

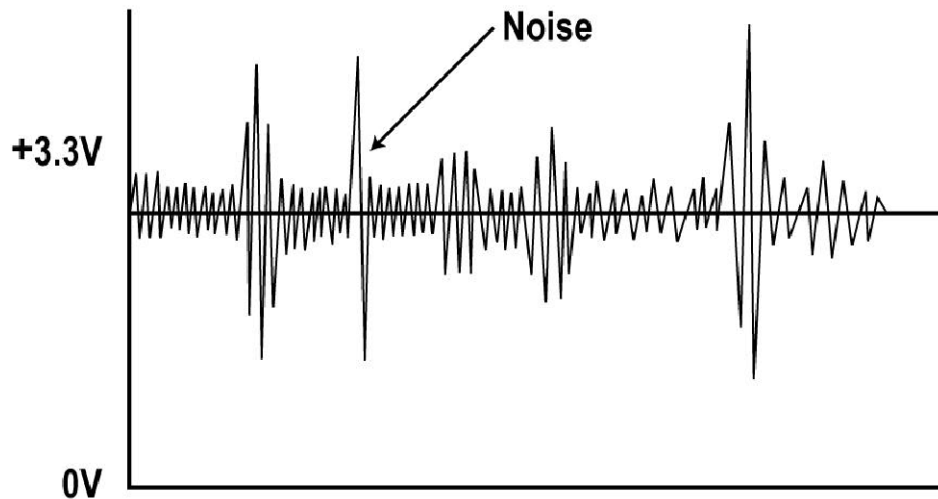
Digital Troubleshooting

Digital Troubleshooting

All of the procedures just described also apply to digital circuits. What makes the troubleshooting more difficult is that so many different signals are usually involved. Instead of a single analog signal being processed by multiple circuits as previously described, dozens of logic input signals may be involved. Their states as well as the type of logic circuits will determine what the multiple outputs should be.

As a starting point, check the supply voltage first to be sure it is correct. Digital circuits are very sensitive to minor variations in supply voltage. Even a few tenths of a volt difference can cause a problem. Look for a power supply problem if the supply voltage is more than $\pm 5\%$ of the stated value.

Digital Troubleshooting: DC Supply



Also use an oscilloscope to observe the DC supply line. If it is too noisy as in the figure, it can cause “glitches” that produce logic errors. This could signal an open supply voltage bypass capacitor associated with the board or IC near the measurement.

Digital Troubleshooting: Inputs and Outputs

A common problem with digital circuits is input/output and interface circuits. Those circuits that drive buses with cables and connectors are often defective.

The four most common internal IC problems are open input, open output, shorted input, and shorted output.

All require that the IC be replaced.

A special form of test instrument called a logic analyzer is useful for troubleshooting complex digital circuits. This oscilloscope-like instrument allows you to observe 8 or 16 digital signals at one time on the CRT. In this way, you can more easily see which one may be wrong and causing the problem.

Documentation is essential in troubleshooting any digital equipment. Read it first to determine if any test procedures are described or any suggestions are given for common problems and solutions.

Digital Circuits with Embedded Controllers

Most digital circuits are implemented today with a single embedded controller. Also called a microcontroller or microcomputer, these devices are complete digital computers on a chip with related memory and I/O circuits.

The digital functions to be performed are implemented in software stored in a ROM.

Troubleshooting any device with an embedded controller requires special circuit emulators that help you to isolate events and capture the state of the controller as it cycles through its programs.

