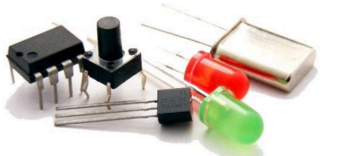


PCB设计 - 常用仪器的使用

工程师的眼睛



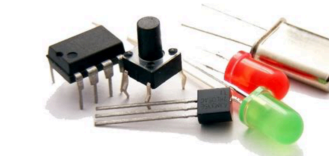
万用表 - 测通断、测电压....





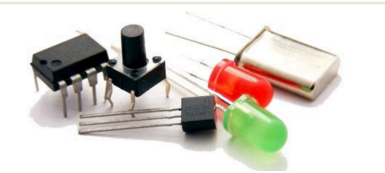
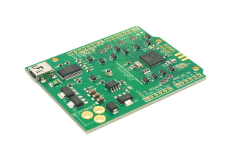
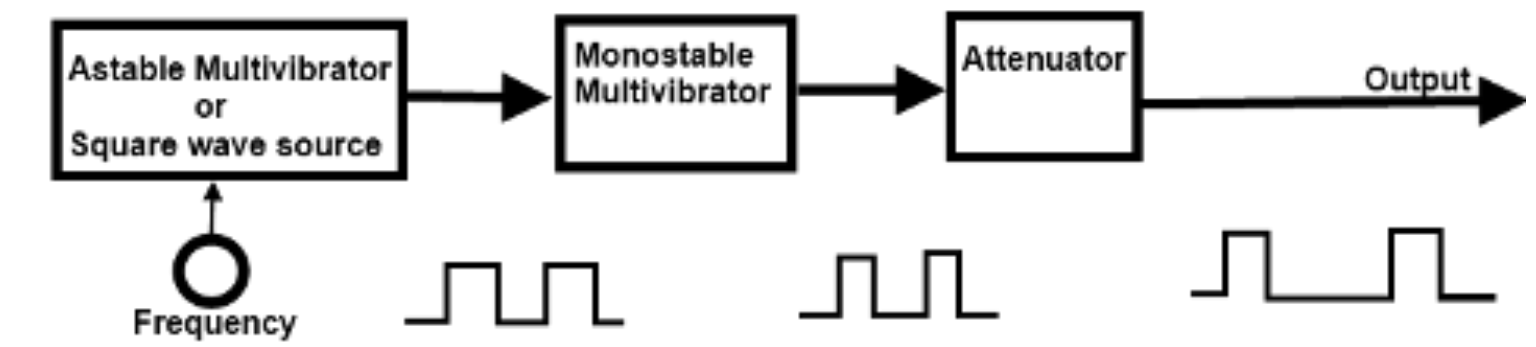
供电电源 - 注意限流

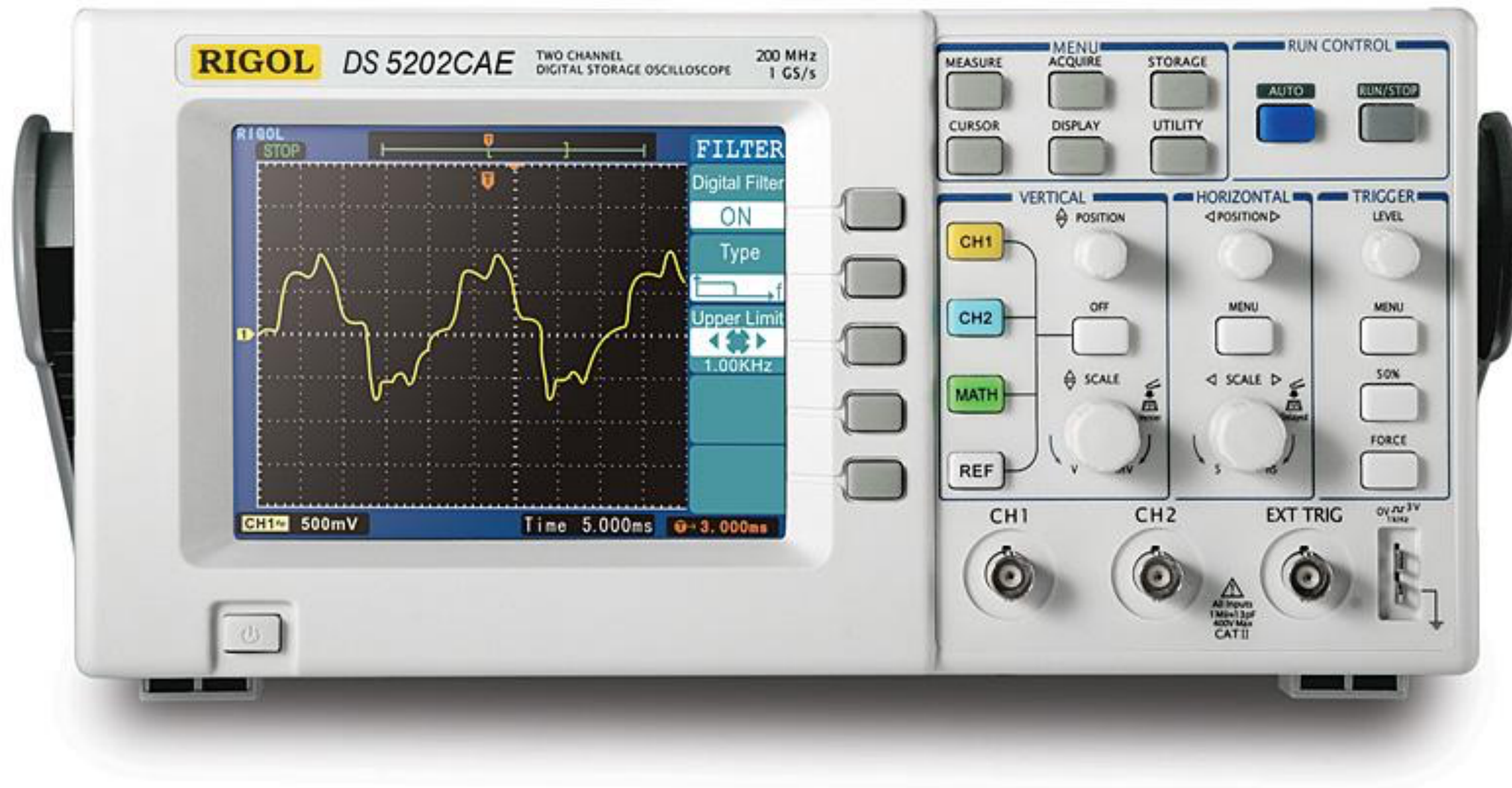
USB充电器电源 - 注意输出电流、纹波以及由于负载过大在USB线上导致的压降



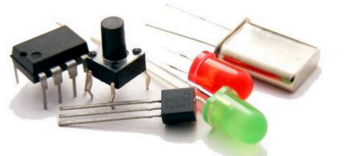


信号源 - 任意信号发生器 (AWG)、模拟信号发生器、脉冲信号发生器
 波形、幅度、带宽、调制

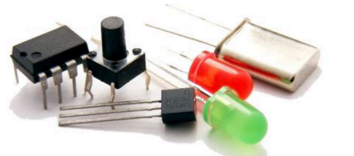
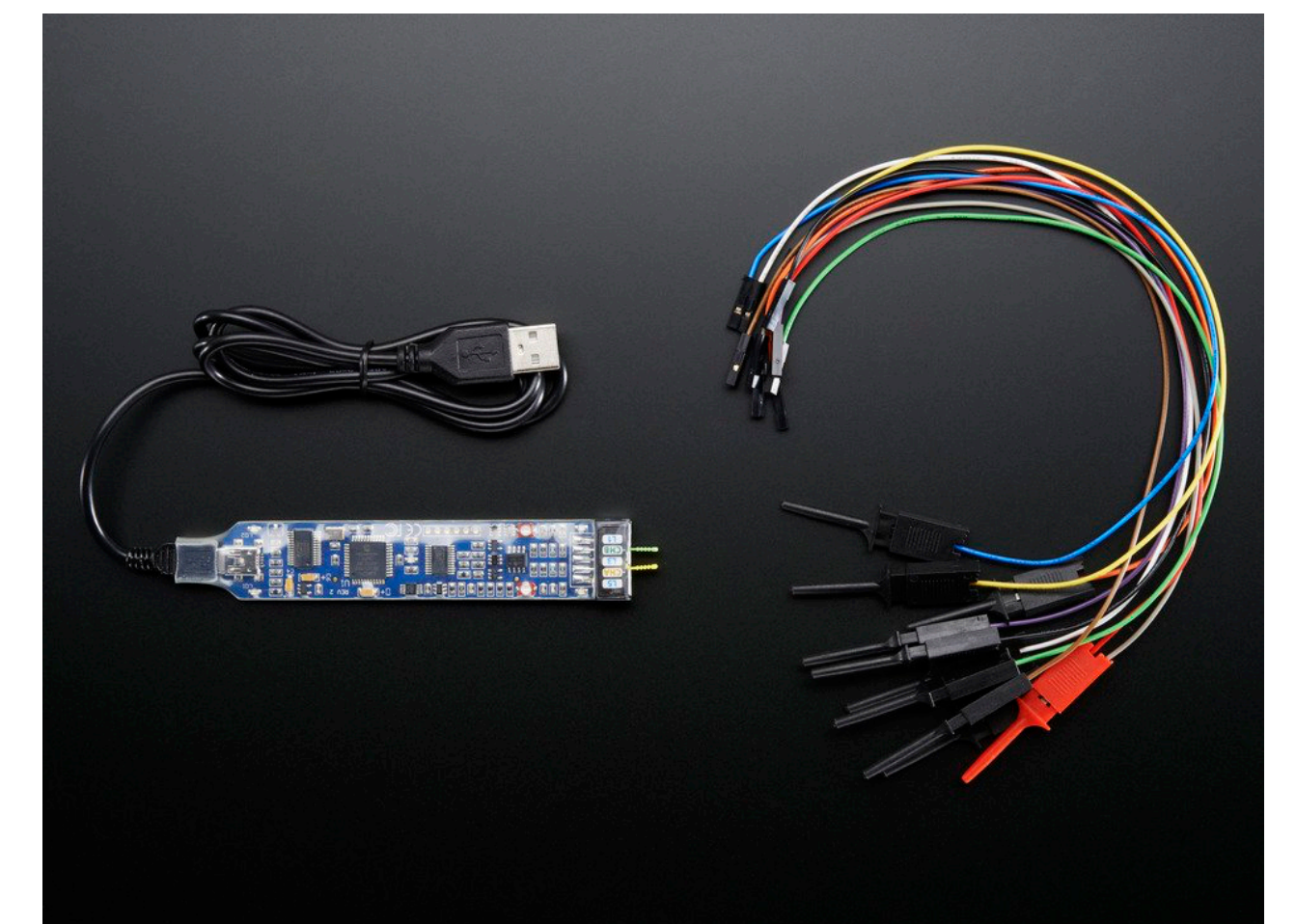
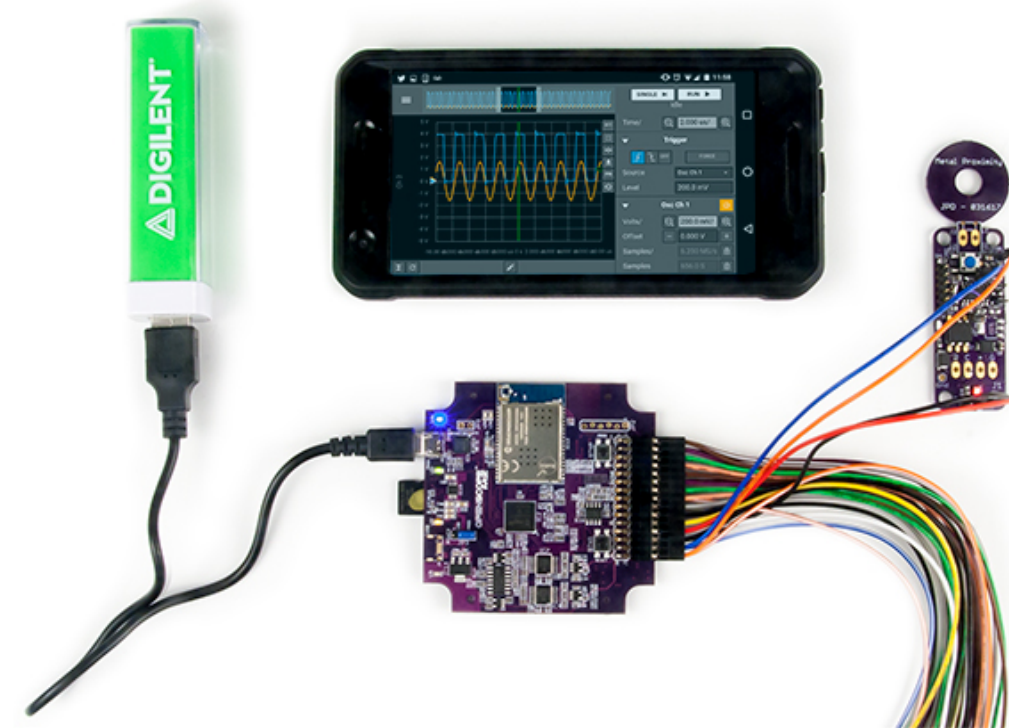
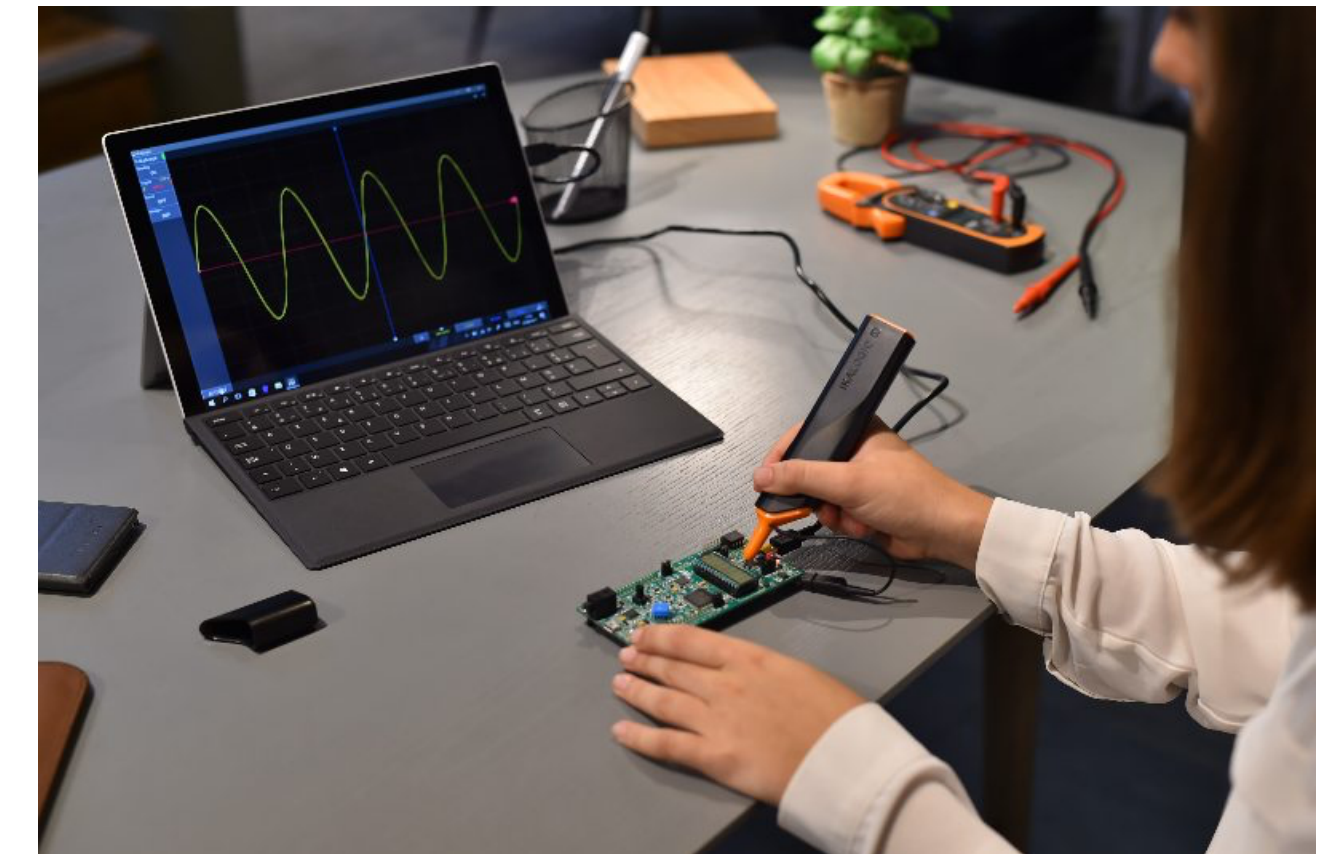




