Electronic article surveillance

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For the use of the term **Electronic article** to mean an electronic version of a journal article, see:electronic article

Electronic article surveillance is a technological method for preventing shoplifting from retail stores or pilferage of books from libraries. Special tags are fixed to merchandise or books. These tags are removed or deactivated by the clerks when the item is properly bought or checked out. At the exits of the store, a detection system sounds an alarm or otherwise alerts the staff when it senses active tags. For high-value goods that are to be manipulated by the patrons, wired alarm clips may also be used; these, being less common and technologically less mysterious, are not covered by this article.

Types of EAS

There are four major types of electronic article surveillance systems :

- Magnetic, also known as magneto-harmonic
- Acousto-magnetic, also known as magneostrictive
- Radio frequency
- Microwave

Magnetic systems

These tags are made of a strip of amorphous metal (metglas) which has a very low magnetic saturation value. Except for permanent tags, this strip is also lined with a strip of ferromagnetic material with a moderate coercive field (magnetic "hardness"). Detection is achieved by sensing harmonics and sum or difference signals generated by the non-linear magnetic response of the material under a mixture of low-frequency (in the 10 Hz to 1000 Hz range) magnetic fields.

When the ferromagnetic material is magnetized, it biases the amorphous metal strip into saturation, where it no longer produces harmonics. Deactivation of these tags is therefore done with magnetization. Activation requires demagnetization.

Due to the convenient dimensions of the tags, and their very low cost, this system is popular in libraries

Magnetic systems are often referred to as 'Electromagnetic' (or EM) systems. EM systems rarely appear in retail environments outside of Europe.

Acousto-magnetic systems

These are similar to magnetic tags in that they are made of two strips, a strip of amorphous metal and a strip of ferromagnetic material. They differ in that these strips are not bound together but free to oscillate mechanically. Also the tag is active when the material is magnetized. The detectors use a 58 kHz (or 66 kHz) magnetic field which induces mechanical resonance by magnetostriction. When the excitating field is turned off, these tags continue to oscillate mechanically, which produces a magnetic signal because of the magnetized second strip. This signal triggers the alarm.

These tags are thicker than magnetic tags and are thus seldom used for books. However they are relatively inexpensive and have better detection rates **(fewer false positives and false negatives)**

Radio-frequency systems

These tags are essentially an LC tank circuit that has a resonance peak at 8.2 MHz or 2 MHz. Sensing is achieved by sweeping around the resonant frequency and detecting the dip. Deactivation is achieved by detuning the circuit by partially destroying the capacitor. This is done by submitting the tag to a strong electromagnetic field at the resonant frequency which will induce voltages exceeding the capacitor's breakdown voltage, which is artificially reduced by puncturing the tags.

Microwave systems

These permanent tags are made of a non-linear element (a diode) coupled to one microwave and one electrostatic antenna. At the exit, one antenna emits a low-frequency (about 100 kHz) field, and another one emits a microwave field. The tag acts as a mixer reemitting a combination of signals from both fields. This modulated signal triggers the alarm. These tags are permanent and somewhat costly. They are mostly used in clothing stores.

Source tagging

Source tagging is the application of EAS security tags at the source, the supplier or manufacturer, instead of at the retail side of the chain. For the retailer, source tagging eliminates the labor expense needed to apply the EAS tags themselves, and reduces the time between receipt of merchandise and when the merchandise is ready for sale. For the supplier, the main benefit is the preservation of the retail packaging asthetics by easing the application of security tags within product packaging. Source tagging allows the EAS tags to be concealed and more difficult to remove.

Installation costs

A single EAS detector, suitable for a small shop, usually costs on the order of a few thousand dollars or euros. Disposable tags cost on the order of cents. The expense of difficult to circumvent, high-end systems is mostly due to the cost of the tags, which use more sophisticated locks and operate in the microwave (UHF) range. Unlike dummy surveillance cameras, dummy EAS systems are ineffective. As all EAS systems get occasionally tripped, not because of shoplifting, but because of tag deactivation faults, or simply by mindless customers, such dummy EAS systems would be spotted rather quickly. Also, the electromagnetic field of all EAS systems can be easily detected using very simple electronics or with common devices such as radio receivers, or depending on the EAS technology used, portable cassette players.

