THE EVOLUTION OF INDUCTIVE LOOP DETECTOR TECHNOLOGY

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Inductive Loop Detector technology has been in use for the detection of vehicles since the early 1960's. The first loop detector designs were based on solid-state analog technology using discrete components including transistors, diodes, etc. These designs were very similar in many respects and provided detection of vehicles occupying the zone defined by the perimeter of the loop. The loop areas varied from small loops (e.g. six ft. by six ft.) to very large loops (e.g. six ft. by 100 ft.). The loop sizes varied depending on the requirements of the control system. Smaller loops were typically used with "volume density controllers" where vehicle count information was needed to vary the timing of traffic signals. Large loops were typically used with "LOC" controllers (loop occupancy control) where the traffic signals responded on demand to the detection of vehicles in the prescribed detection zone. These controllers offered improved efficiency in moving traffic on streets and highways as compared to the earlier "fixed time" controllers, which changed the traffic signals based on a time clock without regard to the vehicle traffic. Over the years reliable vehicle detection has become increasingly important to the proper operation of traffic signals.

By the middle 1970's, advances in solid-state technology made it economically possible to develop loop detectors utilizing digital design techniques. The first "digital loop detectors" entered service in the 1974-1975 time period. With the introduction of digital loop detectors it became possible to reliably detect small motorcycles. In addition to the detection of small motorcycles the overall reliability of vehicle detection significantly improved. Following the introduction of digital loop detectors the earlier analog technology faced obsolescence. By the early 1980's digital loop detectors were replacing the earlier analog loop detector designs.

The performance of the early digital loop detectors was limited by the speed of the available solid-state digital devices. The first digital loop detectors were built using individual digital components such as gates, flip-flops, etc. The next advancement in digital loop detectors took place in the late 1970's when MOS-LSI (metal oxide semiconductor – large scale integration) technology became economically feasible. The MOS-LSI technology made it possible to significantly reduce the component count in each detector; thus improving reliability and reducing manufacturing costs. During the 1980's microprocessor technology advanced rapidly and loop detector designs began utilizing the available industry standard microprocessors. All of the loop detector designs manufactured during the 1980's and early 1990's were similar in concept. As the speed of available electronic components increased during this period the performance and capabilities of the digital loop detectors also increased.

The digital loop detectors manufactured during the 1980's and the first half of the 1990's could all be considered as "hardware-based" designs. That is the detector settings (e.g. sensitivity, loop frequency, etc.) were configured using front panel mounted switches. In some models additional switches were located inside the detectors, due to the lack of available space on the front panel. When additional functions such as timing functions were added to the digital loop detectors additional switches had to be added to facilitate the programming of the additional functions. These "hardware-based" designs had limited flexibility for programming since any function not included, as a standard feature, in the detector could not be implemented without changes to the hardware. In addition to the limitation in flexibility, which was needed for accommodating special requirements in some systems, there was no feedback information available to the user. For example, if a switch were defective it would be very difficult, in most cases, for the user to recognize that the switch was defective. The user would select the correct switch position (e.g. sensitivity) and assume that the sensitivity was properly set; however, due to a faulty switch the sensitivity would not be properly set. Further, due to the lack of feedback information, other than an LED, the user had very limited diagnostic capability.

During the middle 1990's a company named Reno A&E, based in Reno Nevada, introduced the first "programmable software based" digital loop detector technology. Reno A&E changed the design approach from the earlier "hardware based" designs to a new "programmable software-based" design. The programmable software-based designs significantly reduced the number of switches required in the detector. This was accomplished by replacing all but a very few of the switches with an active LCD (liquid crystal display) display. The only switches required on the new programmable software-based designs are used to step through the programming menu and set parameter values. As an example, using the new programmable software-based design a four-channel digital loop detector incorporating many additional functions can be programmed with four normally open contact push button switches. The programmable software-based design totally eliminates the need to have switches located any place other than on the front panel. Additionally, the programmable software-based design provides the capability for programming many "special functions" without changing any of the hardware, with the possible exception of the microprocessor itself. This is very attractive when a user needs a special non-standard function for a specific application. The flexibility of adding the special function without changing the hardware design makes it economically feasible to improve the system operation at a minimal cost!! The "programmable software-based" products produced by Reno A&E are currently protected under U.S. Patent No.

In the "hardware based designs the switches served as the memory for the parameter settings. When the detector is initially "powered on" the microprocessor interrogates the switch settings to obtain the proper operating parameters. In the "programmable software-based" design the parameter settings are stored in non-volatile memory. When the detector is initially "powered on" the microprocessor interrogates the non-volatile memory for the correct operating parameters; thus eliminating the need for the switches. Obviously the flexibility and reliability of the digital loop detector is significantly improved by replacing switch contacts with solid-state non-volatile memory.

By using an active LCD display on the panel of the digital loop detector a very powerful additional capability is provided. This capability is in the form of diagnostics. Information about the detector can be easily displayed on the front panel of the detector making it very easy for the user to verify proper set-up and operation. For example, all the parameter settings are displayed when programmed; so there is no question about the actual settings. Additionally, diagnostic information such as actual loop inductance, change in loop inductance, actual loop operating frequency, timing information, etc. is all available through the display without the need for any external test equipment. Another very powerful feature of the detector is a bar graph, which is included in the display. The bar graph shows the relative magnitude of the inductance change for a given vehicle. By knowing the inductance change in the loop for an average automobile the correct sensitivity setting can be selected for reliable detection of small motorcycles. This feature allows the user to correctly set the sensitivity for motorcycle detection such that the sensitivity is neither set too high nor set too low for the specific loop. As new functions, which improve the efficiency of traffic flow, are identified over time the detector software can be easily enhanced. By simply changing the software in the microprocessor enhancements such as additional features and diagnostics will be available both in relatively short turn around times and at a minimal cost.

The new software-based detector designs utilize the latest available state of the art microprocessor technology. Today's microprocessor technology offers much faster and more powerful computational capability for digital loop detectors. One area of significant importance, which benefits from the new microprocessor technology, is in accurately gathering and processing "inductive loop signature" information. Each vehicle having a different shape, which passes over the inductive loop embedded in the pavement, produces a different "signature". The inductive loop signature can provide valuable information about different shaped vehicles passing over the loops. This information can be utilized by traffic control systems to increase the responsiveness of those systems.

Improving traffic flow by utilizing more intelligence from the embedded loops in the pavement is now possible using a new product named the "TRAFFIC REPORTER". Two leaders in inductive loop technology have jointly developed the "TRAFFIC REPORTER". These two companies are ORINCON, a San Diego California based company, and Reno A&E, a Reno Nevada based company.

As can be seen from the preceding information, "**Inductive Loop Detectors**" have made significant technological advances over the past five years. Advances in electronic technology, coupled with excellent wire insulation for inductive loops in the pavement, make both high performance and high reliability in vehicle detection possible. Moving traffic more efficiently is now possible with the deployment of new products produced by the ORINCON / Reno A&E team.