Training update: Loops and Twisted lead-in

By Brian Dickson

An inductance loop is not a complex piece of electronics, it's just a piece of copper wire in the ground, yet there is still a lot of confusion about how a loop works and how they should be designed. The technique of installing a loop is often passed down from generation to generation. Each year advances are made in the industry, but only a handful of installers adopt them into their techniques. This often results in the same speculations/myths those instructors had, which were passed down from installer to installer thus creating the confusion we have today. By reading the rest of this training update you will have a clear understanding what's wrong with the myth of twisted loop lead-in wire and "magnetic" loop detection.

The belief that loop lead-in wire heading back to the operator for gate installations must be twisted to prevent false detections or cross-talk is incorrect. The confusion comes from loops being used with traffic signals following the IMSA spec No. 50-2-84 lead-in wire, where it is required to twist and shield the lead-ins for transmission cables. The transmission cable is the wires from the pull box to control box that often runs over 200ft. The pull box is where all the loops' lead-in join together to the transmission cables, there are usually 4 pull boxes per installation that can have 5-15 loops run in one conduit leading to the control box. The reason why the IMSA spec was written was to solve the problem of cross-talk between those 5-15+ loops running through such long distances in the same conduit. The spec details the use of a special twisted, jacketed, and shielded wire for loop lead-ins to be connected then run from the pull box to the control box. The spec says nothing about loop lead-ins leading from the loop to the pull box.

There was a study commissioned by the U.S. Department of Federal Highway Administration and Texas Department of Transportation to test cross-talk. The results, "found no indication of false detections (due to cross-talk) over either twisted or untwisted lead wires at all sensitivity settings."* In gate installations 2-4 loops are installed and where the lead-ins join together the distance to the operator is only a distance of 2 ft or less, too little of a distance for cross-talk to have any major effect. Gate installations do not use pull boxes so the above IMSA spec does not even apply to our industry. If lead-ins are ever run together over a distance of 2ft, it is recommended to keep the lead-in at least 2 inches apart from each other.

It is recommended that if you wrap your own loops with 18AWG and larger and don't use backer-rod that the lead-in wires be twisted 6 turns per foot, to prevent false detections from ground vibrations. Cross-talk can be reduced by using different frequencies in the detector. The reason why you twist your lead-in wires is so that the wires will not move. Wires that move even slightly can trip the detector causing phantom detections resulting in repeat service calls. Ground vibrations caused by cars, trains, horses, or even the gate itself can cause loose wires to move. This also applies to lead-ins leaving the saw-cut groove, they should be either twisted or jacketed to prevent movement.

The advantages of not twisting your lead-in wires will result in decreased installation time, you will not have to cut a wider saw-cut groove or spend time manually twisting the wires, and use less wire since wire when twisted is shorter. Twisted wires have a higher chance of becoming nicked while being inserted into the saw-cut groove because the wires are stretched (have greater tension). Instead of twisting lead-in wires you can use jacketed lead-in wire. Using jacketed wire not only prevents movement but adds extra protection against nicks which could cause the wire to short. Understanding how a loop works will strengthen your knowledge about twisted lead-ins and add clarity to the other myth that loops detect through magnetism.

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When a detector energizes a loop with an AC current the size of the loop, the number of windings in the loop, length of lead-in wire, and wire gauge will determine the total resistance or inductance of the loop circuit. The detector will record how much current is flowing through the loop and set that amount as the reference point. When a metal object enters the Electric Magnetic Field (EMF) field created by the loop's AC current, the metal object absorbs some of the collapsing EMF fields. Now that some of the collapsing EMF field is absorbed, it lowers the resistance (inductance) of the loop circuit. This causes a decrease in inductance through the wire that is detected by the detector. When this happens, the detector will either open or close a relay switch that activates a preset command in the gate operator such as open, close, hold, or reverse.

The myth that loops detect magnetism has a strong following. Loops detect inductance as described above. It's easy to see how this myth became so common, especially since exit probes work off of magnetic north and loops create EMF (Electric Magnetic Field) fields. However the idea that loops detect only magnetic metals is easily disproved with aluminum. This causes a lot of confusion with installers who install aluminum gates under the assumption that the loops will not detect the gate since aluminum is not magnetic. Aluminum is a non-ferrous metal (does not contain iron), but aluminum conducts electricity which can trip the detector through inductance. This obviously causes the gate to malfunction and the installer having trouble pinpointing the issue. If this mistake remains undiscovered upon completion of the installation, the customer will most certainly call and complain that their gate continually stays open resulting in a repeat service call.

Brian Dickson is the General Manager of BD Loops, a manufacturer of preformed direct burial and saw-cut inductance loops for the gate industry for more than nine years. BD Loops has over 200,000 loops installed with only one loop failure, and is available through 130 distributors nationally. The company has several letters of recommendation testifying their professionalism and design, and is a member of the following associations: AFA, IDA, NOMMA and IMSA. Visit BD Loops at www.bdloops.com and use the distributor locator tool to find a distributor near you. Call BD Loops at 714.890.1604 or email at BDLoops@aol.com

**reference*

Victor Bhagat and Donald L. Woods, P.E., *NTIS document* PB95216610 – Induction Loop Detector Systems Crosstalk, U.S. Department of Commerce, Aug 1994
This report is available on line from U.S. Department of commerce Research Report 1392-2.