示波器 - 数字采样示波器中的频谱混叠，触发、FFT
示波器探头的正确使用

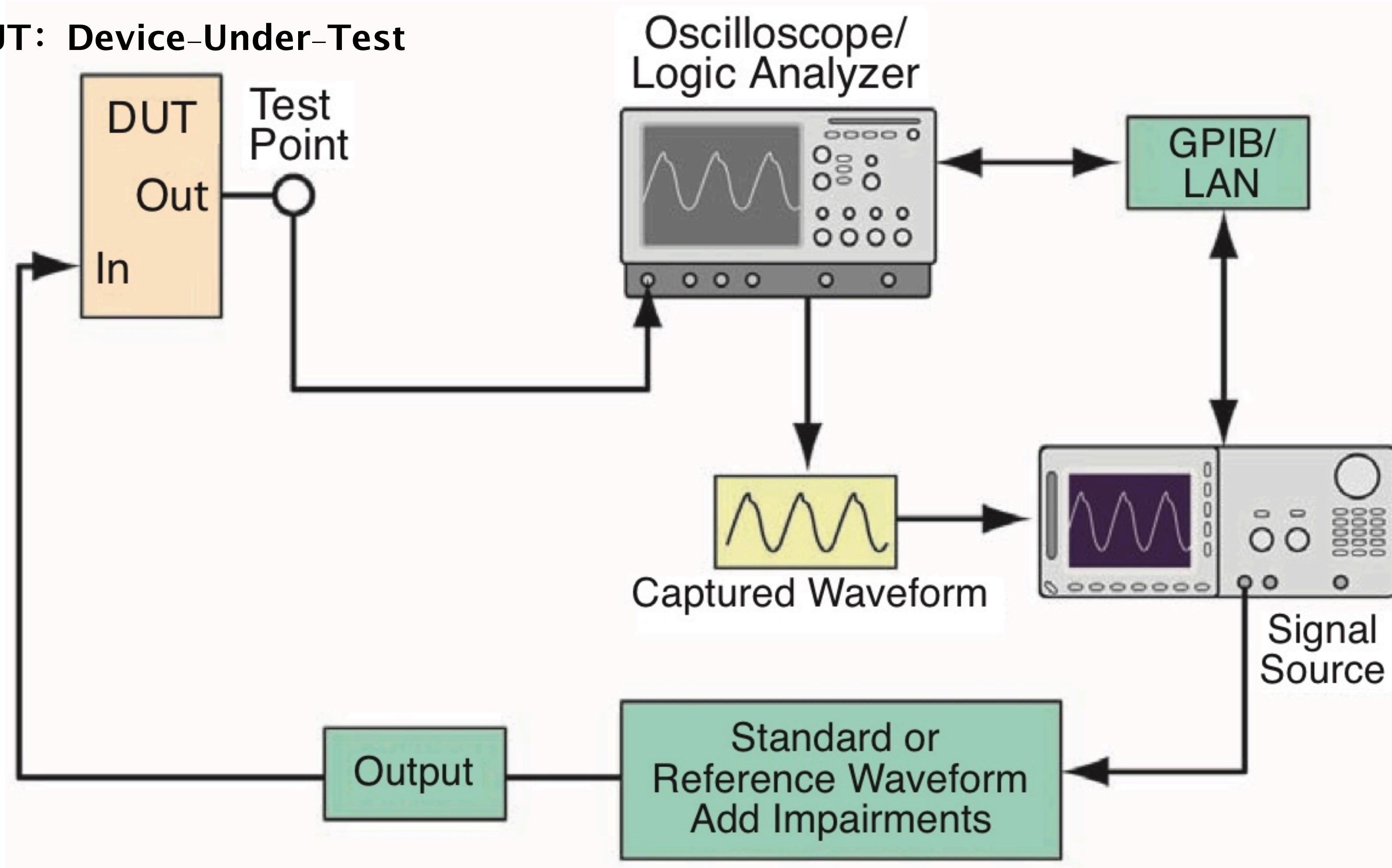


虚拟、口袋仪器



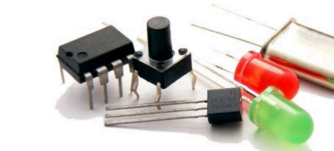
电子产品测量系统构成

DUT: Device-Under-Test

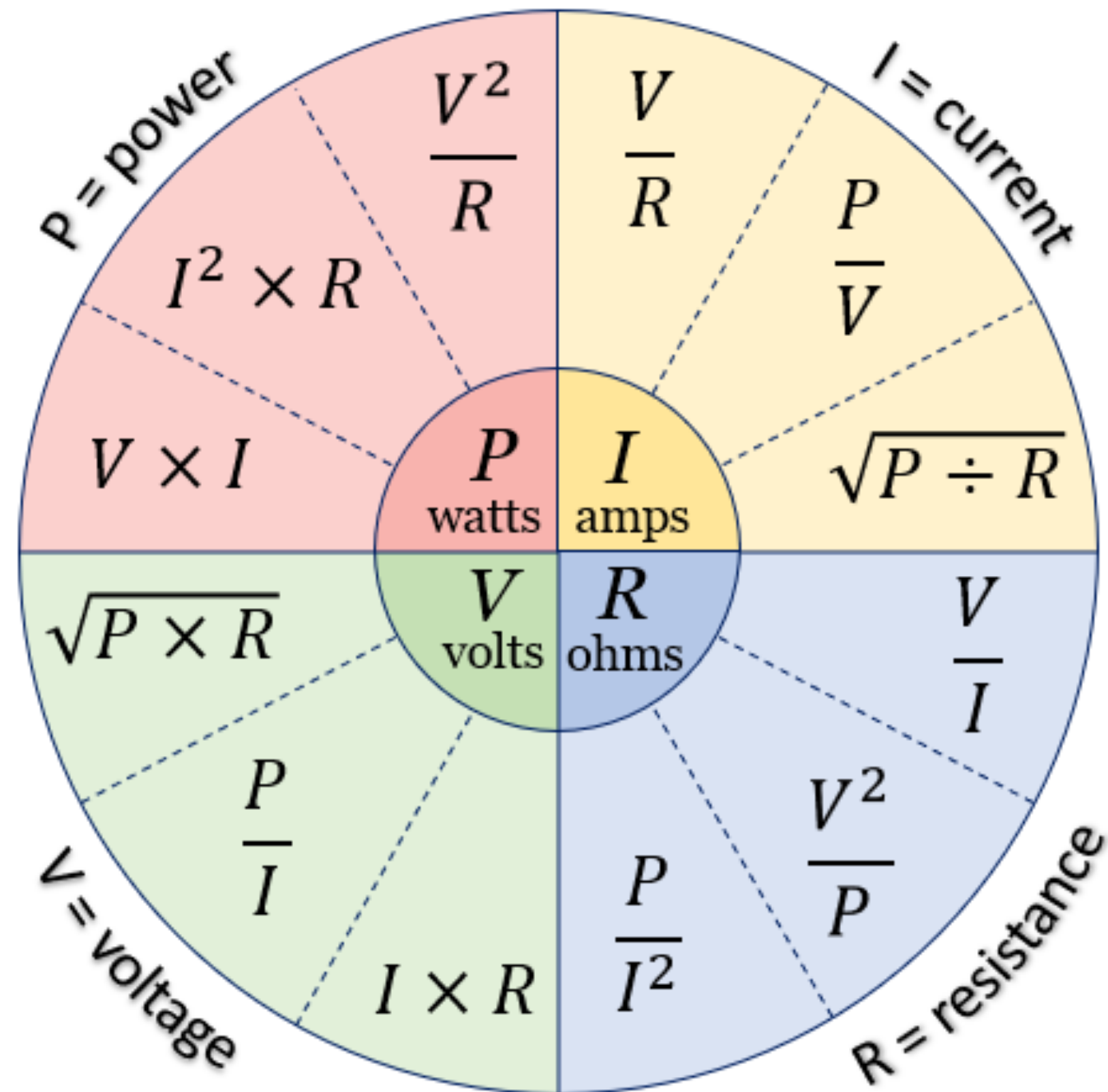


产生激励信号:

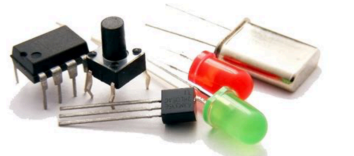
- 模拟波形
- 数字数据模式
- 调制信号
- 刻意产生的噪声



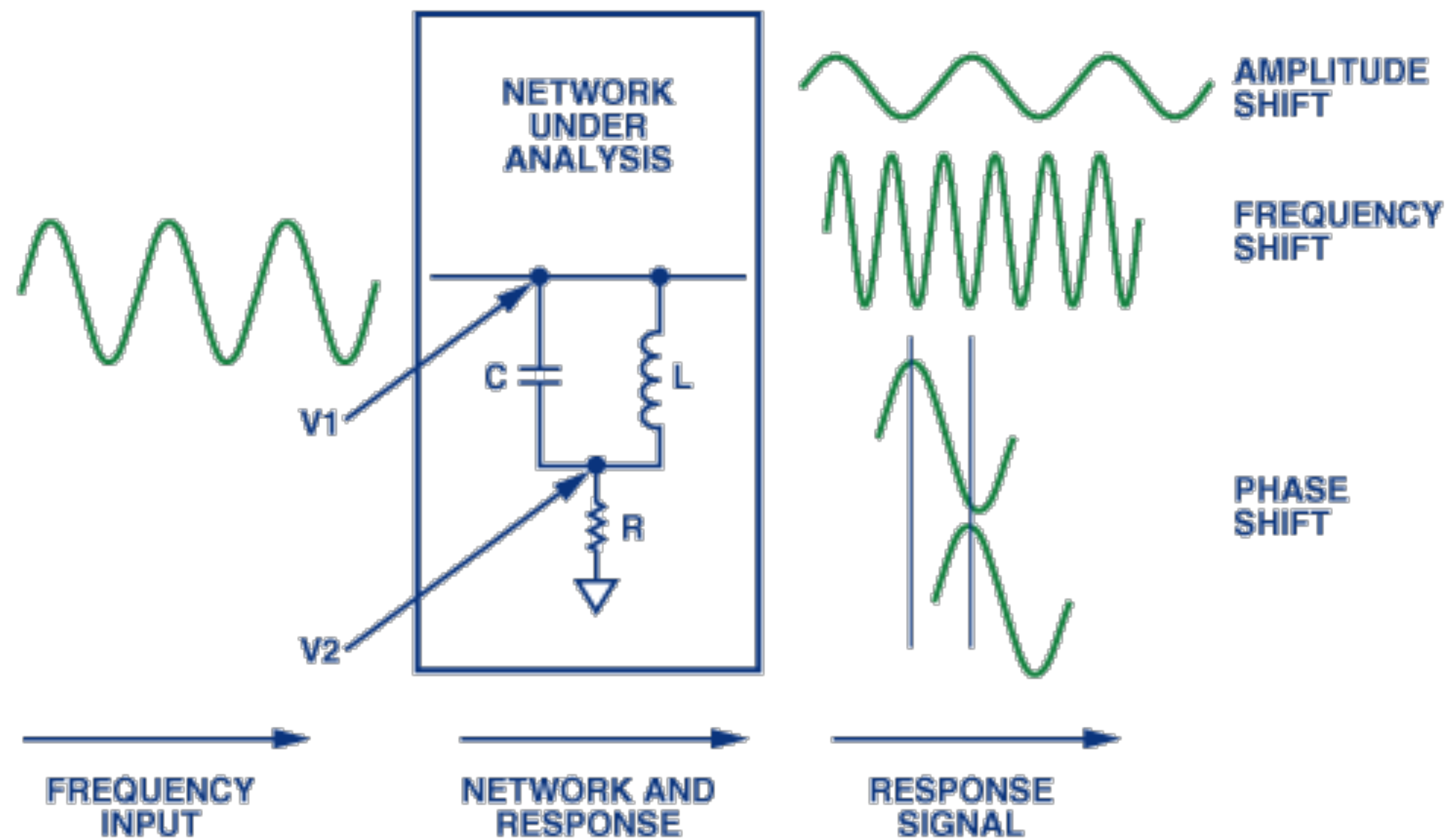
基于欧姆定律的静态参数测量



$I = \frac{V}{R} = \frac{10V}{10\Omega} = 1A$	$R = \frac{V}{I} = \frac{10V}{2mA} = 5k\Omega$	$V = IR = 2mA \cdot 8k\Omega = 16V$
$I = \frac{V}{R} = \frac{10V}{20\Omega} = 0.5A$	$R = \frac{V}{I} = \frac{10V}{10mA} = 1k\Omega$	$V = IR = 1mA \cdot 16k\Omega = 16V$
$I = \frac{V}{R} = \frac{10V}{5\Omega} = 2A$	$R = \frac{V}{I} = \frac{10V}{1mA} = 10k\Omega$	$V = IR = 1mA \cdot 4k\Omega = 4V$



随时间变化的电路

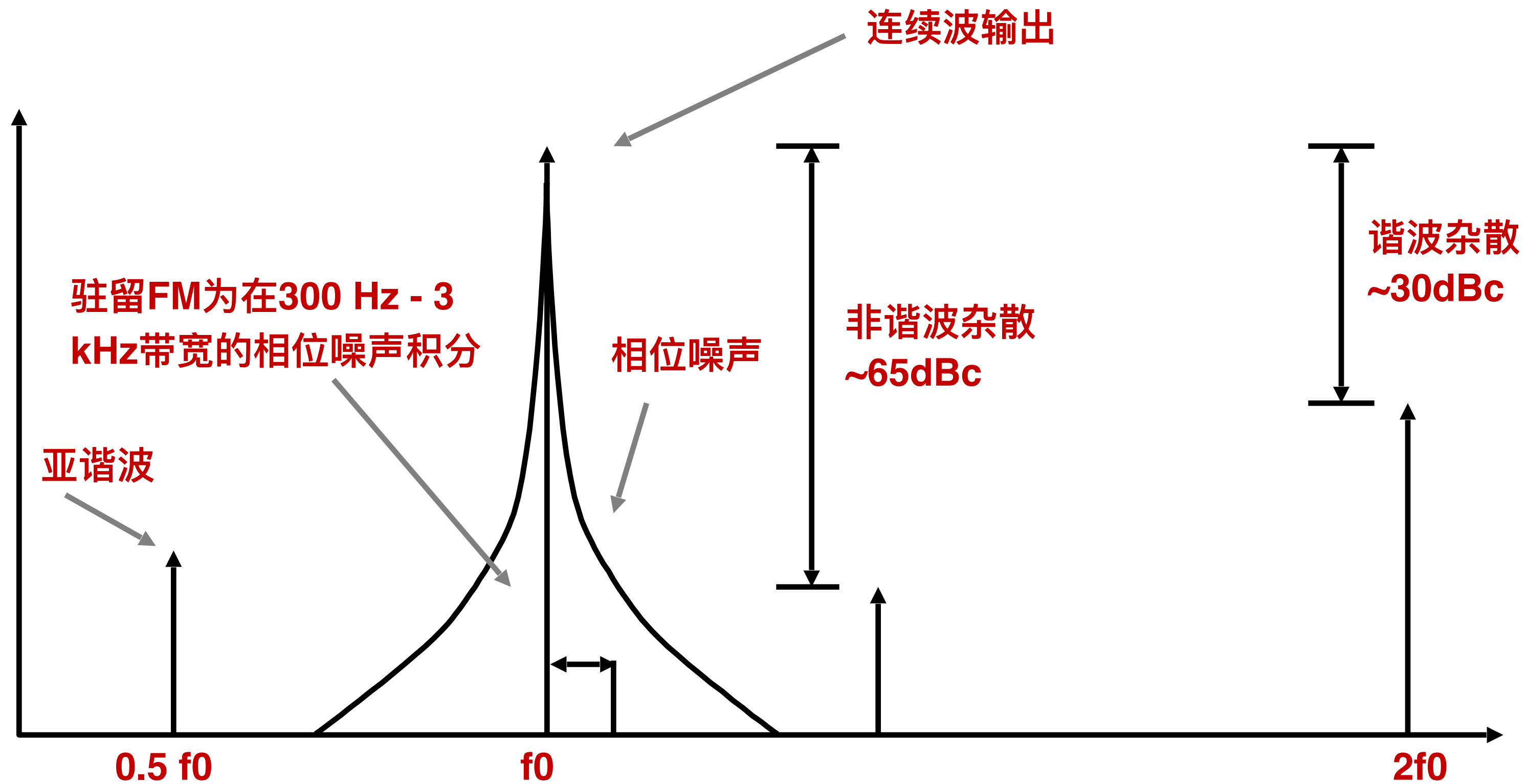


<p>Frequency distortion (amplitude reduction of low frequency component). No phase shift.</p>	<p>Low frequency boost (accentuated fundamental).</p>	<p>High frequency loss. No phase shift.</p>
<p>Low frequency phase shift.</p>	<p>Low frequency loss and phase shift.</p>	<p>High frequency loss and low frequency phase shift.</p>
<p>High frequency loss and phase shift.</p>	<p>Damped oscillation (perhaps poor termination).</p>	<p>Low frequency phase shift (trace thickened by hum).</p>

