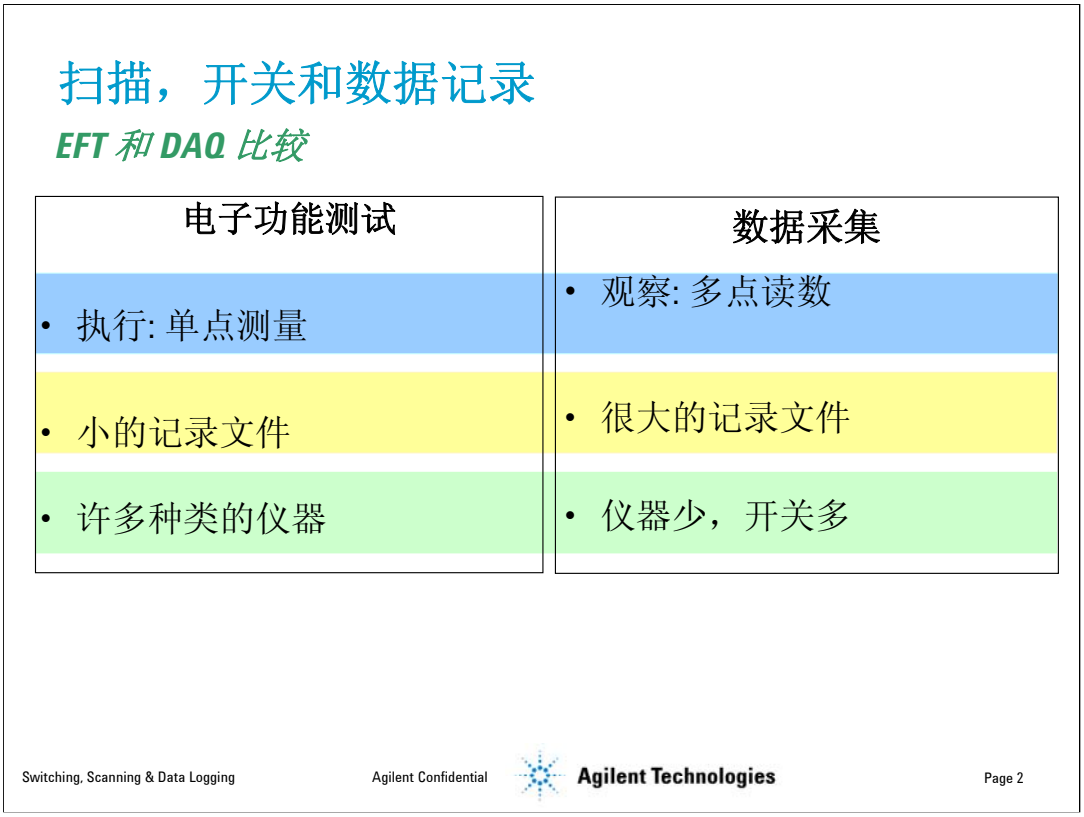
扫描，开关和数据记录

数据采集基本原理

Agilent Technologies

Welcome to part 7 of the Basic Instruments Measurement Fundamentals series. In this session we'll take a break from electronic functional test and spend a few minutes on the fundamentals of data acquisition: transducers, scanning, switching and data logging.

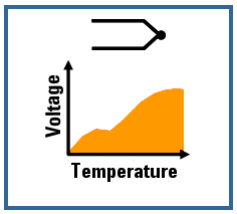


In part 2, the Measurement Fundamentals module, we summarized the key differences between EFT and DAQ in this simple table. EFT systems tend to be complex: they contain several instruments and make many types of measurements. However, they tend to produce a modest amount of raw measured data.

In contrast, DAQ systems use a few instruments and lot of switching to make a few types of measurements – but they make those measurements on dozens and maybe hundreds of points. This approach creates a lot of raw measured data.

扫描，开关和数据记录

- 测量或监视物理现象
  - 用传感器把物理量变换成电量



- 监视一个过程或系统
  - 能通过控制关键参数改变过程或系统

The other key difference is the nature of the problem. EFT is used to test or characterize an **electronic** device or system. Generally, DAQ is used to measure a **physical or mechanical** device or system. To make those measurements with an electronic instrument, we have to convert physical characteristics such as temperature and vibration into electrical signals. We do that using devices called transducers.

DAQ is also used to monitor the state of a chemical process or a complex system such as the devices in a communication network. A DAQ system can be programmed to interact with the process or system and change its behavior.

