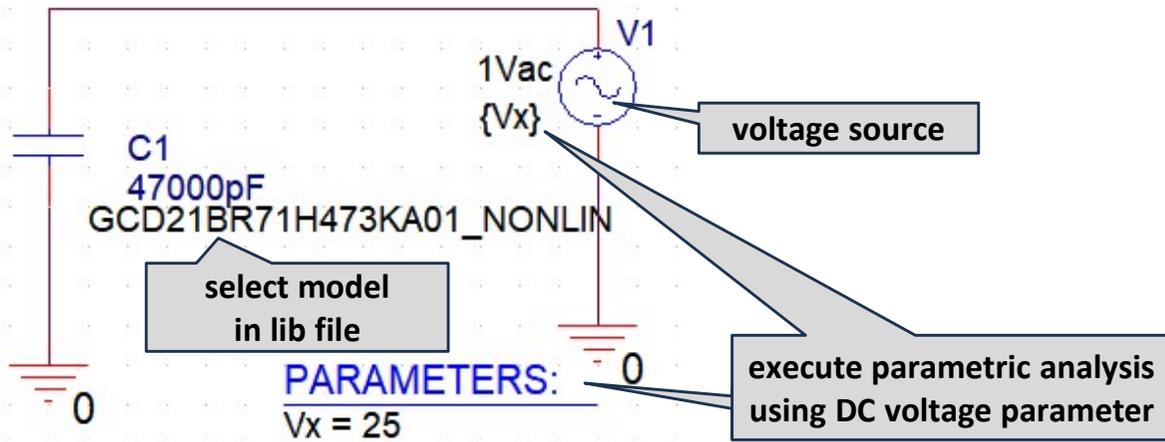
```

part No.

I/O node

encrypted netlist

◎ ◎ Usage Example



Usage Example of Dynamic Models of Murata's MLCC *muRata*

- Spectre -



```
//-----  
// Spectre Model generated by Murata Manufacturing Co., Ltd.  
// Copyright (C) Murata Manufacturing Co., Ltd.  
// Description : 1005M (0402) / X5R / 1uF / 6.3V (Capacitor)  
// MURATA P/N : GRM152R60J105ME15  
// Property : C = 1 [uF]  
// Data Generated on Mar 25, 2024  
//-----  
// Applicable Conditions:  
// Frequency Range = 100Hz - 8GHz  
// Temperature = -55 degC - 85 degC  
// DC Bias Voltage = 0V - 6.3V  
// Small Signal Operation  
//-----  
// Encrypted Netlist  
//-----  
simulator lang=spectre  
  
subckt GRM152R60J105ME15 (Port1 Port2)  
parameters temperature=25  
//pragma protect begin_protected  
//pragma protect data_method = AES  
//pragma protect data_keyowner = Cadence Design Systems.  
//pragma protect data_keyname = CDS_KEY  
//pragma protect data_keyversion = 4  
//pragma protect data_block  
gT2sLj81pdD5vJ9gvdsgTjt5Zx+DDU7I3Z8xHZ0+pSR+hoptcfThRCvpyQzhhdIn  
/gG70uyProG/6J5NqeBRDzUa2zRPxQ12TzIqJS7PSRYfRCPVEXtmgnm5cUWMe1H  
DRpGON8VqZe7CBE1VL+N3mc2zTYf4q3N5Hav+P1OHVUPjeAbbyo/bUP8BqfdAWTv  
5ozx8LepiTeoLtkivsefWfIzzd3tk71LSieUhb5aDwtCnK9A60kicd972RrEU/  
//-----
```

part No. I/O node

encrypted netlist

© Usage Example

```
//Spectre_2024/05/07 16:41:58  
simulator lang=spectre  
↓  
include "GRM152R60J105ME15_Spectre.mod"  
↓  
Sweep1 ac start=1e3 stop=2e10 log=100  
parameters DCbias=0  
↓  
V1 (N001 0) vsource type=sine dc=DCbias mag=1  
XC1 (N001 0) GRM152R60J105ME15 temperature=25
```

Added mode file to be used

Added GRM152R60J105ME15 between node "N001" and 0

Usage Example of Dynamic Models of Murata's MLCC *muRata*

- ADS -



© Usage Example

model definition

NETLIST INCLUDE

```
MurataDynamicModel_C_Include
muRata AC
AC1
SweepVar="freq"
Start=100 kHz
Stop=1000 MHz
Dec=100
```

GCD21 component

select model in GCD21 component

PARAMETER SWEEP

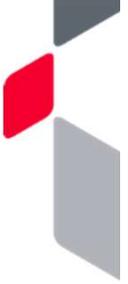
```
ParamSweep
Sweep1
SweepVar="Vx"
SimInstanceName[1]="AC1"
SimInstanceName[2]=
SimInstanceName[3]=
SimInstanceName[4]=
SimInstanceName[5]=
SimInstanceName[6]=
StatusLevel=2
Start=0
Stop=50
Step=25
```

Sweep "Vx"

Var Eqn

