Digitized Signals Are the Future of the Black Box

An Introduction to Digital Signals

Signals of any kind are a way to deliver a message to a destination. When digital signals transmit information, they do so by turning signals into code. This is binary code, which is very specific and easily quantified. When that code is sent via wave pulses, the transmission of the signal is very reliable.

Why Digital Signals Work Well

What makes this so reliable is the fact that digital signals are actually quite resistant to outside noise disturbances. While other kinds of communication will almost always be transmitted along with some kind of undesirable noise (making a recording much harder to hear), digital signals can be encoded and sent without too much outside interference. One of today's commonly used devices made the switch from analog to digital signaling within the last 20 years. You might know it as the black box.

Component One of Black Box: the CVR

Many have heard of "the black box," a device used for recording what happens during an airplane's flight. What most people don't know is that the black box is really a common term for two pieces of recording equipment that are onboard every commercial and corporate airplane. The first is called a cockpit voice recorder, or CVR. The CVR is attached to multiple microphones located in the cockpit and it records any communication and all the sounds in the cockpit. In the case of an accident, the investigators who listen to a CVR recording can actually hear two things: first, what was said by the pilots and/or crew right before the incident; and second, the sounds in the background. Well-trained investigators can detect unusual engine noise, strange pops and other signals that help alert them to figure out what went wrong with the flight.

Component Two of the Black Box: the FDR

The second part of the so-called black box is the flight data recorder, or FDR. This piece of equipment does not record the people onboard, but all technical aspects of a flight. Sensors all over the plane detect and send information to a flight data acquisition unit which, in turn, is hooked up to the FDR. The FDR is usually attached to the plane's tail, where it's least likely to be damaged in case of an accident. In the U.S., the Federal Aviation Administration requires FDRs to record at least 88 parameters, or aspects, of a commercial flight. As a few examples, these parameters can include the time, altitude, airspeed, direction, movement of the flaps on the wings, the flow of fuel, and use of autopilot. Then, in case something happens, investigators can use this information to recreate a simulation of the entire flight, from takeoff to the incident. In conjunction with the information from the cockpit voice recorder, they can get a picture of what happened.

The Origins of the Black Box

Making a recording of *some* aspect of a flight began with the beginning of flight itself. The Wright brothers, who created the first airplane, actually used a device to record their propeller rotations. (Think of it as the very first FDR, except that it only recorded a single kind of data!) Some basic recording devices were invented and used during the 1930s and during World War II, but they weren't commonplace. It was two decades later that aviation recorders began to become more widespread. The modern day black box is credited as an invention by an Australian scientist, Dr. David Warren.

Warren came up with the idea that multiple aspects of all flights should be recorded while he was working at the Aeronautical Research Laboratory in Melbourne. He was helping investigate an accident by the world's first jet-powered commercial aircraft, the Comet. Without any kind of recording, the crash was a total mystery to him and his co-investigators. He demonstrated the first basic flight data recorder in 1957. It was called a "red egg" for its shape and color. The red egg was fireproof and shockproof. It could reliably record both a plane's instrument readers and the pilots' voices, using only one wire. It also included a device to then decode all this information back on the ground.

The red egg wasn't put into widespread use immediately. In 1960, however, there was another unexplained plane crash in Australia; this time in Queensland. After that, Australia became the first country in the world to mandate that the device be used on all commercial aircraft.

The Modern Day Black Box

The black box is now used on all commercial aircraft and corporate jets. It's unclear exactly where the term came from, but it's possible it came from something a journalist told Dr. Warren about his red egg. Supposedly, he said, "this is a wonderful black box." At any rate, the phrase doesn't refer to the black box's color—the equipment is actually painted bright orange, in order to make it easier to find.

The modern device is used around the world and is highly regulated. International standards mandate that it be able to withstand high acceleration and deceleration, high and low temperature fires, deep sea pressure, submersion in seawater or other liquids, and high impact and being crushed.

Why Digital Signaling is Important to the Black Box

Beginning in the 1990s, the technology employed by the black box was greatly improved. Newer black boxes were being built with solid state memory boards, which use memory chips to record and store information. This digital system is an improvement over the original system, magnetic tape technology, for several reasons. First off, magnetic tape needs to be pulled across an electromagnetic head. Solid state technology, however, has no moving parts making it both more reliable as an encoder of information and less likely to break. Second, the original cockpit voice recorder could only hold about a half-hour of information. It would record in a loop,

recording over every half-hour, so the last half-hour of a flight was all investigators could hear. With solid state technology, the CVR can record up to two hours, which provides much more information. Furthermore, the flight data recorder can hold up to 25 hours using solid state technology.

Solid state memory boards are also better than magnetic tape technology concerning what the flight data recorder can record. While the old technology was able to record up to 100 different aspects or parameters of a flight, solid state technology records up to 700.

What has remained the same, from one technology to the next, is the way the black box is powered. Both types draw energy from two generators which are powered by the plane's engines.

The black box records and provides a huge amount of information. However, its technology helps determine how quickly investigators can analyze and use that information. In the case of an investigation, it can take weeks, even months, for investigators to download all the information from black boxes still using magnetic tape technology. And that's *before* they can even start studying and processing what happened! Using digitally equipped black boxes, however, they're able to download all the information from a flight in a matter of minutes. What a vast improvement! Black box manufacturers have made a complete switch to digital signaling from the old analog ways, and no longer make the magnetic tape recorders.