Work-Ready Electronics

Synchronizing Curriculum to the Rapidly Changing Workplace

Module: A Systems View of Electronics

WORKREADY ELECTRONICS

A Systems View of Electronics

In the past, electronic technicians worked primarily with the nitty gritty of electronics: the components like resistors, capacitors, diodes, transistors, integrated circuits (ICs) and printed circuits boards (PCBs).

Over the years, that emphasis has changed. While electronic techs still do work with components and PCBs, most job activities today center around larger electronic devices like ICs. During the past decades, integrated circuits have gotten larger and now include more circuitry than ever before. What was once a large PCB with hundreds of components on it is now a single integrated circuit smaller than a postage stamp. With all the components inside, the electronic technician cannot access them much less test or replace them. As a result, the tech is left with replacing the IC if it is bad or merely testing it to see if the inputs and outputs are correct.

Module Overview

Today, the greater part of a tech's work now deals with a higher level. Specifically, he or she works more with larger PCBs containing many ICs, plug-in modules, subassemblies, and complete pieces of equipment, and entire systems as well as their power and cabling. The technician's work is at a higher level. The focus is on signal flow through the system and testing the system to see that it meets specific standards. Rarely does the tech replace individual components as was once the case.

This module presents an overview of how a technician should view electronic equipment and systems today and an approach to understanding their operation and troubleshooting.

Prerequisites

This module is designed to be used in upper level courses in a two-year community or technical college curriculum. Ideally, the student should have completed courses in the following:

- DC circuits
- AC circuits
- Semiconductor fundamentals and solid state circuits
- Digital fundamentals with an introduction to microcontrollers

What Technicians Need to Know

Hierarchy of electronic components and systems

Definition of system

Basic model of how all electronic circuits and equipment work

Major categories of circuits and processes

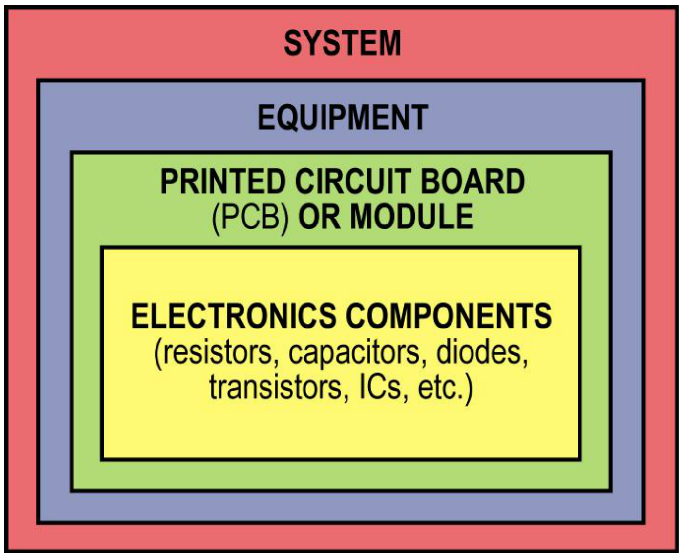
Basic specifications of any circuit or piece of equipment including gain, attenuation, frequency response, input and output impedances, and power requirements

System power requirements

Common types of interfaces and connections used between circuits, equipment, and systems

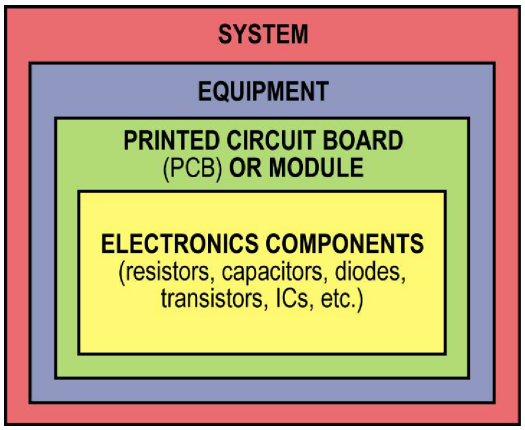
Hierarchy of Electronic Equipment

The Structure of Electronic Equipment



The figure above shows the various levels of complexity that exist in any piece of electronic equipment. The very heart of the equipment is all the components that make it up. Most of the components are integrated circuits (ICs) but many discrete components like resistors, capacitors, and power transistors are also used. As usual, these are mounted on a printed circuit board (PCB).