```
VAR
VAR1
Vx=0
```

Usage Example of Dynamic Models of Murata's MLCC *muRata* - SIMetrix/SIMPLIS™ -



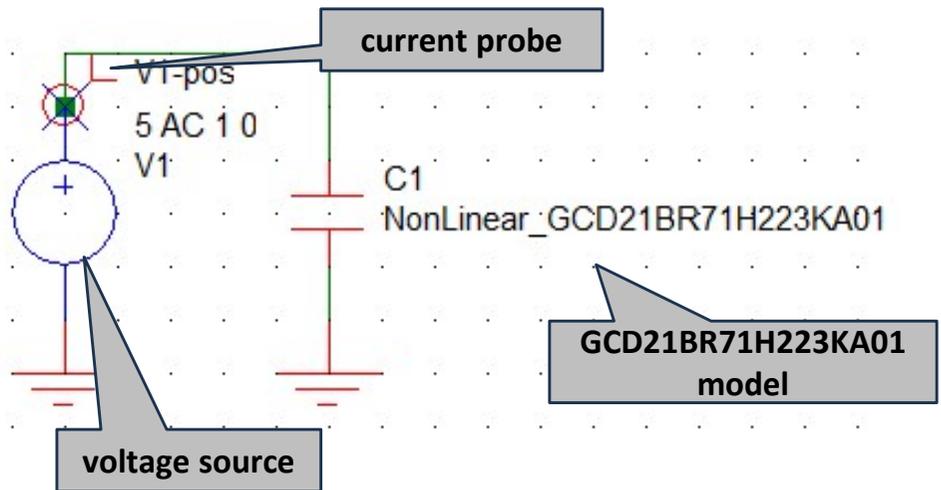
```

GCD21BR71H223KA01_SM.encr - メモ帳
ファイル 編集 表示
-----
*
* SIMetrix Model generated by Murata Manufacturing Co., Ltd.
* Copyright(C) Murata Manufacturing Co., Ltd.
* Description : 2012M(0805)/X7R/22000pF/50V (Capacitor)
* MURATA P/N : GCD21BR71H223KA01
* Property : C = 22000 [pF]
*
*-----
* Applicable Conditions:
* Frequency Range = 100kHz - 6GHz
* Temperature = -55 degC - 125 degC
* DC Bias Voltage = 0V - 50V
* Small Signal Operation
*
*-----
* Encrypted Netlist
*-----
.subckt NonLinear_GCD21BR71H223KA01 Port1 Port2 PARAMS: temperature=25
*#ASSOC symbol=cap category=Murata_Capacitors_Dynamic simulator = simetrix
?@@--START ENCRYPTION: "SMX_AES GCD21BR71H223KA01 Cap Model"
?@@e01y7T6i9Jb1bEcyz9MO/Xty3UOSIph0tkD0pLqyd3g76QpvoyLd/jm3EUzDE15i?##
?@@8FaZdlYciLghvoZPrIethMv7PXMeYKUHApudfOT+Pz5HDXOPN3ntaywwd09SA5P5?##
?@@lvrMN3m+Mez7cFtgcRcSv0WDF4cmY2Dz+fCHNclvr0DD0KmrRiClc77i8w7hvd1d3++?##

```

encrypted netlist

© Usage Example



Usage Example of Dynamic Models of Murata's MLCC *muRata*

- HSPICE™ -



GRM219B31A226MEA0_H.mod - メモ帳

```

ファイル(E) 編集(E) 書式(O) 表示(V) ヘルプ(H)
-----
*
* HSPICE Model generated by Murata Manufacturing Co., Ltd.
* Copyright(C) Murata Manufacturing Co., Ltd.
* Description : 2012/B/22uF/10V (Capacitor)
* MURATA P/N : GRM219B31A226MEA0
* Property : C = 22 [uF]
*
*-----
* Applicable Conditions:
* Frequency Range = 100Hz - 6GHz
* Temperature = -25 degC - 85 degC
* DC Bias Voltage = 0V - 10V
* Small Signal Operation
*-----
* Encrypted Netlist
*-----
.subckt GRM219B31A226MEA0 Port1 Port2 temperature=25
.PROT ddl1
A9(8S#Uc(1Y)E-U>9%;x5I#'%S$b-, (2/E5bVWc'F:9h]Uc:Xj5EJh>(%j)7-U# /JS;b-I:'%EP$V,c' /
X256;>7[ /3) -($-J)'%(=X;w'k%*7!;j4)u ))0.+p9=aS_uh: H)<339!1T$1Gi-!*-7HjLEuh(=X]w'
Z.[5'0X;V=q6mE S)ERhc*¥:s7[;c)¥+ZE-,PI/:T3J4:5P)y=+Ic[/S*x<6($X;WhajHSuv)h5I9!1E$1

```

part No. I/O node

Definition of temperature specification method
This is the default value with no specified temperature when called

encrypted netlist

◎ Usage Example

HSPICE_main_C.cir - メモ帳