网络响应测试

不同的电路网络对方波信号的响应 (时域)



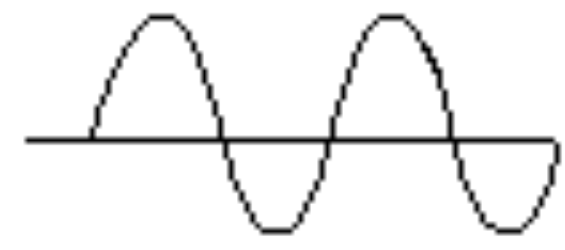


典型的频域谱线

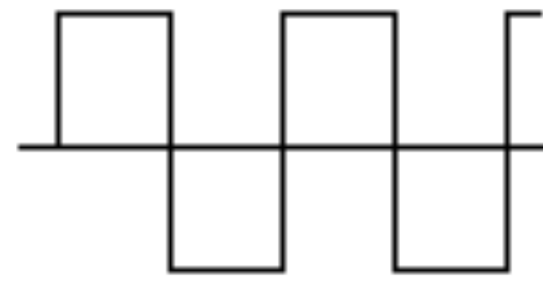


信号特性1 - 波形

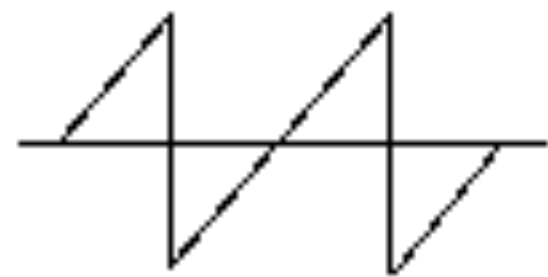
常用波形



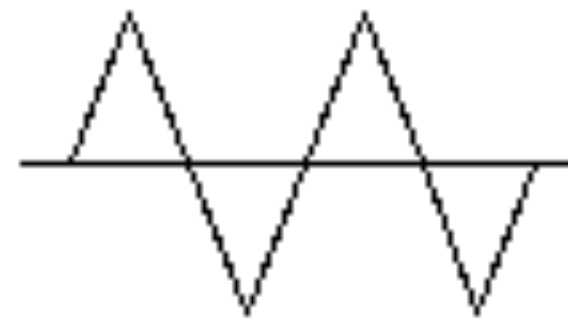
Sine



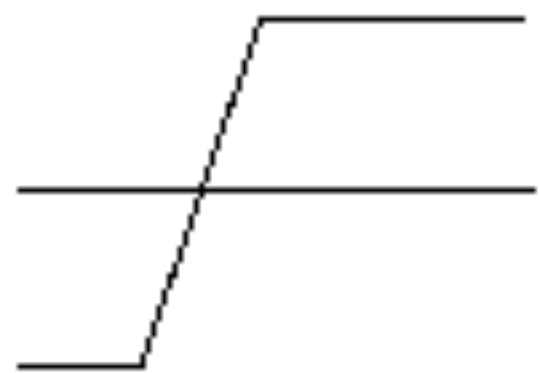
Square



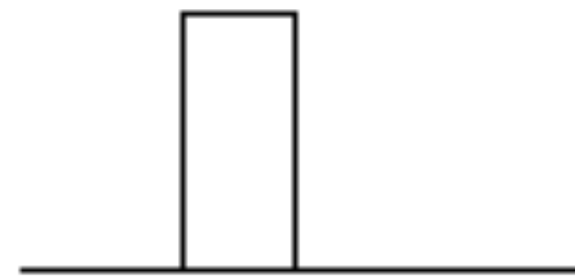
Sawtooth



Triangle

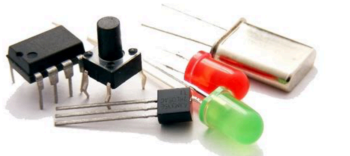


Step

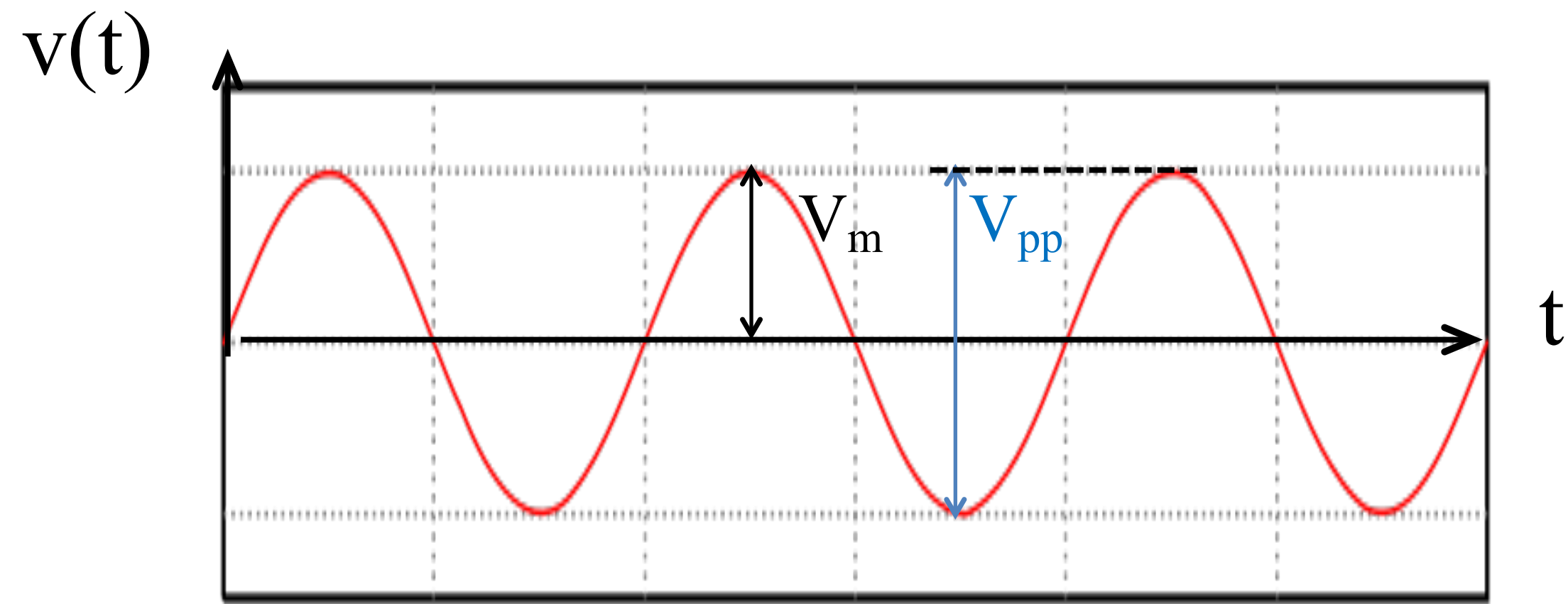


Pulse

- 正弦波 - 是否存在失真、非线性、谐波?
- 方波 - 重复方波脉冲, 用作时钟或测试运放的快速转换特性
- 锯齿波 - 缓慢上升、快速下降, 用于控制模拟示波器或电视扫描
- 三角波 - 上升、下降时间相同
- 阶梯波 - 从一个电平快速变化到另一个电平
- 脉冲信号 - 快速上升时间、持续幅度、快速下降
- 任意波形 - 一般是包括无法用函数表示的其它波形



模拟信号波形特征



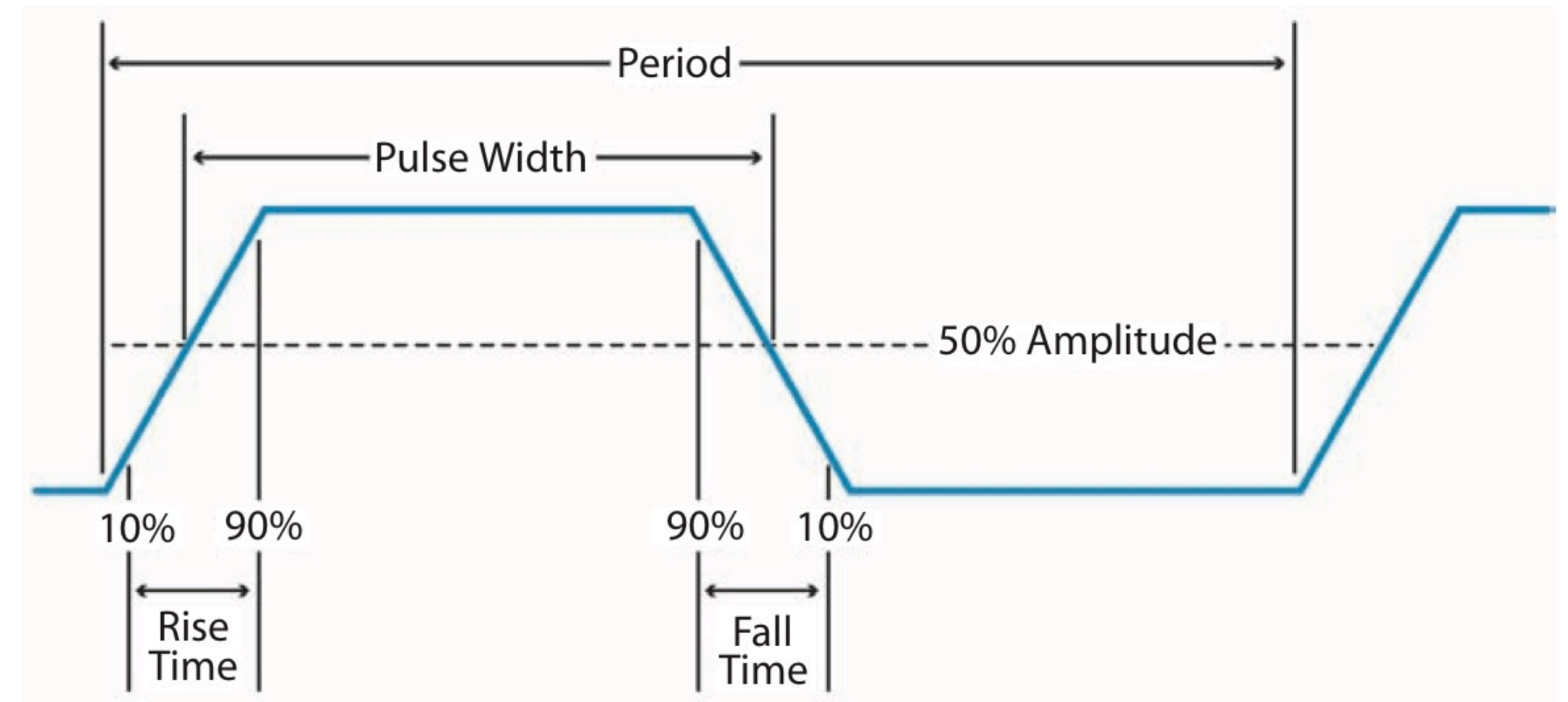
$$v(t) = V_m \sin(2\pi f t + \varphi) [V]$$

↑ 幅度
 ↑ 频率
 ↙ 相位

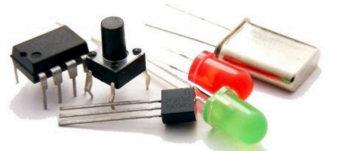
$$2V_m = V_{pp} \text{ (peak-to-peak峰峰值)}$$