For the rest of this session we'll focus on the basics of measuring or monitoring physical phenomena.

议题

扫描，开关和数据记录

- 客户和他们的需求
- 测量，传感器和开关
- **Agilent DAQ** 仪器
- 小结
- 了解更多情况

And here is our agenda for the next 20 minutes

We'll start with an overview of the customers who measure and monitor physical phenomena and we'll describe their requirements.

Next, we'll discuss the most common types of physical measurements and the most widely used types of transducers. We'll also take a brief look at the three major switching configurations and the three most common types of switches.

After that, we'll compare – again – the 34970A and the 34980A, and then take a closer look at the one that is best suited to handle data acquisition applications.

As usual, we'll conclude the session with a quick review of the highlights and a brief list of additional resources that will help you learn more about scanning, switching & data logging.

客户和他们的需求

数据采集

- **Agilent 客户**
  - **行业:** 制造业，汽车，通信，航空航天，电子
  - **产品生命期**
    - **研发或设计验证**
      - 物理量测量
      - 环境测试
    - **制造或运行**
      - 过程或系统监视
- **典型要求**
  - **许多点，少数几种测量**
  - **传感器和信号调整**
  - **用于低频信号的扫描和开关**

Customers who utilize data acquisition work in many of the same companies and industries as our EFT customers. However, DAQ customers may be mechanical engineers, chemical engineers or process control engineers who are also very familiar with computers, programming and test equipment.

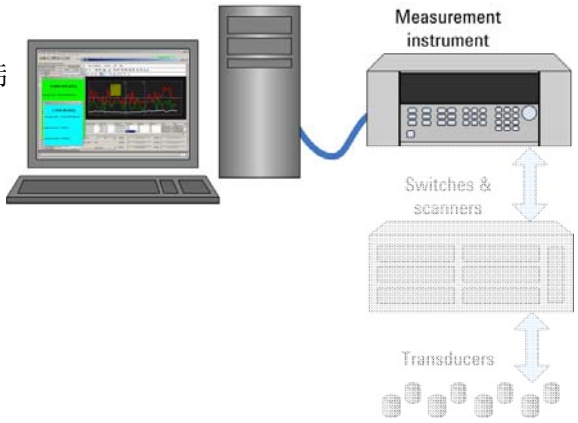
Their applications tend to match up with the stages of the product lifecycle. In R&D and design verification, data acquisition may be used for physical measurements of mechanical assemblies such as airplane wings and car bodies – or for environmental testing of electronic assemblies. In manufacturing or operations, data acquisition may be used to monitor a chemical process or monitor the devices in a communication system.

In most cases, the actual requirements are fairly similar: transducers are connected to a scanner or switch; these connect many points to perhaps one measurement instrument, which makes a few types of measurements on the signal from every transducer.

测量，传感器和开关

系统的基本体系结构

- 数据采集系统
  - 目标: 监视，测量，分析，控制
- 基本部件
  - 控制器
  - 软件
  - 接口
  - 仪器
  - 开关和扫描器



If we look at the basic structure of a data acquisition system, it's similar to an EFT system. The objectives are similar and the basic elements are familiar.

We've already mentioned one key difference: a DAQ system relies on transducers to convert physical properties into electrical signals.

The other major difference is in the switching. DAQ systems often rely on a type of switch called a scanner. Scanners connect multiple points sequentially to a single measurement device such as a voltmeter or digitizer.

传感器

- 把物理量...
  - 温度
  - 相对湿度
  - 流量
  - 流速
  - 声压
  - 位移
  - 速度
  - 加速度

变换成电量

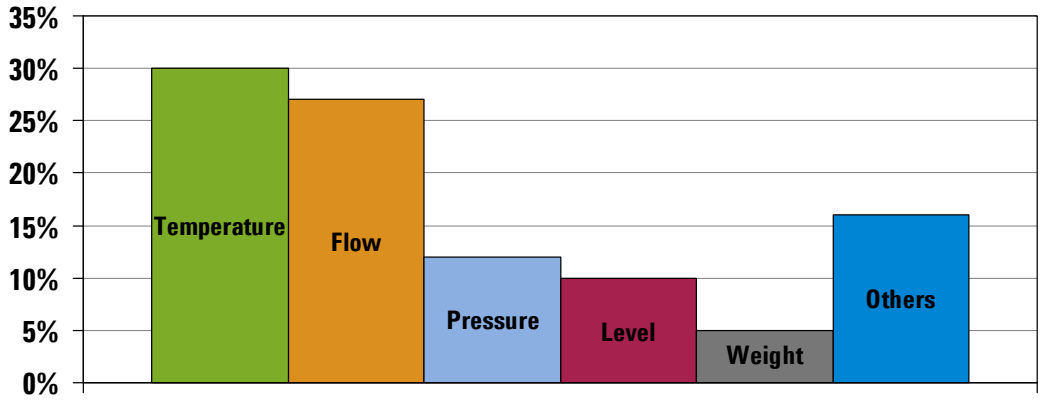
- DC 电压
- DC 电流
- AC 电压
- AC 电流
- 电阻
- 频率
- 调制