The Structure of Electronic Equipment



The PCB usually forms one major element of a larger electronic device. It is often called a module and may actually be contained in some kind of enclosure. One example is a personal computer power supply with its single PCB in a vented steel box with fan. Larger, more complex pieces of equipment are typically made up of one or more interconnected PCBs or modules. A personal computer is an example that includes a mother board, memory modules, the power supply, and disk drives, etc.

Systems

A TV set is another example of a piece of equipment made up of several PCBs and modules of one type or another.

At the next level is the system. A system is usually made up of two or more pieces of electronic equipment interconnected to do some particular function. For instance, a home entertainment system is made up of a TV set, VCR, DVD, and DVR units plus the audio components like a surround sound amplifier, CD player, tuner, speakers, and other equipment.

The technician's role today is more in dealing with the whole system than the details of the individual components. Because it costs more to repair a PCB or module at the component level than it does to buy a new module, defective modules are simply discarded and replaced with a new one. Not only is it less expensive to do this but also it is faster and less disruptive to the user.

What is a System?

The generic definition of “system” is a combination of multiple related elements organized into a more complex whole to perform some useful purpose.

For electronics, we can say that a system is an assembly of electronic and sometimes mechanical components as well as the software that operate together as a unit to perform some function.

Another definition is a collection of hardware, software, and related devices that operate as a unit to perform a particular service.

The key thing you should recognize from these rather broad definitions is that a system may take on many sizes, shapes, and functions. An embedded microcontroller is an example of a system on a chip (SoC) since it is made up of a CPU, memory, input/output circuits, and other circuits to form a complete computer that is usually dedicated to monitoring and controlling some other device.

Other System Examples

A TV set or cell phone is also a system since it is made up of components that work together to do some special operation.

Home security and alarm components in your home form another type of system. The fire department radio communications equipment forms a system.

On a larger scale, a TV station is a system. So is a cable TV head end. The cable head end is the building or facility where all the TV signals from satellites and TV antennas are collected and signal conditioned to send them out over the cable. The telephone system is probably the largest system in the world. The Internet is also a huge system. The global positioning system (GPS) is one of the larger and more complex satellite navigation systems. The cell phone system is another example.

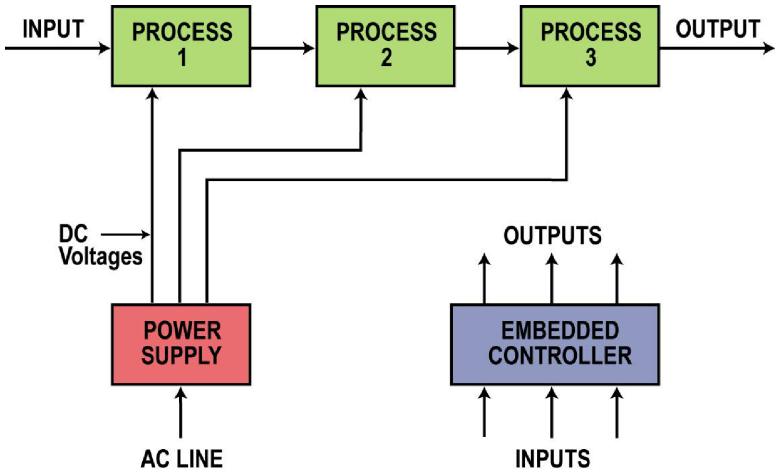
Block Diagrams

Electronic technicians and engineers used to work primarily with schematic diagrams, or drawings, that showed the interconnection of every resistor, capacitor, IC, and transformer. Those are still used but to a lesser degree. Today most diagrams are at a higher level. That is they don't show as many discrete components but show blocks representing ICs and other larger assemblies. These block diagrams are the key working documents of most electronic equipment and systems. Each block represents an IC, a circuit, or assembly that does some particular thing. It may be an amplifier, filter, memory, regulator, or disk drive. The diagram uses lines to show the various interconnections between the blocks. These lines may be copper traces on a PCB, wires, or cables with connectors. The block diagrams show the relationship between the blocks and the flow of signals between them.

A Model for How Electronic Equipment Works

Every electronic circuit or piece of equipment can be represented by the simple diagram shown above. The input (or multiple inputs in some cases) is the electrical signal produced by the application. These signals are then processed by the circuit, module, or equipment. The result is one or more outputs. The outputs are other electrical signals that will go on to produce some useful end result.

