Idris Technology
Recommendations regarding long feeder cables

Date: November 2009

Diamond Consulting Services Ltd (DCS) has developed the Idris patented vehicle detection system which, over the last ten years, has become the market leader for vehicle classification in axle-based tolling applications. More than 1500 lanes of Idris have been deployed across North America and Europe.

The core Idris product is a vehicle detection system based entirely on inductive loop sensors. As such, it is immune to weather variations and has a low maintenance requirement.

Helping technology partners to progress into new areas with the security of knowing the technology incorporated in their systems meets specification and accuracy requirements is paramount to the success of DCS.

One of the primary issues which must be addressed by technology partners is the location of equipment cabinets with respect to the loops. The electrical characteristics of the feeder cables combine with those of the actual loops but are an undesirable “dead weight” which, as distances increase, will eventually cause signal deterioration in the form of attenuation and noise. While closer is always better, DCS recognizes that there are situations where customer requirements must be met or where flexibility in cabinet placement can lead to significant savings in time and cost to the project.

With this in mind, DCS has undertaken a project to analyze what constitutes an acceptable upper limit to feeder length. It must be stated immediately that there is no “brick wall” figure because so many other conditions play a part in the total system performance. The objective of this study is therefore to provide ITPs[1] with guidelines to help them get the specified accuracy from Idris in adverse situations.

Test strategy

Feeder cable in the UK is defined by the the Highways Agency's TR2031 document, currently at revision E, which specifies the following worst case characteristics:

Inductance	Resistance	Capacitance
1000 µH/km	12.1 Ω/km	90 pF/m

These values were used to add balanced impedances between the loops and the detector to simulate various lengths of feeder cable. An initial run was done with no added impedance (i. e. at zero feeder length) to be used as a baseline for comparing the other runs.

The test setup consisted of a pair of main loops (2 x 2 m) and set of axle loops (one 18” and one 9”) installed at the DCS headquarters. To maintain consistency, a single vehicle was used, with markings on the vehicle and the ground to ensure a repeatable, straight line trajectory. Each

1 Idris Technology Partners

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impedance was tested at the highest and lowest frequencies to which the detector could tune that circuit. Each run consisted of four passes over the loops: a double reverse-forward sequence.

Idris Version 4.30q was run on a Nortech system consisting of an IDP328 processor, a TD724ID detector and a PS112B power supply.