The vast range of physical properties is equaled or exceeded by the huge variety of transducers that produce an electrical property we can measure with an electronic instrument.

We won't cover them all today. Instead, we'll focus on the most common physical measurement...

常用测量

物理特性



... and that is temperature.

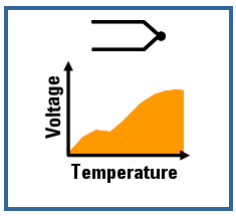
Looking at the chart, it's easy to imagine measurements of temperature, flow, pressure, level and weight being used to monitor vats or tanks of fluids being mixed to form an end product: gasoline, liquid detergent, toothpaste, beverages and even perfume. The testing environment may be quite different from the world of electronic functional test.

And, again, there many ways to measure each of these properties. Even if we limit our focus to temperature and the most common transducers...

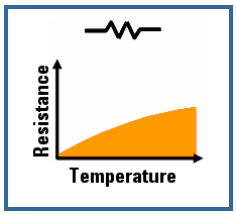
传感器

常用的温度传感器

- 热偶
  - 优点: 自供电，简单，耐用，便宜，种类多，温度范围宽
  - 缺点: 非线性，电压低，需要参考结，最不稳定，最不灵敏



- 电阻温度探测器 (RTDs)
  - 优点: 最稳定，最精确，有比热偶好的线性
  - 缺点: 昂贵，需要电流源，电阻变化小，四线测量，自热效应



... there are four major types to consider. These are the ones customers typically use with DAQ systems so it's worth a quick look at each type.

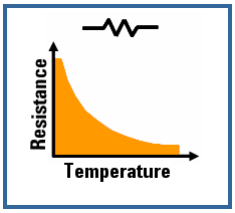
A thermocouple is a junction of two dissimilar metals – a bimetallic junction. When this junction is heated, the thermocouple produces a voltage that depends on the junction temperature and the composition of the wires. The graph on the right shows the symbol for a thermocouple and a typical temperature-versus-voltage characteristic. As you can see, the relationship between temperature and voltage is far from linear. This is just one disadvantage of thermocouples. {touch on advantages and disadvantages}

Resistive temperature detectors or RTDs are more linear than thermocouples, as shown in the chart. RTDs also tend to be more stable and more accurate. However, they also have several disadvantages: {see slide}.

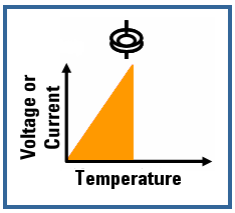
传感器

常用的温度传感器

- 热敏电阻
  - 优点: 高灵敏度，两线电阻测量
  - 缺点: 非线性，有限的温度范围，不结实，需要电流源，自热效应



- IC 基传感器
  - 优点: 最好的线性，最高的输出，便宜
  - 缺点: 温度 < 250°C, 需要电源，自热效应，有限的配置



Thermistors are another type of resistance-based temperature transducer. As you can see, resistance falls as temperature increases; however, this is not a linear relationship. On the positive side, thermistors require just two wires and provide high sensitivity. On the negative side, they are fragile and have a limited temperature range.

In recent years, integrated circuit technology has been applied to many types of transducers. IC-based temperature sensors are very linear and are less expensive than most other types. However, they have a limited temperature range and require an external power source.

In all, thermocouples are still the most common. Let's take a closer look.