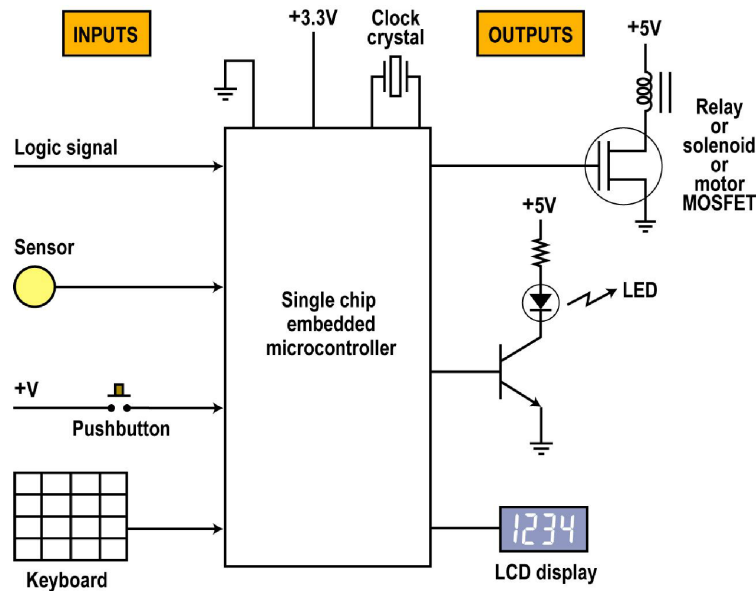
Troubleshooting Embedded Controllers

Embedded controllers require special test systems that are designed especially for those designing, building, and testing the circuits. Those systems are rarely available to the technician. DO NOT attempt to troubleshoot such systems without the special equipment.

Troubleshooting any product with an embedded controller is difficult because normally you do not have sufficient information on the device to troubleshoot it.

In many, if not most cases, the problem is NOT in the embedded controller chip but instead with one or more inputs or outputs.

Microcontroller Inputs



Chances are that in any product with an embedded controller, the problem lies with circuits outside the chip.

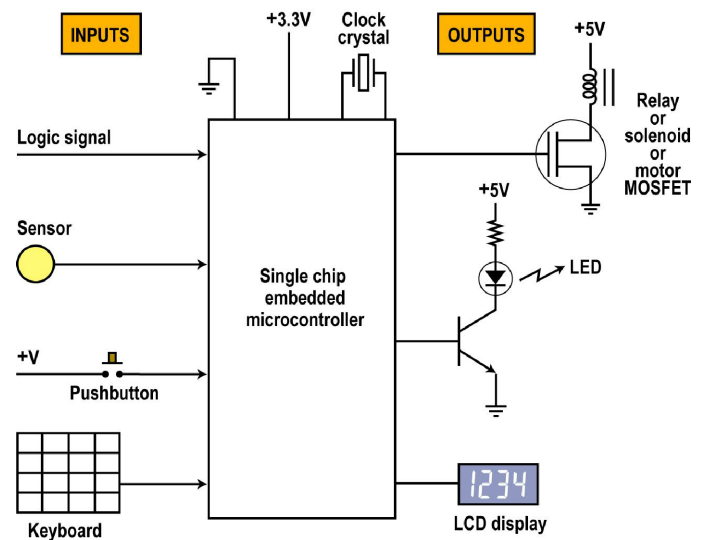
This arrangement shown in the figure above is typical of most products. Inputs come from sensors, switches, or other devices or circuits. You can normally test these with a meter or oscilloscope.

Checking Microcontroller I/O

The clock is controlled by a very reliable external crystal. Test for the presence of a clock signal at one of the crystal connections. It should be a square wave in the 2 to 20 MHz range.

The microcontroller outputs go to control lights, relays, solenoids, motors, liquid crystal displays (LCDs), and transistors. These can also be tested with standard test equipment.

All of the techniques described earlier, especially substitution and signal tracing apply in these circuits.



Is it Hardware or Software?

In an embedded controller, the problem is usually hardware even though all operations are determined by the software.

The software is rarely the problem because it is stored in a ROM on chip that rarely fails. If the product worked initially, the problem is probably a failed input or output device or the microcontroller chip itself.

Replacing the entire module containing the embedded controller is the usual repair approach.

Test your knowledge

Troubleshooting Electronic Circuits and Systems Knowledge Probe 4 Digital Troubleshooting

Click on [Course Materials](#) at the top of the page.
Then choose **Knowledge Probe 4**.

Development Team

Dr. Michael Lesiecki

Tom McGlew

Louis E. Frenzel

Phyllis J. Cooke

Bryan McIntyre

Laura Marmolejo

Project Principal Investigator

Project Manager

Principal Module Author

Editor

Graphics

Contributing Developers