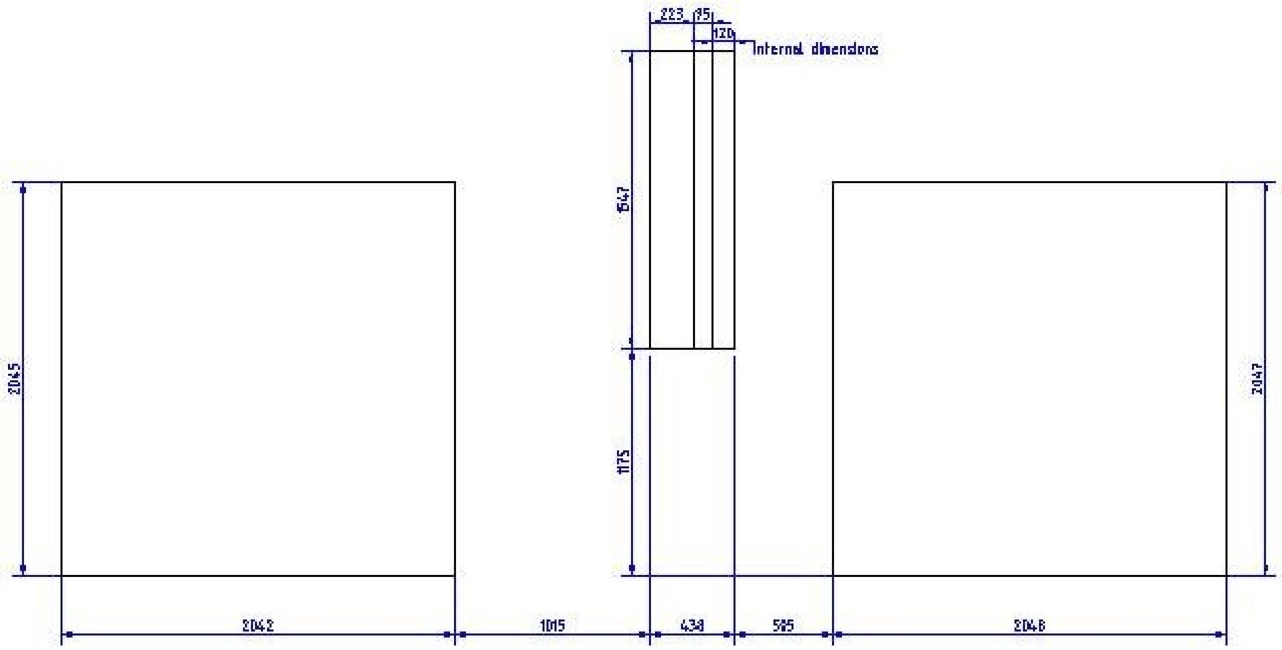

Figure 1: Test loop "as-cut" dimensions

Results

Attention was focused on the axle loops as their normal amplitudes are lower than those of the main loops, so attenuation has a more significant effect on the their performance.

To evaluate the effects of adding the feeder cable to the circuit, three peak amplitudes were collected for each of the runs:

1. the 18” axle-loop peak
2. the rear axle 9” axle-loop peak