False Alarms

A major concern with these systems is when false alarms occur. A false alarm (or false positive) is when the alarms go off when a person passes through the gate without having stolen any merchandise. This most often is due to tags on merchandise not being properly deactivated. In some older systems electronic devices have been known to set off alarms. False alarms are embarrassing not only for honest customers who accidentally set off an alarm, but for the business as well - who now have an upset customer on their

Tag orientation

Except for microwave, the detection rate for all these tags drops when their containing plane is orthogonal to the axis of the detection loops. When the average magnetic flux from the emitting coils that crosses the tags is near zero, detection cannot occur. This is a serious shortcoming of these tags and is well-known and documented in the corresponding patents. The solution would be to place three mutually orthogonal tags on each item. Another solution would be to place a set of three mutually orthogonal pairs of coils (as suggested in the patents); however, this is cumbersome. **Better systems will have special coil dispositions with a more complicated disposition of flux lines, making it difficult but not impossible to find an exit trajectory minimizing the flux crossing the tags.**

Magnetic activation and deactivation

Deactivation of magnetic tags is achieved by straightforward magnetization using a strong magnet. Magneto-acoustic tags require demagnetization. However sticking a powerful magnet on them will bias disposable magnetic tags and prevent resonance in magneto-acoustic tags. Similarly sticking a piece of metal, such as a large coin on a disposable radio-frequency tag will shield it. Non-disposable tags will require stronger magnets or pieces of metal to disable or shield since the strips are inside the casing and thus further away.

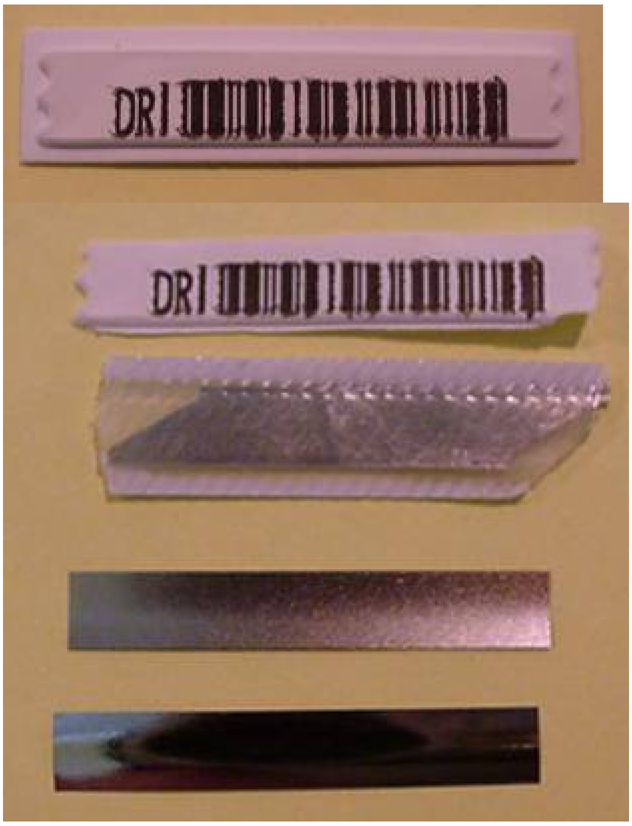
Reactivating magnetic tags by demagnetizing them can be accomplished as follows. Solidly attach a small magnet (such as a Neodymium-Iron-Boron magnet from an old harddisk, but any magnet will do) to an electric drill. Setting the drill to the slowest speed and, taking all appropriate safety measures, turn the magnet. This will create an alternating magnetic field. Approach the tag, then slowly pull it away. This will demagnetize and thus reactivate it.