```

ファイル(E) 編集(E) 書式(O) 表示(V) ヘルプ(H)
-----
.option post=2
.inc ./data/GRM219B31A226MEA0_H.mod
.ac dec 41 100 6e9
.print ac vr(V1) vi(V1)
.param DCbias=4
V1 N001 0 DC=DCbias AC=1.0
XC1 N001 0 GRM219B31A226MEA0 temperature=125
.end

```

Added mod file to be used

The DC superposition current value is automatically detected.

Added GRM219B31A226MEA0 between node "N001" and 0
Set "temperature=125" as a parameter

Dynamic Model of Power Inductors



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.

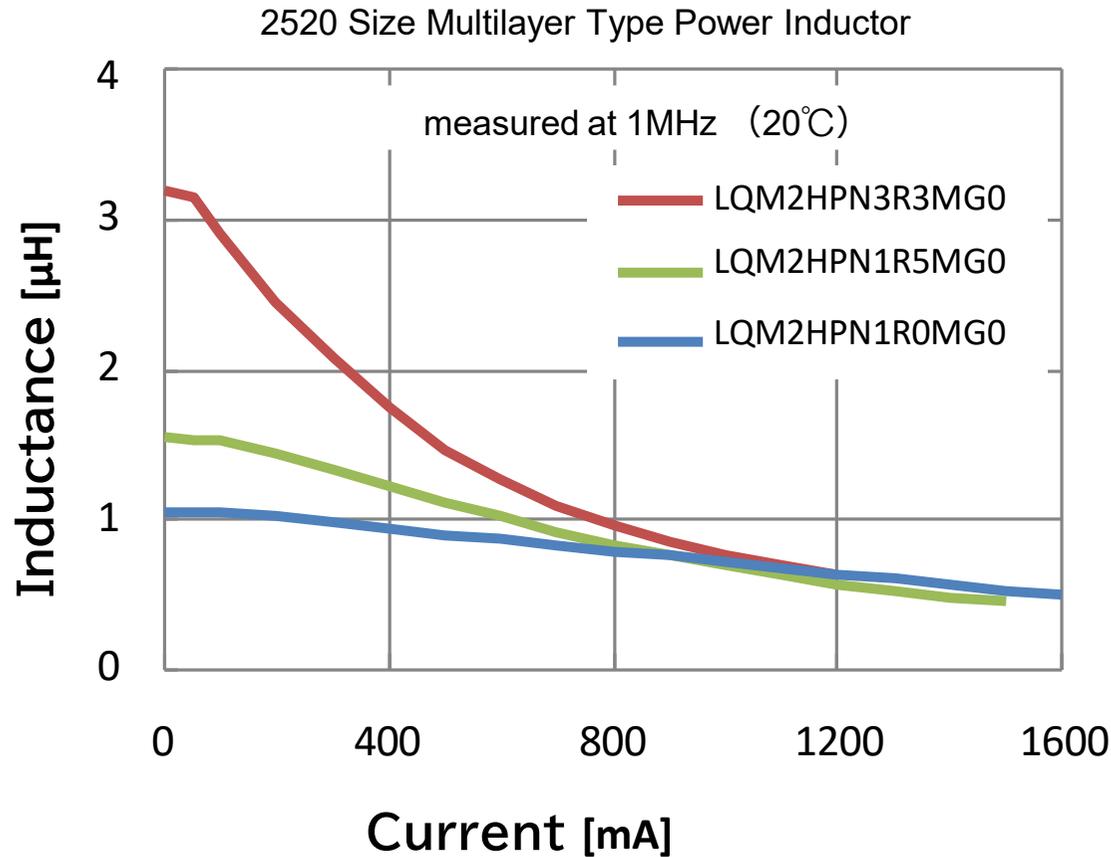


In a circuit where a power inductor is used, the current which flows into the power inductor is not constant.

||

The inductance value is not constant during operation.

Example of Power Inductor Current - Inductance Characteristics

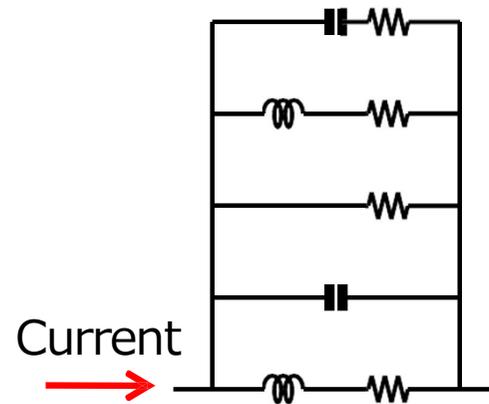


=> In ferrite based power inductors, when a large current flows through, since the ferrite approaches magnetic saturation, the permeability decreases during the process. The inductance also decreases because the inductance is proportional to the permeability. The above figure shows the characteristics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

Comparison between Murata's Conventional Models and Actual Measurement Value