3. the front axle 9” axle-loop peak

Each run yielded four values for each of these which were averaged to reduce the effect of possible differences caused by vehicle position and speed.

The resulting average amplitude values for each run were then normalised with respect to the zero-feeder run and are shown in Figures 2 and 3 while the absolute values for are shown in Figures 4 and 5.

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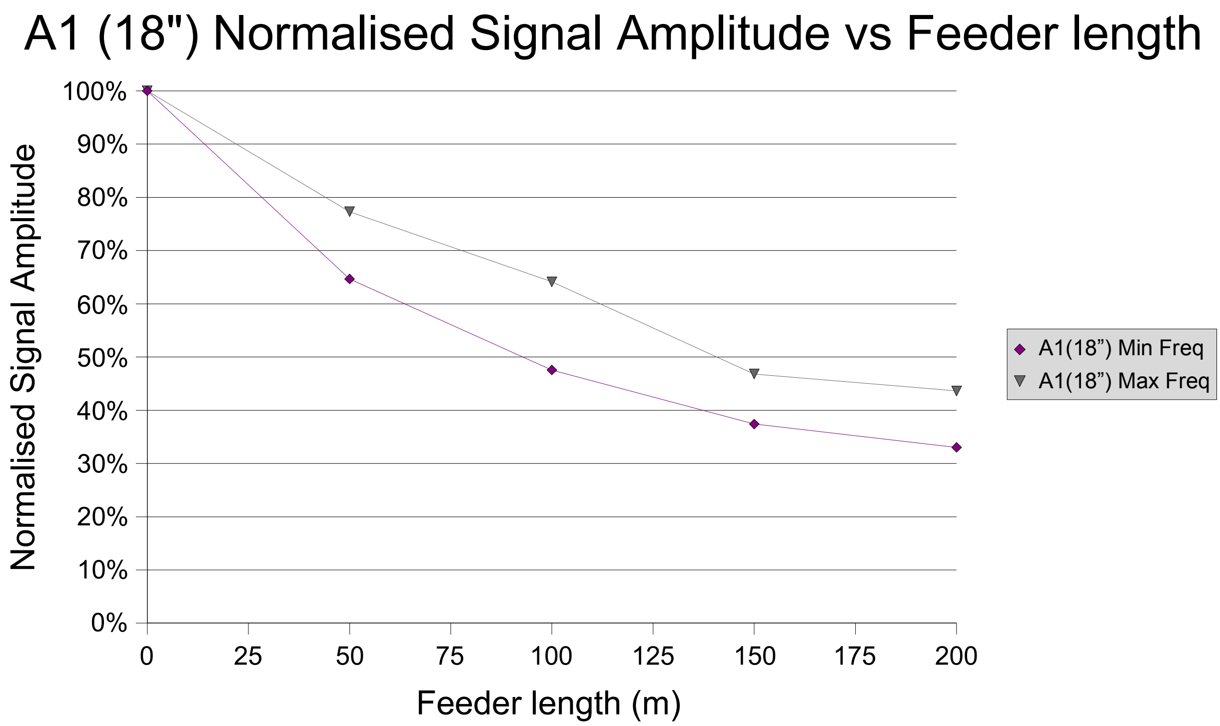