$$v(t) = V_m \sin(2\pi f t) [V] + V_{dc} \text{ 直流偏移}$$

脉冲信号特征

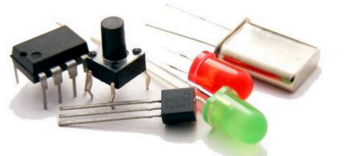
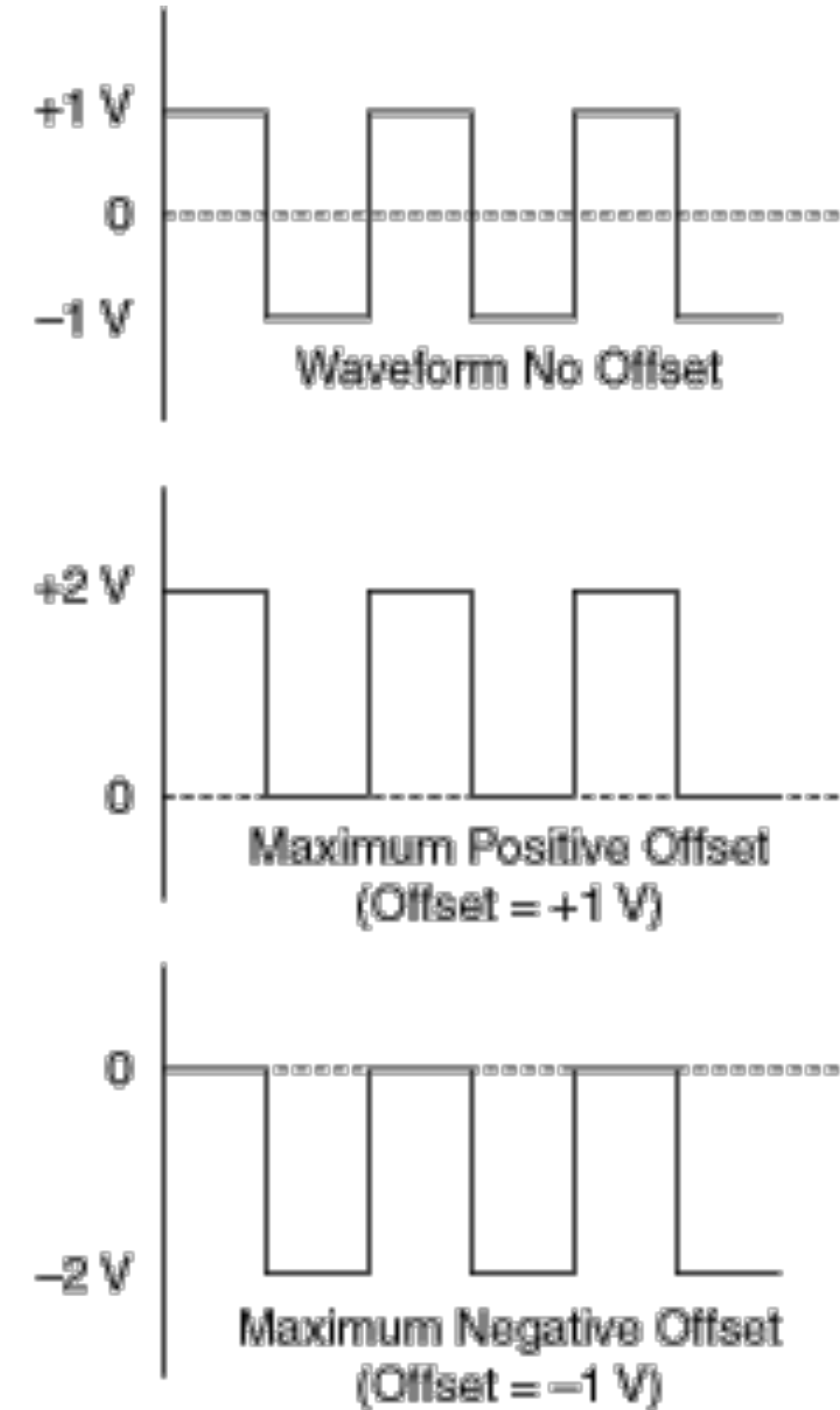
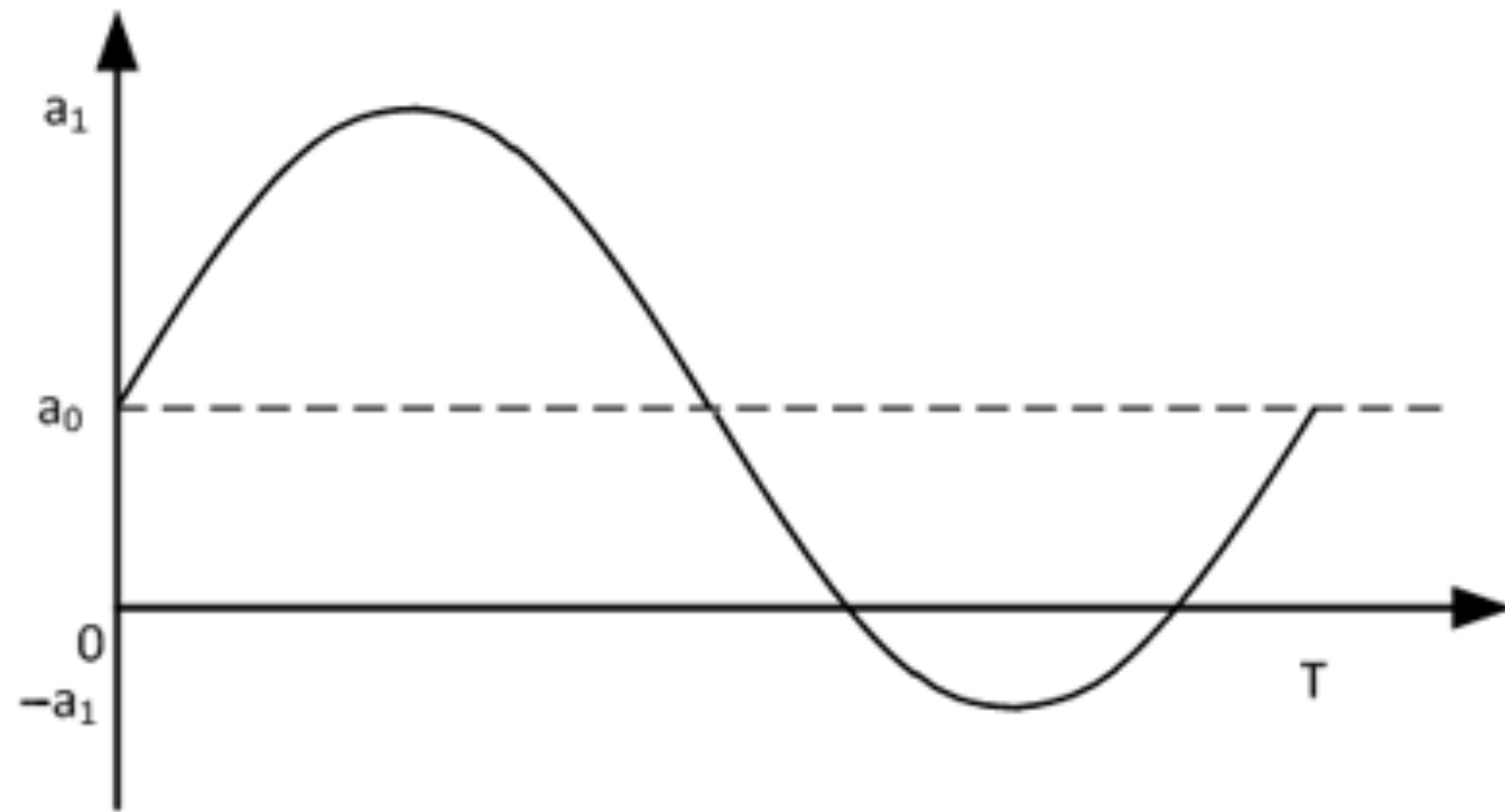


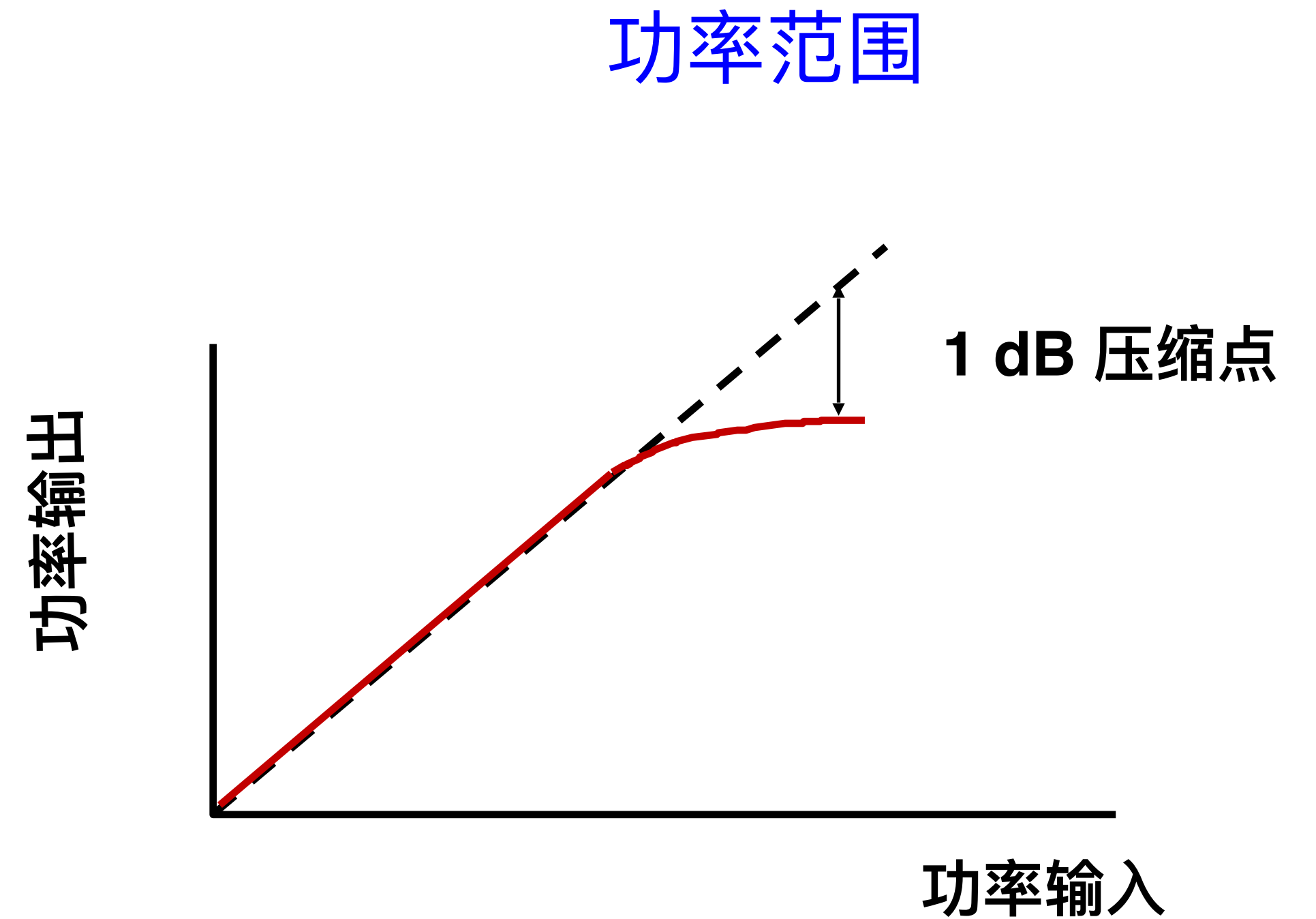
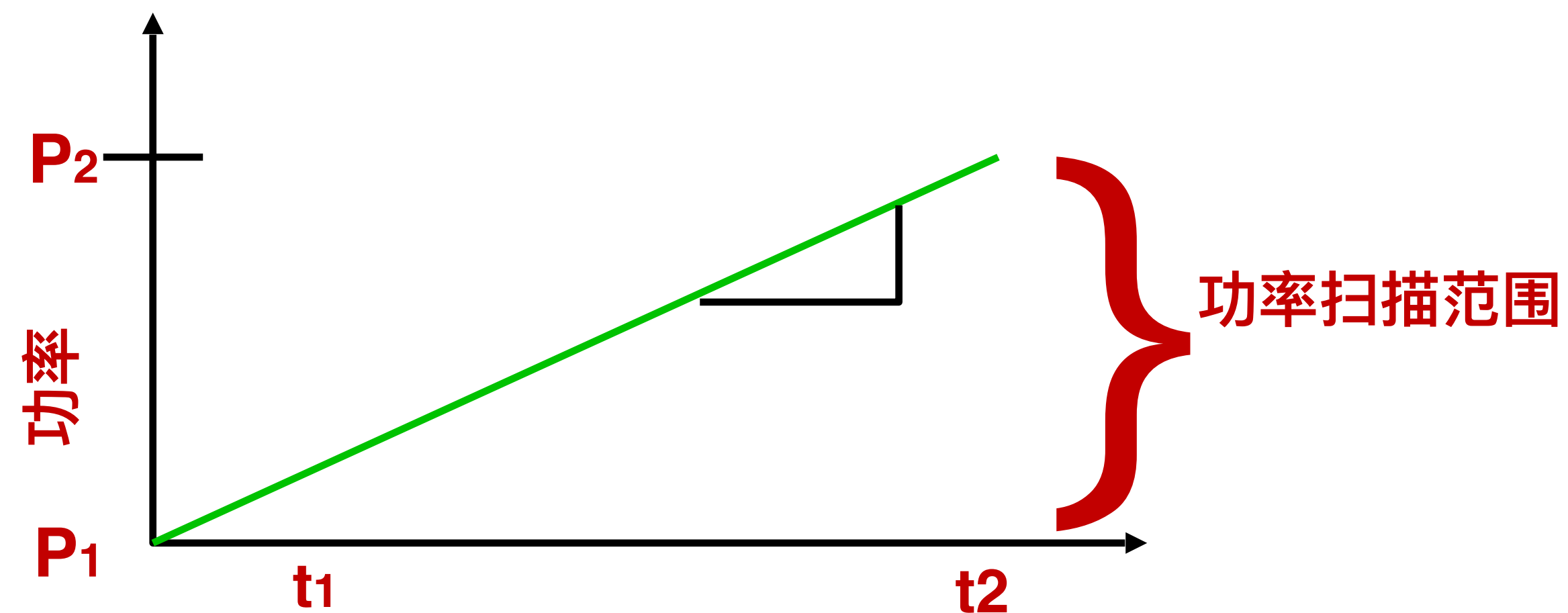
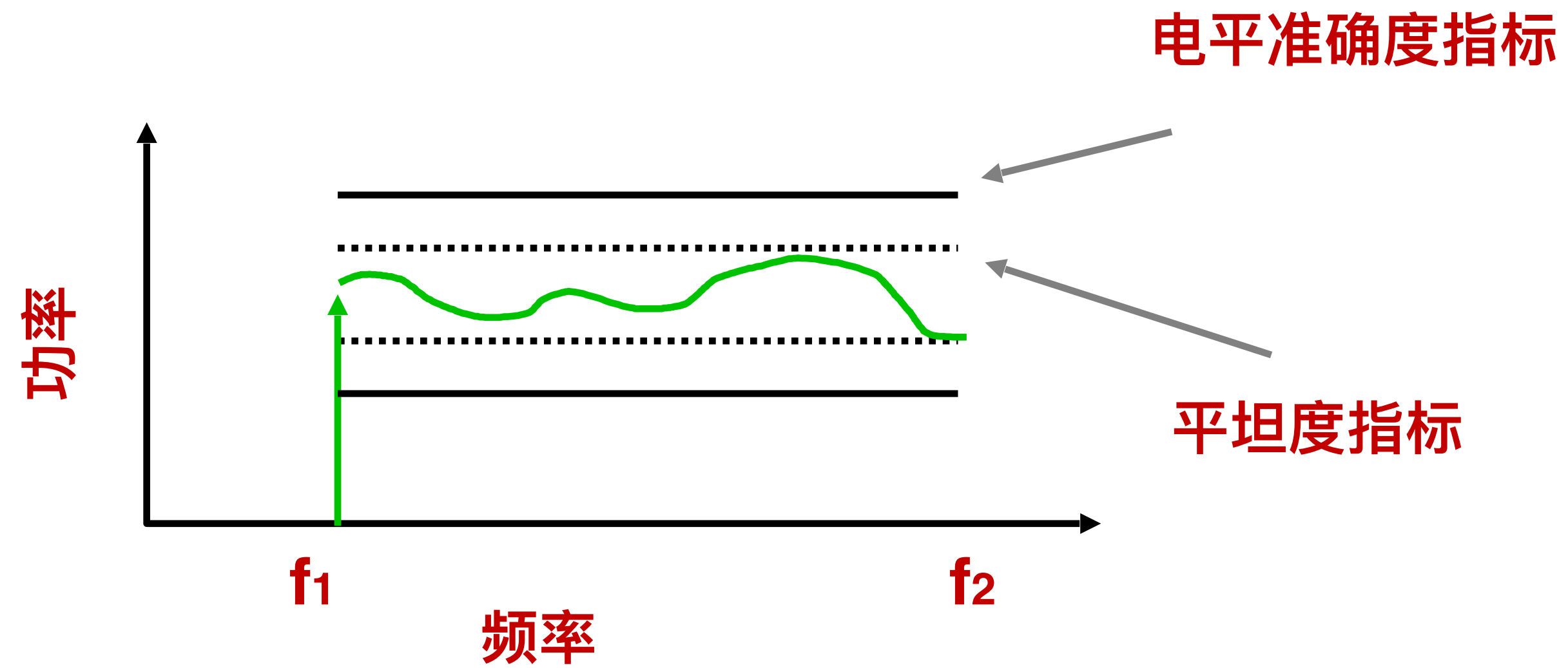
- 上升时间：脉冲边沿从低电平到高电平的时间
- 下降时间：脉冲边沿从高电平到低电平的时间
- 脉冲宽度：脉冲从低到高，再从高到低的时间，以全电压的50%为测量基准



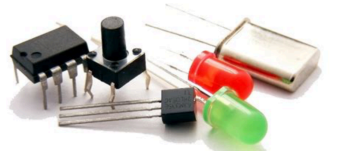
信号幅度特性

- 幅度 - 准确度、调节的分辨率
- 动态范围 - 从最小信号到最大信号的跨度 (dB)
- 直流偏移 - 在交流信号上叠加的直流分量
- 输出阻抗 - 一般为50

