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PEPPERL+FUCHS

LC20-DT Bluetooth Diagnostic Unit
User Manual

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Contents

1. Introduction

The LC20-DT is a hands free low energy Bluetooth diagnostic unit. The unit is compatible with Pepperl+Fuchs LC20 range of parking detectors. The LC20-DT is capable of providing installation/service personnel with feedback of the detector loop installation and the detector configuration setup. This information is used to verify the correct operation of a parking detector installation.

The unit attaches to the front of any of the LC20 parking detectors and acquires data from the detector via an optic link. A Pepperl+Fuchs Diagnostic App is supplied with the unit that can run on smart devices with either iOS or Android operating systems. Data acquired from the parking detector is sent over a Bluetooth link to the App that displays the detector installation information. Data displayed include the following; Loop excitation frequency, Loop frequency drift, Minimum and maximum detection level detected and detector DIP switch configuration. The App has the capability to generate a report based on the installation information gathered by the LC20-DT Diagnostic unit. This report can be used for signing off a site.

2. Technical Specifications

Power Supply	1 X 3 V, 240 mAh coin cell battery (CR2032)
Auto Power Off	2 Minutes after last operation
Visual Indications	1 X bi-colour LED (Red and Green)
Frequency Resolution	1 Hz
Sensitivity Resolution	0.001 % ΔL/L
Operating Systems	iOS and Android
Storage Temperature	-20^{o}C to +80^{o}C
Operating Temperatures	-5^{o}C to +80^{o}C
Dimensions	54mm (h) x 38mm (w) x 23mm (d)
Battery Life (Standby)	≤ 1250 days
Battery Life (Continuous)	≤ 7.5 hours
Operating Range	≤ 10 m

3. LC20-DT Overview

1 Power and status LED
2 ON/OFF button
3 Phototransistor
4 Attachment magnet

3.1.1 Power and Status LED

The LC20-DT is equipped with a status LED to give a visual indication of the current mode or state of the unit. The unit has four states and is indicated by the LED as follows:

- ***The LED is flashing RED every second:***
  In this mode, the LC20-DT is powered ON and is discoverable and connectable to other devices.

- ***The LED is constantly illuminated RED:***
  This mode indicates that the LC20-DT is paired with a smart device. It is now ready to transmit data from a parking detector to the smart device App.

- ***The LED is flashing GREEN:***
  This indicates that the LC20-DT is successfully receiving data from the parking detector it is attached to.

- ***The LED is flashing GREEN and RED in rapid succession:***
  This indicates that the device is being reset. This will happen when the LC20-DT is disconnected from the device it was paired to.

3.1.2 ON/OFF button

The ON/OFF button will turn the device ON or OFF. If the device is OFF and the button is pressed, the device will turn on and the LED will start flashing RED. The device can be turned OFF by pressing the button again.

The device has a smart power control which will automatically turn the device OFF if the unit has been left unused (not paired with a smart device AND not receiving data from a detector) for 2 minutes.

3.2 Operating Instructions

To use the Diagnostic unit follow these instructions.

1. Turn the device ON by pressing the ON/OFF button once. The LED should come on and flash RED every second. This indicates that the device is powered ON and is ready to be paired with a smart device.

2. Turn the Bluetooth module on your smart device on and open the LC20-DT Diagnostic App. Press 'Scan' and wait for the App to connect to the unit. Once the Diagnostic unit is paired with your smart device the RED LED will stop flashing and stay ON. The device is now ready to be attached to a parking detector.
   Please note: Should more than one LC20-DT be ON at the same time, the App will search for the first LC20-DT it finds and connect to that one. The LC20-DT whose LED stopped flashing RED and stays ON, is the one the App connected to.