Loops: Phantom Detections and Air pockets

By Brian Dickson

"So that's why my gate opens when I come down my driveway on my horse!" Proclaimed Mr. J. "I was told it was the metal in the horse shoes, but the gate would still open even when they were off." This is what one my friends said after I educated him about air pocket in loop design. The problem with Mr. J.'s gate is his horse was causing ground vibrations that resulted in a Phantom Detection. Phantom Detections happen when the gate/door opens when nothing is there, or when its not suppose to. This is one of the leading reasons why installers must do a repeat service call on brand new gate/door systems with loops installed. The amount of time traveled to get to the job site could cost quite a bit. I'm from California and it takes 1-2 hours to revisit a job site with traffic. Therefore understanding what is causing these "Phantom Detections" and how they can be prevented can save you money and preserve your image of professionalism and knowledge to your customer.

The best place to start would be to understand how an inductance detector and loop works. The detector will energize the loop wire with an oscillating signal current. This current will cause Electro Magnetic Field (EMF) fields around each wire and a level of inductance will result. The inductance level will change if any conductive material enters the detection field. This change in induction will cause a change in current flow. The detector has a circuit that looks for a change in current and will trip a switch when a change is detected.

A change in inductance can be caused by slightly moving the loop wire windings closer or further apart from each other (an example is the vibration caused when a horse comes down the driveway). This moving of the loop winding CAN TRIGGER the detection circuit. When loop windings are lying loose in a conduit or air hose, slight ground vibrations from a vehicle or gate/door movement could cause loop winding to move ever so slightly that end up setting off the detector. To see this effect for yourself, hook up a coiled up induction loop to a detector and slightly disturb the coil. You will experience a detector trip with the slightest movement. This happens because each loop wire has its own EMF field that will interact with the adjacent wire's EMF field. Depending on the field relationship, either the fields will double in value or cancel each other out. This change will either increase or decrease the inductance that will result in a change in loop current.

Depending on which loop in the loop system is being affected by ground vibration will cause different results. A free exit loop (Automatic exit loop) the gate/door will open on its own. A reverse loop (Obstruction detection loop) the gate/door will being to close then reopen. By understanding which loops are being affected gates/doors can be serviced more efficiently.

Sadly it is still common practice that installers will continue to make their own direct burial loops by running wire through PVC or an air hose. Another problem is the air pocket in the loop design can weaken a concrete structure, in some cases as much as 40%. If a loop is being installed in a parking garage or where the concrete is vital to structural integrity, an air pocket shouldn't be allowed at all. Loops wrapped through PVC also have a history of water getting inside of the air pocket causing the loop to short to ground causing the loop to not work at all. Problems can often occur after rain or sprinklers then magically disappear. This is because an air pocket is present. To prevent an air pocket in the loop, try using a preformed loop without an air pocket or a loop filled with a sealant throughout the entire loop.

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Inductance Loops and Loop Phasing – How they work

By Brian Dickson

When Direct current passes through a wire an Electric Magnetic Field or Flux (EMF) is created around the wire. An example is when a wire is coiled around a metal rod then energized with a battery; current flows through the wire and causes the rod to act like a magnet. The more turns in the coil or increases in current flow the greater the magnetic field or pull.

If the current is removed, the magnet field collapses back into the wire. In the case of Alternating Current such as AC, the current changes direction and sets up a magnetic field opposite of the same when the current was passing in the opposite direction. In an AC circuit, the field that is collapsing is pushing against the new developing field. This "pushing back" is a form of resistance known as Inductance. Anytime you have AC passing through a wire you will have this special resistance of Inductance. All detection loops will have AC current applied to them. That is why detection loops are referred to as Inductance loops. This inductance is measured in units of Henrys. A common range of inductance for a detection loop is 40 to 300 micro Henrys.

When a detector energizes a loop with an AC current; the size of the loop, number of winding in the loop, length of lead-in wire and wire size will determine the total resistance or inductance of the loop circuit. The detector will determine how much current is flowing through the loop and set that amount as the standard. When a metal object enters the EMF field created by the loop current, the metal object absorbs some of the collapsing EMF fields. Because some of the collapsing EMF field is now absorbed, it lowers the resistance in the loop circuit. This causes an increase in current flow through the wire that is detected by the detector. When this happens, the detector will either open or close a relay switch that activates a command in the gate operator such as open for exit, reverse for safety, or hold open or close for a swing gate with a center or shadow function.

Loop phasing comes into play when two loops are used with the same detector. A common application would be when two reverse loops are used with one on each side of a sliding or vertical gate. Proper phasing is accomplished when the loops are connected in series with each loop current flowing in the same clockwise or counter clockwise direction.