传感器

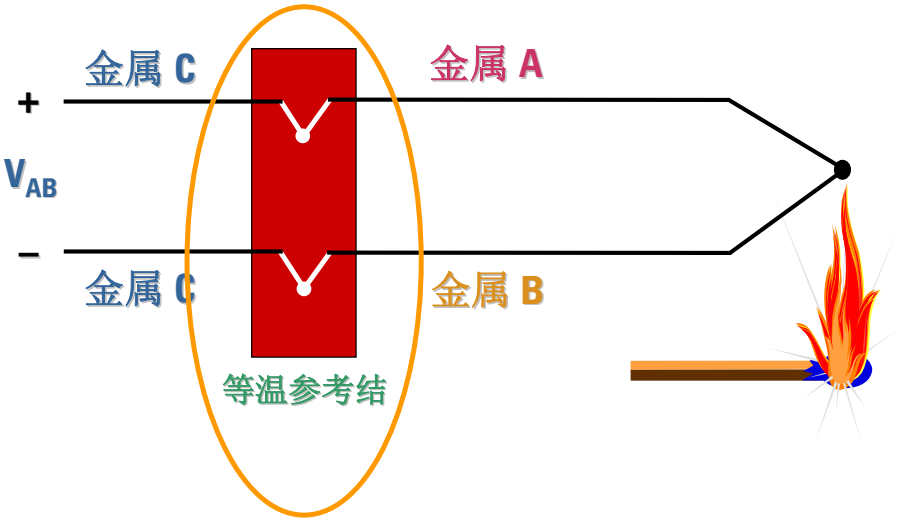
热偶

Thermocouples have been around the longest and are also the most common. Unfortunately, thermocouple measurements are tricky.

As mentioned two slides ago, thermocouples use a bimetallic junction to produce a voltage that's proportional to temperature. Well, when we connect a thermocouple to the terminals of a DMM...

传感器

热偶



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...we create two more thermocouple junctions.

To minimize this effect, these junctions are placed on what's called an isothermal block or isothermal reference junction. The DMM will sense a voltage that represents the difference in temperature between the point of measurement and the isothermal block. The temperature of the isothermal block is monitored by another sensor and this information is supplied to the controller, which calculates the absolute temperature at the point of measurement.

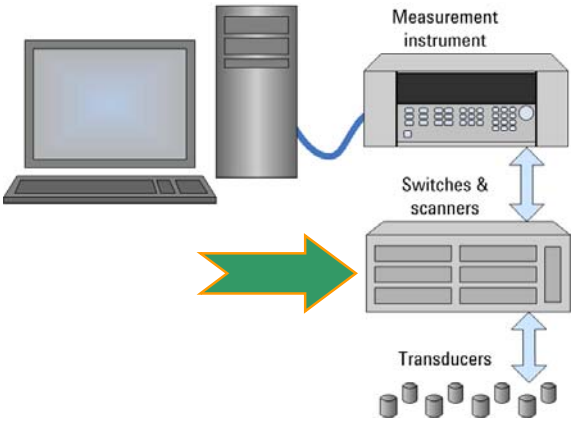
This is a widely used approach, but it isn't provided by all manufacturers. Most notably, makers of PC plug-in cards omit this capability.

Fortunately, Agilent makes it all much easier by providing the isothermal reference junction and the required conversion in various products. For example, these capabilities are built into three of the 34970A's plug-in modules – the 34901, 34902 and 34908 – as well as the 34980A's 34921A plug-in module and L4421A LXI module.

开关

三种基本配置

- 系统部件
  - 控制器
  - 软件
  - 接口
  - 仪器
  - **开关和扫描器**
    - 简单开关
    - 多路开关
    - 矩阵开关



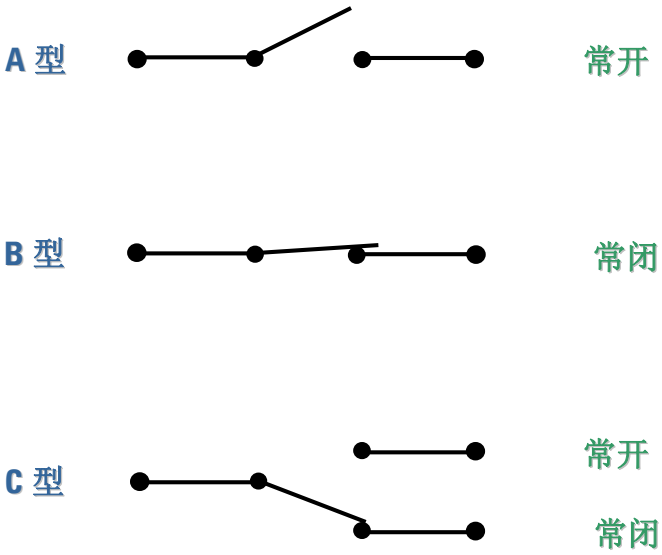
That's a brief look at transducers, which are at the bottom of our system diagram. Moving upstream takes us to the switches and scanners that provide the necessary signal conditioning and connect the signals to the input of the DMM, digitizer or other measurement instrument.