3. Attach the LC20-DT to the front of the parking detector and ensure that it is properly in place – the phototransistor on the LC20-DT needs to align with the power LED, and the unit should not rest on the DIP switches or overhang on the side of the detector. Once the LC20-DT is properly attached to the parking detector, the LED will start flashing GREEN. This indicates that the LC20-DT is successfully receiving data from the parking detector. The App will now display a new page containing all the relevant information of the detector installation and the battery status of the LC20-DT.

4. Once the installation is complete, the command buttons in the App can be followed to generate an installation report which can be printed or emailed.

NOTE: The LC20-DT has a power saving mode which allows the device to turn itself OFF after 2 minutes of no operation. This will only happen if the unit is not paired with a smart device AND not receiving data from a detector.

3.3 Connecting the LC20-DT to a parking detector

The LC20-DT attaches to any Pepperl+Fuchs LC20 parking detectors by means of a magnet. The phototransistor on the LC20-DT needs to perfectly align with the power LED on the detector to successfully receive data from the detector. It is, therefore, important to ensure that the LC20-DT is properly placed onto the parking detector. As illustrated in **Figure 1**, the LC20-DT should not overhang any of the sides of the detector and it should also not rest partly on the DIP switches. However, a marginal misalignment of the phototransistor will not hinder the operation of the device.

Figure 1: Connecting a LC20-DT to a parking detector

3.4 Replacing the Battery

To replace the battery on the LC20-DT, un-screw the two screws on the bottom of the LC20-DT housing and remove the bottom cover. To remove the old battery, use your fingers to grab the edge of the battery that is touching the copper plate and firmly pull up, as illustrated below. Once the battery is removed, push the ON/OFF button once.

Figure 2: Removing the battery

To put a new battery in, place one side of the battery underneath the copper plate on the battery holder and then push the opposite side of the battery down (see illustration below).

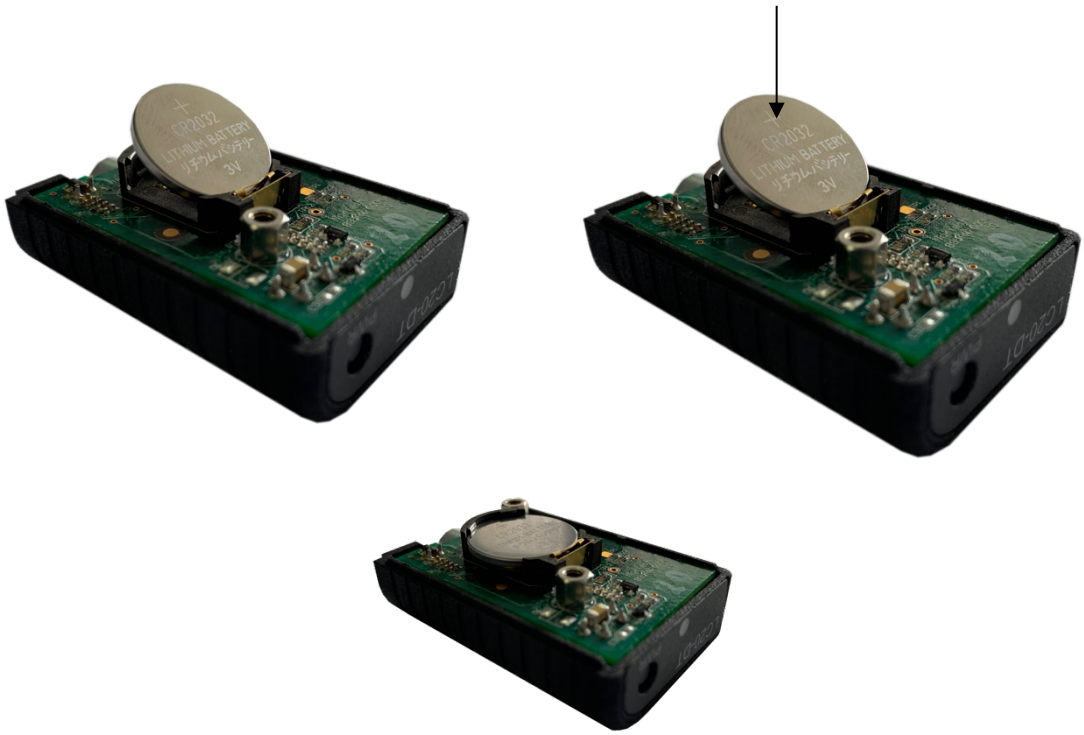
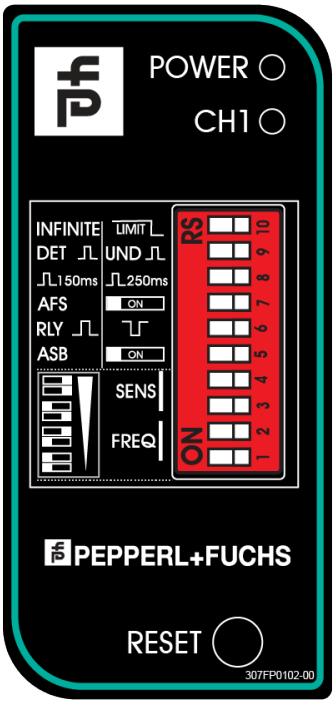