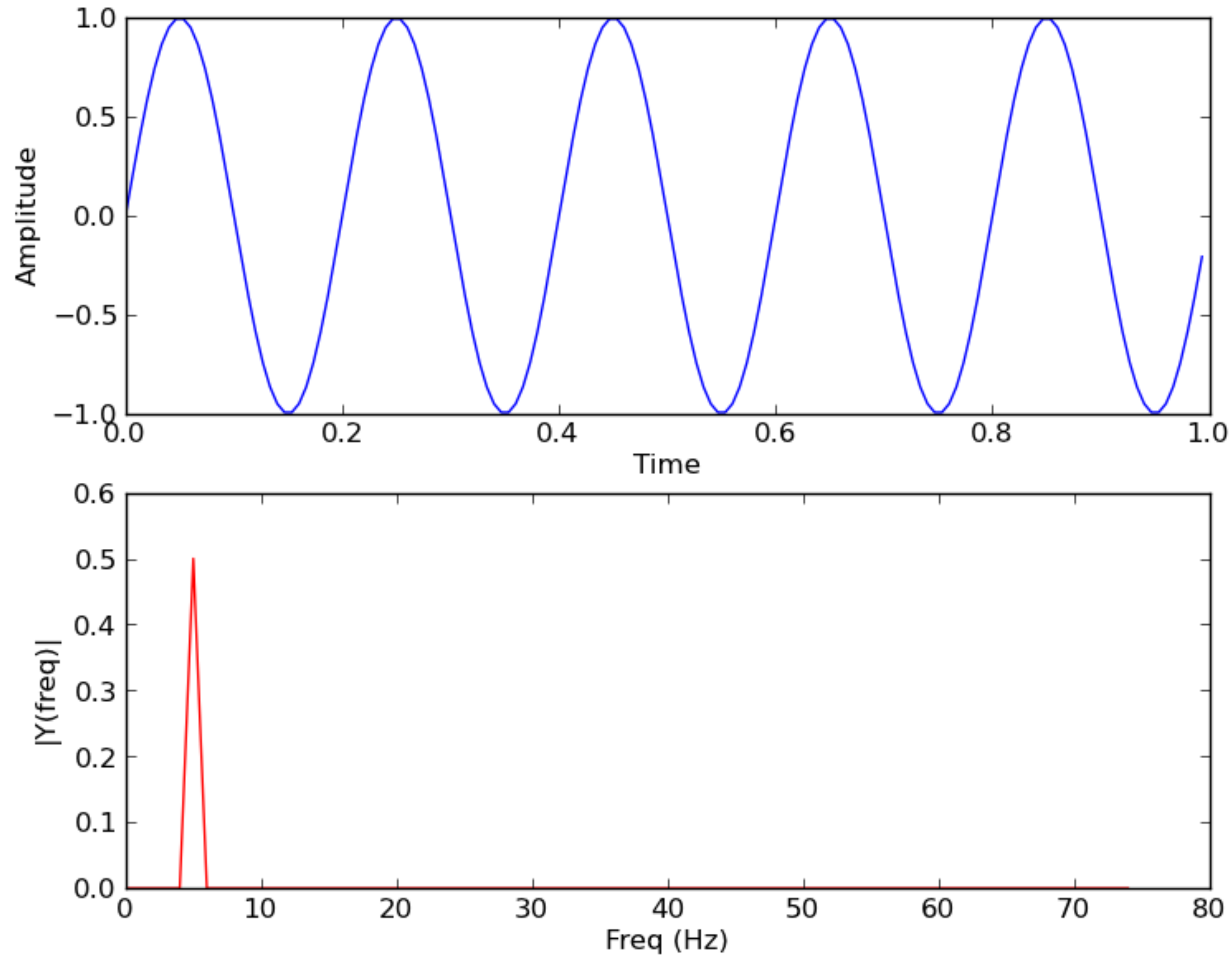




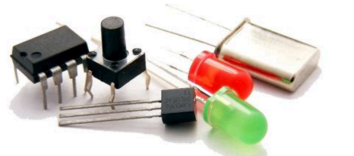
1dB压缩点是一个通用的放大器指标，用于定义一个放大器的线性范围，通过功率扫描来实现。

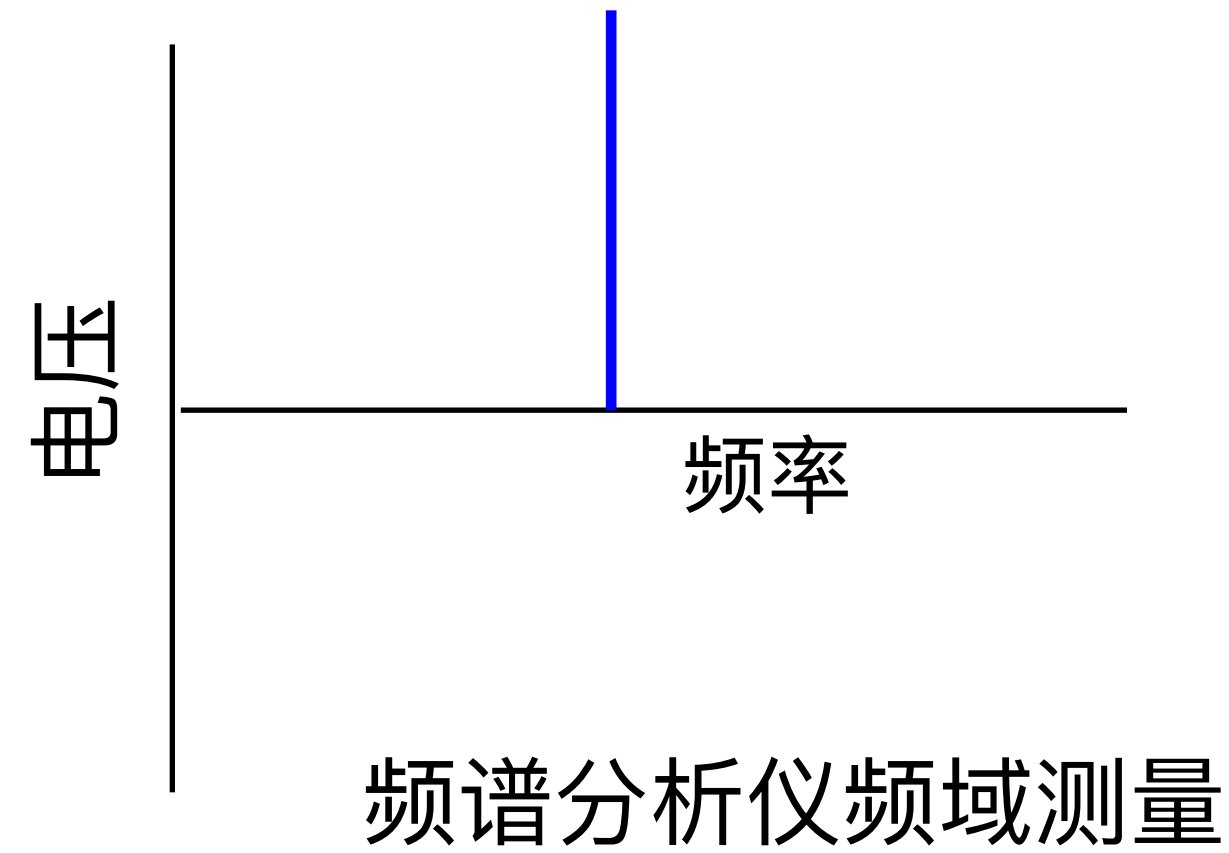
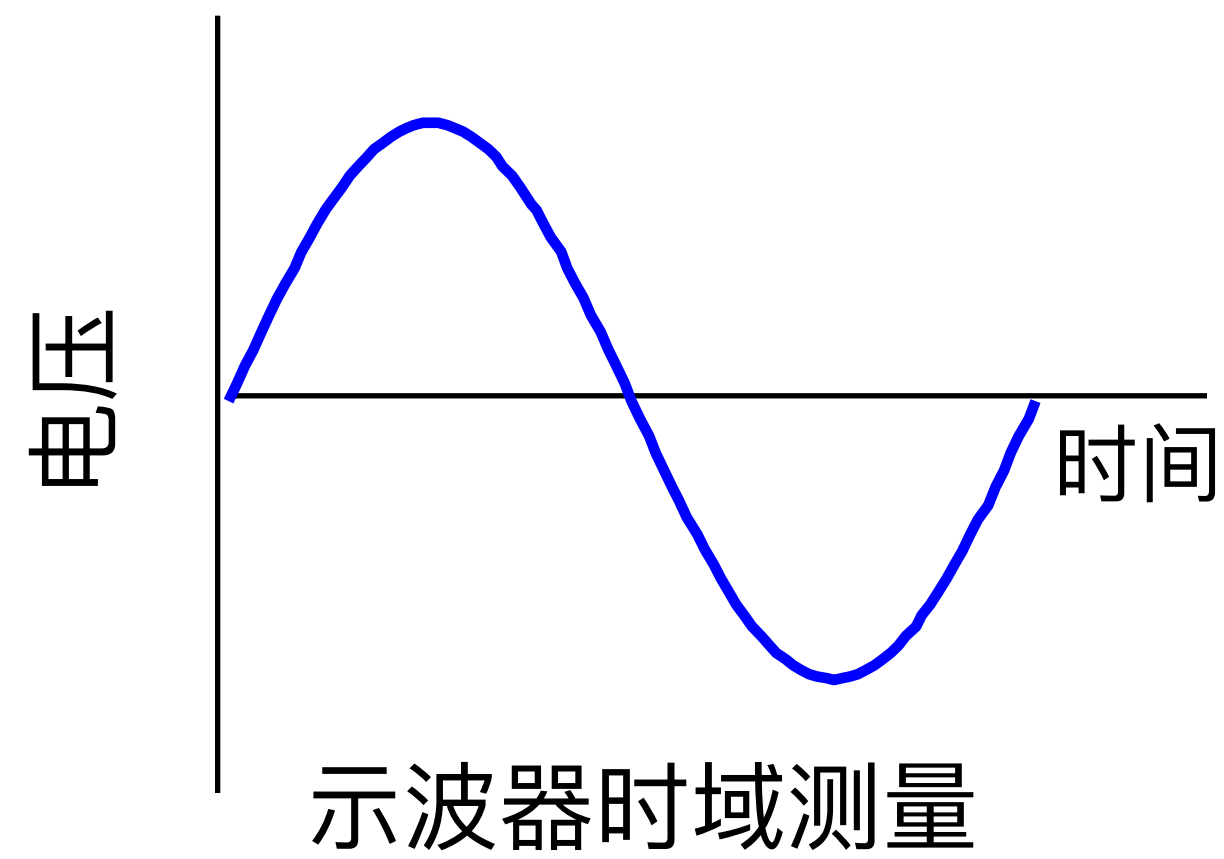