The three basic switching topologies or configurations listed here are readily available as commercial products. Simple switches, multiplexers and matrix switches can address a wide range of general-purpose applications.

Let's take a closer look at each type.

开关

简单开关

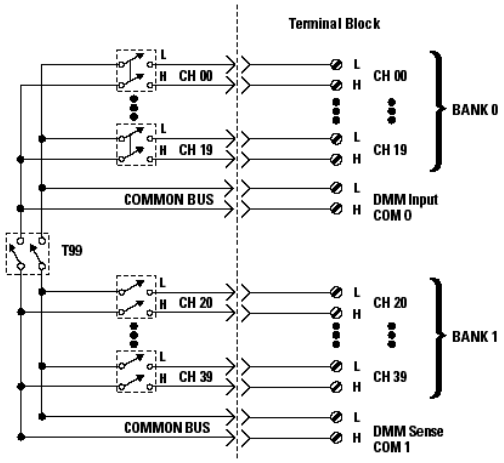


Three types or forms of simple switches are the basic building blocks of most switching networks. They may be used individually or combined into multiplex or matrix configurations.

开关

多路开关

- 一至多或多至一连接
  - 通常用于数据采集
  - 经济
- **安全:“先断后通”**



A multiplexer or “MUX” creates one-to-many or many-to-one signal paths. For example, one instrument can be configured with switches to measure many different points using a MUX. Or one point can be measured with many different instruments to provide different measurements such as frequency and voltage.

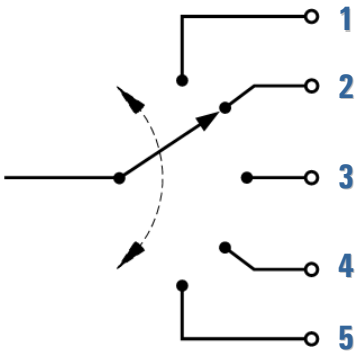
This level of flexibility combined with the typical internal technology make this a very economical switch configuration.

In addition, multiplexers are thought of as a very safe switch because they often use “break-before-make” relay closures. This ensures that only one connection is made at a time and there is less likelihood of a program error causing the connection of two DUT points.

开关

扫描多个信号

- 依次测量多个输入
  - 用一个 ADC 测量多个输入
  - 用多路开关把信号切换到 ADC
  - 开关可以是机械开关或电子开关



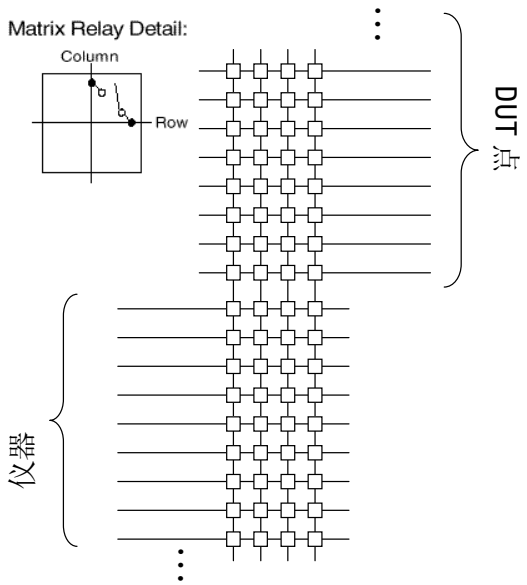
Scanning is simply the process of using a series of switches to sequence through multiple inputs – one at a time – and taking a measurement. This is economical for two reasons:

1. It requires only one ADC to measure multiple channels or points
2. It is typically implemented with a multiplexer

开关

矩阵开关

- 把几个通道接到几个测试点上
  - 在 EFT 应用中广泛使用
  - 能够按任意方式重新配置
  - ***注意***
    - *有可能偶尔把源接到一起*
    - *连线多，对噪声和串扰更敏感*



A matrix switch is a set of rows and columns that can make a connection at any crosspoint; multiple switches can be closed at the same time. This level of flexibility enables on-the-fly reconfiguration that makes it possible to connect any instrument input or output to any DUT input or output.

