

电子电路与综合实验

Simulink与通信电子系统仿真

通信电子系统仿真技术

- * 常用的通信电子系统仿真技术按照系统层次可分为三大类：
 - 网络层次的系统分析与仿真
 - 链路层次的系统分析与仿真
 - 电路层次的系统分析与仿真

链路层次的仿真

- * 链路层次上研究的是针对不同物理信道中的信息承载波形的传输问题。
- * 仿真模型中的模块，如滤波器、放大器等仅作功能性的描述。
- * 通过对输入输出波形或符号的仿真，来验证系统设计是否满足要求。
- * 常用的链路层次仿真的软件有：Agilent ADS、Matlab/Simulink等。

Matlab与Simulink

- * Matlab是在学术界和工程界被广泛采用的科学语言，目前已经成为科学工作者进行数值计算、系统建模仿真、数值结果处理与交流的事实标准平台。
- * Simulink是Matlab中的一个建立系统方框图和基于方框图的系统仿真环境，是一个对动态进行建模、仿真和仿真结果可视化分析的软件包。

Simulink平台的特点

- * 使用Simulink，用户可以将一系列图形化的系统模块连接起来，从而建立起一个直观而又功能多样的动态系统模型。
- * Simulink可以避免或减少编写Matlab仿真程序的工作量，简化仿真建模的过程，更加适合于大型系统的建模和仿真，如对超外差接收机系统、调频广播系统的仿真等。

Simulink平台的特点

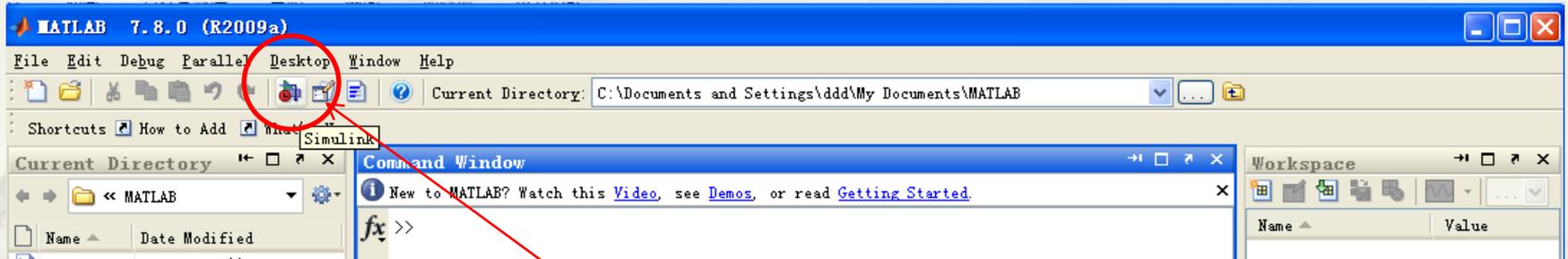
- * 1990年，Simulink首次作为Matlab的软件工具包推出，并很快就成为了系统建模和仿真的主流软件工具。
- * 目前Matlab/Simulink国内常用的版本有5.3版、6.5版、7.0版、R2006a、R2008b、R2009a等。

Simulink平台的特点

- * Simulink仿真环境附带了许多专业仿真模块库。利用这些模块库可以快速的建立相关专业领域的系统模型进行仿真，而不需要用户详细了解各个模块内部的实现细节。
- * Simulink仿真环境提供了对Matlab语言、C语言、数字电路硬件描述语言、以及DSP系统等硬件系统间的接口。

Simulink的启动

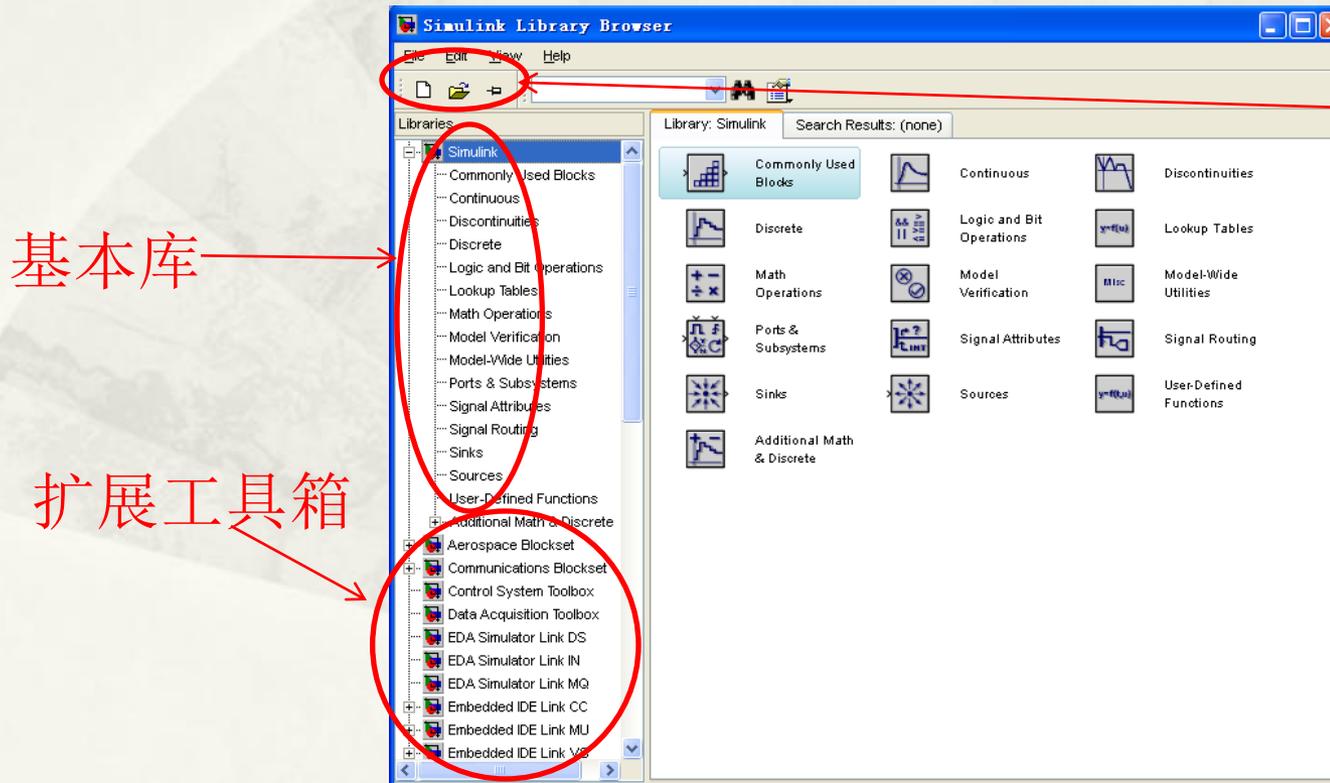
- * 可从Matlab主界面的工具栏中点击Simulink图标，启动Simulink界面。