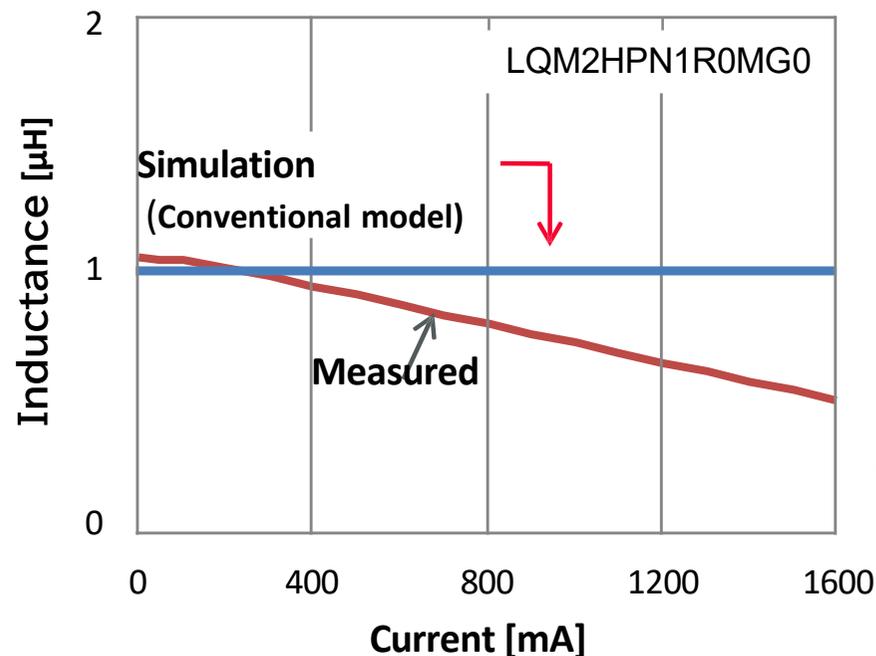


(1) Murata's conventional equivalent circuit model of an inductor (Example)



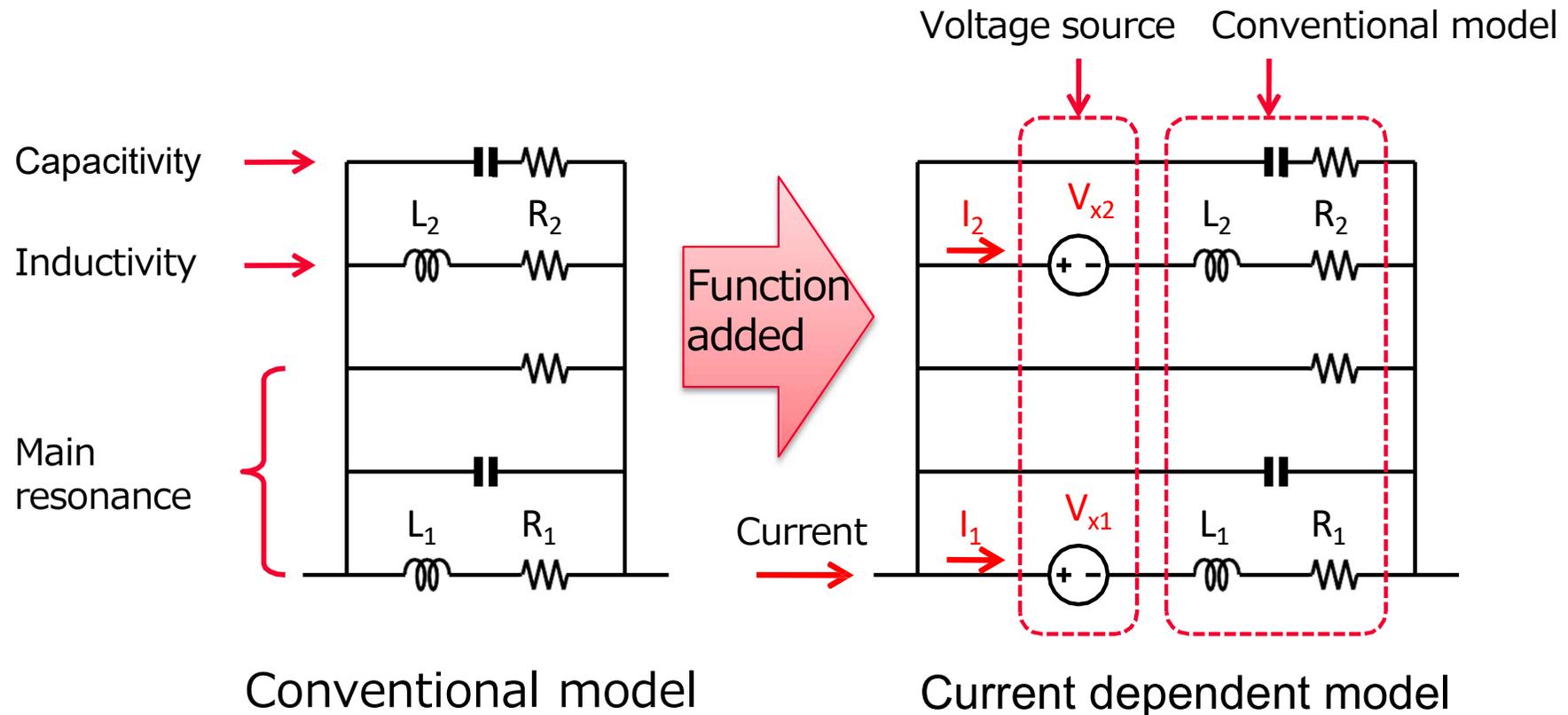
=> Even when the current changes, the constant of each component does not change (DC superposition characteristics are not reflected)

(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)

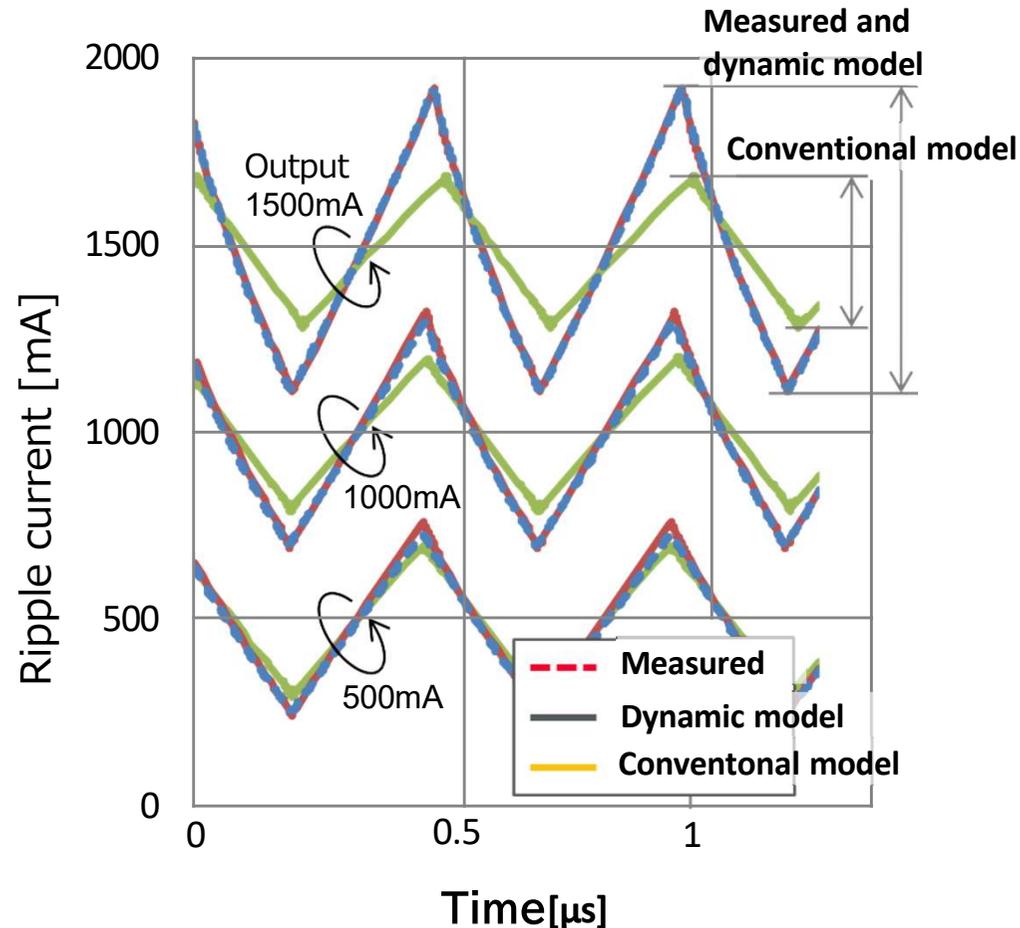


=> Adding current dependency to several components of a conventional model, realized a dynamic model which responds to the change of inductance along with the change of the real time current.

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



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

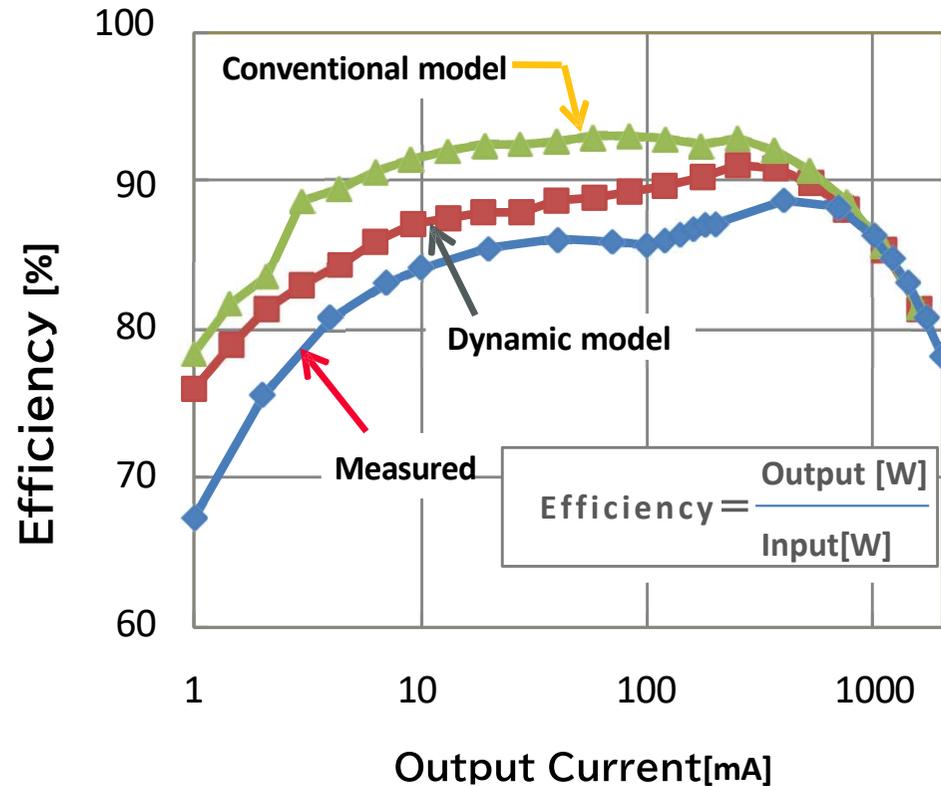


=> In a conventional model, since the current dependent characteristics of an inductor are not reflected, the simulation results deviate from the measured value. On the other hand, in a dynamic model, results close to the actual measured value could be acquired.

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



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.

- Analog Devices LTspice™
<https://www.murata.com/ja-jp/tool/data/librarydata/library-ltspice>
- Cadence™ OrCAD Capture