However, matrix switches come with two important cautions:

- Care must be taken to avoid unwanted connections such as output to output.
- Because there is so much wiring within these switches, they are susceptible to noise and crosstalk.

One final observation: matrix switches are typically more expensive than multiplexers because they use more costly switching technology inside.

开关种类

- **电枢继电器**
  - 慢
  - 能承受较大功率
- **场效应晶体管 (FET)**
  - 快
  - 低电压和电流
- **干簧继电器**
  - 较好兼顾了速度，功率和成本

Here is a quick look at each type of switch relay:

- Armature relays are slow but offer high power handling, making them a good choice for the connection of power supplies and loads. They are also a good choice when low thermal offset is required.
- FET switches provide very fast open/close speeds, but they have lower voltage ratings and poor on-resistance. As a result, these are not recommended for stimulus or power supply connections.
- Reed relays are more common in high speed test systems because they offer relatively fast switching, good current handling and low on-resistance.

In terms of cost, armature relays are usually the least expensive, FETs the most expensive, and reed relays are somewhere in between.

议题

扫描，开关和数据记录

- 客户和他们的需求
- 测量，传感器和开关
- **Agilent DAQ 仪器**
- 小结
- 了解更多情况

As an intermediate summary, a good data acquisition instrument would make it easy to use various types of transducers and connect their signals to a measurement instrument. Let's take another look at the 34970A and the 34980A and see which one is a good choice for data acquisition.

Agilent DAQ 仪器

- **34970A 数据采集，控制和开关单元**
  - 数据记录器，DAQ 系统或低价的开关单元
  - 3 槽主机
  - **最大 60 通道**
  - 8 种插入模块
  - 内置6½位数字万用表（可选）
  - GPIB 和 RS-232 接口
  - BenchLink 数据记录器软件
  - IntuiLink for Excel
- **34980A 多功能开关 / 测量单元**
  - 最适合用于设计验证和制造
  - 8 槽主机
  - **最大 560 通道**
  - 19 种插入模块
  - 内置6½位数字万用表（可选）
  - GPIB, LAN 和 USB I/O
  - BenchLink 数据记录器软件
  - IntuiLink for Excel
  - 图形网络浏览器界面

Here we see almost the same features we looked at in the “Understanding Systems” module. The one exception is the third item in each list. The 34970A supports a maximum of 60 channels in one mainframe and the 34980A supports up to 560 channels.

While the 34980A is a great fit for EFT applications, it can also address high channel count DAQ applications. The 34970A is a great solution for low channel count DAQ applications – and it offers a few additional capabilities that are especially useful in DAQ.

Agilent DAQ 仪器

- **L4400 系列 LXI 开关和控制仪器**
  - LXI C 类一致性
  - 以太网连接就绪
  - 体积小，1U 高度，半机架宽度
  - 图形网络界面
  - 适用于大多数程序环境的软件驱动程序
  - 价格低
- **L4400 系列包括覆盖下列门类的 8 种模块**
  - 低频开关 (3)
  - 射频和微波开关 (1)
  - 系统测量和控制 (3)
  - 数字万用表 (1)

The L4400 Series instruments are a relatively new member to the Agilent product family. There are eight models currently available: seven that are taken from the most popular 34980A modules and one with the inner workings of a 34411A DMM in a smaller, faceless footprint. For data aquisition applications, they give the customer flexibility to start out small with one or two low cost switching and control cards. If the customers needs increase they can easily add on more cards as needed. The L4400 LXI modules can only be controlled by software or by a built-in LAN interface.

Agilent 34970A

数据采集，控制和开关单元

- 紧凑，经济的解决方案
- 作为独立数据记录器工作
  - 非易失性存储器，带时间戳记
  - 掉电恢复
- 内置信号调整
  - RTD, 热偶，热敏电阻和其它
- **BenchLink 数据记录器软件**

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In design verification applications, the 34970A makes it easy to measure many points and make a few specific tests. Whether the application is in an environmental test chamber or at a remote location, the 34970A includes useful capabilities such as non-volatile memory with time stamping and power-fail recovery – data is retained and the unit automatically resumes testing after power is restored.

The 34970A even includes a “quick start” kit that includes everything a customer needs to start making measurements as soon as they take the product out of the box: a thermocouple, a screwdriver, an RS-232 cable and, of course, a CD with the BenchLink data logger software.