Simulink

Simulink的启动

- * Simulink提供了大量的专业库，如通信系统、信号处理、电气工程等。



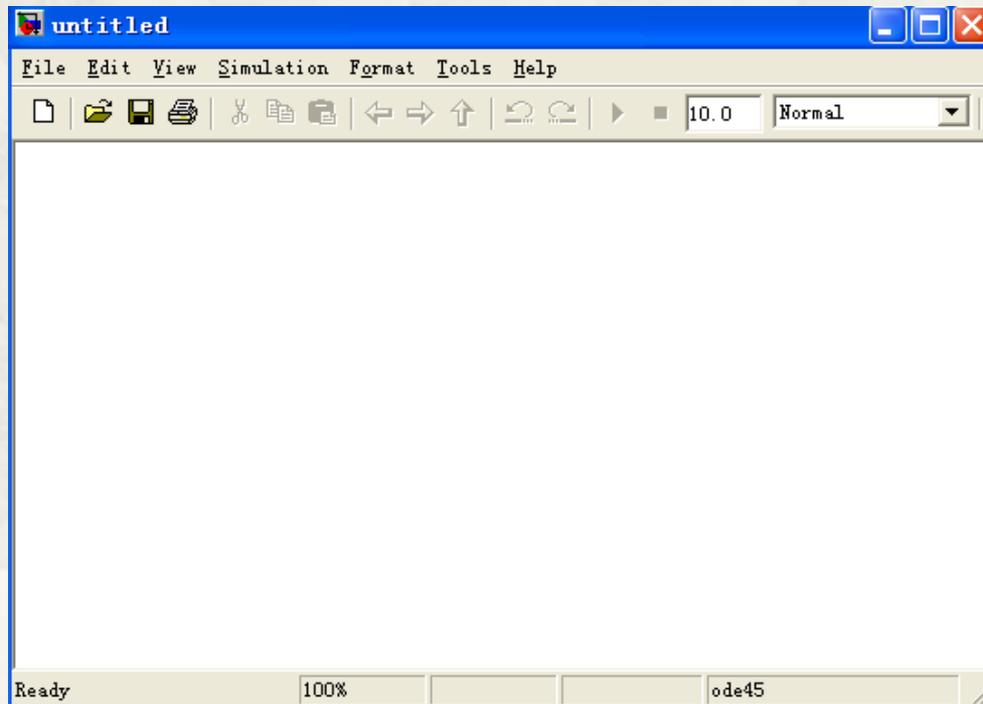
建立或打开
仿真文件

基本库

扩展工具箱

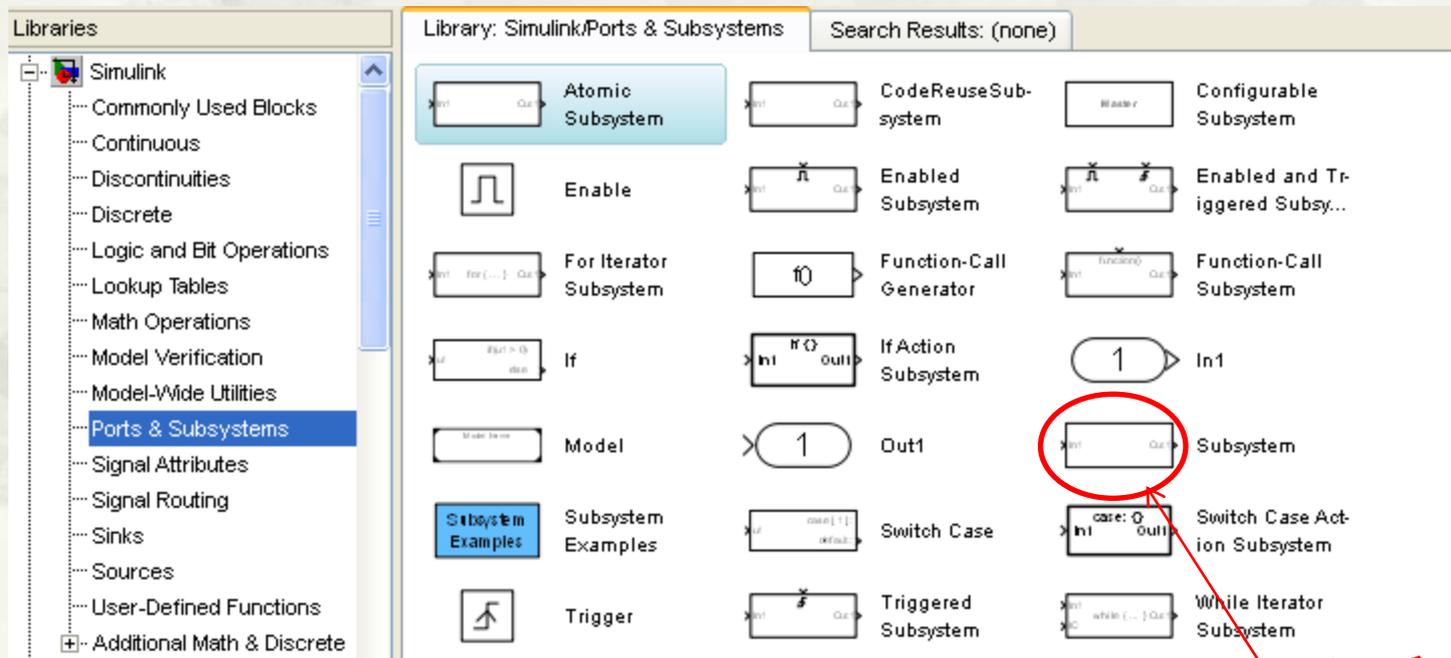
Simulink仿真示例

- * 点击“新建”按钮，便可生成一个Simulink仿真文件。



Simulink仿真示例

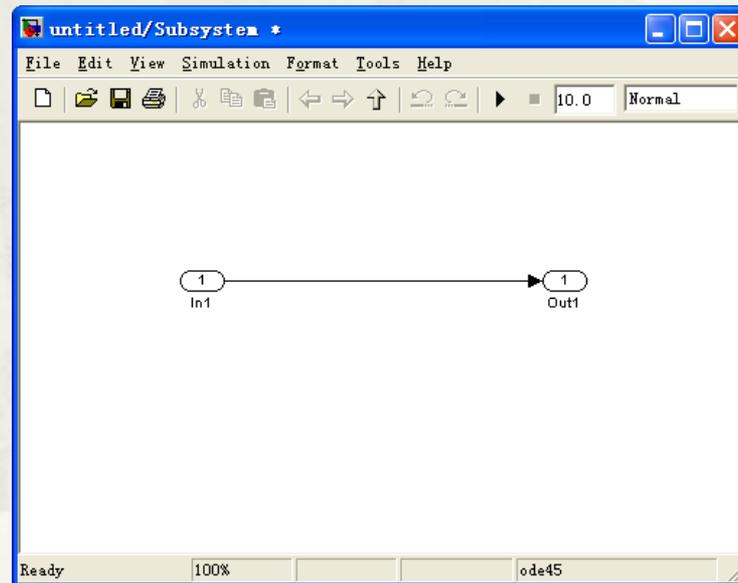
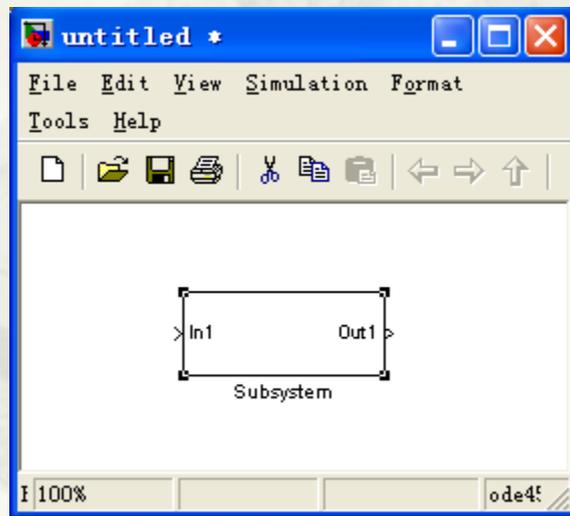
- * 从端口与子系统库中调出“子系统”模块。



