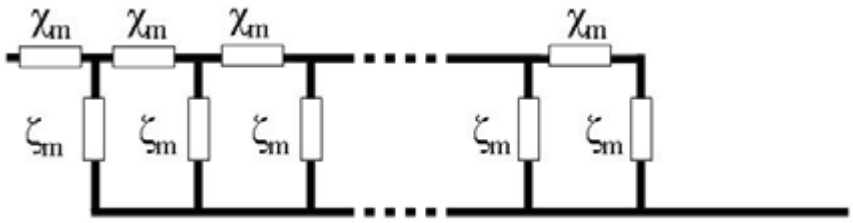
Bisquert Open Model



$$Z = \sqrt{\zeta_m \chi_m}\coth\left(L\sqrt{\frac{\chi_m}{\zeta_m}}\right) \quad \text{where} \quad \zeta_m = r_m \quad \text{and} \quad \chi_m = r_k \,||\, q_m$$

이 때 Constant Phase Element q_m이

$$q_m = \frac{1}{Q_y s^{Q_a}} \quad \text{where } s = j\omega \text{ and } j = \sqrt{-1}$$

으로 표현되어지므로

$$\chi_m = \frac{r_k}{1 + r_k Q_y s^{Q_a}}$$

$$Z = \sqrt{\frac{r_m r_k}{1 + r_k Q_y s^{Q_a}}}\coth\left(L\sqrt{\frac{r_m}{r_k}\left(1 + r_k Q_y s^{Q_a}\right)}\right)$$

이 된다.

이 모델을 Element A라 하고 ZMAN에 추가해보자. Appendix 1, 2, 3를 참고하면서 다음 테이블의 Steps을 따라 하자.

1. Add "A" element in SIMPLE category	
Category	SIMPLE
Model	A
Formula	coth(AL * sqrt(Am / Ak * (1 + Ak * Ay * pow(s, Aa)))) * sqrt(Am * Ak / (1 + Ak * Ay * pow(s, Aa)))
Note	Refer to Appendix 1 and 2 • $\mathrm{AL} = \mathrm{L}$ • $\mathrm{Am} = \mathrm{r_m}$ • $\mathrm{Ak} = \mathrm{r_k}$ • $\mathrm{Ay} = \mathrm{Q_y}$ • $\mathrm{Aa} = \mathrm{Q_a}$ • $\mathrm{s} = \mathrm{j\omega}$
Steps	Refer to Fig. 1 ~ 3 (1) Open **Model Editor** dialog (2) Select **SIMPLE** item in the **Category** list (3) Select **Model > New/Edit...** in menu (4) Select **A** as **Symbol** (5) Type "Bisquert Open" in the **Alias** blank (6) Type above formula in the **Formula** blank (7) Click the **OK** button (8) Select **Parameter** tab and type default values
2. Make Rs-A-L1 Model in USER category	
Category	USER
Model	Rs-A-L1
Steps	Refer to Fig 4 ~ 5 (1) Select **USER** item in the **Category** list (2) Select **Model > New...** in menu (3) Type "Rs-A-L1" in the **Model** blank (4) Click the **OK** button (5) Select **Parameter** tab and type default values