Figure 3: Replacing the battery

4. LC20 Parking Detector DIP Switch Configuration

4.1 1 Channel switch configuration



4.1.1 Presence Time (switch 10)

The presence setting determines how the detector will track a detect. There are two modes, permanent presence and limited presence.

Permanent presence mode is aimed at maintaining the presence of a vehicle over the loop by continuously compensating for all environmental changes. This is used in situations where safety is involved and the detector is required to maintain the detect until the vehicle leaves the loop.

Limited presence is aimed at limiting the presence of a vehicle over the loop. This is used in situations where statistics or control is involved and a vehicle parked over the loop should not prevent continued operation. The presence time is related to the size of the detect. Typically a 1% ΔL/L will timeout after approximately 1 hour.

4.1.2 Pulse on Detect or Un-detect (switch 9)

The user can select the detector to pulse on detect, as a vehicle enters the loop or pulse on un-detect, as the vehicle exits the loop.

4.1.3 Pulse Width (switch 8)

The pulse width of the relay can be selected to be either 150ms or 250ms.

4.1.4 Automatic Frequency Selection (AFS) (switch 7)

This setting allows the detector to briefly evaluate all five frequency bands and select the best operating frequency available. The tuning time with AFS switched on can range between 5 to 20 seconds. With AFS switched off, the frequency can be selected manually.

4.1.5 Fail-safe or Fail-secure (switch 6)

The relay output operation of the presence relay can be switched between fail-safe and fail-secure via the DIP switches. In fail-safe, the output is the same in detect as it is with no power applied to the unit. Related to an access control situation, this is used where the loss of power must not lock people out. Either a valid detect situation, or a power failure / fault will provide a signal.

In fail-secure, the output is the same in un-detect as it is with no power applied to the unit. Related to an access control situation, this is used where the loss of power must not allow free entry. Only a valid detect situation will provide a signal.

4.1.6 Automatic Sensitivity Boost (ASB) (switch 5)

ASB is a mode which alters the un-detect level of the detector, and can be toggled on or off via the DIP switches. ASB causes the sensitivity level to be boosted to a maximum on detection of a vehicle, irrespective of the current sensitivity level, and maintained at this level during the entire presence of the vehicle over the loop. When the vehicle leaves the loop and the detection is lost, the sensitivity level reverts to the pre-selected level. This is typically used for vehicles with high beds, or vehicles towing trailers, where it is important to not lose the detect over the entire length of the vehicle.

4.1.7 Sensitivity (switch 4 and 3)

The sensitivity of the detector determines the change of inductance necessary to produce a detect. The LC20-1 provides a selectable range of four sensitivity settings. Sensitivity is defined as a change in the inductance, with the LC20-1 it ranges from 0.01% to 0.1%, with 0.01% being the highest sensitivity selection.