How Electronic Equipment Works

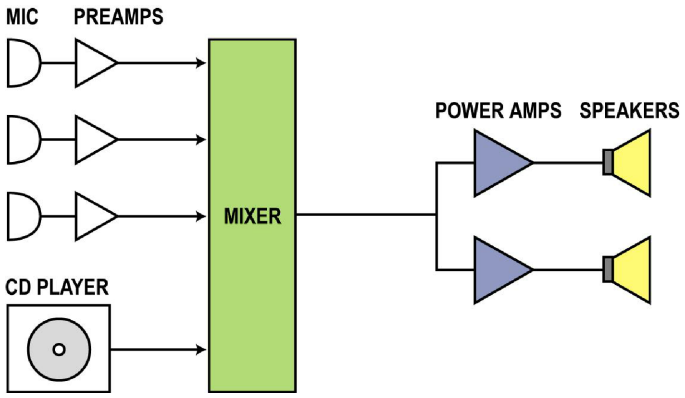


In most applications, there are several circuits or modules connected to one another in cascade. Here each block performs one part of the processing.

Note that all electronic equipment or circuits require some kind of power supply that delivers one or more DC voltages.

Today, virtually all systems contain one or more embedded controllers that monitor, control, and perform some processing in the system.

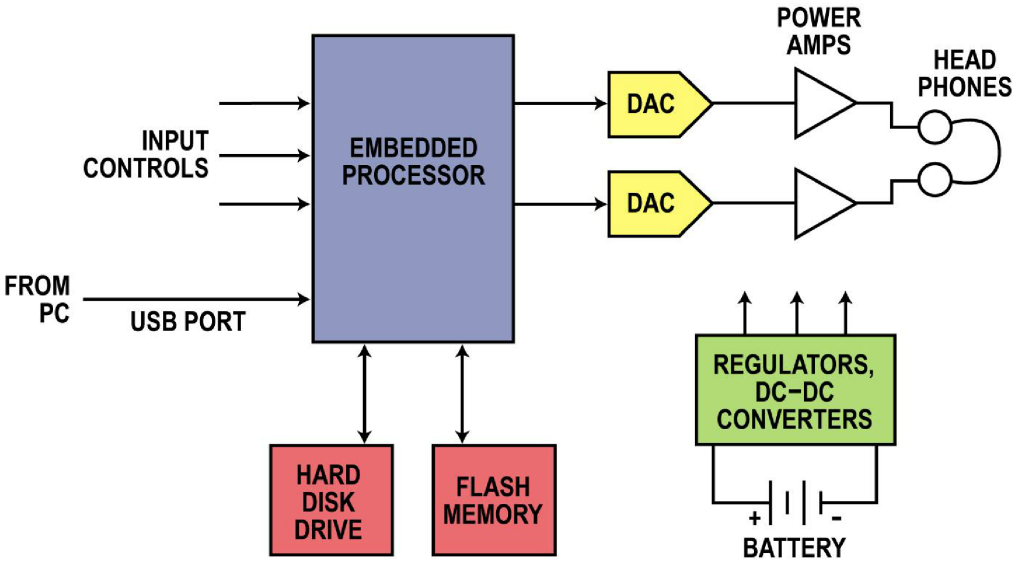
A Simple Example



This figure shows a simple public address system. The input comes from a microphone that generates an electrical signal that corresponds to the voice or music it hears. The signal is then amplified in a preamplifier. The preamp signal is fed to a mixer where other microphones are also connected. A music source such as a CD player may also be used as an input.

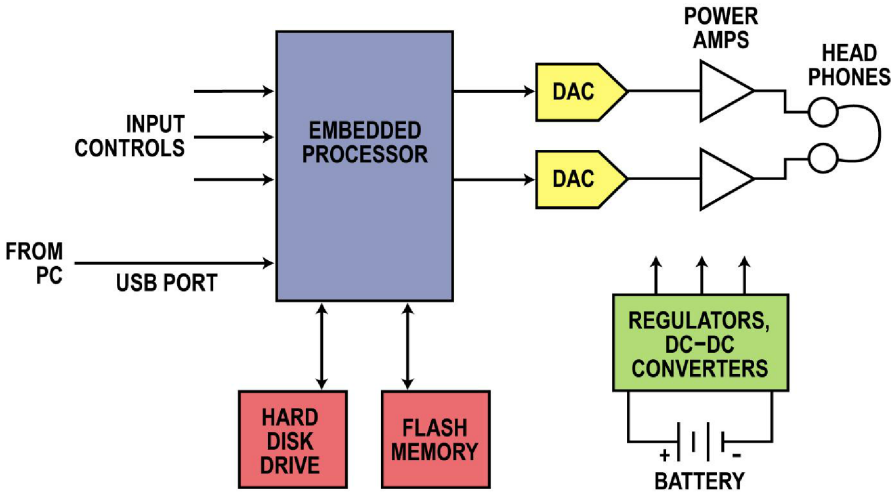
The mixer combines the inputs and provides a way to adjust the volume on each. The composite output is then amplified in one or more power amplifiers and applied to one or more speakers.