子系统

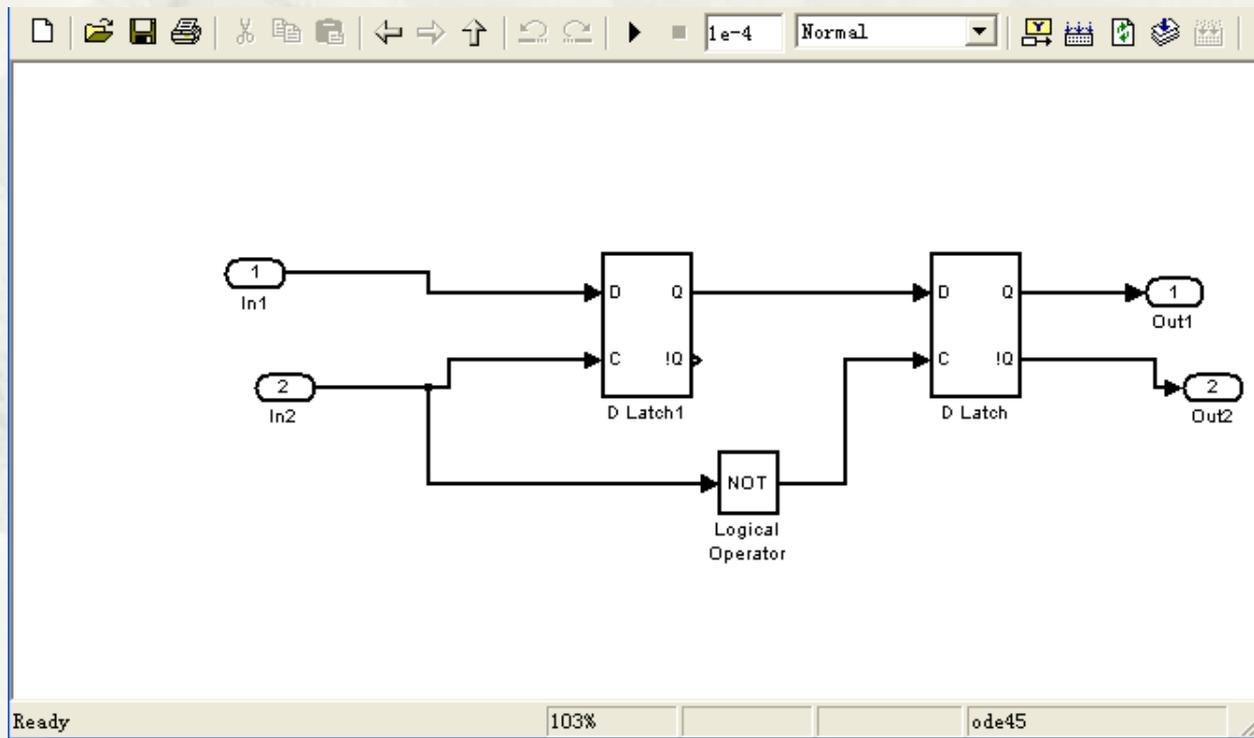
Simulink仿真示例

- * 在仿真主界面中，双击“子系统”模块，可进入其中。



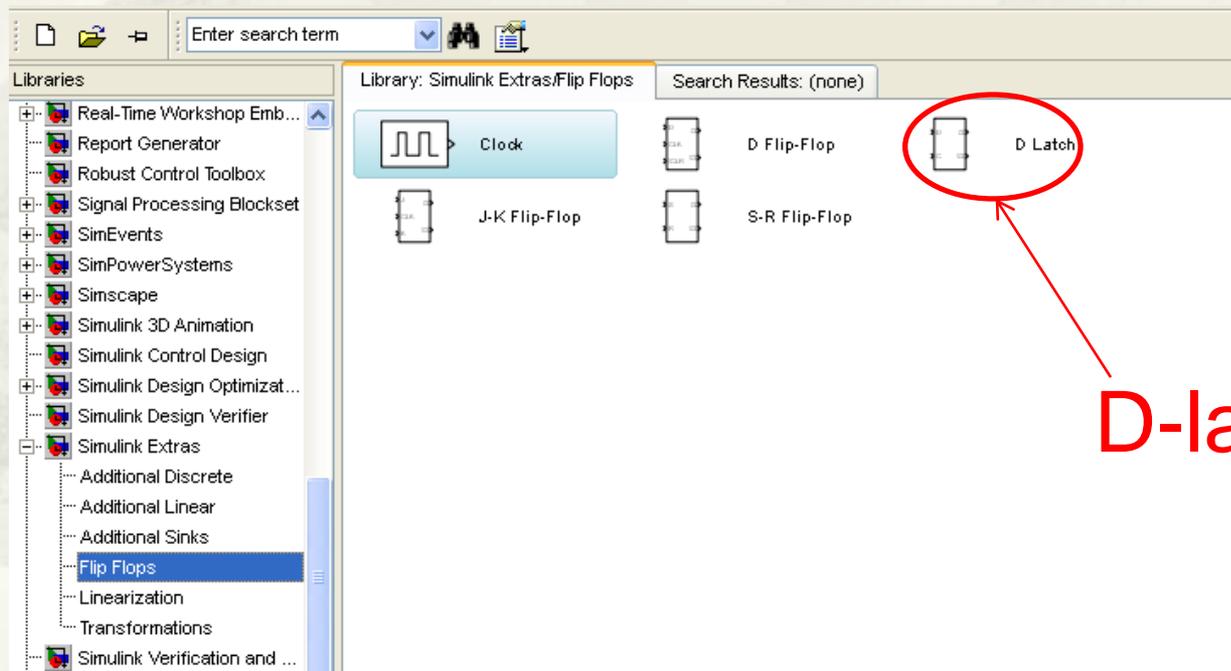
Simulink仿真示例

- * 从将仿真所需模块从相应的模块库中找出拖入仿真界面，完成模块间连线连线。



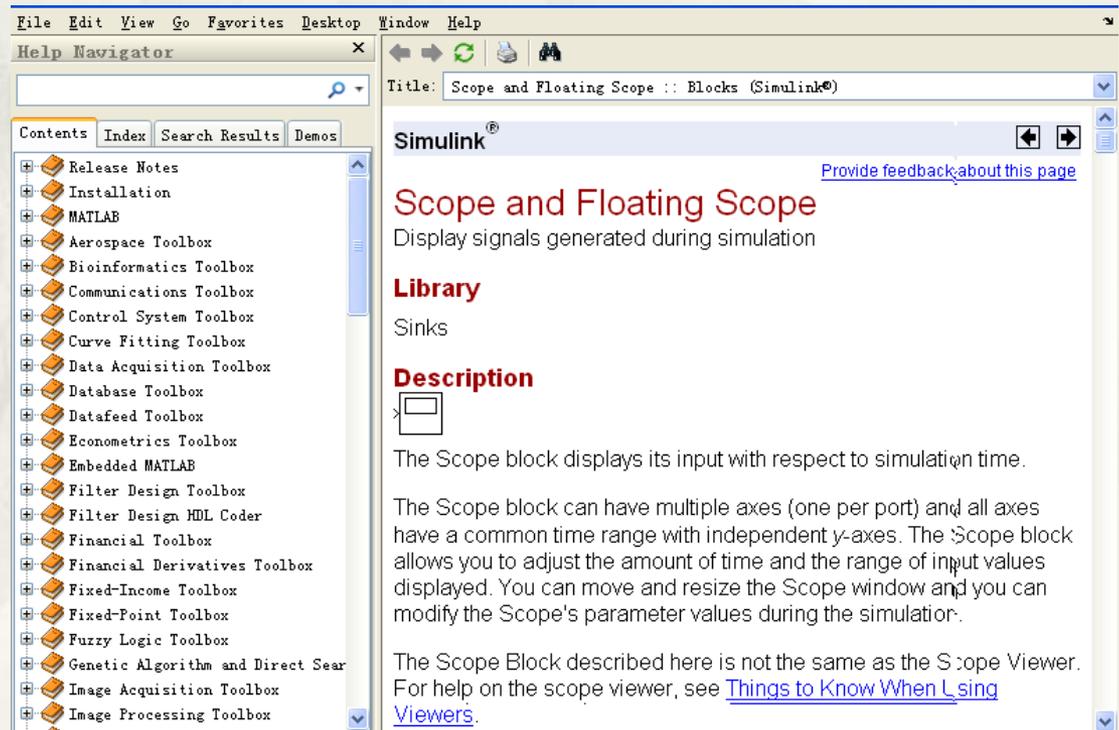
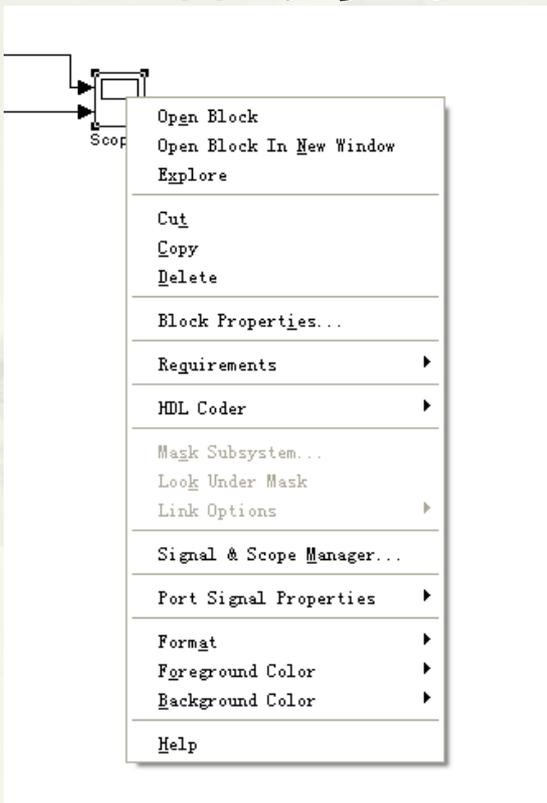
Simulink仿真示例