信号频域特性 - 频率



- 频率范围
- 频率准确度
- 频率稳定度
- 可调频率精度





连续波

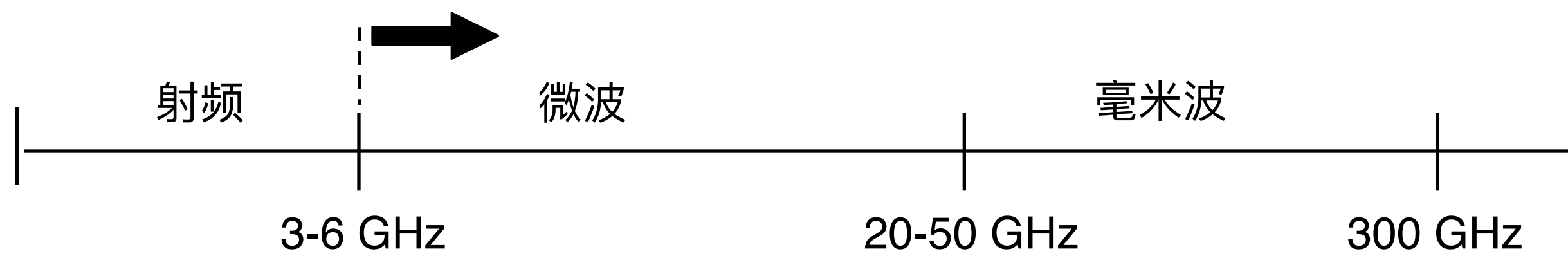
- 产生单频、固定频率的正弦波

扫频

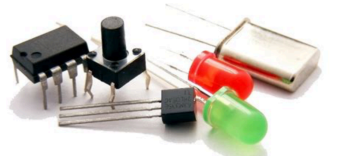
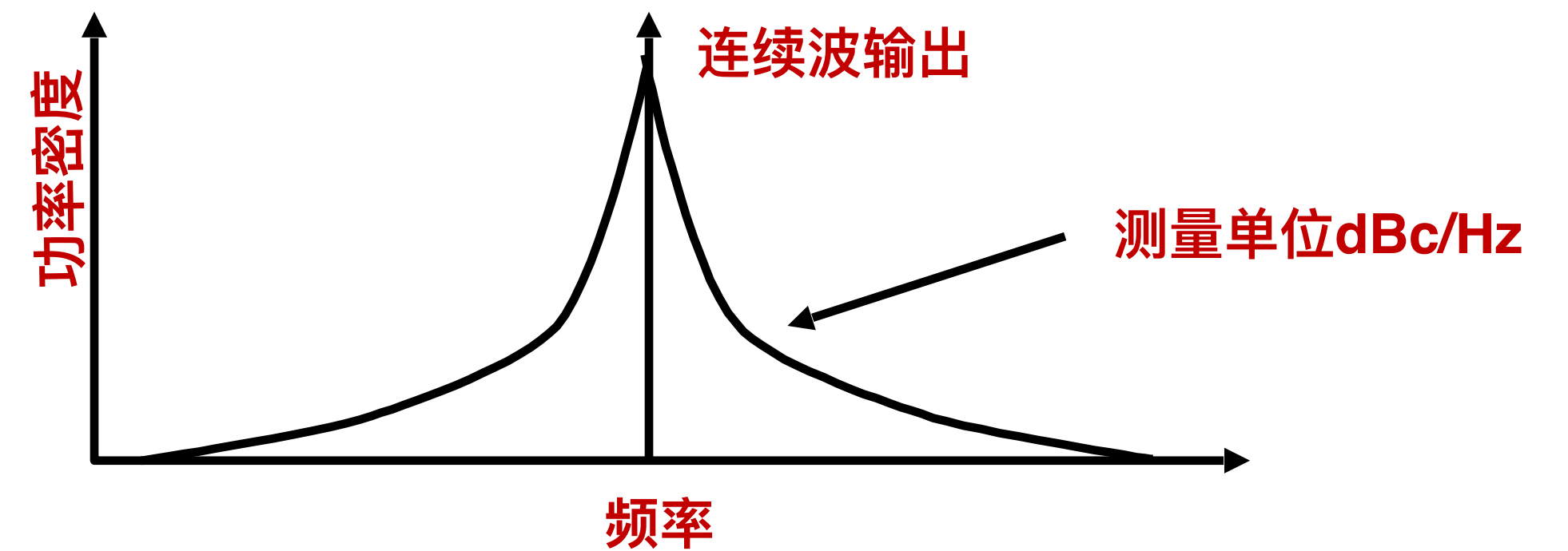
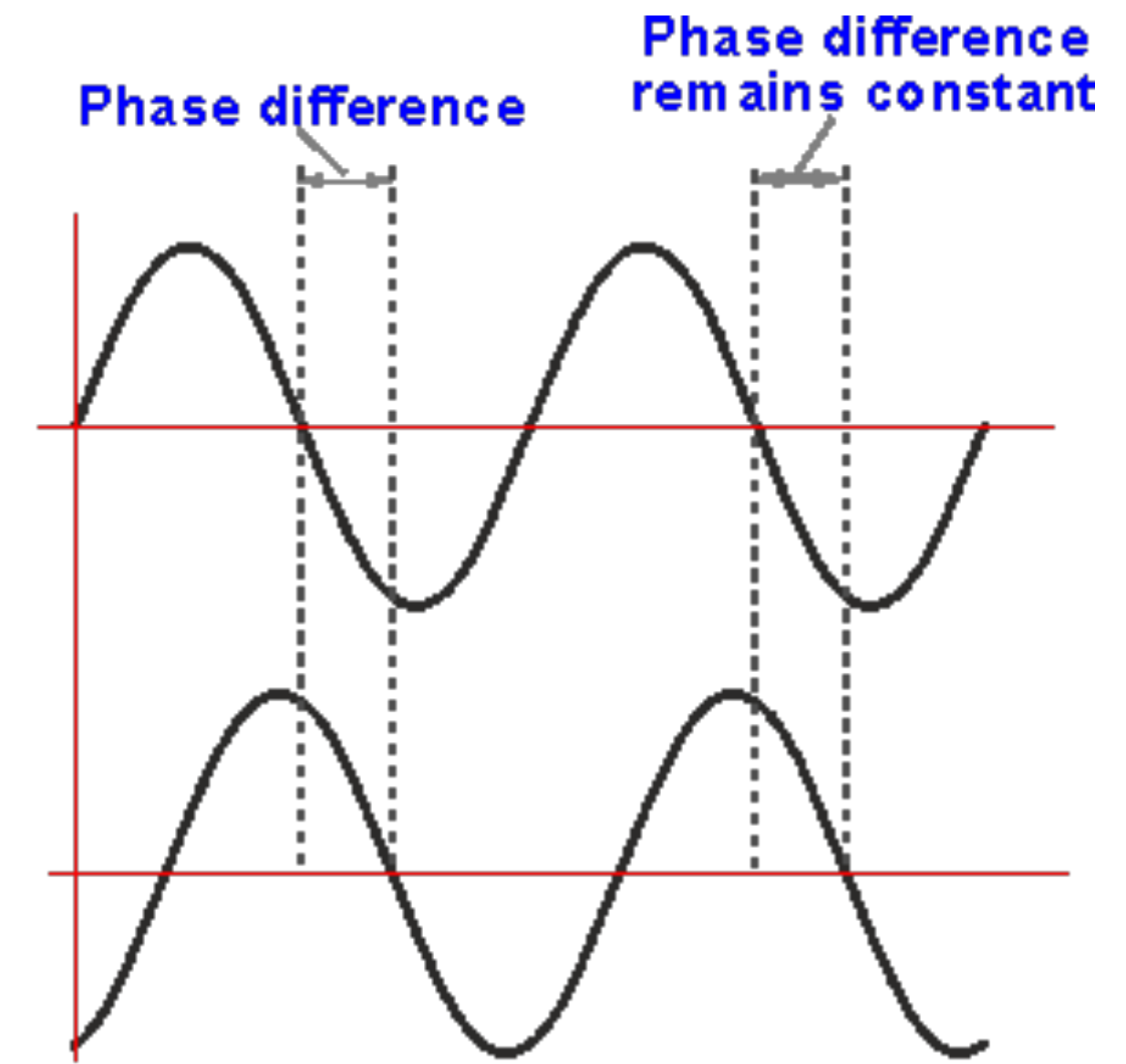
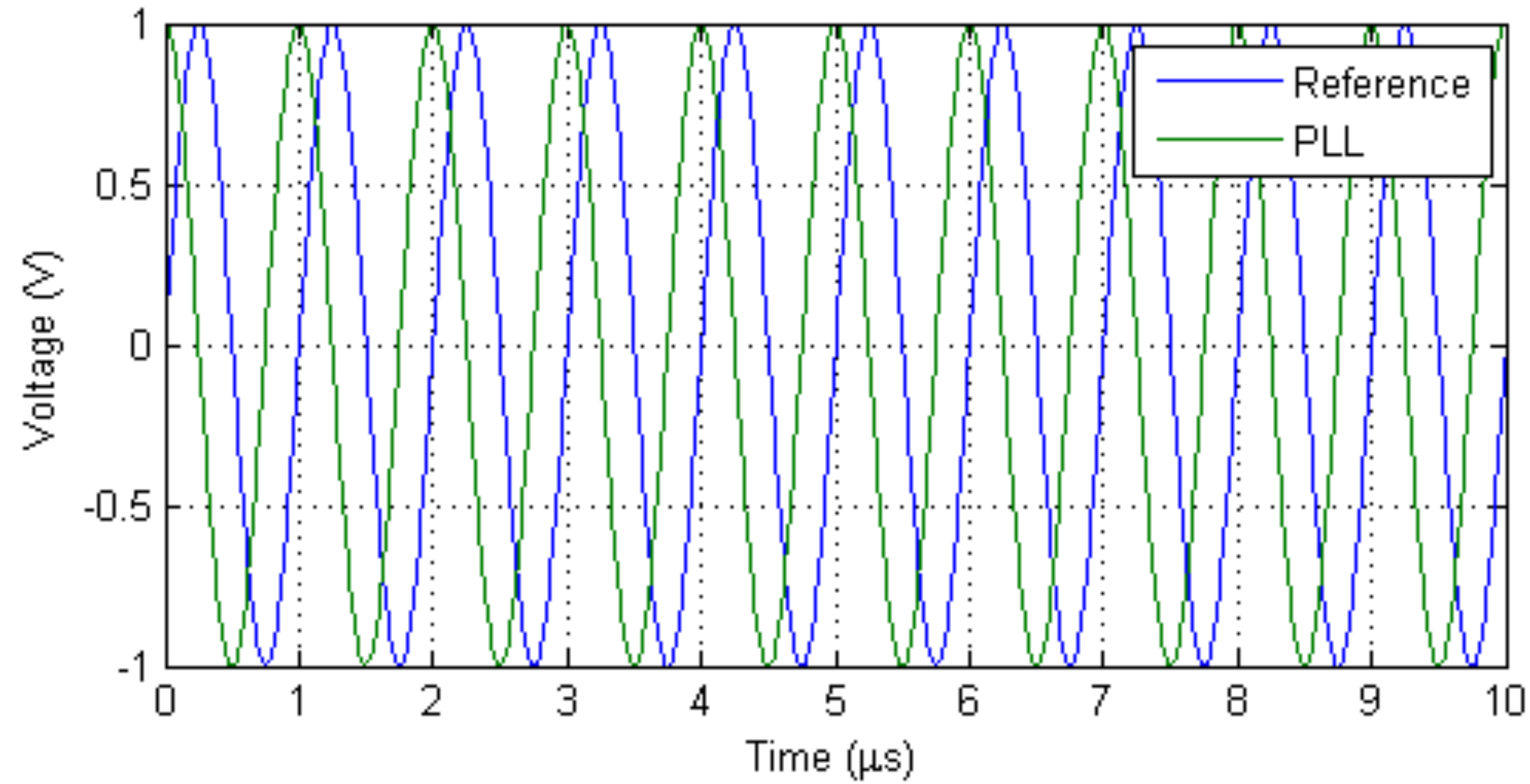
- 在一定频率范围内进行扫描
- 可能是相位连续的

信号发生器

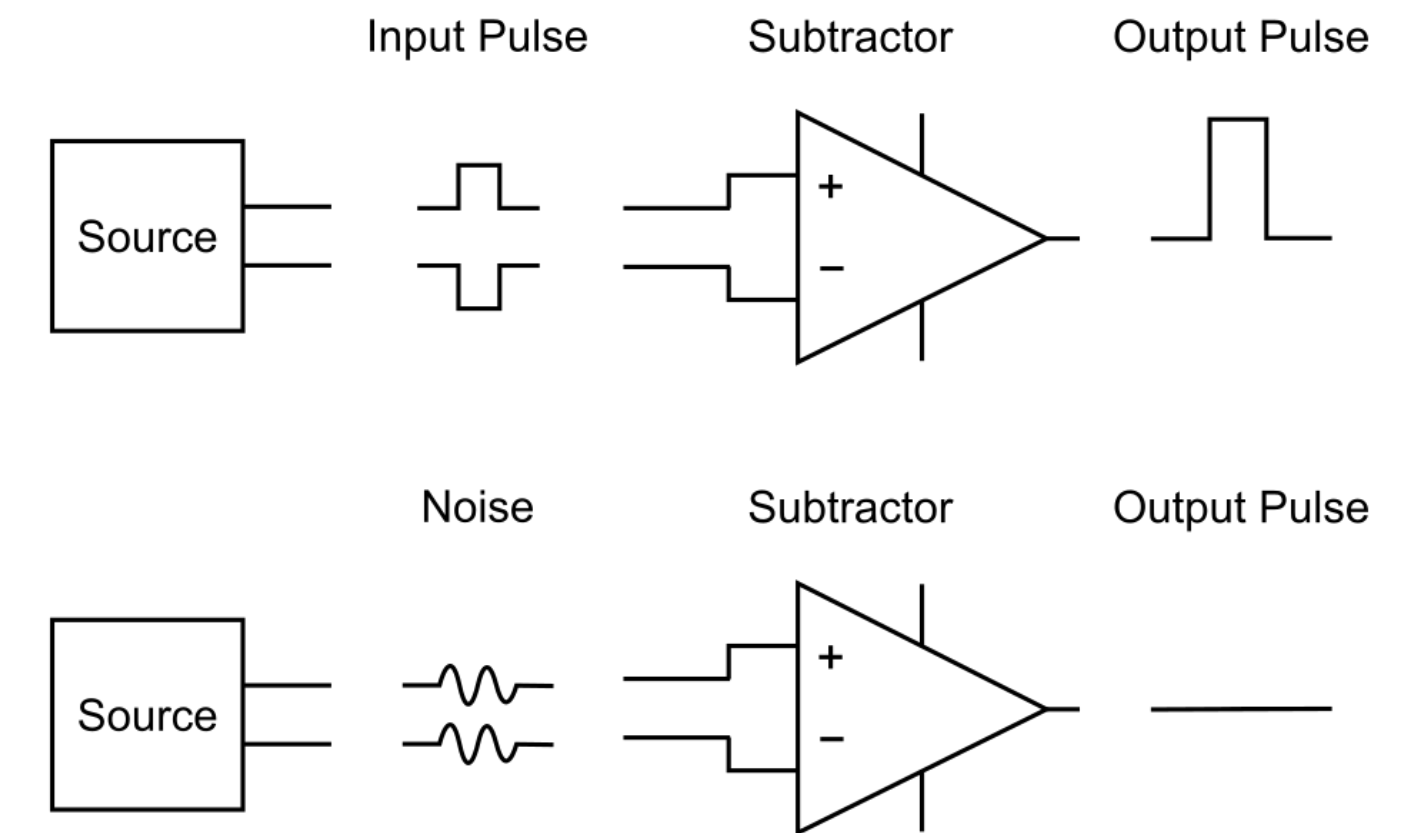
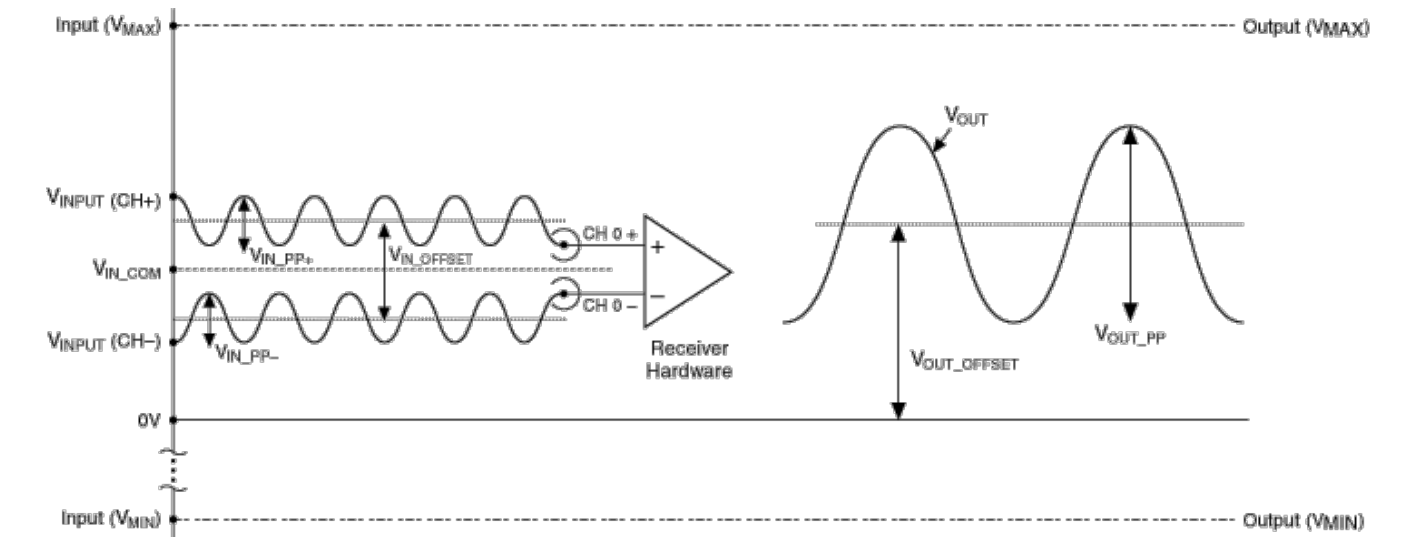
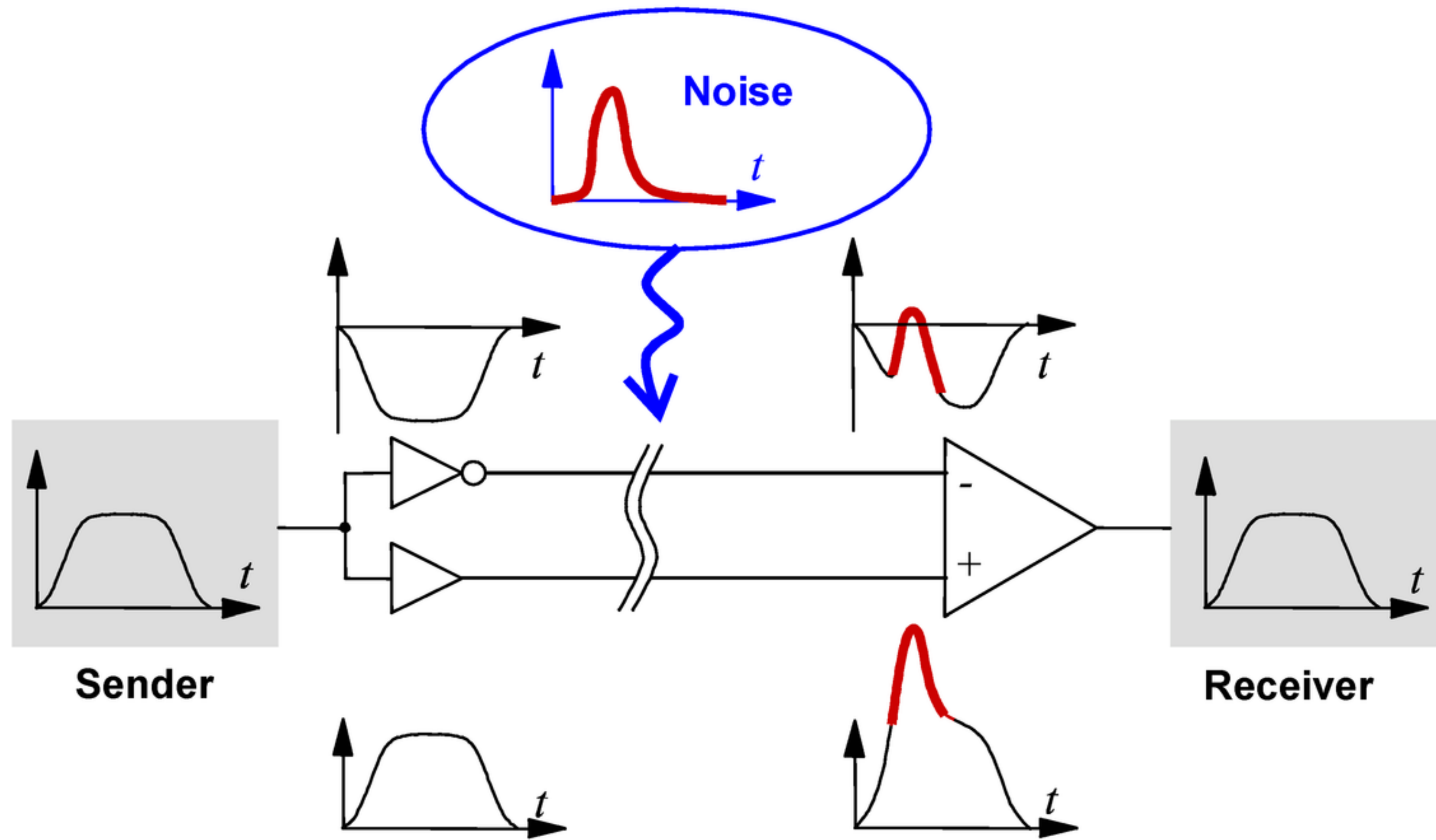
- 添加了调制
- 产生“真实世界”的信号