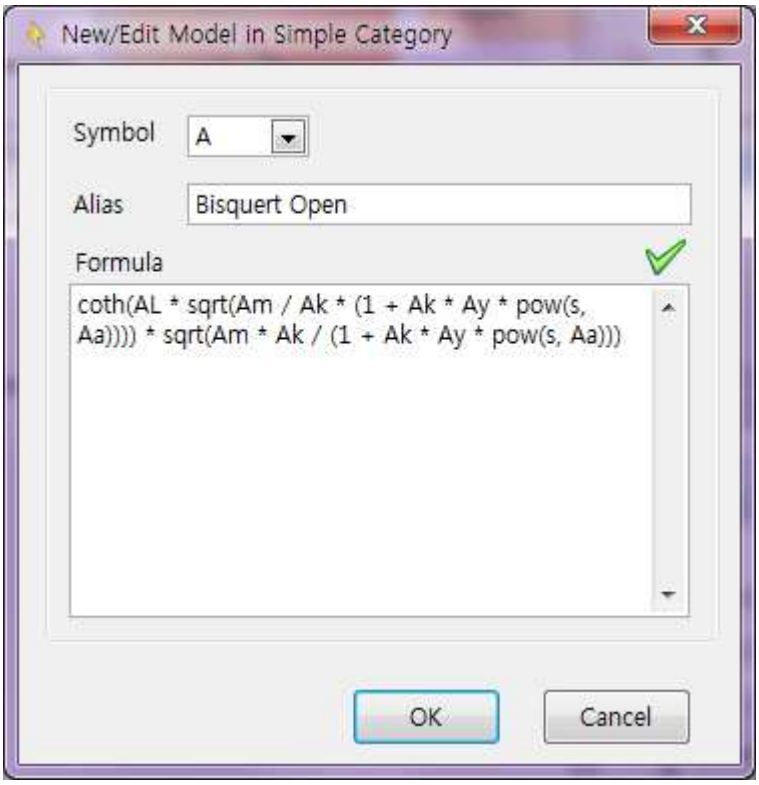

New/Edit Model in Simple Category
Symbol
A
Alias
Bisquert Open
Formula
coth(AL * sqrt(Am / Ak * (1 + Ak * Ay * pow(s, Aa)))) * sqrt(Am * Ak / (1 + Ak * Ay * pow(s, Aa)))
OK
Cancel

Fig 1

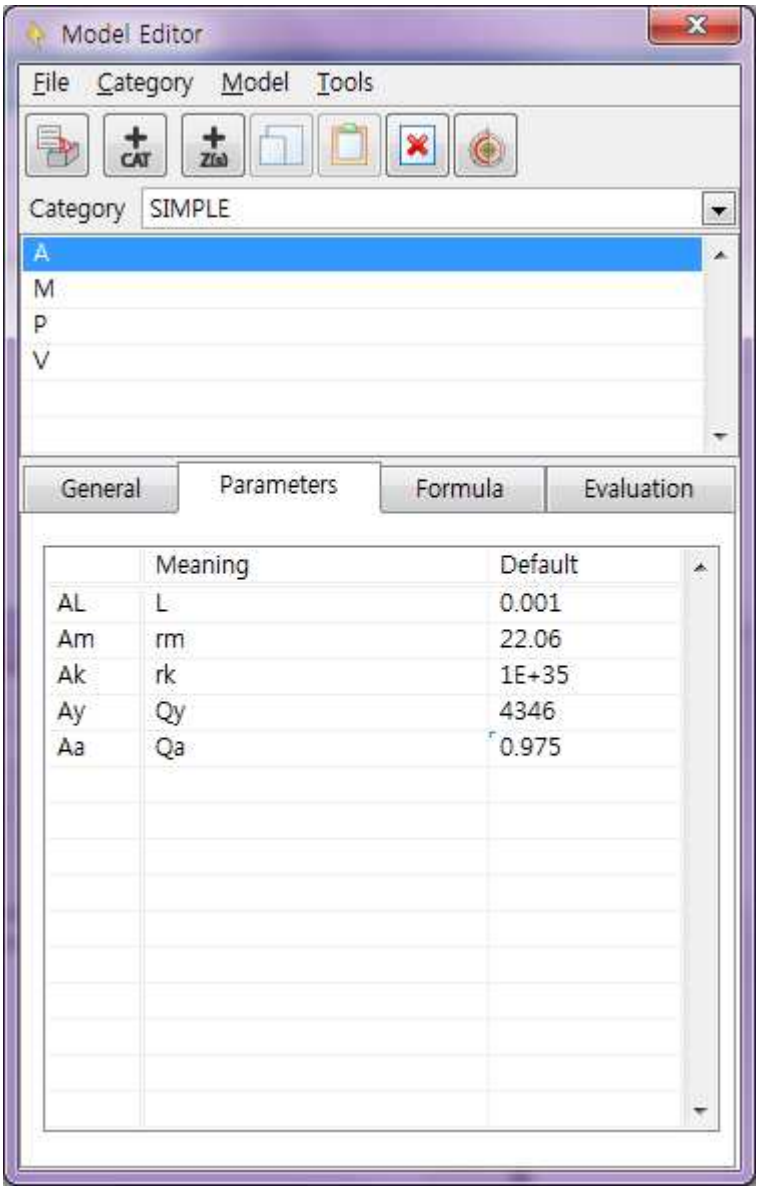

Model Editor
File Category Model Tools
Category SIMPLE
A
M
P
V
General
Parameters
Formula
Evaluation
Meaning
Default
AL L 0.001
Am rm 22.06
Ak rk 1E+35
Ay Qy 4346
Aa Qa 0.975