- * Simulink中提供了丰富的数字逻辑电路模块，进行数字电子系统的功能仿真。



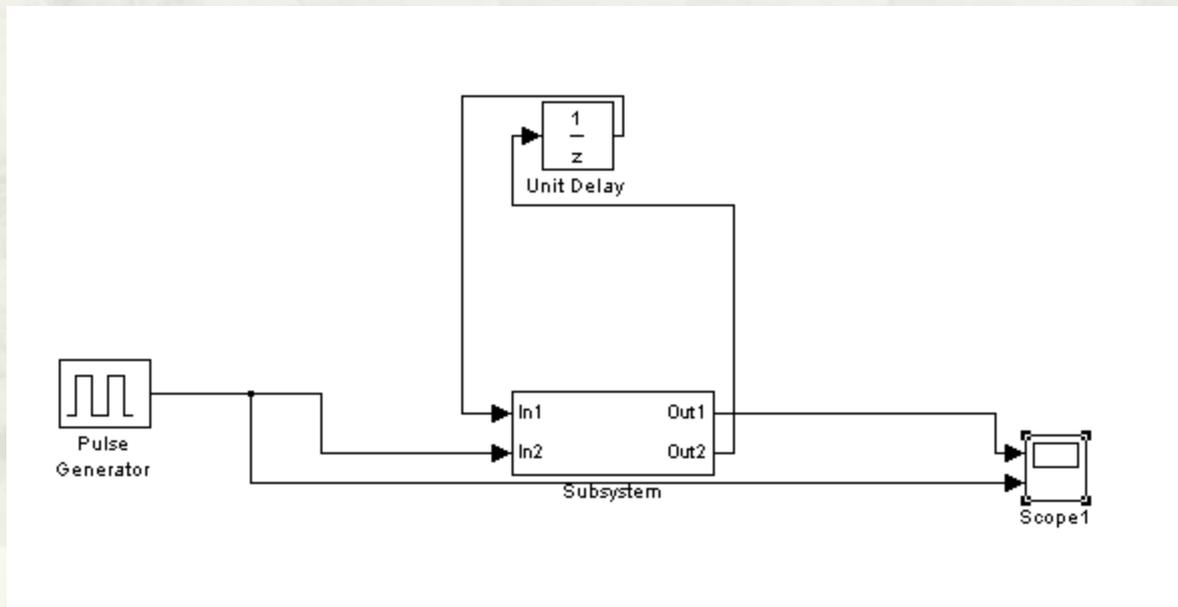
Simulink仿真示例

- * Simulink中提供了丰富的模块帮助信息，便于使用者的学习。



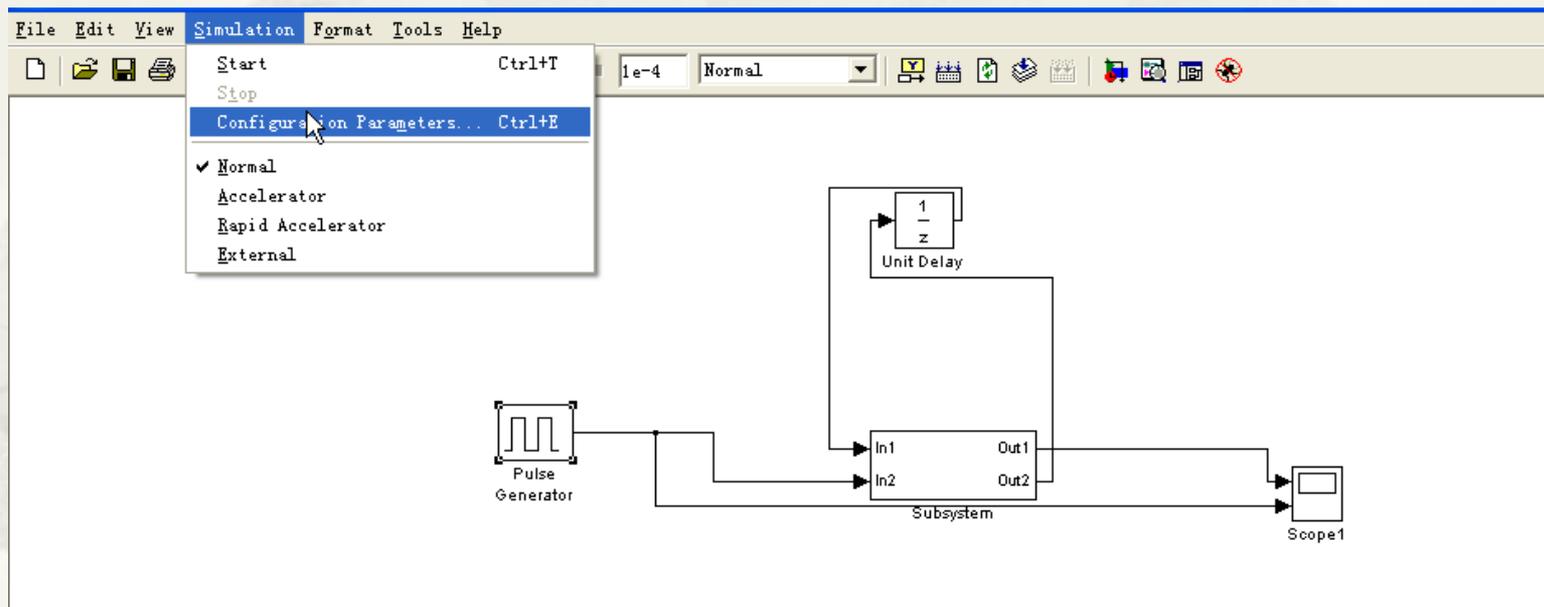
Simulink仿真示例

- * 子系统完成定义后，可作为通用模块反复复制调用。



Simulink仿真示例

- * 仿真系统构建完成后应设定仿真的相关参数。



Simulink仿真示例

- * 在仿真参数的设置中应注意系统运行速率与步长的关系。

The image shows the 'Solver Configuration' dialog box in Simulink. The 'Simulation time' section has 'Start time' set to 0.0 and 'Stop time' set to 1e-4. The 'Solver options' section has 'Type' set to 'Variable-step', 'Solver' set to 'ode45 (Dormand-Prince)', 'Max step size' set to 'auto', 'Min step size' set to 'auto', 'Initial step size' set to 'auto', 'Relative tolerance' set to 1e-3, 'Absolute tolerance' set to 'auto', and 'Shape preservation' set to 'Disable all'. The 'Tasking and sample time options' section has 'Tasking mode for periodic sample times' set to 'auto'. The 'Zero-crossing options' section has 'Zero-crossing control' set to 'Use local settings', 'Algorithm' set to 'Nonadaptive', 'Time tolerance' set to 10*128*eps, 'Signal threshold' set to 'auto', and 'Number of consecutive zero crossings' set to 1000. Red circles and arrows highlight the 'Stop time' field (labeled '仿真时间') and the 'Relative tolerance' field (labeled '仿真步长').

Simulation time

Start time: 0.0 Stop time: 1e-4

Solver options

Type: Variable-step Solver: ode45 (Dormand-Prince)

Max step size: auto Relative tolerance: 1e-3

Min step size: auto Absolute tolerance: auto

Initial step size: auto Shape preservation: Disable all

Number of consecutive min steps: 1

Tasking and sample time options

Tasking mode for periodic sample times: auto

Automatically handle rate transition for data transfer

Higher priority value indicates higher task priority

Zero-crossing options

Zero-crossing control: Use local settings Algorithm: Nonadaptive

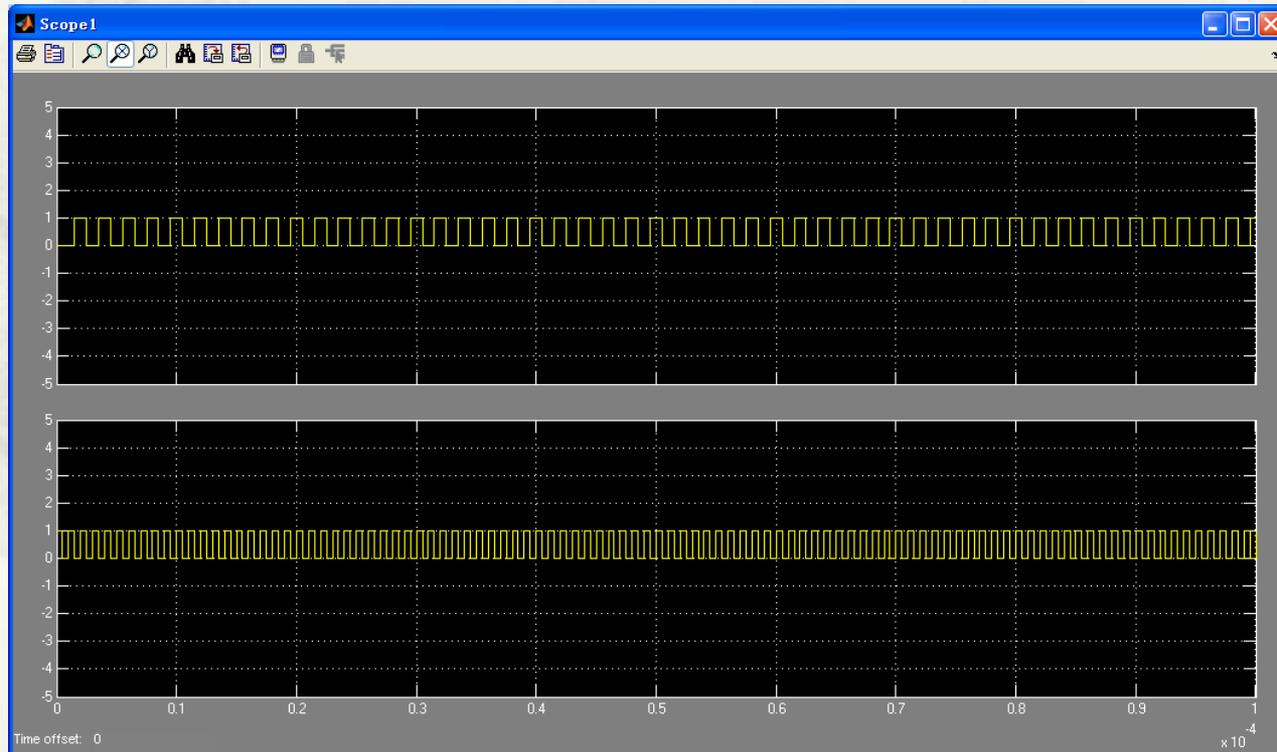
Time tolerance: 10*128*eps Signal threshold: auto

Number of consecutive zero crossings: 1000

OK Cancel Help Apply

Simulink仿真示例

- * 仿真完成后可在相应的虚拟仪器中观察到仿真结果。



Simulink与通信系统仿真

- * Matlab在demo中提供了大量的通信系统仿真实例供初学者学习。

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Communications Blockset DEMOS

Communications Blockset™ extends Simulink® with a comprehensive library of blocks for designing and simulating the physical layer of communication systems for comm helps you model wireless and wireline systems and their semiconductor components.