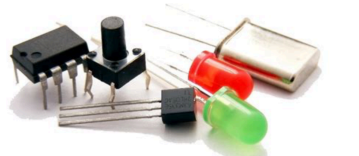
信号频域特性 - 相位



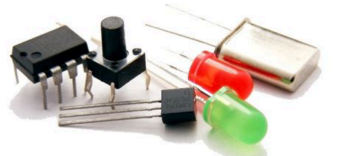
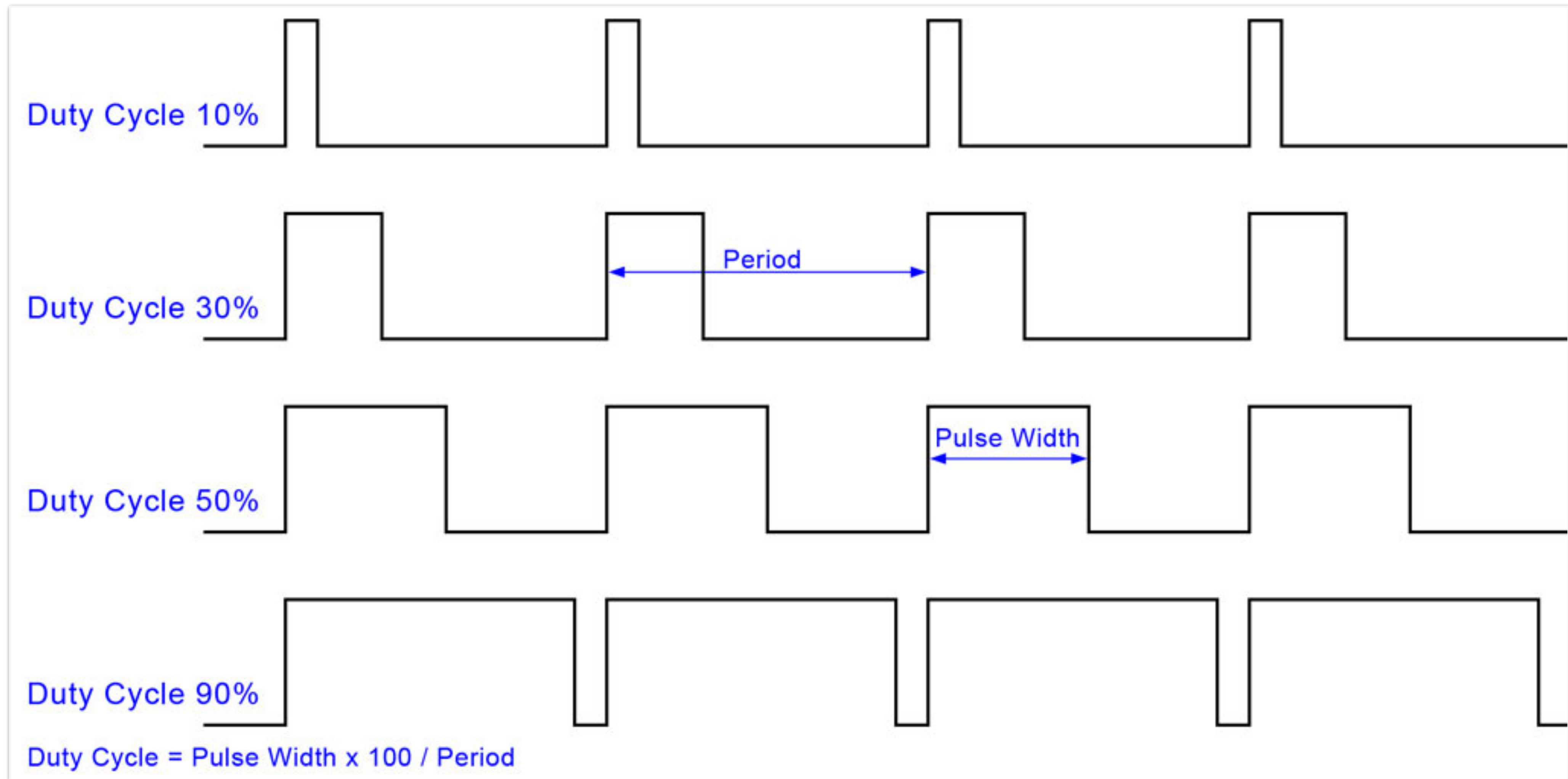
单边信号：差分信号



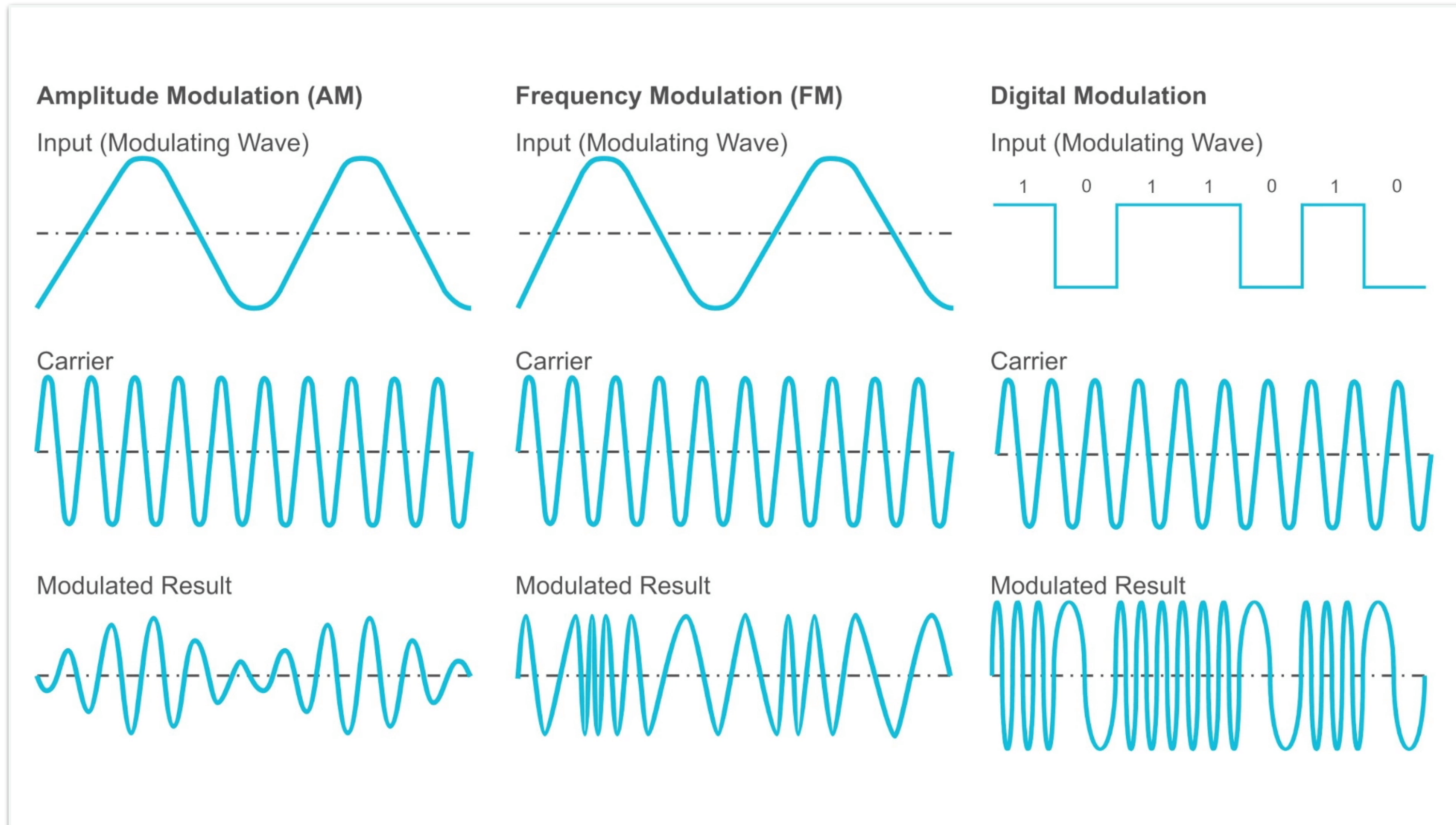
差分信号抗共模干扰能力强，但要注意走线，否则会导致脉冲噪声



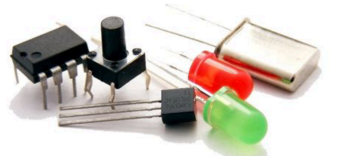
脉冲信号占空比/延时



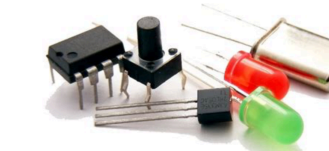
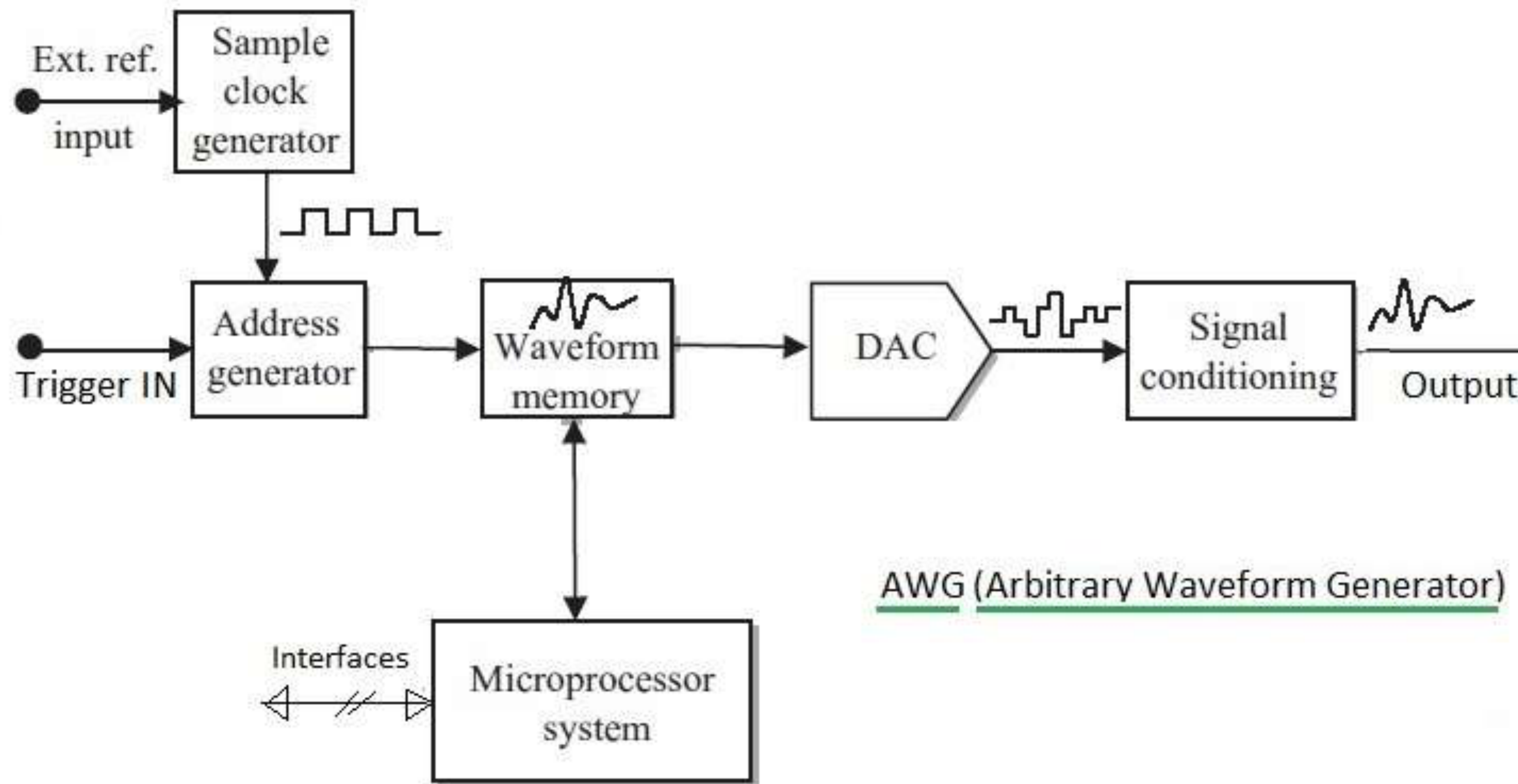
复合信号



- 模拟调制、数字调制、脉宽调制、正交调制
- 数字模式和格式
- 伪随机数据流



任意波形发生器系统构成



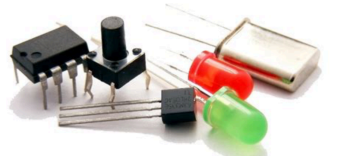
任意波形发生器产品举例 - Rigol



型号 - DG1022

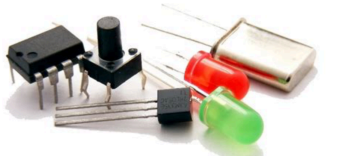
- 输出：5种标准波形，并内建48种任意波形
- 调制：AM、FM、PM、FSK
- 提供：线性/对数扫频和Burst
- 正弦波：1 μ Hz ~ 20MHz
- 方波：1 μ Hz ~ 5MHz
- 任意波形：1 μ Hz ~ 5MHz
- 波形存储长度：1K个点
- 采样：100Msps/14bits
- 输出信号：2mVpp 到10Vpp (50 Ω)
- 直流偏移：5V

Model	Max Output Frequency - SINE	Max Output Frequency - Square	Max Sample Rate	Max Arb Length	Channels	Price (USD)
DG5352	350 MHz	120 MHz	1 Gsa/s	128 Mpt	2	\$14,186
DG5351	350 MHz	120 MHz	1 Gsa/s	128 Mpt	1	\$10,626
DG5252	250 MHz	120 MHz	1 Gsa/s	128 Mpt	2	\$8,852
DG5251	250 MHz	120 MHz	1 Gsa/s	128 Mpt	1	\$7,245
DG4202	200 MHz	60 MHz	500 MSa/s	16 Kpt	2	\$1,880
DG4162	160 MHz	50 MHz	500 MSa/s	16 Kpt	2	\$1,312
DG5102	100 MHz	100 MHz	1 Gsa/s	128 Mpt	2	\$5,072
DG5101	100 MHz	100 MHz	1 Gsa/s	128 Mpt	1	\$4,232
DG4102	100 MHz	40 MHz	500 MSa/s	16 Kpt	2	\$1,028
DG5072	70 MHz	70 MHz	1 Gsa/s	128 Mpt	2	\$3,024
DG5071	70 MHz	70 MHz	1 Gsa/s	128 Mpt	1	\$2,058
DG4062	60 MHz	25 MHz	500 MSa/s	16 Kpt	2	\$966
DG1062Z	60 MHz	25 MHz	200 MSa/s	8 Mpt	2	\$903
DG2041A	40 MHz	40 MHz	100 MSa/s	512 Kpt	1	\$995
DG1032Z	30 MHz	25 MHz	200 MSa/s	8 Mpt	2	\$524
DG1022Z	25 MHz	25 MHz	200 MSa/s	2 Mpt	2	\$359
DG1022A	25 MHz	5 MHz	100 MSa/s	4 Kpt	2	\$376
DG1022	20 MHz	5 MHz	100 MSa/s	4 Kpt	2	\$299