Sw4	Sw3	Sensitivity
Right	Right	(0.01%) - High Sensitivity
Left	Right	(0.02%) - Medium High Sensitivity
Right	Left	(0.05%) - Medium Low Sensitivity
Left	Left	(0.10%) - Low Sensitivity

4.1.8 Frequency (switch 2 and 1)

The frequency switches are used to shift the operating frequency of the detector. This is primarily used to handle situations in which more than one detector is used at the same site. The detectors must be set-up to ensure no crosstalk (interference) occurs between adjacent loops connected to different detectors. This is achieved by ensuring that the loops of the two detectors are spaced sufficiently apart (approximately 2 metres between adjacent edges) and also ensuring that the detectors are set to different frequencies.

Sw2	Sw1	Frequency
Right	Right	High Frequency
Left	Right	Medium High Frequency
Right	Left	Medium Low Frequency
Left	Left	Low Frequency

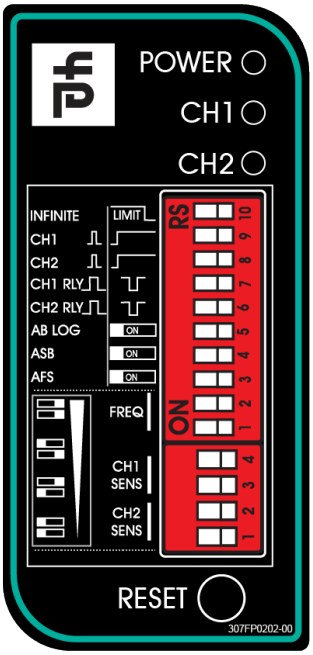
4.1.9 Push button (Retune and Powerfail)

The push button can be used to initiate a retune or to switch Powerfail on or off depending on how long the push button is held in.

Switch	Description	Hold	Function
Push Button	Reset	3 sec	This would initiate a detector retune
	Power fail status	10 sec	Hold for 10s to determine the state of Powerfail. If the LEDs are ON, Powerfail is ON. If the LEDs are OFF, Powerfail is OFF.
	Power fail toggle	30 sec	Holding for 30s will toggle the Powerfail status. The state of Powerfail is known after holding for 10s. After 30s, if the LEDs turn OFF, Powerfail is now OFF. If after 30s the LEDs turn ON, Powerfail is now ON.

The LC20 has a Powerfail function which has been designed to retain the memory of a vehicle on the loop in the event of a power fail situation. This is designed specifically for fail safe situations to retain the output state and prevent a glitch on the outputs, in the event of a power failure.

4.2 2 Channel switch configuration



4.2.1 Presence (switch 10)

The presence setting determines how the detector tracks a detect. There are two modes, permanent presence and limited presence.

Permanent presence mode is aimed at maintaining the presence of a vehicle over the loop by continuously compensating for all environmental changes. This is used in situations where safety is involved and the detector is required to maintain the detect until the vehicle leaves the loop.

Limited presence is aimed at limiting the presence of a vehicle over the loop. This is used in situations where statistics or control is involved and a vehicle parked over the loop should not prevent continued operation. The presence time is related to the size of the detect. Typically a 1% ΔL/L will timeout after approximately 1 hour.

4.2.2 Pulse on detect / Presence on detect (switch 9 and 8)

When a vehicle enters the loop the relay can either give a 150ms pulse on detect, or give an output for the entire time that the vehicle is detected by the detector. This setting can be made for each channel respectively as indicated on the faceplate.

4.2.3 Fail-safe or Fail-secure (switch 7 and 6)

The relay output polarity of the presence relay can be switched between fail-safe and fail-secure via the DIP switches.

In fail-safe, the output is the same in detect as it is with no power applied to the unit. Related to an access control situation, this is used in situations where the loss of power must not lock people out. Either a valid detect situation, or a power failure/ fault will provide a signal.