Channel Coding

- Convolutional Encoder with Uncoded Bits and Feedback
- Iterative Decoding of a Serially Concatenated Convolutional Code
- Punctured Convolutional Coding
- Reed-Solomon Coding with Erasures, Punctures, and Shortening
- Tail-Biting Convolutional Coding

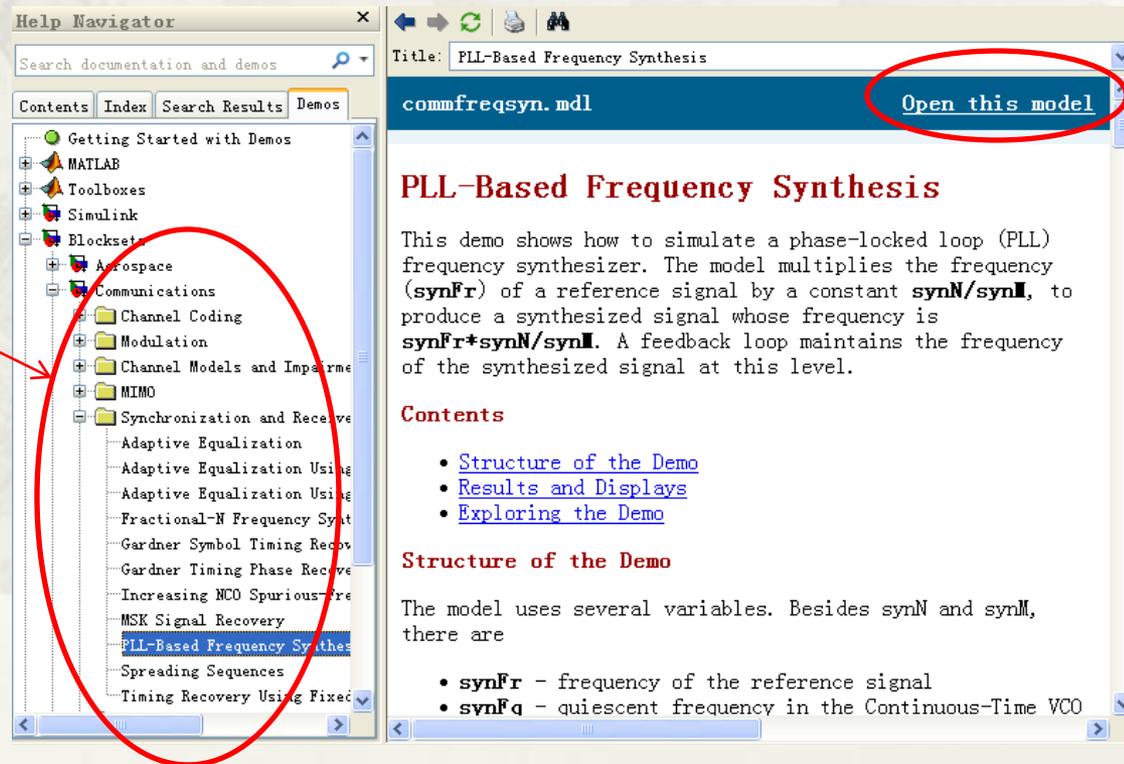
Modulation

通信实例分区

PLL的Simulink仿真

- * 可在Demo的相关分区中找到PLL的通信系统仿真实例。

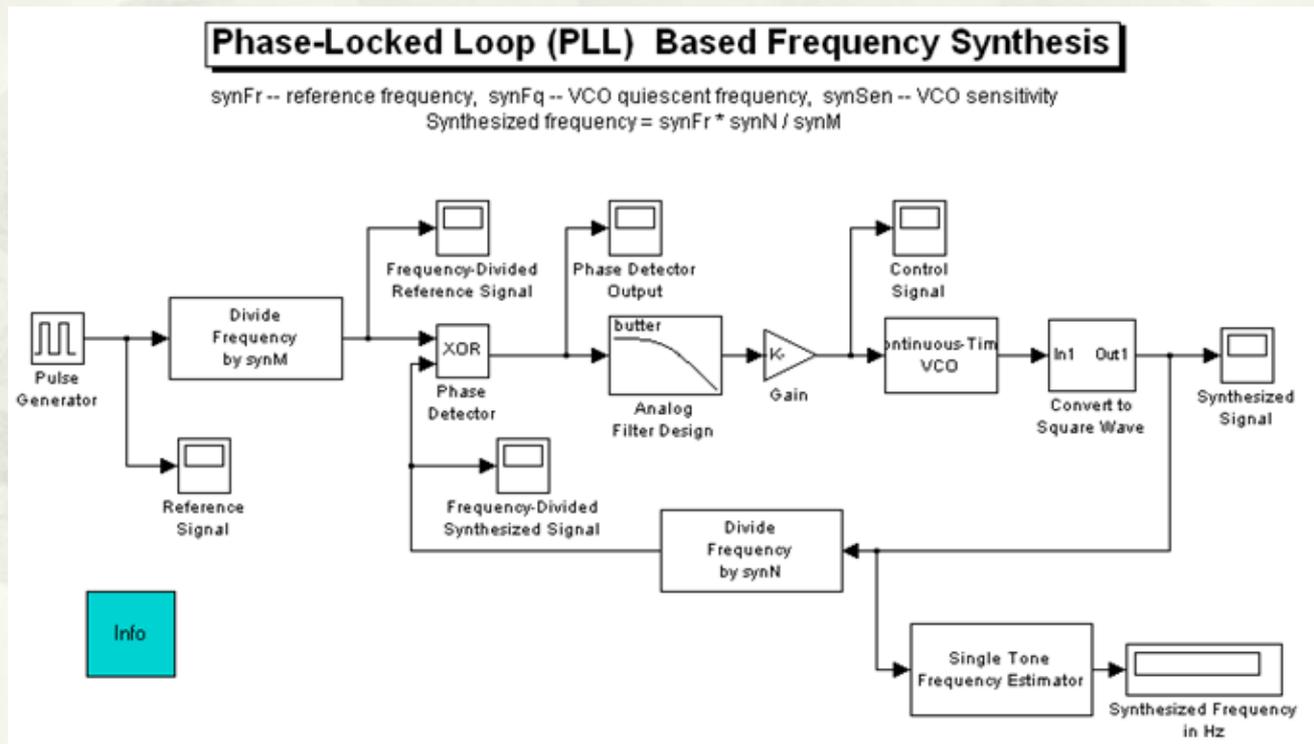
PLL仿真
模型文件
所在的分
区



点击打开
PLL仿真
模型文件

PLL的Simulink仿真

- * PLL的通信系统仿真实例中展现了一个整数频率合成器的实例。



PLL的Simulink仿真

- * PLL的主要的器件参数既可以直接在各个模块中直接修改，也可以在工作区中输入。

The screenshot displays the MATLAB Simulink environment. On the left, the Command Window shows several warning messages related to solver selection and discrete/continuous state handling. The central Workspace window lists the following variables:

Name	Value
synFq	30000000
synFr	30000000
synM	3
synN	10
synSen	40000000
tout	<201x1 double>

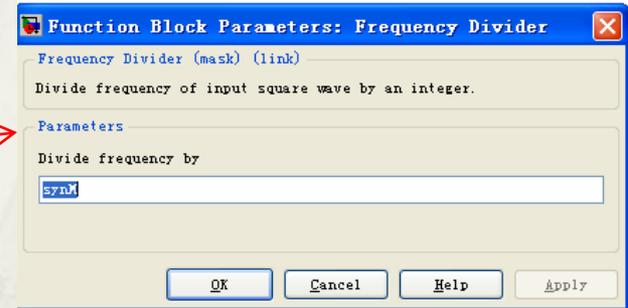
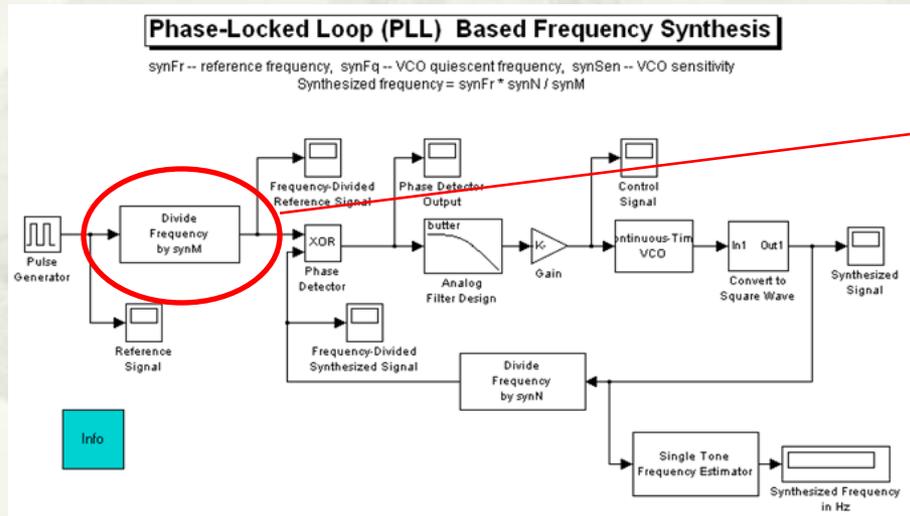
On the right, the Variable Editor for 'synFr' is open, showing a table with the value 30000000 in the first row, column 1.

	1	2	3
1	30000000		
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

Red circles highlight the Workspace and Variable Editor windows, with an arrow pointing from the 'synFr' variable in the Workspace to the Variable Editor.