<https://www.murata.com/ja-jp/tool/data/librarydata/library-orcad>
- Cadence™ PSpice
<https://www.murata.com/ja-jp/tool/data/librarydata/library-pspice>
- Cadence™ Spectre
<https://www.murata.com/ja-jp/tool/data/librarydata/library-spectre>
- Keysight PathWave ADS
<https://www.murata.com/ja-jp/tool/data/librarydata/library-keysight2>
- Simetrix Technologies SIMetrix/SIMPLIS™
<https://www.murata.com/ja-jp/tool/data/librarydata/library-simetrix>
- Synopsys HSPICE™
<http://www.murata.com/ja-jp/tool/library/hspice>

[Contained Products]
Power Inductor : All series

- ※LTspice is a registered trademark or trademark of Analog Devices, Inc.
- ※Cadence is a registered trademark or trademark of Cadence Design Systems, Inc.
- ※Simetrix/SIMPLIS are registered trademarks or trademarks of Simetrix Technologies Inc.
- ※HSPICE is a registered trademark or trademark of Synopsys, Inc.

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



■ Symbol file (Ext.asy)

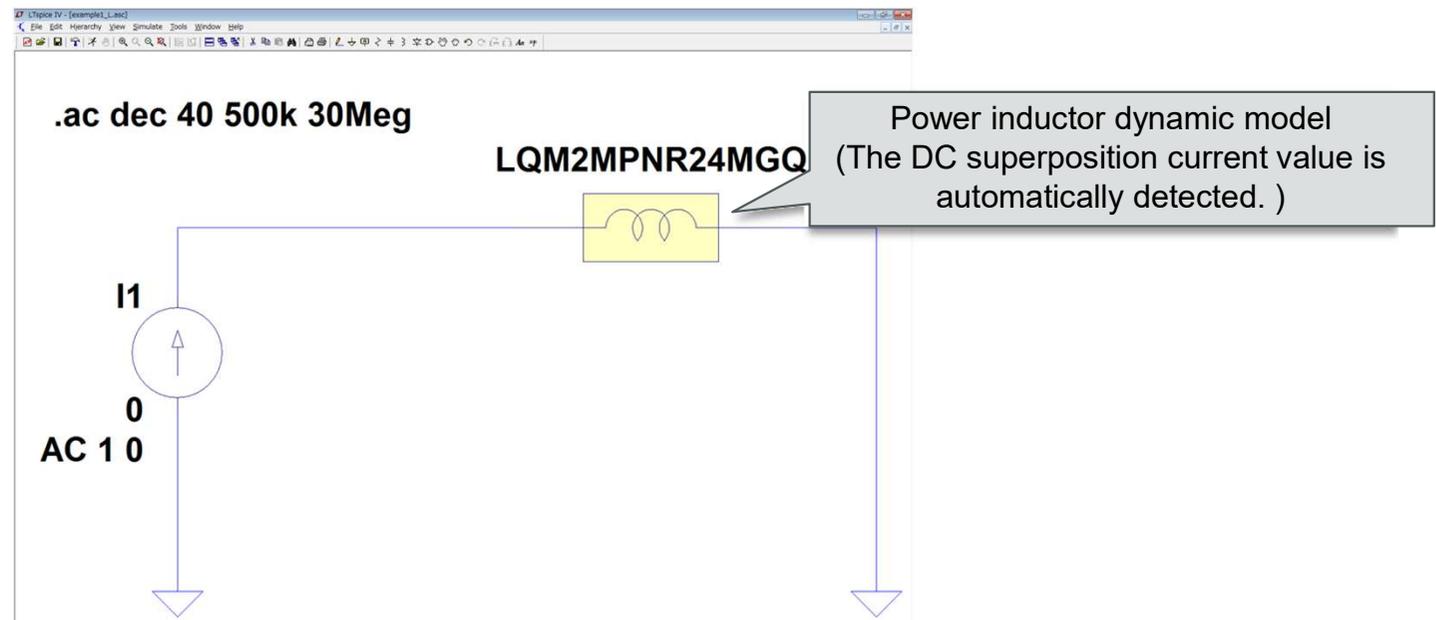
Create and save any folder after the "sym" folder in the folder where LTspice is installed.
Example) C:\Program Files (x86)\LTC\LTspiceIV\lib\sym\murata_Inductor

■ 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



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