In fail-secure, the output is the same in un-detect as it is with no power applied to the unit. Related to an access control situation, this is used in situations where the loss of power must not allow free entry. Only a valid detect situation will provide a signal.

4.2.4 AB Logic (switch 5)

AB logic can be used to count the cars going in a specified direction. A transition from loop 1 to loop 2 (classified as forwards) results in a 150ms pulse output on Relay 1. A transition from loop 2 to loop 1 (classified as backwards) results in a 150ms pulse output on Relay 2. This function can easily be switched off by making use of the DIP switches as indicated on the tables.

4.2.5 Automatic Sensitivity Boost (ASB) (switch 4)

ASB is a mode which alters the un-detect level of the detector, and can be toggled on or off via the DIP switches. ASB causes the sensitivity level to be boosted to a maximum on detection of a vehicle, irrespective of current sensitivity level and maintained at this level during the entire presence of the vehicle over the loop. When the vehicle leaves the loop and the detection is lost, the sensitivity level reverts to the pre-selected level. This is typically used for vehicles with high beds, or vehicles towing trailers, where it is important to not lose the detect over the entire length of the vehicle.

4.2.6 Automatic Frequency Selection (AFS) (switch 3)

This setting allows the detector to briefly evaluate all five frequency bands and select the best operating frequency available. The tuning time with AFS switched on can range between 5 to 20 seconds. With AFS switched off, the frequency can be selected manually.

4.2.7 Frequency (switch 2 and 1)

The frequency switches are used to shift the operating frequency of the detector. This is primarily used to handle situations in which more than one detector is used at the same site. The detectors must be set-up to ensure no crosstalk (interference) occurs between adjacent loops connected to different detectors. This is achieved by ensuring that the loops of the two detectors are spaced sufficiently apart (approximately 2 metres between adjacent edges) and also ensuring that the detectors are set to different frequencies.

The loops connected to multichannel detectors are not susceptible to crosstalk due to the design of the loop interface.

Sw2	Sw1	Frequency
Right	Right	High Frequency
Left	Right	Medium High Frequency
Right	Left	Medium Low Frequency
Left	Left	Low Frequency

4.2.8 Sensitivity (switches 1 to 4)

The sensitivity of the detector determines the change of inductance necessary to produce a detect. The LC20-2 provides a selectable range of four sensitivity settings. Sensitivity is defined as a change in the inductance, with the LC20-2 it ranges from 0.01% to 0.1%, with 0.01% being the highest sensitivity selection.

Sw4	Sw3	Sensitivity Channel 1
Right	Right	(0.01%) - High Sensitivity
Left	Right	(0.02%) - Medium High Sensitivity
Right	Left	(0.05%) - Medium Low Sensitivity
Left	Left	(0.10%) - Low Sensitivity

Sw2	Sw1	Sensitivity Channel 2
Right	Right	(0.01%) - High Sensitivity
Left	Right	(0.02%) - Medium High Sensitivity
Right	Left	(0.05%) - Medium Low Sensitivity
Left	Left	(0.10%) - Low Sensitivity

4.2.9 Push button (Retune and Powerfail)

The push button can be used to initiate a retune or to switch Powerfail on or off depending on how long the push button is held in.

Switch	Description	Hold	Function
Push Button	Reset	3 sec	This would initiate a detector retune
	Power fail status	10 sec	Hold for 10s to determine the state of Powerfail. If the LEDs are ON, Powerfail is ON. If the LEDs are OFF, Powerfail is OFF.
	Power fail toggle	30 sec	Holding for 30s will toggle the Powerfail status. The state of Powerfail is known after holding for 10s. After 30s, if the LEDs turn OFF, Powerfail is now OFF. If after 30s the LEDs turn ON, Powerfail is now ON.