Figure 2: A1 (18") Loop performance

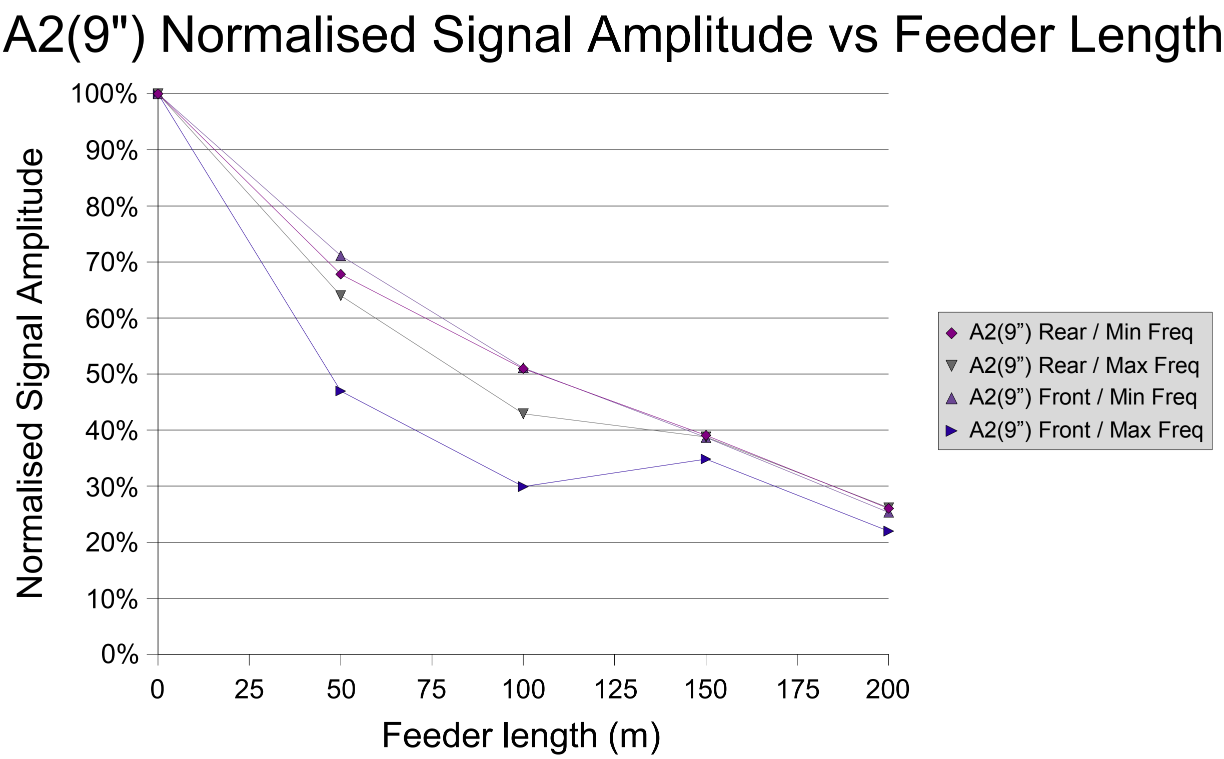

Figure 3: A2 (9") Loop performance

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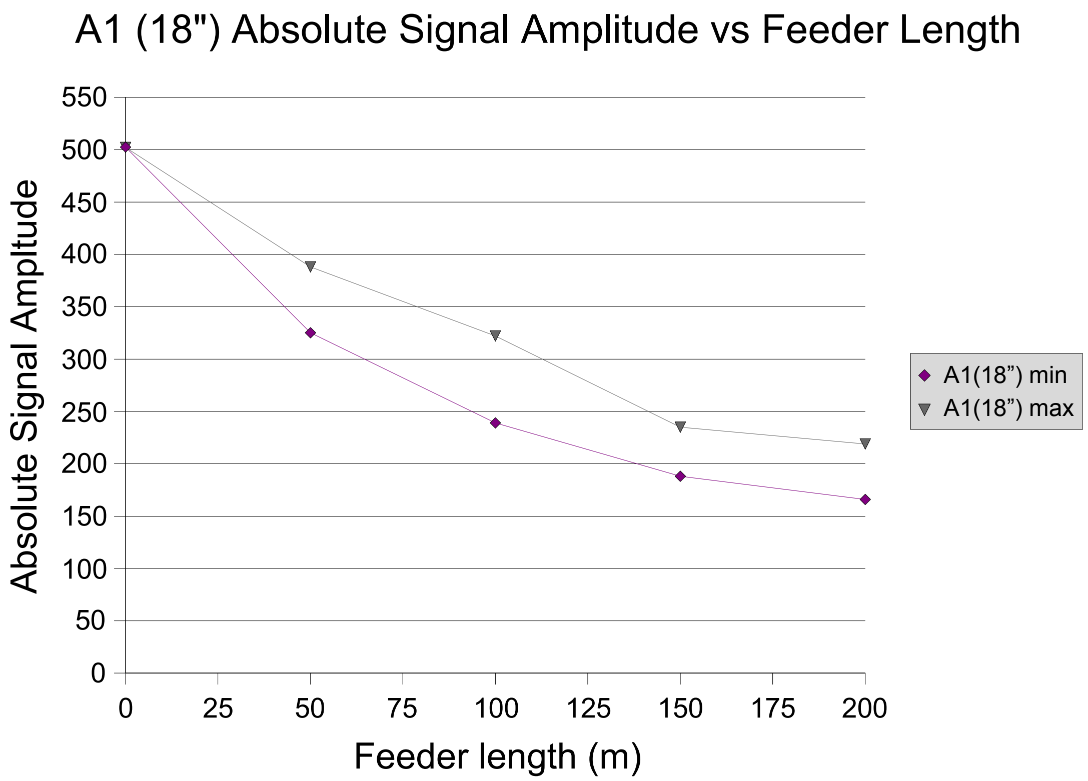