Shielding

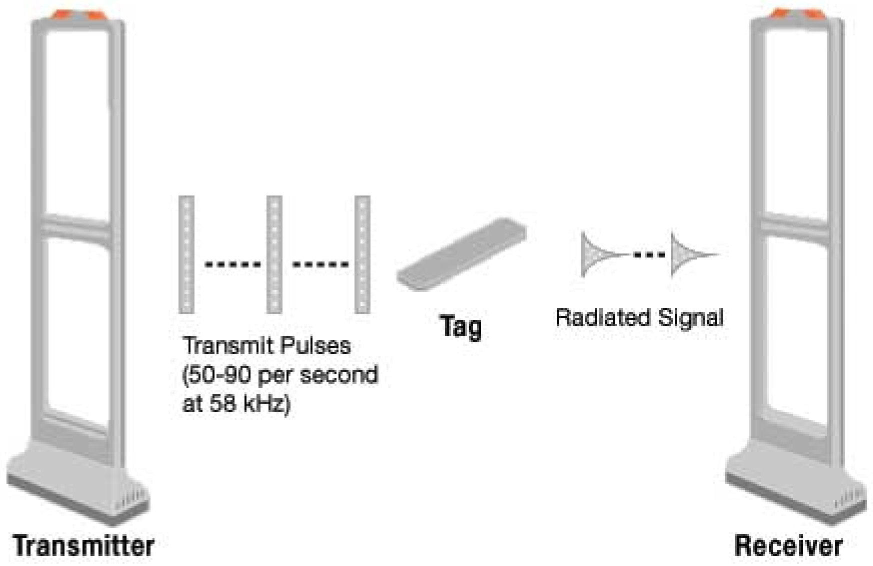
By enclosing the tag in a conductive material (often called a booster bag), it is possible for shoplifters to carry away goods without triggering many EAS systems, in particular radio-frequency systems. For older systems a single sheet of aluminium foil can be an effective shielding material. Nowadays, multiple or thicker layers of aluminum, or a better (that is, more conductive) shielding material like copper foil or wire mesh is more effective. Fabrics offered to shield RF emissions (like mobile phone radiation) are also effective in the 900 MHz range. **Magnetic or magneto-acoustic systems operate at very low frequencies. Therefore, they use [near-field] magnetic coupling which is immune to this kind of electrostatic shielding.**

What's the Third Type of EAS System Used Most Often?

The newer acousto-magnetic system, which has the ability to protect wide exits and allows for high-speed label application, uses a transmitter to create a surveillance area where tags and labels are detected. The transmitter sends a radio frequency signal (of about 58 kHz) in pulses, which energize a tag in the surveillance zone. When the pulse ends, the tag responds, emitting a single frequency signal like a tuning fork. While the transmitter is off between pulses, the tag signal is detected by a receiver. A microcomputer checks the tag signal detected by the receiver to ensure it is at the right frequency, is time-synchronized to the transmitter, at the proper level and at the correct repetition rate. If all these criteria are met, the alarm occurs.



A typical AM tag from Wal-Mart



AM material is highly **magnetostrictive**, which means that when you put the tag material in a magnetic field, it physically shrinks. The higher the magnetic field strength the smaller the metal becomes. The metal actually shrinks about one-thousandth of an inch over its full 1.50 inch length.

As a result of driving the tag with a magnetic field, the tag is physically getting smaller and larger. So if it is driven at a mechanically resonant frequency, it works like a tuning fork, absorbing energy and beginning to ring.

This tag also requires **bias magnet** material in addition to active element material. The active material will shrink no matter which direction the magnetic field is placed upon it. If the tag is driven with Frequency, F, it gets smaller as the magnetic field increases and larger as it's driven towards zero. This means that while it is being driven at F, the tag is trying to work at 2F, because at both positive and negative halves of the drive signal, the tag is getting smaller. To get the tag to work at F, a bias field is required. The bias is provided by a semi-hard magnetic element in the label. When magnetized, the bias prevents the active element from ever being in a zero field condition. So for an entire half of the drive signal, the tag shrinks. Then it expands for the other half. This results in an F response.

When you walk through the gate with a tag, the transmitter in the gate energizes the material and causes it to resonate at F. The transmitter then stops. The tag will continue to "ring" at F for a short period of time, and the receiver listens for that frequency. If it hears it, it knows there is a tag and sounds the alarm.

When the AM tag is demagnetized, it is deactivated. When it's magnetized, it is activated. (This is the opposite of how the deactivation of EM tags works.)