The LC20-2 has a Powerfail function which is designed to retain the memory of a vehicle on the loop in the event of a power fail situation. This is designed specifically for fail safe situations to retain the output state and prevent a glitch on the outputs in the event of a power failure.

5. Troubleshooting

5.1 Fault Finding

Problem	Possible Resolution
RED LED is not coming on when the ON/OFF button is pushed	• Ensure that the battery is properly inserted in the battery holder • Check the battery voltage. Replace if necessary.
The LC20-DT does not connect to the smart device.	• Check that the LED is flashing RED on the LC20-DT. If it is solid RED, the LC20-DT is paired with another smart device – turn the LC20-DT OFF and ON again. If it is flashing green and red, the device is being reset - wait a moment and try • Kill the app and turn the Bluetooth on the smart device OFF and turn it back ON again. Reopen the app and try again. • Check the battery voltage of the battery and replace if necessary.
LC20-DT is connected to a detector but the GREEN LED is not flashing	• Ensure that the LC20-DT is properly in place. The unit should not rest on the DIP switches or overhang on the side of the detector. • Ensure that the LC20-DT is successfully paired with the smart device. The RED LED should be constantly ON to indicate this. • Ensure that the parking detector is powered.

6. Theory of Application

6.1 Loop Frequency and Inductance Change

The inductive loop is energised by an AC signal which is produced by an oscillator in the vehicle detector. The operating frequency of the oscillator is determined by both the physical characteristics of the loop and the frequency determining components within the detector.

When a vehicle enters the loop, the loop inductance decreases causing a corresponding increase in oscillator frequency. Experience has shown that the percentage change of inductance (Δ L/L) from an unoccupied loop to an occupied loop is extremely repeatable for a given loop size and geometry, and for a given location of the vehicle with respect to the loop.

The LC20-DT Diagnostic Unit displays both the absolute loop frequency and the percentage change in inductance (Δ L/L). For the case of an unoccupied loop, the percentage change in inductance will remain at zero (small values may occur due to oscillator or loop drift). A vehicle traverses the loop, the change in frequency and inductance may be observed.

The percentage change in inductance (Δ L/L) is a measure of the sensitivity of the loop detector installation. For a given vehicle, the value will be dependent on various factors including:

- Loop size
- Loop depth below ground level
- Amount of residual metal in close proximity to the loop

Absolute loop frequency may be in the range of 18 kHz – 100 kHz. Change in inductance, however, is vehicle and installation dependent. Its merit lies in comparisons between various vehicles at a particular site or between various sites with the same vehicle.

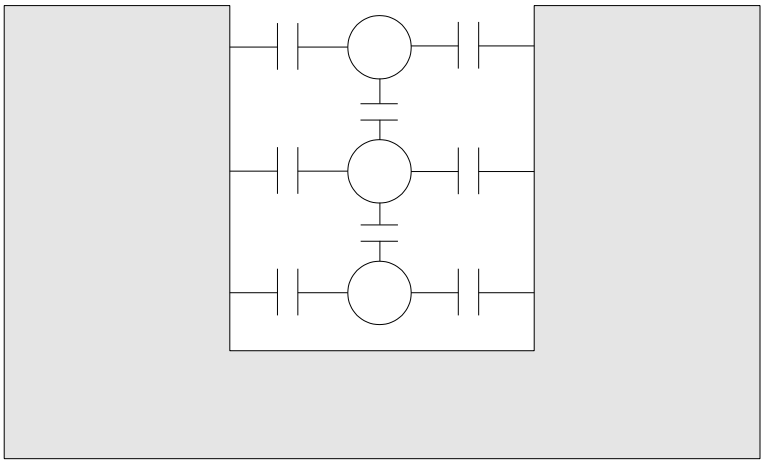
The relationship between absolute loop frequency and absolute loop inductance is exponential in nature and is dependent on the particular detector type. Curves which define this relationship can be found in at the end of this manual.