Fig 2

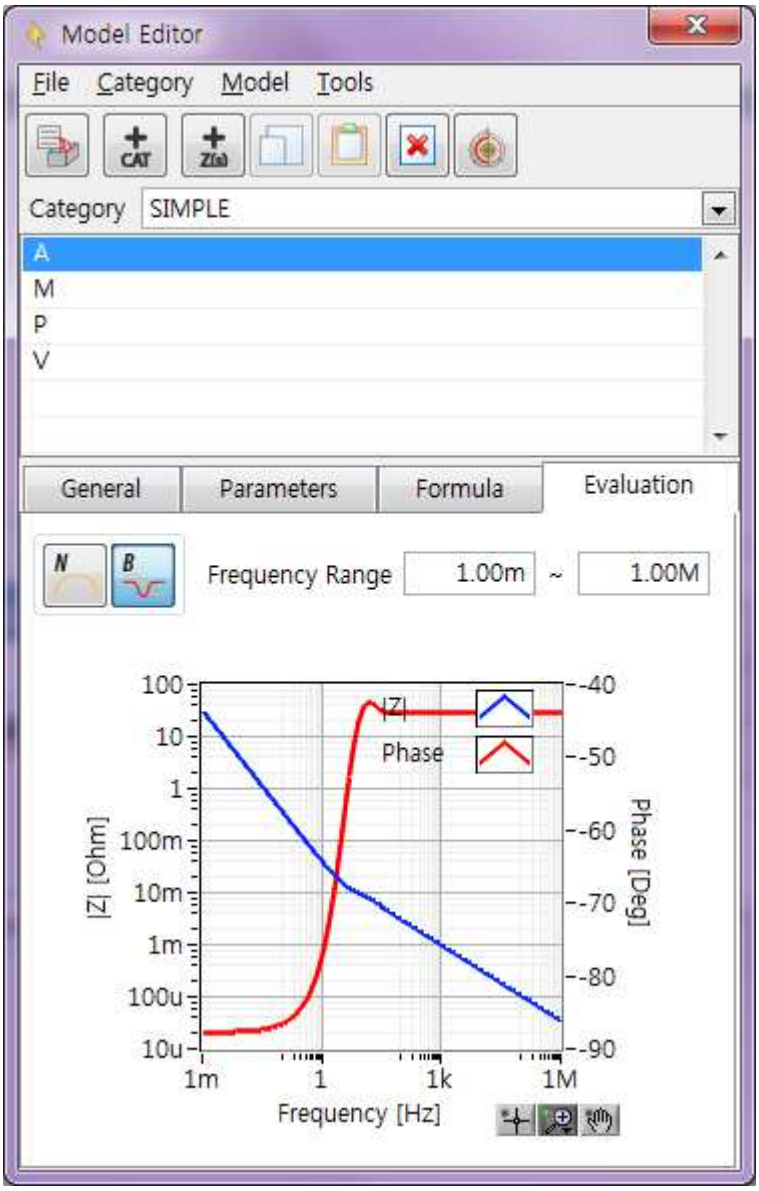

Model Editor
File Category Model Tools
Category SIMPLE
A
M
P
V
General Parameters Formula Evaluation
Frequency Range 1.00m ~ 1.00M
|Z|
Phase
|Z| [Ohm]
Phase [Deg]
Frequency [Hz]