```
LQM2MPNR24MGH_P.mod - メモ帳
ファイル(E) 編集(E) 書式(O) 表示(V) ヘルプ(H)
**$ENCRYPTED_LIB
**$PARTIAL
*-----
* PSPICE 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
*-----
* Encryp
*-----
.subckt LQM2MPNR24MGH port1 port2
$CDNENCSTART
eee8c5c7a2bc4b01f045f303678664e7916da0bae22e8cb0bba041dd67c69ce448ea70148a9ac1670c8926c1e
6a46f4e4a7006c7d3d503a78d3c8f2104a6a3f8d859eb3553d9a91294fd429388bcb1ddedb571d6878eeec08
fd0d27d8bc408b7a80e20a04097ae60587568e99bb4c24f00abf73b59eb73958667b0549088555add
f9c40f9087cefa0f3f9367711c25089517ac78b222f7a90e8d9287927890b527e6dbd264f9e
```

part No. I/O node encrypted netlist

◎ Usage Example

```
PSPICE_main_L.cir - メモ帳
ファイル(E) 編集(E) 書式(O) 表示(V)
.inc ./data/LQM2MPNR24MGH_P.mod
.ac dec 41 500e3 30e6
.probe
.param Ibias=3.4
I1 0 N001 DC {Ibias} AC 1 0
XL1 N001 0 LQM2MPNR24MGH
.end
```

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 - Spectre -