With the current flowing in the same direction in each loop, you will notice that the two loop legs nearest the gate will have currents moving in the opposite directions. This will cause what is referred to as a "Field Cancellation Effect". That is, the fields of sensitivity will both have the same magnetic polarity (North or South) toward each other. Since like fields repel, the fields of sensitivity are pushed up and away from each other, causing a dead or null field between the loops. This null or Cancellation effect will allow the loops to be placed closer to the gate without being detected. Because the fields are pushed up, they now are more sensitive next to the gate path, making for a safer reversing loop feature.

On the other hand, if the loops are connected with the current flowing in the opposite directions, the poles of each loop will have an opposite polarity, causing the fields to attract to each other.

This will cause what is referred to as a “Field Enhancement Effect”. This will cause the area between the two loops (the gate path) to attract to each other. This effect will increase the sensitivity in the zone where the gate travels, increasing the chance of the gate being detected as it closes. If detected, the reverse detector will keep reversing the operator as the gate tries to close, setting up the requirement to send out a service technician. By arming yourself with this knowledge you will have less repeat service calls and happier customers.

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Loops: How to Ensure Proper Placement and Size

By Brian Dickson

Mrs. Jones was heading off to work in her brand-new luxury vehicle. She clicks the remote for her slide gate and it dutifully opens. As she begins to clear the driveway, she remembers that she forgot her laptop that she needs for an important meeting. Mrs. Jones puts her car in park and jumps out to retrieve the laptop from the kitchen. On her way toward the house, she hears a loud crunching sounds – her new car is being crushed by her slide gate!

Mrs. Jones was obviously upset. How could this have been prevented? Other than remembering her laptop in the first place, loops could have been installed to detect that her car was in the gate path. Loops are the safest method of detecting vehicles in the gate path as they are not affected by weather or obstructions the way photo eyes can be. What dealers and installer must understand is how many loops need to be placed in the different gate systems and where. To better understand this, we will look at three types of common gate systems: slide gates, swing gates, and double swing gates.

How Many and What Size

Slide gates require two reverse loops, one on each side of the gate — two feet from each curb and four feet away from the gate — to completely cover the gate path. You can come as close as two feet from the gate if the loops are properly phased. By using the proper layout and knowing the driveway width, you can determine the size of the loops needed. The two dimensions you need to find are the short and long leg of the loop.

To find the long leg of the loop (z), subtract the driveway width (x) by four feet, represented by this formula: $x - 4 = z$. The short leg is determined by which types of vehicles are going through the gate. This is important because the short leg of the loops determines the detection height. If residential vehicles (low to the ground) are the only vehicles passing through, four feet is recommended. If commercial vehicles (UPS trucks for example) will be passing through, higher detection is required and 6 feet is recommended. An exit loop in this gate system is optional and follows the same formulas as the reverse loops. Exit loops can be located up to 1,000 feet from the gate. The advantage of a longer lead-in on the exit loop is to minimize the wait time for the gate to open

Swing gates require a total of three loops: two reverse loops on each side of the gate and a shadow loop. Reverse loops being installed on a swing gate need to be placed on each side of the gate, two feet from each curb and four feet away from the gate in its open position. Finding their size follows the same formula as slide gates: $x - 4 = z$. What is different in this gate system is the addition of a shadow loop. This loop is placed under the opening path of the gate, two feet away from the curb and four feet away from the gate in its closed position and four feet away from the gate in its open position. To determine the leg of the loop that is parallel to the gate in its closed position (y) subtract the driveway width (x) by 6 feet, represented by this formula: $x - 6 = y$. To find the leg of the loop that is parallel to the curb (a) subtract the driveway width (x) by four feet, represented by this formula: $x - 4 = a$. An exit loop in this gate system is optional and can be the reverse loops on the inside of the property (which will require a separate detector) or another loop can positioned a minimum of four feet away from reverse loop on the inside of the property.

Double swing gates require a total of three loops: two reverse loops on each side of the gate and a shadow loop. The reverse loops follow the same method of installation as swing gates; two feet from each curb and four feet away from the gate in its open position. Finding their size follows the same formula as slide gates and swing gates ($x – 4 = z$). To find the shadow loop leg that is parallel to the gate in its closed position (b), you need to subtract the driveway width (x) by eight; represented by this formula: $x – 8 = b$. To find the shadow loop leg that is parallel to the gate in its open position (c), you need to divide the driveway width (x) by two, then subtract that amount by four feet represented by this formula: $(x / 2) – 4 = c$. An exit loop in this gate system is optional and can be the reverse loops on the inside of the property (which will require a separate detector) or another loop can positioned a minimum of four feet away from reverse loop on the inside of the property.

Whenever possible you should install loops as direct burial instead of sawcut. The loops will last longer and you will avoid sawcutting which will make a grooved tattoo in Mrs. Jones's driveway.

Materials Count

Now that you understand the proper placement and size of loops we will go into a detail about the material you are using. The best quality wire you should be using should be close to or around 14AWG, as higher-gauge wire has less resistance (which means higher detection). Loops should never have an air pocket within the loop because ground vibrations can cause false detections which results in repeat service calls. This means loops should never be inside a conduit. The lead-in part of the loop should be inside plastic/PVC conduit.

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