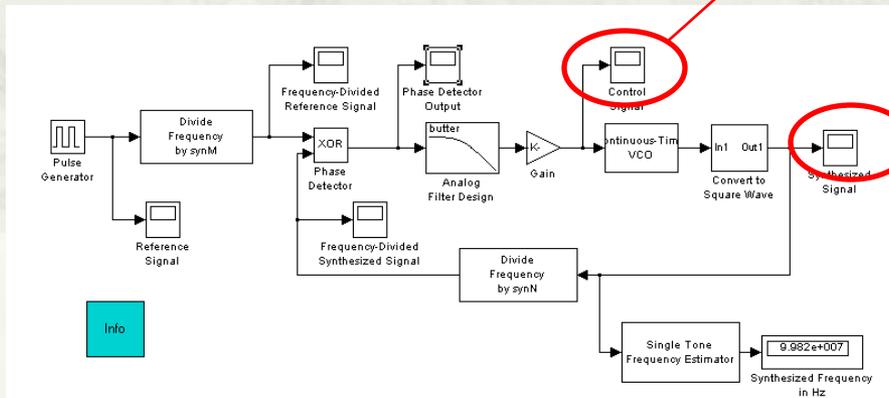
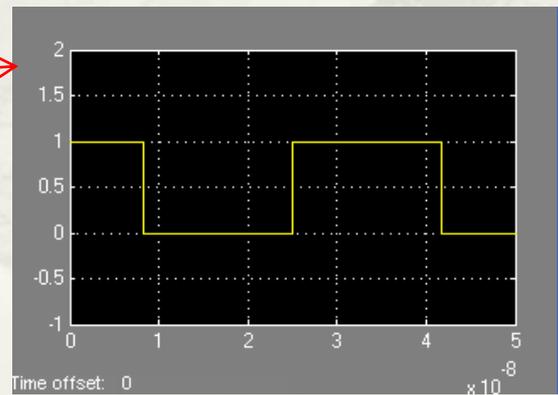
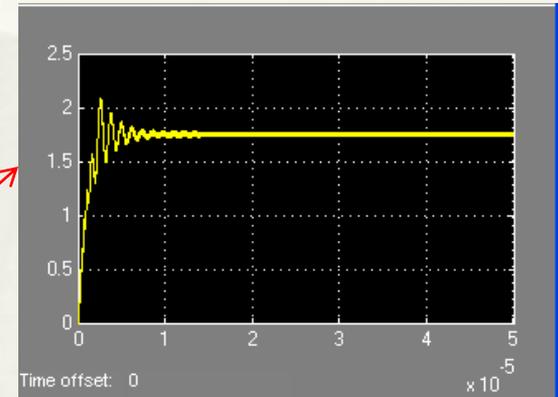
PLL的Simulink仿真

- * PLL的主要的器件参数既可以直接在各个模块中直接修改，也可以在工作区中输入。

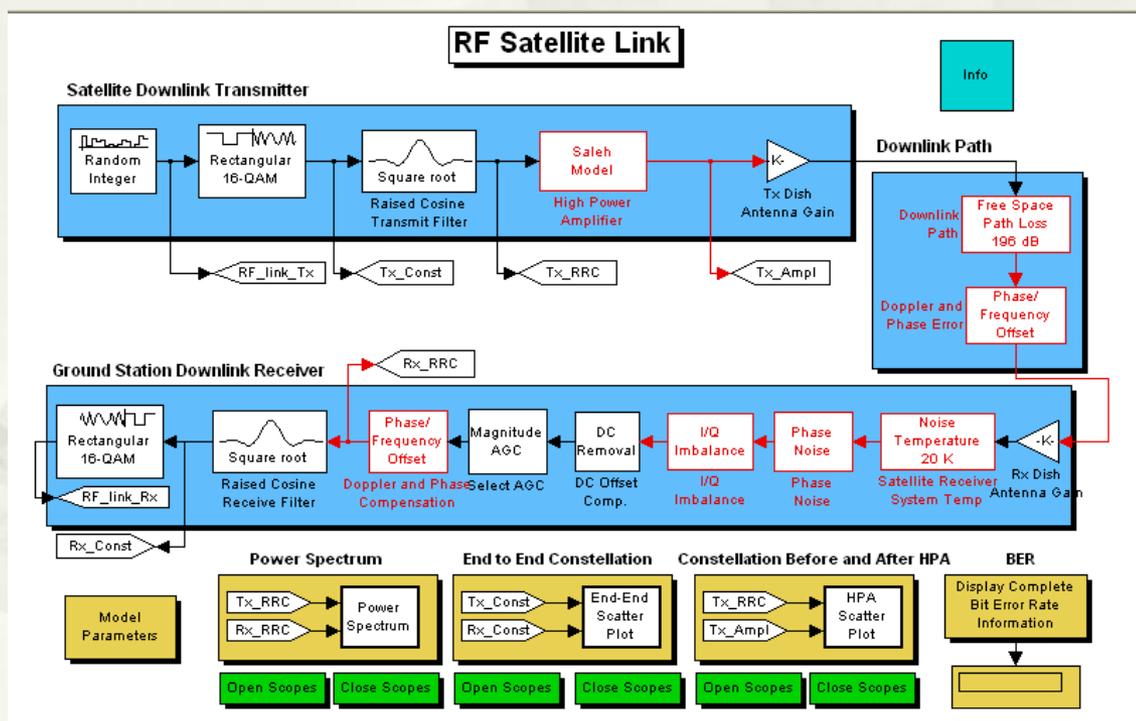


PLL的Simulink仿真

➤ 仿真完成后，可以点击各个虚拟仪器，观察各个节点的输出信号。



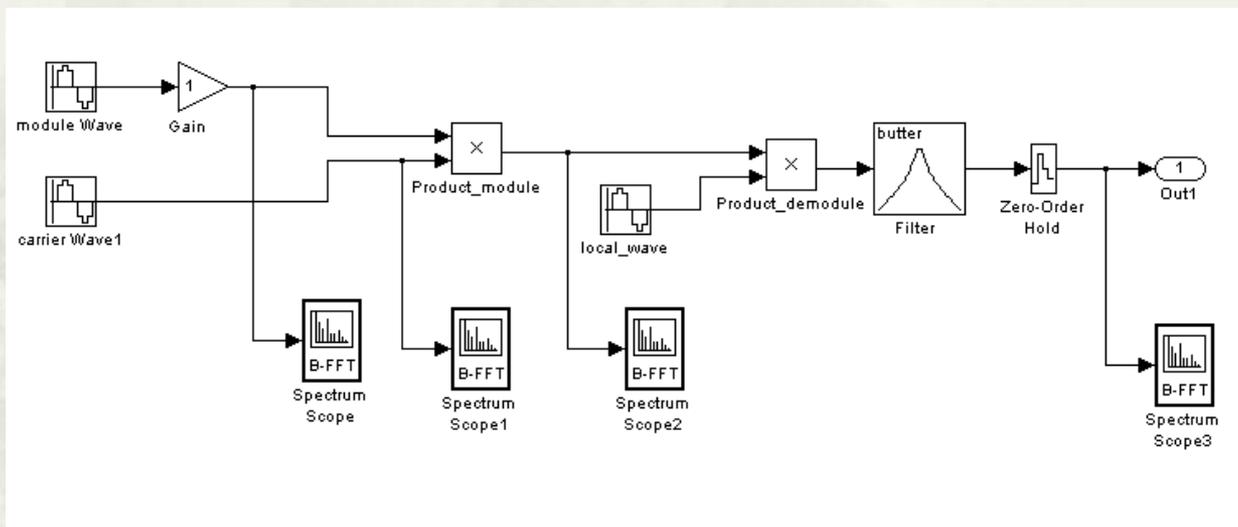
Simulink中的收发机系统仿真



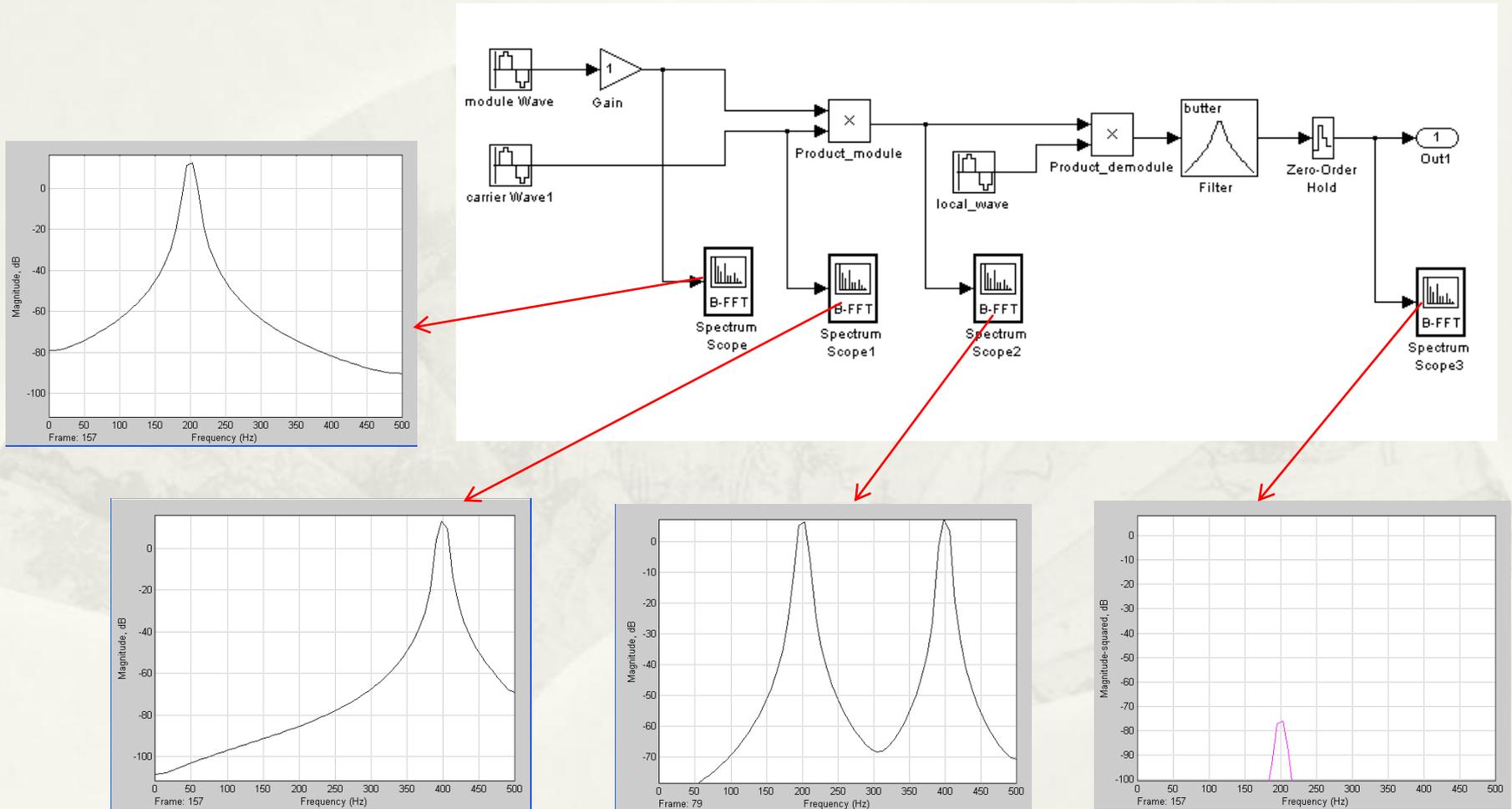
➤在 Simulink 中，接收机或发射机的仿真模型是由常用通信元件模块组合构成的。