```
LQM2HPN1R0MGH_Spectre.mod (~\SPICE\150625_test\data) - GVIM
File Edit Tools Syntax Buffers Window Help
// -----
// Spectre Model generated by Murata Manufacturing Co., Ltd.
// Copyright(C) Murata Manufacturing Co., Ltd.
// Murata P/N : LQM2HPN1R0MGH
// Description : Size 2.5 * 2.0 * 1.0mm / L = 1uH / Imax = 2A / Rdc = 0.05ohm
// Frequency Range : 500.0kHz - 30.0MHz
// Voltage Condition : DC-DC Converter, Input Voltage = 3.6V, Output Voltage = 1.8V
// Model generated 2014/04/02(Ver 1.05), measured 2014/04/02
// A part No. been a I/O node
// -----
simulator lang=spectre
subckt LQM2HPN1R0MGH (port1 port2)
//pragma protect begin_protected
//pragma protect data_method = RC5
//pragma protect data_keyowner = Cadence Design Systems.
//pragma protect data_keyname = CDS_KEY
//pragma protect data_keyversion = 2
```

© Usage Example

```
Spectre_main_L.cir (~\SPICE\150625_test) - GVIM
File Edit Tools Syntax Buffers Window Help
simulator lang=spectre
include "../data/LQM2HPN1R0MGH_Spectre.mod"
Sweep1 ac start=500e3 stop=30e6 log=40
parameters DCbias=2
I1 (0 N001) isource type=sine dc=DCbias mag=1
XL1 (N001 0) LQM2HPN1R0MGH
```

Added mode file to be used

The DC superposition current value is automatically detected.

Added LQM2HPN1R0MGH between node "N001" and 0

Usage Example of Dynamic Model of Murata's Power Inductor - ADS -

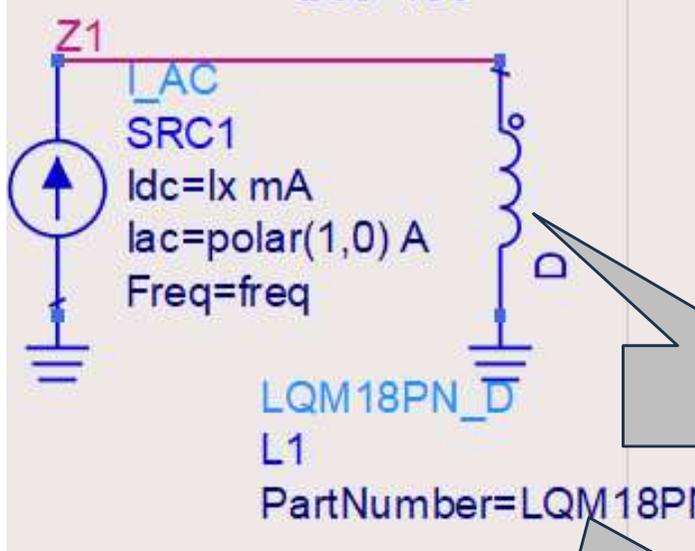


© Usage Example

model definition

NETLIST INCLUDE

```
MurataDynamicModel_L_Include
muRata AC
AC1
SweepVar="freq"
Start=100 kHz
Stop=100 MHz
Dec=100
```



LQM18PN
Component

select model in LQM18PN component

PARAMETER SWEEP