6.2 Loop Frequency Drift

This is a measure of the quality of loop installation. The display of drift value represents the absolute difference between the current loop frequency and the reference loop frequency (defined at the last reset/retune).

Abnormal values of loop frequency drift can indicate a loop installation of poor quality. Drift occurs primarily as a result of changes in ambient temperature and should normally be less than 3%. Values significantly greater than 3% are generally indicative of loops of poor quality. Potential causes include damaged insulation (low resistance earth path), ingression of moisture and movement of loop wires.

Ingression of moisture also results in increased loop frequency drift. Capacitive coupling exists between loop turns and the side walls of the loop slot as shown in the figure below.



Loop capacitance coupling in roadway slot

This capacitance is directly proportional to the dielectric constant of the slot sealing material. If this material is hygroscopic (readily absorbs and retains water) or incomplete (does not fill the slot or encapsulate the wires) allowing water to enter the slot and penetrate between loop conductors, the capacitance will change greatly due to the high dielectric constant of water. This change in loop capacitance will shift the loop operating frequency thus causing loop frequency drift to increase.

6.3 Detection Sensitivity

Detection sensitivity may be defined as the threshold level at which the smallest change in inductance results in an output actuation. This is clearly dependent on the inductive loop characteristics and may be adjusted by the sensitivity switch setting on the detector itself.

With the detector set to maximum sensitivity, relatively smaller changes in inductance result in detection. Detector sensitivity settings are designed such that maximum sensitivity should be capable of detecting all vehicles while lower settings would eliminate detection of bicycles, supermarket trolleys, and the over-hang of high bed vehicles.

Maximum and minimum values correspond to the largest and smallest changes in inductance resulting in detection since the last time the detector was reset (manual or power reset).

The desired level of sensitivity may be achieved by comparison between recorded changes and sensitivity switch settings at a particular site.

To reliably determine which sensitivity level should be used at any particular site, the sensitivity level of the detector should be set to maximum (to ensure that all vehicles are detected). A variety of vehicles matching the types used on the site should be driven over the loop to determine the level of change. The vehicle with the lowest change should be used to then determine the sensitivity threshold of the detector. A threshold more sensitive than the observed change should be selected.

If a particular vehicle was to be excluded (e.g. supermarket trolley) then the threshold level selected on the detector would be less sensitive than the maximum change recorded for the vehicle.

6.4 Crosstalk Prevention

When two or more loop configurations are in close proximity, the fields of one loop can interfere and disturb the field of another. This phenomena, known as crosstalk, can cause false detects and cause the detector to lock-up and no longer function. The problem also exists when reinforcing used to strengthen a structure is in close proximity to the loop. It provides an efficient means of coupling two loops together.

Crosstalk can be eliminated by following a few simple steps:

- Always ensure separation between loops when planning a new site. Where possible ensure a minimum distance of 2 metres between loops.

- When using non-multiplex detectors, change the number of turns between adjacent loops by one or two turns, if a number of loops are being installed.

- When reinforcing is present, the number of turns should be increased by two or more to compensate for the loading effect of the loop caused by the reinforcing. There will be a loss in sensitivity. The loop should also be mounted as far from the reinforcing as possible, typically 150mm. Care should be taken to ensure that no loop cable is exposed after sealing compound is applied.

- The loop feeder should ideally be a twisted pair with a low series resistance so that the feeder does not reduce sensitivity. The twisting of the feeders is especially important as this will counteract the effects of noise and crosstalk form adjacent feeders and power cables. Typical twists are greater than 1 turn per 3 centimetre. (33 twist per metre).

- Once detectors have been connected and powered up the loop frequencies must be measured to check frequency separation between loops. When only one multiplex detector is used, this does not need to be done. If more than one detector is used this is crucial. Record the frequencies and check that there is at least 2000Hz separation between all loops in close proximity to one another. Note that this situation can be severely aggravated by the presence of steel reinforcing below the road surface.

APPENDIX – INDUCTANCE/FREQUENCY CURVES