Simulink中的收发机系统仿真

➤ 一个典型的收发机系统的Simulink仿真系统如图所示，该系统可以具备了一个收发机系统的基本功能。



Simulink中的收发机系统仿真



通信系统仿真常用模块

* 信号源库

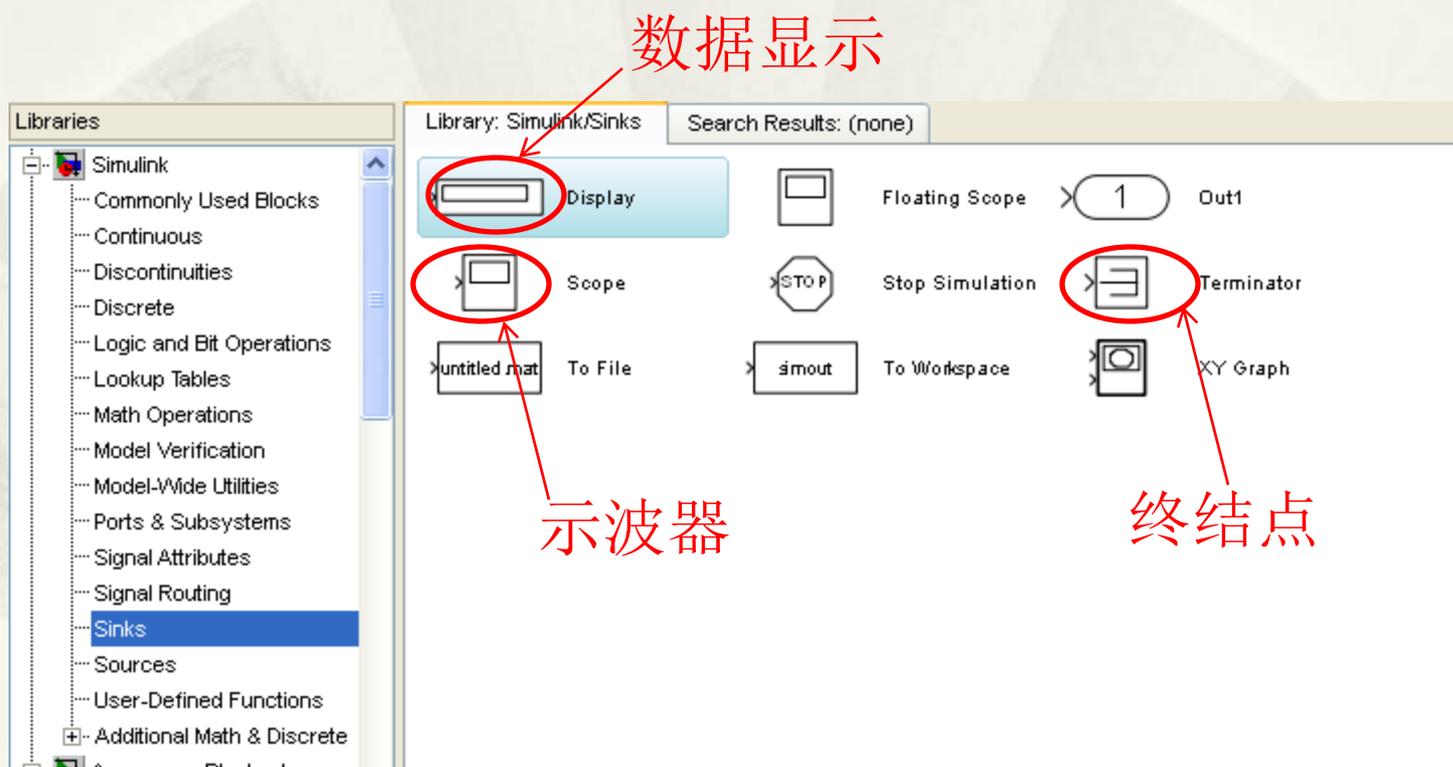
The image shows the Simulink Sources library window. The left sidebar lists various categories, with 'Sources' selected. The main area displays a grid of signal source blocks. Three blocks are highlighted with red circles and red arrows pointing to Chinese labels:

- Constant**: A block with the number '1' inside a square. An arrow points to it from the label '常数' (Constant).
- Pulse Generator**: A block with a square wave icon. An arrow points to it from the label '脉冲源' (Pulse Source).
- Sine Wave**: A block with a sine wave icon. An arrow points to it from the label '正弦波' (Sine Wave).

Other visible blocks include Band-Limited White Noise, Chirp Signal, Clock, Counter Free-Running, Counter Limited, Digital Clock, From File, From Workspace, Ground, In1, Repeating Sequence, Repeating Sequence Interpol..., Repeating Sequence Stair, Signal Builder, Signal Generator, Step, and Uniform Random Number.