This is a good example of the importance of digging deep enough to match the right product to the right application.

议题

测量电压，电阻和其它参数

- 客户和他们的需求
- 测量，方法和提高
- **Agilent** 数字万用表
- 小结
- 了解更多情况

That's our quick look at data acquisition, transducers, switching and the 34970A.

Let's bring this session to a close with a quick review of the highlights and a look at some additional resources that can help you learn more about switching, scanning and data acquisition.

小结: 开关，扫描和数据记录

- **DAQ: 测量物理现象或条件**
  - 传感器把物理量变换成电量
  - 通常为低频信号
- **测试点多，测试类型少**
  - 仪器加开关和扫描
  - 选择开关：速度，承载功率，可靠性和价格
- **同样的公司，不同的客户**
  - 机械，化工，工业流程工程师
- **34970A 最适合低通道数的 DAQ**
  - 34980A 最适合 EFT 和高通道数 DAQ

Generally, DAQ is used to measure a physical or mechanical device or system. To make those measurements with an electronic instrument, we use transducers to convert physical characteristics such as temperature and vibration into electrical signals.

We route tens or hundreds of those signals through switches or scanners and send them to a few instruments to make a few types of measurements. This approach creates a lot of raw measured data that will be processed in the system's host computer.

DAQ customers work in many of the same companies and industries as our EFT customers – but they may be mechanical engineers, chemical engineers or process control engineers who are also very familiar with computers, programming and test equipment.

With its compact size, capabilities such as non-volatile memory, time stamping, power-fail recovery, and a "quick start" kit, the 34970A is the best fit for low channel counts DAQ applications.

了解更多情况

Agilent DAQ 仪器

- 产品网页
  www.agilent.com/find/34970A
  - 观看 34970A 数据记录视频演示
- 应用指南
  - *选择正确的数据采集系统* (AN 1412)
  - *进行高精度的温度测量* (AN 1425)
  - *把继电器工作寿命延至最长* (AN 1399)

We hope this session inspires your interest in learning more about physical measurements and data acquisition.

To see a demonstration of the 34970A, you can visit the product page and view a brief, informative online demonstration of data logging.

We have also compiled a wealth of information in a variety of application notes that address topics such as temperature measurements and switching.

But first, here's a quick quiz to test your knowledge on the subject matter just presented.

小测验

DAQ 系统的主要目标 —— 监视、测量、分析、控制，以及基本系统硬件部件都与 FET 相似 。但两者也有一些重要差别。下面哪一项不是 DAQ 与 FET 的主要差别？

- A) 系统仪器少，开关多，特别是称为扫描器的开关多
- B) EFT 系统产生大量原始数据，这些数据被收集在很大的数据文件中
- C) 系统用传感器把物理现象变换成可扫描和测量的电信号
- D) EFT 系统用几种类型的仪器进行许多单点测量

不正确。这是 DAQ 和 EFT 的一项重要差别 。正确答案是 B

您没有完整回答这一问题

是：

正确答案是：

提交 清除

目前在工业中最常使用哪一种温度传感器？

- A) 热敏电阻
- B) 电阻温度探测器
- C) 热偶
- D) IC 基传感器

不正确。正确答案是 C

您没有完整回答这一问题

您的回答正确！

正确答案是：

提交 清除

您的答案是：

矩阵开关配置采用“先断后通”安全特性

- A) 对
- B) 错

正确！多路开关 (MUX) 配置使用了这一安全特性。

您没有完整回答这一问题

您的回答正确！

正确答案是：

提交 清除

您的回答是：

下面哪一项不是矩阵开关的缺点？

- (●) A) 不允许把任何仪器的输出接到任何 DUT 输入
- ( ) B) 比多路开关贵得多
- ( ) C) 能允许有害的连接，如输出至输出
- ( ) D) 对噪声和串扰敏感

不正确。正确答案是 A。

您没有完整回答这一问题

您的答案是：

正确答案是：

提交 清除

您的回答正确!

DAQ 主要用于制造和运行

- A) 对
- B) 错

正确！DAQ 用于研发，设计验证，制造和运行。

您没有完整回答这一问题

您的回答是：

正确答案是：

提交 清除

您的回答正确！

感谢您的与会

结束

As we conclude this session, I'd like to thank you for taking the time to learn about data acquisition. You're now ready for last module of the Basic Instruments Measurement Fundamentals which will provide an overall recap of the last 7 modules.