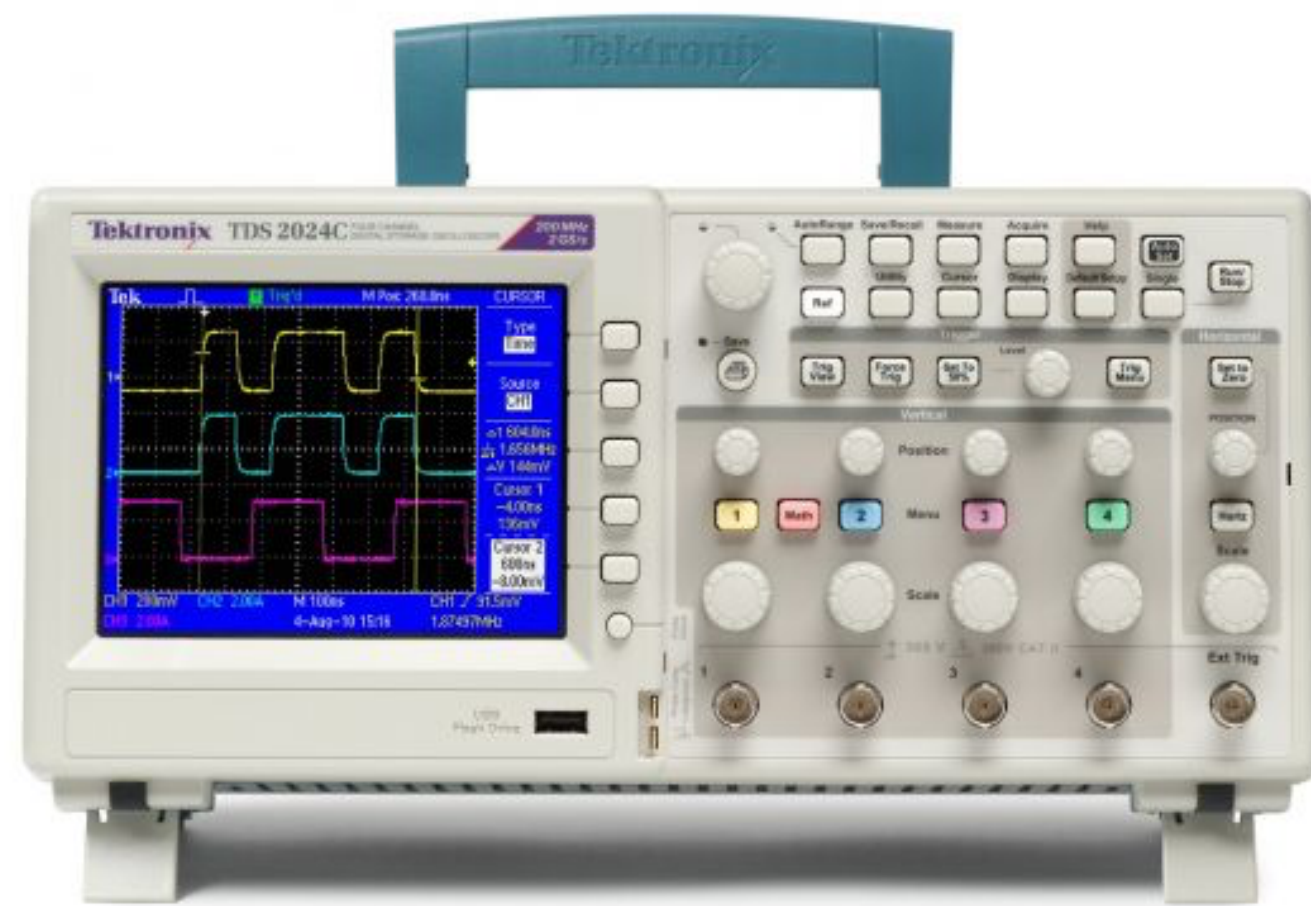


信号源的用途

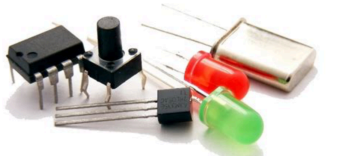
- 检查每一级电路的增益、频率响应，对接收端进行校准
- 信号源提供用于测试电路的各种波形，一般来讲都是低功率的
 - 验证（Verification） – 分析数字调制
 - 定标（Characterization） – 测试D/A和A/D转换器
 - 压力/临界点测试 – 通信接收机的压力测试



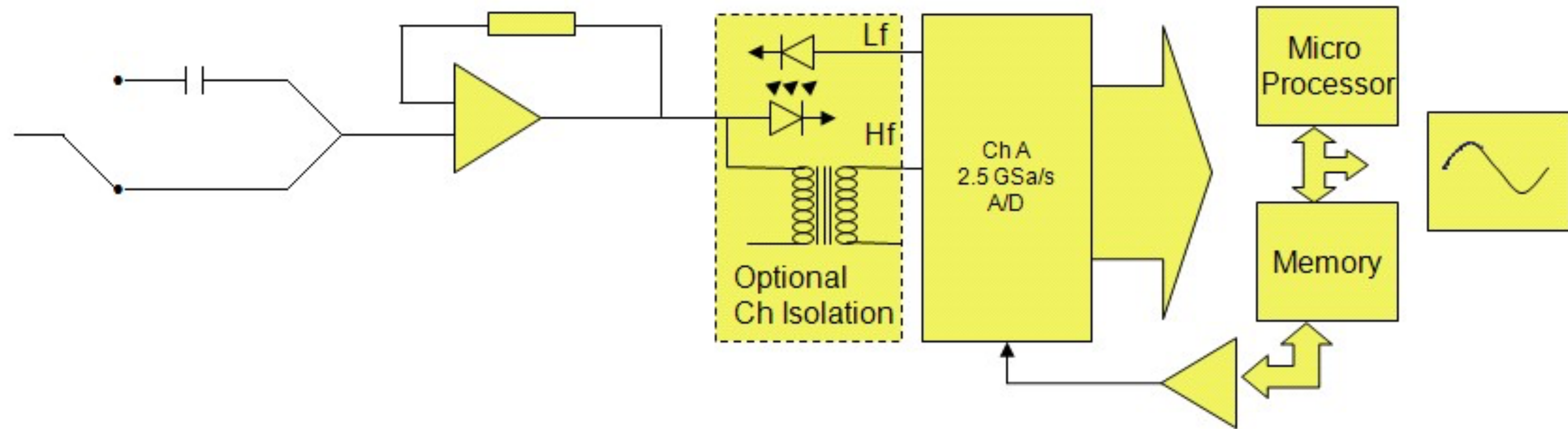
示波器



- 将输入的电信号变成在屏幕上可视的信息
- 以二维的方式动态地描述随**时间变化**的电信号
(信号幅度、噪声、频率)
- 是工程师测试、验证、调试电路的重要工具
- Scope、DSO、Digital Scope、CRO、MSO



示波器工作原理



Input Coupling
•AC or DC

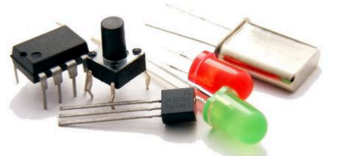
Amplitude Control
•Attenuation
•Amplification

Channel Isolation
•Up to 1000 Volt isolation
•Available on some scopes

A to D Conversion
•Real time
•Up to 2.5 GSa/s

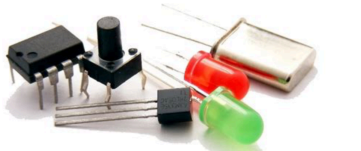
Triggering
•Edge
•Edge Delay
•Pulse Width
•N-Cycle

System Control
•Sample Storage
•Measure functions
•Graphics processing
•User interface

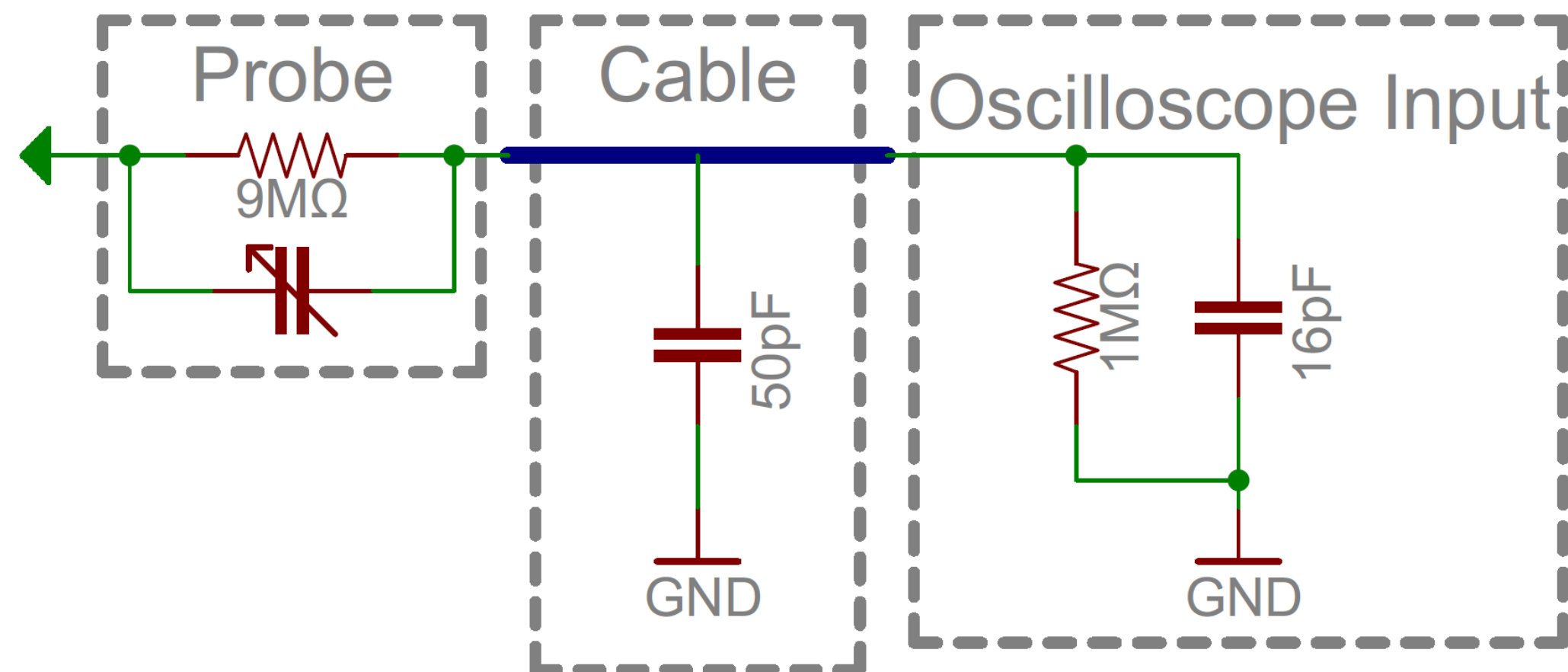


探头 - Probe

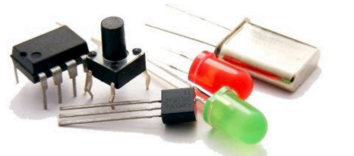
- 将待测设备的信号传递给示波器的BNC输入
- 探头根据应用场景（高频、高电压、高电流等）分为多种
- 最常用的为“无源10:1分压探头”



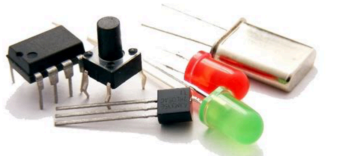
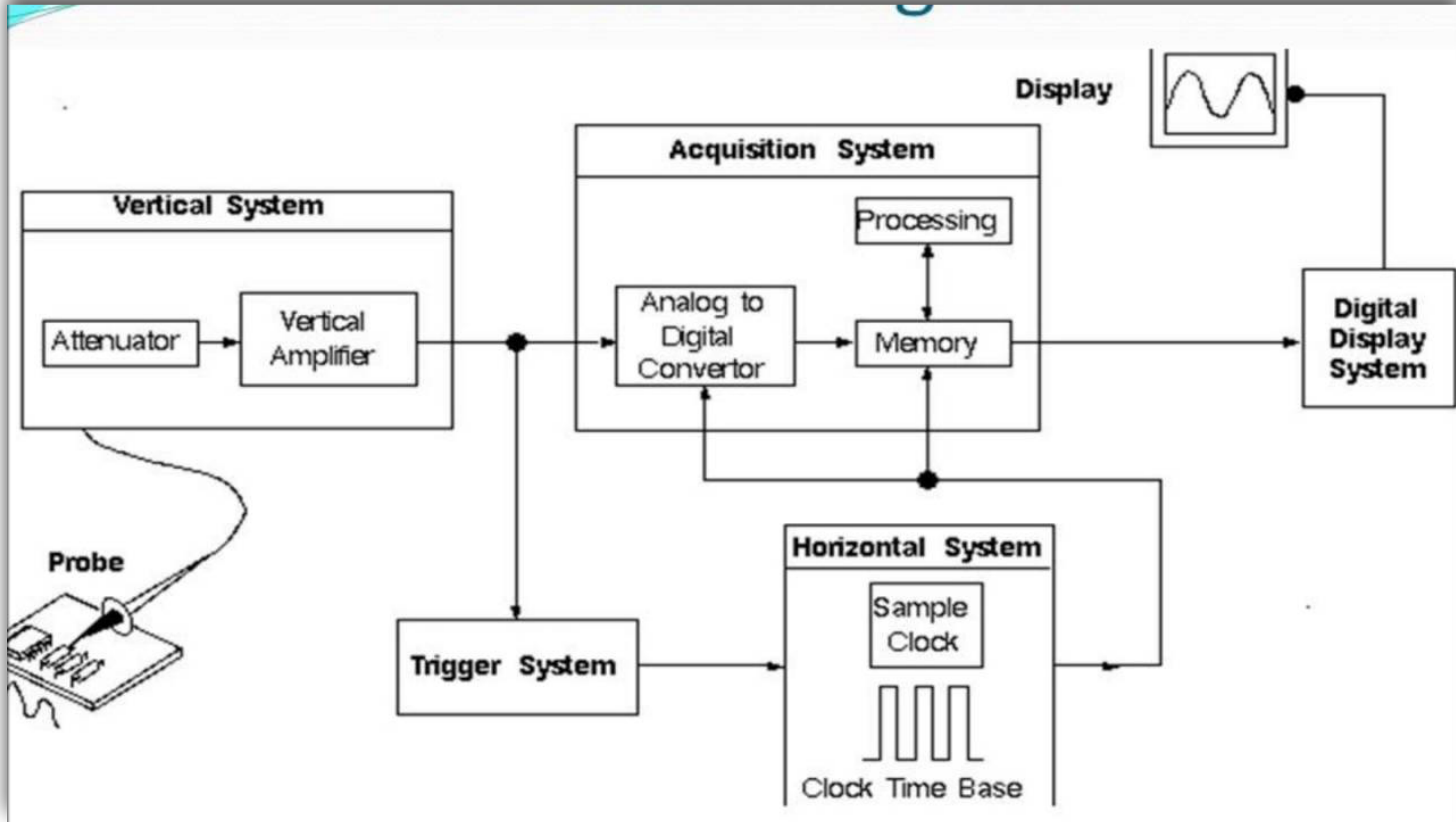
无源10:1分压探头



- 无源 - 没有任何晶体管、运算放大器之类的有源器件
- 10:1分压 - 将输入的电压降低为1/10, 同时将输入阻抗扩大了10倍
- 低频/直流模式 - 9M欧姆和1M欧姆串联
- 动态/AC模式 - 电容补偿

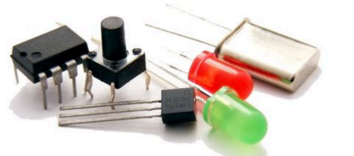


触发



主要指标

- 通道数
- 模拟带宽
- 采样率
- 存储深度
- 波形更新率
- 高级的触发模式



关于贸泽电子 - www.mouser.cn

The screenshot shows the Mouser Electronics website interface. At the top, a blue banner features the slogan '在MOUSER 采购很EASY!' and three key benefits: '数百万产品 一站式购齐', '接受微信支付 付款更简单', and '上海客服 本土支持'. Below this is a navigation bar with the Mouser logo, '联系Mouser (上海) 400-821-6111 | 反馈', and options for '产品', '制造商', '更多', '订单历史', '登录', '注册', and a shopping cart icon. A search bar is located below the navigation bar, with filters for '全部', '物料编号/关键字', '有库存', and 'RoHS'. The main content area includes a '产品类别' sidebar with categories like 'LED照明', '工业自动化', '工具与供应', '工程工具', '无源元件', '内存和数据存储器', '电线与电缆', '电路保护', and '电源'. A central banner promotes '额满免运费*' (Free shipping when order value reaches 175 yuan) and includes a QR code for WeChat. At the bottom, there is a '最新产品' section with logos for Texas Instruments, Infineon, Intel, and Molex.

- 与非网/摩尔吧多年合作伙伴
- 全球领先的电子元器件授权分销商
- 700家原厂/500万现货库存
- 小批量采购，170元免邮费
- 1-2周交货