Fig 3

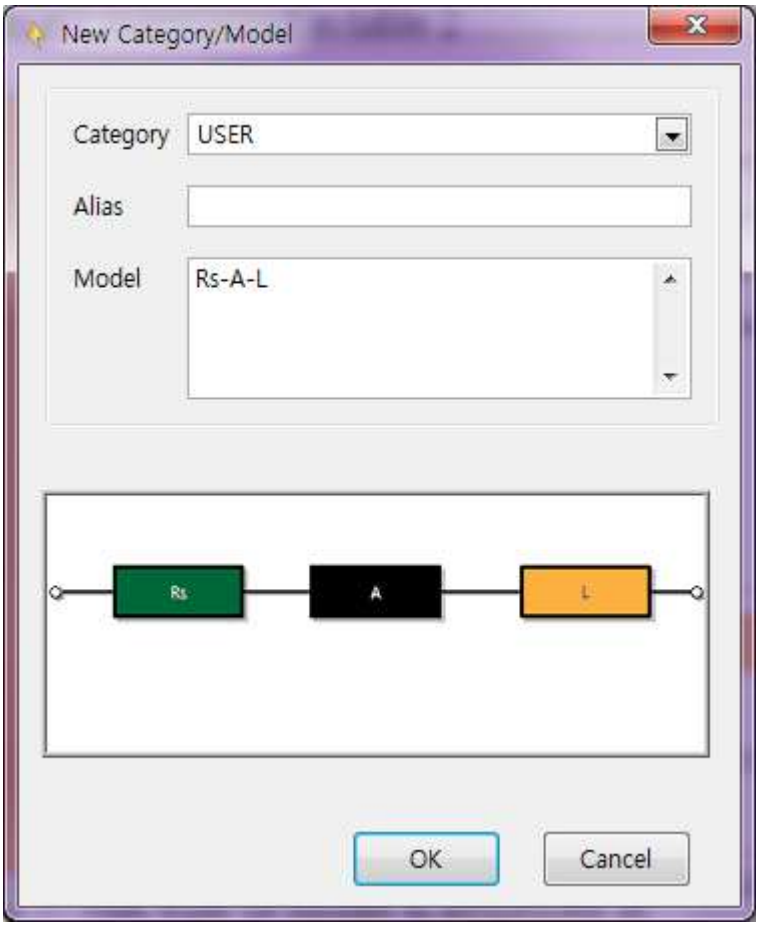

New Category/Model
Category
USER
Alias
Model
Rs-A-L
Rs
A
L
OK
Cancel

Fig 4

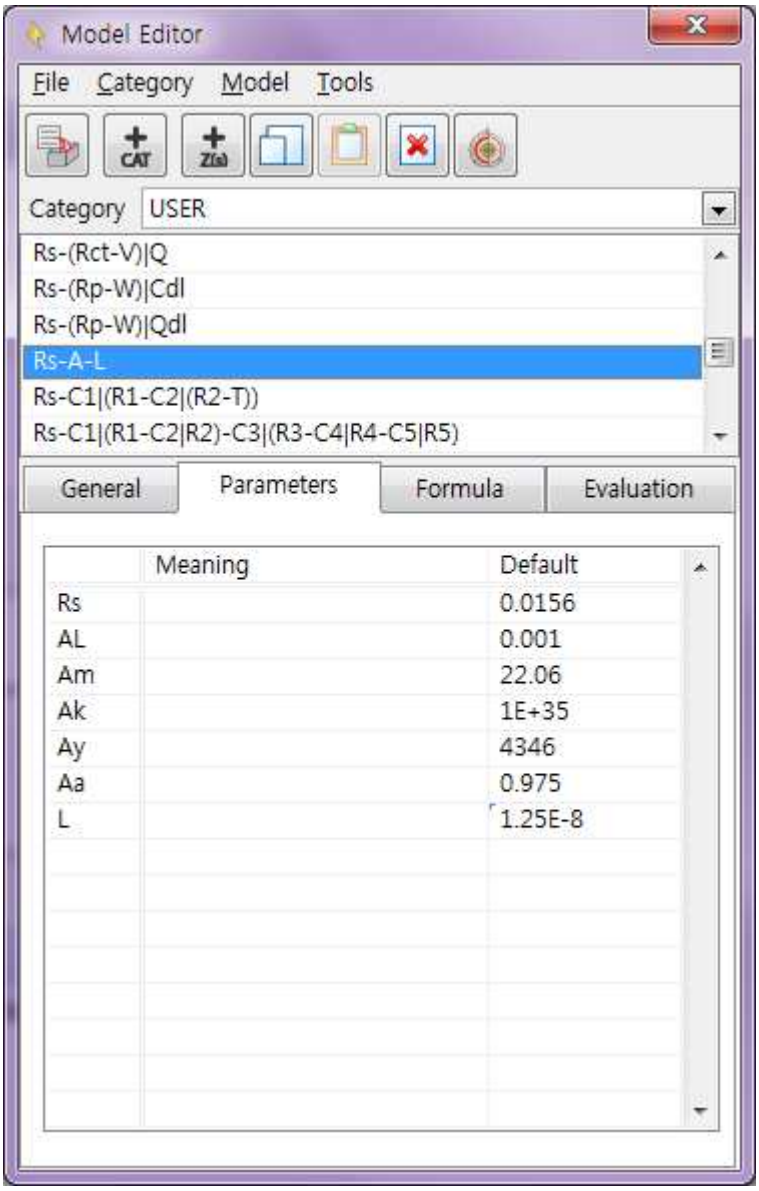

Model Editor
File Category Model Tools
Category USER
Rs-(Rct-V)|Q
Rs-(Rp-W)|Cdl
Rs-(Rp-W)|Qdl
Rs-A-L
Rs-C1|(R1-C2|(R2-T))
Rs-C1|(R1-C2|R2)-C3|(R3-C4|R4-C5|R5)
General
Parameters
Formula
Evaluation
Meaning
Default
Rs 0.0156
AL 0.001
Am 22.06
Ak 1E+35
Ay 4346
Aa 0.975
L 1.25E-8