A More Complex Example



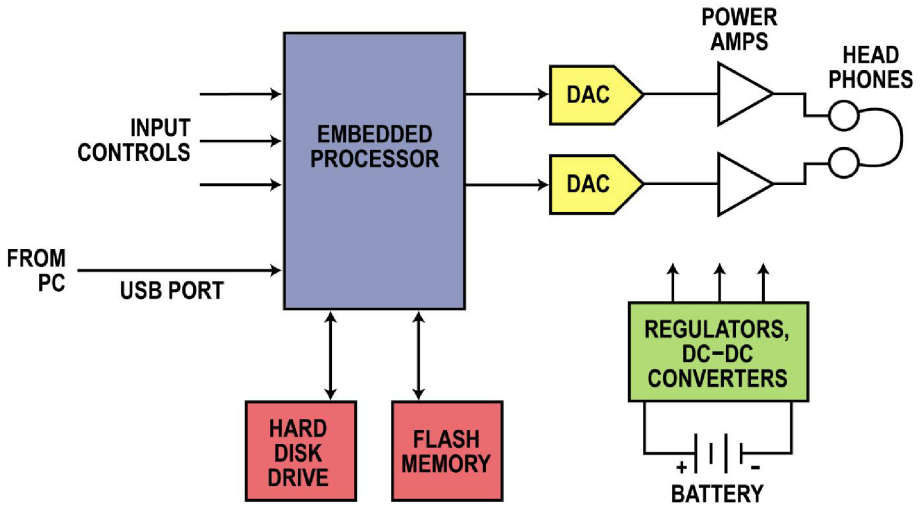
Another example is an Apple iPOD or any MP3 music player. The input is digital music downloaded from a PC via a USB port. This music has been digitally compressed (MP3 or AAC) so that it can be transmitted faster and so that it takes up less capacity of an electronic memory.

Example Operation: Process



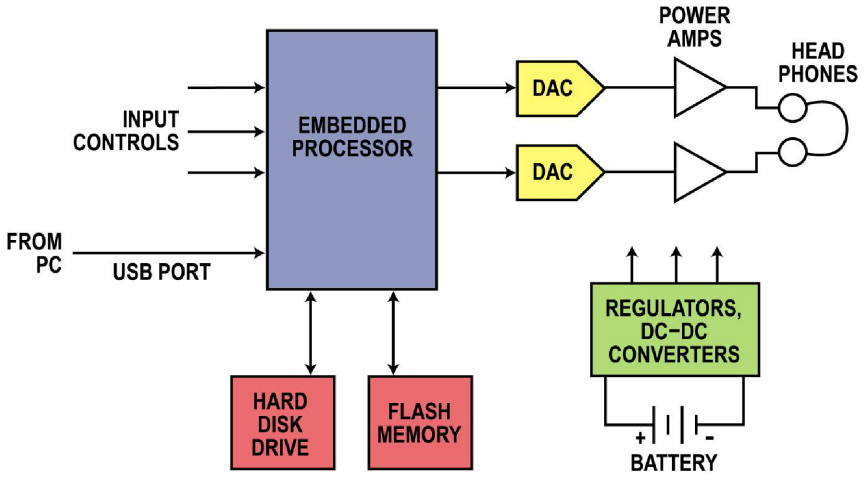
The compressed digital music is then sent to a tiny magnetic hard drive or a semiconductor memory called flash memory. An embedded controller controls everything. To play a song, you provide inputs via push buttons. These are interpreted by the embedded controller. The embedded controller in turn operates the various circuits. The selected song is found on the hard drive or in flash memory and sent to the processor that decompresses the digital data. This is the main process performed.

Example Operation: Output



The decompressed digital data in the form of stereo sound signals is sent to digital-to-analog converters (DACs) that recover the original analog sound which is then amplified and sent to the headphones.

Power Management



A power supply made up of a battery, voltage regulators, DC-DC converters, battery charger and power management system provides DC voltages for all other circuits.

The player itself is a form of system. Inside is the embedded controller which constitutes a system itself. The disk drive itself is a complete system with inputs and outputs. So we often have several smaller systems within larger systems.

Test your knowledge

A Systems View of Electronics
Knowledge Probe 1
Hierarchy of Electronic Equipment

Click on Course Materials at the top of the page.
Then choose **Knowledge Probe 1**.