HR-261, Modifications to Improve the Reliability of the Iowa DOT Frost Detector

Abstract

Systems for detection of frost and ice on highway bridges have been commercially available for 15 years. The operation of the available systems is usually dependent upon temperature and humidity or the difference in conductivity of water in the liquid and frozen state. These systems also operated on the theory that water freezes on bridge decks at 32 ºF. Investigation in Iowa determined that after the first application of salt to the bridge deck, frost seldom formed above 22ºF.

The investigation of commercial frost and ice detectors led to the consideration of the most desirable operation characteristics for a dependable system and the study of the theory and design features necessary to build such a system.

A frost and ice detection system for bridge decks based on the detection of the heat of fusion was developed. This system was not affected by the change of temperature at which frost forms on salt treated bridges.

There are occasions when frost is indicated by the frost detector but none has formed on the bridge floor. The falsing is caused by car tires striking a heated transducer causing it to cool suddenly, triggering the frost alarm. This type of falsing by the frost detector causes the reliability to be less than required by the Iowa DOT.

The objectives of this research were to eliminate the falsing caused by passing vehicles and to incorporate the necessary modifications into an existing frost detector for performance evaluation.

It was proposed to accomplish the objectives by designing a new differentiator circuit to process the signal from the transducer. A National Semiconductor LM398 sample and hold integrated circuit was modified to perform as a differentiator. The output of the LM398 was controlled by a voltage clock causing it to perform as a digital differentiator. It was not possible to implement a double differentiator in this manner.

It was concluded that the project should be terminated because of the inability to design a new double differentiator circuit that would give sufficient amplification without excess interference. No other approach is envisioned at this time which would be 100 percent reliable in preventing falsing and be 100 percent reliable in detecting frost.