Fig 5

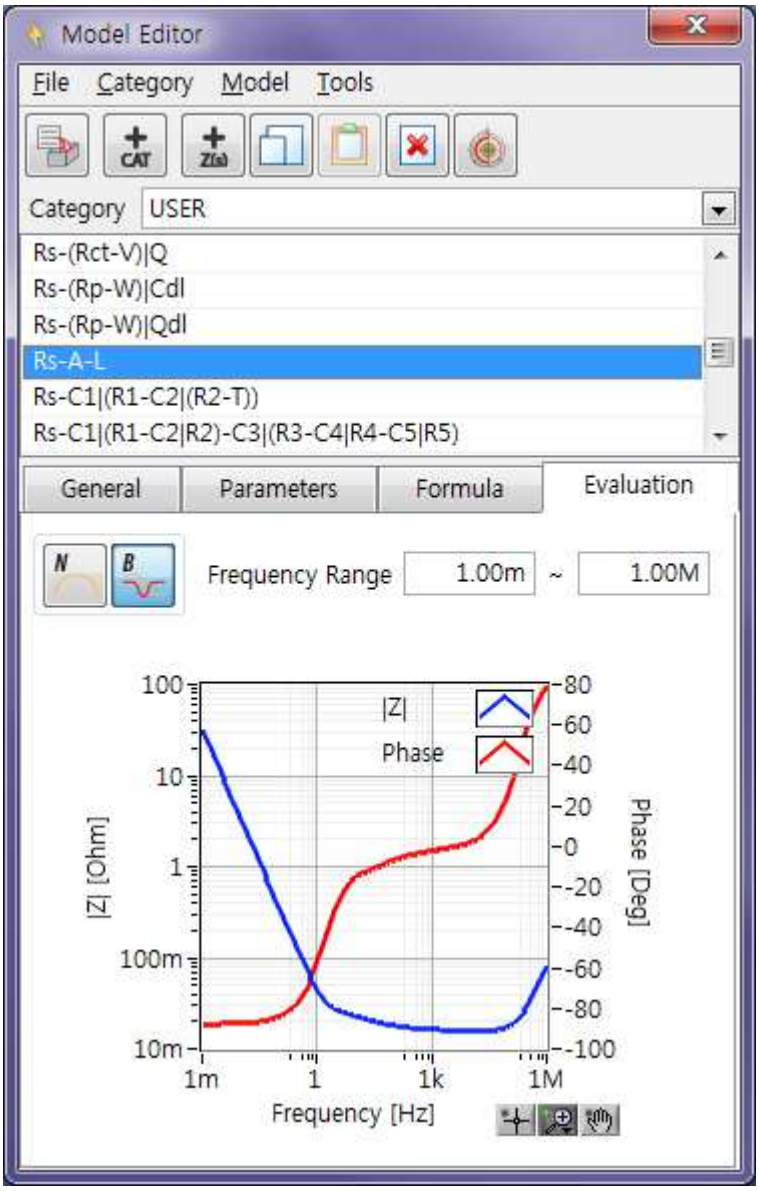

Model Editor
File Category Model Tools
Category USER
Rs-(Rct-V)|Q
Rs-(Rp-W)|Cdl
Rs-(Rp-W)|Qdl
Rs-A-L
Rs-C1|(R1-C2|(R2-T))
Rs-C1|(R1-C2|R2)-C3|(R3-C4|R4-C5|R5)
General
Parameters
Formula
Evaluation
N
B
Frequency Range
1.00m
~
1.00M
|Z|
Phase
|Z| [Ohm]
Phase [Deg]
Frequency [Hz]
100
10
1
100m
10m
1m
1
1k
1M
80
60
40
20
0
-20
-40
-60
-80
-100

Fig 6

Appendix 1. List of Functions

Constants	
pi	Returns pi

Functions	
abs(x)	computes the absolute value of x
acos(x)	inverse cosine of x
acosh(x)	inverse hyperbolic cosine of x
acot(x)	inverse cotangent of x
acoth(x)	inverse hyperbolic cotangent of x
asin(x)	inverse sine of x
asinh(x)	inverse hyperbolic sine of x
atan(x)	inverse tangent of x
atan2(x,y)	inverse tangent of x/y
atanh(x)	inverse hyperbolic tangent of x
ceil(x)	computes the smallest integer greater than or equal to x
cos(x)	cosine of x
cosh(x)	hyperbolic cosine of x
cot(x)	cotangent of x
coth(x)	hyperbolic cotangent of x
csc(x)	cosecant of x
csch(x)	hyperbolic cosecant of x
deg(x)	converts radians to degrees (x*180/p)
e(x)	returns e or the argument multiplied by e
erf(x)	Error function
erfc(x)	Complementary Error function
exp(x)	e raised to the x power (exponential function)
factr(x)	factorial
floor(x)	computes the largest integer less than or equal to x
fract(x)	computes the fractional part of x
gamma(x)	Gamma function
gammai(a,x)	Incomplete Gamma function
getexp(x)	computes the exponent of a floating-point value
getman(x)	computes the mantissa of a floating-point value
int(x)	computes the integer part of x
ldexp(m,e)	computes a floating-point number from mantissa and exponent