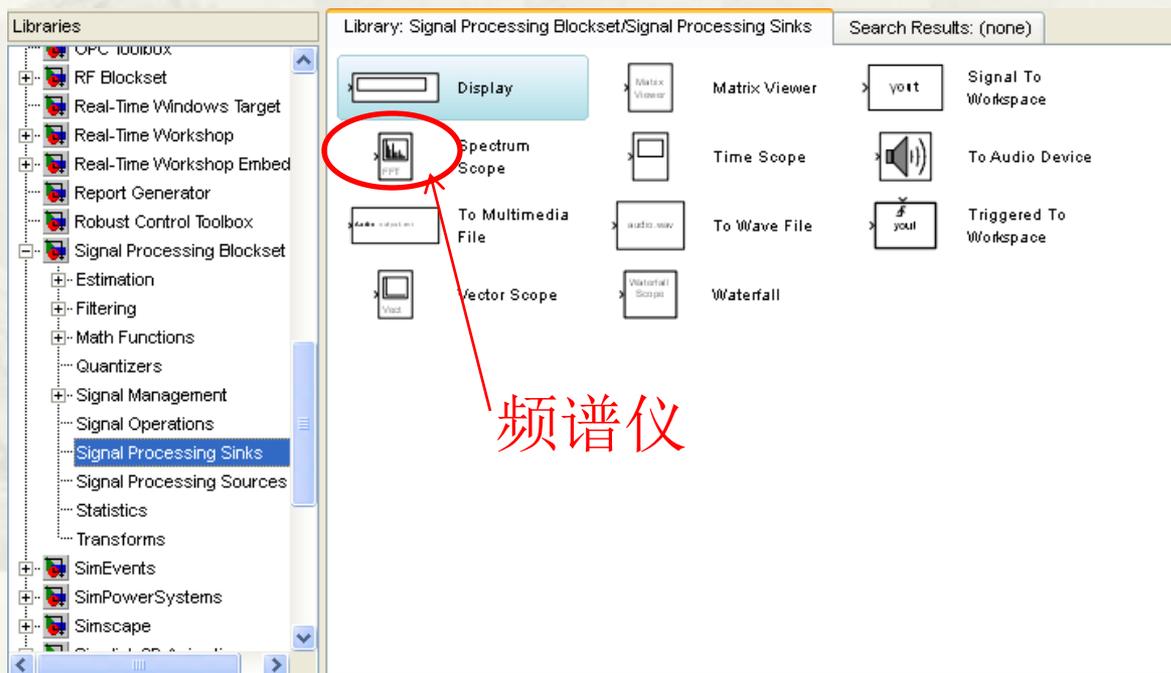
通信系统仿真常用模块

* 信号终端与仿真显示仪器库



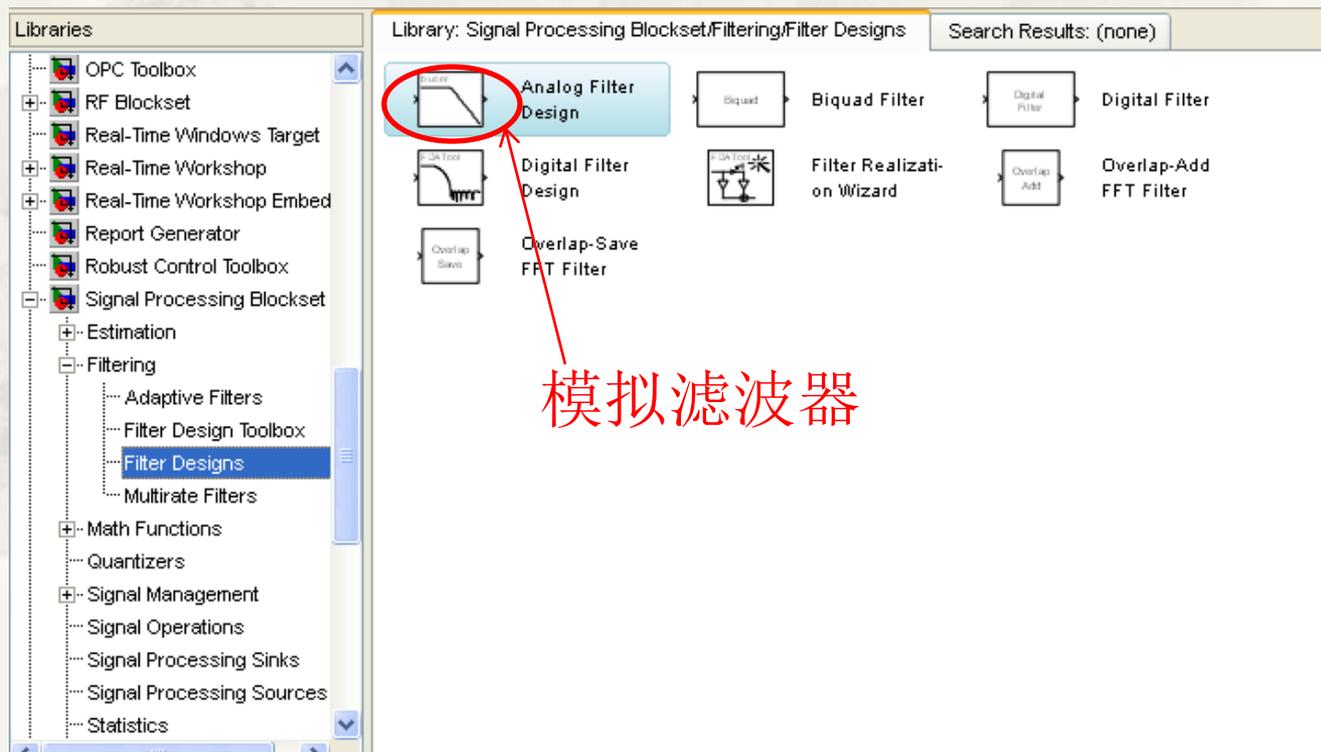
通信系统仿真常用模块

* 信号处理专用终端与仿真显示仪器库



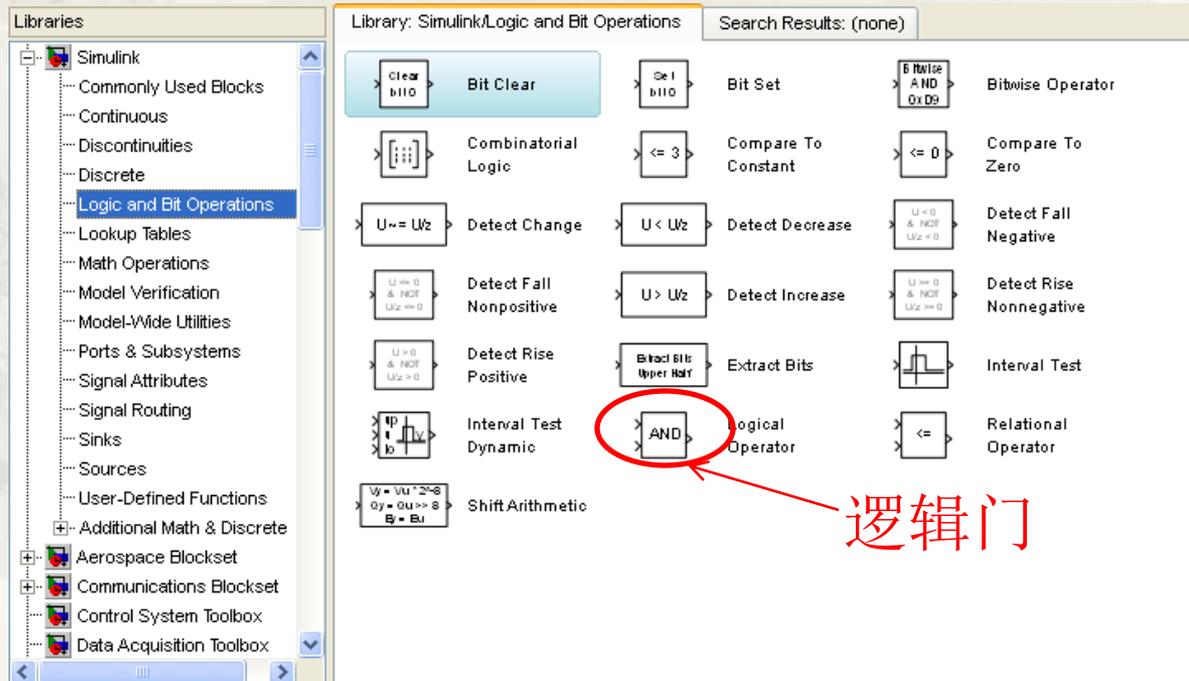
通信系统仿真常用模块

* 滤波器设计库



通信系统仿真常用模块

* 逻辑运算与位运算库



通信系统仿真常用模块

* 数学函数库

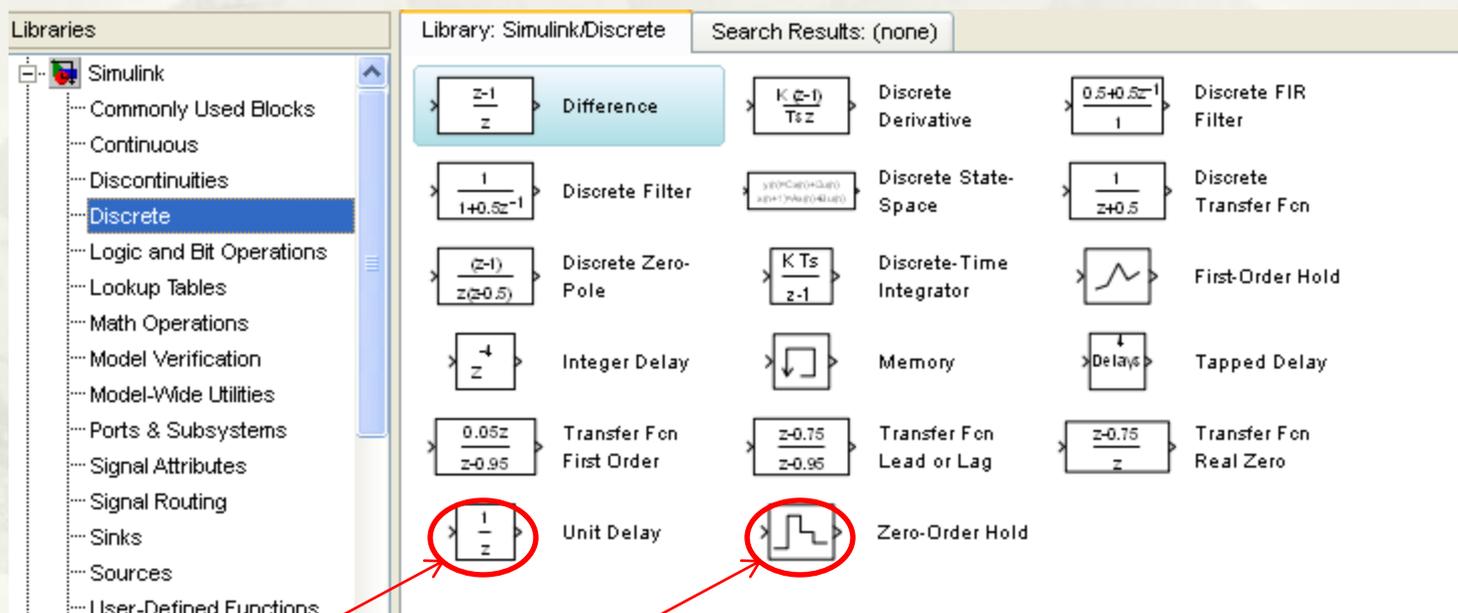
The image shows a screenshot of the Simulink Math Operations library. The left pane shows the library structure with 'Math Operations' selected. The main pane displays various mathematical blocks. Three blocks are highlighted with red circles and red arrows pointing to Chinese labels:

- 增益 (Gain):** A block with a triangle and the number '1' inside, representing a gain of 1.
- 求和 (Sum):** A block with a circle containing a plus sign and an 'x' below it, representing a summing junction.
- 乘积 (Product):** A block with a square containing an 'x' inside, representing a product operation.

Other visible blocks include Abs, Add, Algebraic Constraint, Assignment, Bias, Complex to Magnitude-Angle, Complex to Real-Imag, Divide, Dot Product, Magnitude-Angle to Complex, Math Function, MinMax, MinMax Running Resettable, Matrix Concatenate, Min, Polynomial, Permute Dimensions, Product of Elements, Real-Imag to Complex, Reshape, Rounding Function, Sign, Sine Wave Function, Slider Gain, Squeeze, Subtract, Sum of Elements, Trigonometric Function, Unary Minus, and Weighted Sample Time Math.

通信系统仿真常用模块

* 离散系统库



单位延迟 零阶保持器