Figure 4: A1 (18”) Absolute amplitude vs feeder length

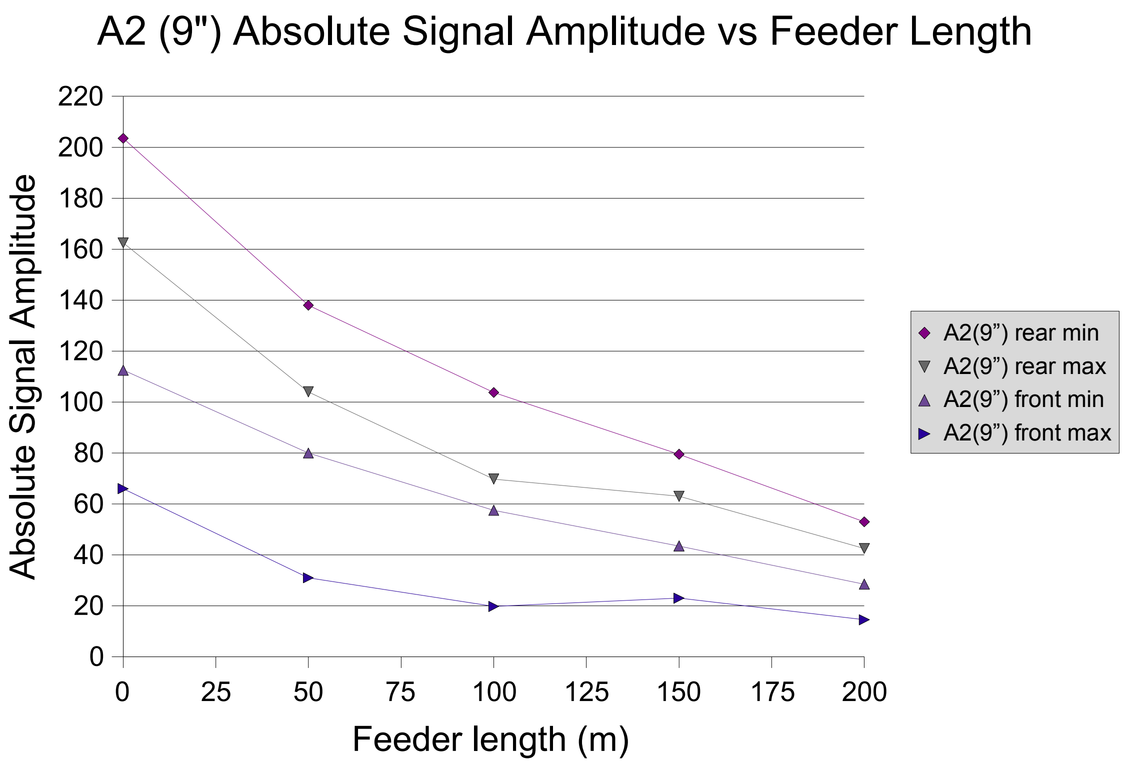

Figure 5: A2 (9") Absolute amplitude vs feeder length

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Analysis

As expected, the graphs show significant attenuation as feeder length increases. As low-level signals could ultimately cause Idris to miss axles, it is strongly recommended that high-resolution detectors (such as the Nortech TD724ID and the Peek High-resolution model) be used in such cases.

Figure 4 shows that the amplitudes generated by the 9” loops are significantly higher at lower frequencies so it is a clear advantage to choose these where possible (other conditions permitting, of course).

It is noticeable from Figures 1 and 2 that, while the amplitude at higher frequencies is actually higher for the 18” loop, it is more irregular in both cases. This suggests that the system becomes less stable at those higher frequencies and this therefore constitutes a second argument in favour of using lower frequencies for longer feeders.

Care was taken during the testing process to monitor the noise levels in the data collected. In most cases they remained acceptable (< 8) but at higher frequencies, occasionally the detector would tune to a frequency which resulted in a very high noise level. In these cases the frequency band was lowered manually to one where the noise levels were acceptable.

The amplitudes in Figure 4 suggest that, as a rule of thumb, feeder lengths up to 150 m are very likely to provide acceptable performance at sites which do not suffer from other problems such as excessive noise or electrical interference.

Recommendations

While reiterating that there is no fixed figure of maximum feeder length due to the diversity of site issues affecting loop performance, DCS has concluded from this study that 150 m is the practical limit between a site that is likely to perform acceptably and one that could have performance issues.

To aid ITP's in achieving the expected performance from sites where long feeders are necessary or convenient, DCS has put together the following list of recommendations:

- Use high-resolution detectors such as the Nortech TD724ID and the High-resolution Peek detector
- At installations where long feeders will be necessary, particular care must be taken with the depth of the axle loop cuts: the top of the 9” loop wiring must not be more than 0.5 inches from the surface (or the amplitude of the signal will be further jeopardized)
- Choose the lowest available frequencies for the axle loops and, therefore, the highest ones for the main loops, which are less susceptible to amplitude issues
- As always, careful attention to all aspects of the installation will pay off in terms of performance and, where long feeders are involved, this is even more important:
  - depth and width of cuts
  - looptail and feeders twisted to the correct number of turns per meter
  - absence of moisture in the cut
  - appropriate sealant, correctly poured to prevent cable movement

Finally, each site has its own peculiarities. Tune the detectors carefully and check the results with the tools provided by DCS, such as startcheck and newscan or equivalent.

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