ln(x)	natural logarithm of x (logarithm to the base e)

log(x,y)	logarithm of y to the base x
log10(x)	logarithm of x to the base 10
log2(x)	logarithm of x to the base 2
pi(x)	returns pi or the argument multiplied by pi
pow(x,y)	x raised to the y power
pow10(x)	10 raised to the x power
pow2(x)	2 raised to the x power
rad(x)	converts degrees to radians (x*p/180)
random(x,y)	generates random numbers within the specified range
sec(x)	secant of x
sech(x)	hyperbolic secant of x
sign(x)	returns the sign of x
sin(x)	sine of x
sinc(x)	sin(x)/x
sinh(x)	hyperbolic sine of x
spike(x)	Spike function
sqrt(x)	computes the square root of x
square(x)	Square function
step(x)	Step function
tan(x)	tangent of x
tanh(x)	hyperbolic tangent of x

Appendix 2. Naming Convention for Circuit Element

Parameter naming convention for circuit element

ZMAN accepts only the following parameters:

A, AA, AB, AC, … , Aa, Ab, Ac, …
B, BA, BB, BC, … , Ba, Bb, Bc, …
…
Z, ZA, ZB, ZC, …, Za, Zb, Zc, …

- A parameter must consist of symbol and (or) an alphabetical character.
- A parameter name is case sensitive; i.e. AA and Aa are considered to be distinct parameters.

Appendix 3. Naming Convention in a model

Element naming convention in a model

Variables are distinguished by names. There are the following rules of naming variables:

- The first character should be a Symbol character(A to Z) and followed by alphabetical characters (capital and small letters), decimal digits, and underscore (_)
- A name is case sensitive; i.e. lowercase and uppercase letters are considered to be distinct characters
- There is no limit of name length; herewith all characters are significant