```
ParamSweep
Sweep1
SweepVar="Ix"
SimInstanceName[1]="AC1"
SimInstanceName[2]=
SimInstanceName[3]=
SimInstanceName[4]=
SimInstanceName[5]=
SimInstanceName[6]=
StatusLevel=2
Start=000
Stop=600
Step=600
```

VAR
VAR1
Ix=0

Sweep "Ix"

LQM18PN Component

select model in LQM18PN component

Usage Example of Dynamic Model of Murata's Power Inductor - Simetrix/SIMPLIS™ -

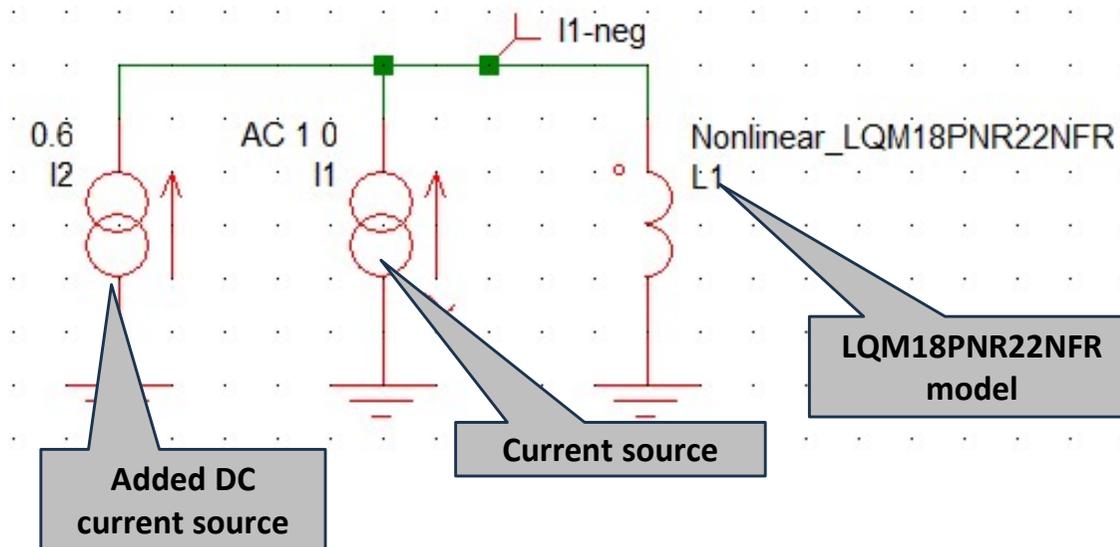


```

LQM18PNR22NFR_SM.encr - メモ帳
ファイル 編集 表示
-----
*
* SIMetrix Model generated by Murata Manufacturing Co., Ltd.
* Copyright(C) Murata Manufacturing Co., Ltd.
* Murata P/N : LQM18PNR22NFR
* Description : Size 1.6 * 0.8 * 0.8mm / L = 0.22uH / Imax = 1.25A / Rdc = 0.11ohm
* Frequency Range : 753.0kHz - 30.0MHz
* Voltage Condition : DC-DC Converter, Input Voltage = 3.6V, Output Voltage = 1.8V
* Model generated 2014/04/14(Ver 1.05), measured 2014/03/31
* A patent has been applied for
*
-----
.subckt Nonlinear_LQM18PNR22NFR port1 port2
*#ASSOC symbol=Ind category=Murata_Inductors General simulator=simetrix
?@--START ENCRYPTION: "SMX_AES_LQM18PNR22NFR_SM.encr Inductor M"
?@Tno56sPF00w5U/zpWu8ucIoAv401RmMJ+MsILKBetgfUVoZfx4A5VMk6P029F10+?##
?@c0Ym1n+FCrs9jpYs82wE+/VfPR70QEx9vX0/DVSWW5o47tr33YRRTgyihpt3Pav1?##
?@GRLLe0CSHiGZQH9IbcEyLu6j5hjVLMNqkMv68mzPfp4Sdt+w8Fe1kiHz7njKW17H?##
?@u385j+YcLbEHn/SB4zuiZOK3qaj6zY17LJXJUlgbgPLFN8WkjQ9Ae0LOYc0PQfUc?##
?@m7~1.~V~7V~0C~0~f0~...DT0~1..TNE?;0D+-10.1V?E~0~07~...+E4+E~/E01/f~...JND/?##
    
```

encrypted netlist

◎ Usage Example



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



```
LQM32PN1R0MG0_H.mod - メモ帳
ファイル(E) 編集(E) 書式(O) 表示(Y) ヘルプ(H)
-----
*
* HSPICE Model generated by Murata Manufacturing Co., Ltd.
* Copyright(C) Murata Manufacturing Co., Ltd.
* Murata P/N : LQM32PN1R0MG0
* Description : Size 3.2 * 2.5 * 0.9mm / L = 1uH / Imax = 1.8A / Rdc = 0.048ohm
* Frequency Range : 500.0kHz - 30.0MHz
* Voltage Condition : DC-DC Converter, Input Voltage = 3.6V, Output Voltage = 1.8V
* Model generated 2014/04/15(Ver 1.05), measured 2014/04/01
* A patent has been applied for
*
* -----
* Encry part No. t I/O node
* -----
*
.subckt LQM32PN1R0MG0 port1 port2
.PROT ddl1
A9(8S#Uc(1Y)E-U>9%;x5I#'$S$b-, (2/E5bVWc'F:9h]Uc:Xj5EJh>(%j)7-U#/#JS;b-I:'%EP$V,c'/25b]-
y7/xiW8SP:=. t4¥w(6
>h$#T;9WE26M'2c9V-0IRIw'J(==;Q
9-%28MD)! =Xz5=#Y0ra1RG%ULWtp'xF.*[B:4f9b+' 98b-.X6

```

encrypted netlist

◎ Usage Example

```
HSPICE_main_L.cir - メモ帳
ファイル(E) 編集(E) 書式(O) 表示(Y) ヘルプ(H)

.option post=2
.inc ./data/LQM2MPNR24MGH_H.mod
.ac dec 41 500e3 30e6
.print ac vr(V1) vi(V1)
.param Ibias=1.8

I1 N001 0 DC=Ibias AC=1,0
XLT N001 0 LQM2MPNR24MGH

.end
```

Added mod file to be used

The DC superposition current value is automatically detected.

Added LQM2MPNR24MGH between node "N001" and 0