LD470

4 CHANNEL VEHICLE LOOP DETECTORS

USER MANUAL

PROCON ELECTRONICS

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TABLE OF CONTENTS

1. AN OVERVIEW OF THE LD470

The LD470 is a high performance Eurocard 4 channel inductive loop detector designed for use in traffic control applications, toll systems and vehicle counting.

The detector uses loop multiplexing to prevent crosstalk between adjacent loops and is easy to set-up and install.

On power up or reset the detector performs an automatic tune procedure and is ready for use within seconds.

The LD470 can operate as a standard 4 channel detector or may be configured for directional logic where loops 1 and 2 and loops 3 and 4 work in pairs to give a direction output.

The LD470 can perform occupancy calculations and speed measurement.

Two communications ports are provided:

A Modbus RS232 communications port located on the front faceplate is used for configuration and diagnostics with a notebook computer or with the LD470 handheld diagnostic unit.

A Modbus RS485 communications port on the connector at the rear of the unit can be used to connect many detector units to a central computer or controller. Configuration and diagnostics can also be accessed from this port.

The communications allows access to internal parameters such as loop input status, loop fault status and counters, speed and occupancy.

The LD470 uses the latest ARM7 32bit processor for peak performance.

Standard features of the detector are :

- **Reset Switch**.
  The reset switch enables the detector to be manually reset during commissioning and testing. This results in the detector re-tuning the sensing loop and becoming ready for vehicle detection.

- **Presence / Passage feature**.
  Each channel can be individually setup to operate in presence or passage mode.

- **Selectable Presence Time**.
  Each channel can be individually setup for a presence time from seconds to hours.

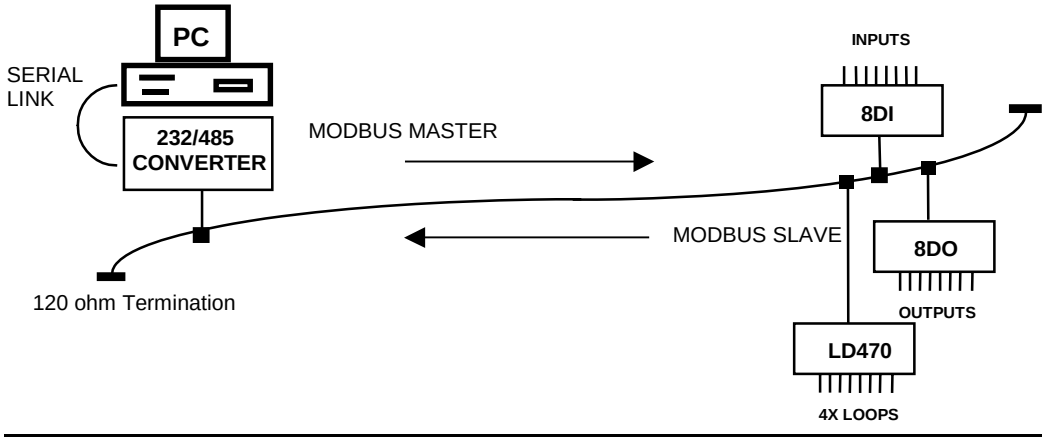
- **Selectable Sensitivity**.
  Any combination of detect sensitivity level can be selected from 0.02% to 10.00%. The undetect sensitivity level can also be programmed as required. An individual channel can be switched off. This will prevent the fault output from being activated by unused loops.

- **Switch selectable Frequency**.
  Four frequency settings are available to prevent cross-talk between adjacent loops.

- **Network Layout.**

  The diagram below shows how the LD470 may be connected to a Modbus network. The LD470 can be placed on the network with other I/O products such as the popular **PROMUX** from Procon Electronics.

A typical application is where a **PC** (Personal Computer) is connected to the Network. Many SCADA software packages support the MODBUS Master Protocol and can hence retrieve data from the LD470 as well as Input Modules or send data to Output Modules. The **serial port** of the PC is connected to an **RS232/RS485 Converter** which in turn is connected to the Network.



LD470 MODULE SELECTION TABLE

MODEL	MODULE TYPE
LD270	2 Channel Eurocard Traffic Detector With Relays
LD270O	2 Channel Eurocard Traffic Detector With OptoCoupler Outputs
LD470	4 Channel Eurocard Traffic Detector With Relays
LD470O	4 Channel Eurocard Traffic Detector With OptoCoupler Outputs

2. LD470 HARDWARE

2.1 SPECIFICATIONS

1.	Power Supply:	19.6V - 28.8VDC.
2.	Microprocessor:	32 bit ARM7 @ 50Mhz.
3.	LD470 Relay Output:	These outputs have a normally closed relay contact rated at 0.5A/24VDC.
4.	LD470O Optocoupler Outputs:	These outputs are normally open solid state transistor outputs rated at 10mA/35VDC.
5.	Indicators:	LED indicators show: Detect state and Loop Fault.
6.	Sensitivity Range:	0.02% - 10.00%. (10.00 = Channel Disable)
7.	Inductance Tuning Range:	15 - 1500 uH.
8.	Response Time:	10ms – 65535ms ± 4ms.
9.	Failsafe: fault	1. The channel output will go into detect if a loop is detected or the power fails. 2. The fault output will indicate a fault during a loop fault or power fail.
10.	Frequency Range:	Four step adjustable 15 – 130KHz.
11.	Protection:	Loop isolation transformer, zener diode and Gas Arrestor protection on loop input.
12.	Communications:	1. RS232 - 19200, 8, n, 1 ID = 1. 2. RS485 – Baud (2400,4800,9600,19200,38400, 57600,115200).
13.	Communications Protocol:	Modbus RTU.
14.	Connector:	DIN 41612 Form C.
15.	Dimensions:	160mm X 100 X 25mm
16.	Operating Temperature:	-40°C to +80°C
17.	Storage Temperature:	-40°C to +85°C
18.	Humidity:	up to 95% non condensing

2.2 WIRING – LD470 Relay outputs

TERMINAL	FUNCTION	TERMINAL	FUNCTION
2a	CH3 Loop Input	2c	CH1 Loop Input
4a	CH3 Loop Input	4c	CH1 Loop Input
6a	No Connection	6c	Fault Relay N/O
8a	CH3 Output N/O	8c	0V
10a	CH3 Output N/C	10c	RESET
12a	Earth	12c	Earth
14a	CH3 Output Common	14c	CH4 Output N/O
16a	CH2 Output N/O	16c	CH1 Output N/O
18a	CH2 Output Common	18c	CH1 Output Common
20a	CH2 Output N/C	20c	CH1 Output N/C
22a	RS485 Comms +	22c	CH4 Output N/C
24a	RS485 Comms -	24c	CH4 Output Common
26a	CH2 Loop Input	26c	CH4 Loop Input
28a	CH2 Loop Input	28c	CH4 Loop Input
30a	+24 VDC	30c	+24 VDC
32a	0V	32c	0V

2.3 WIRING – LD470O Optocoupler Outputs

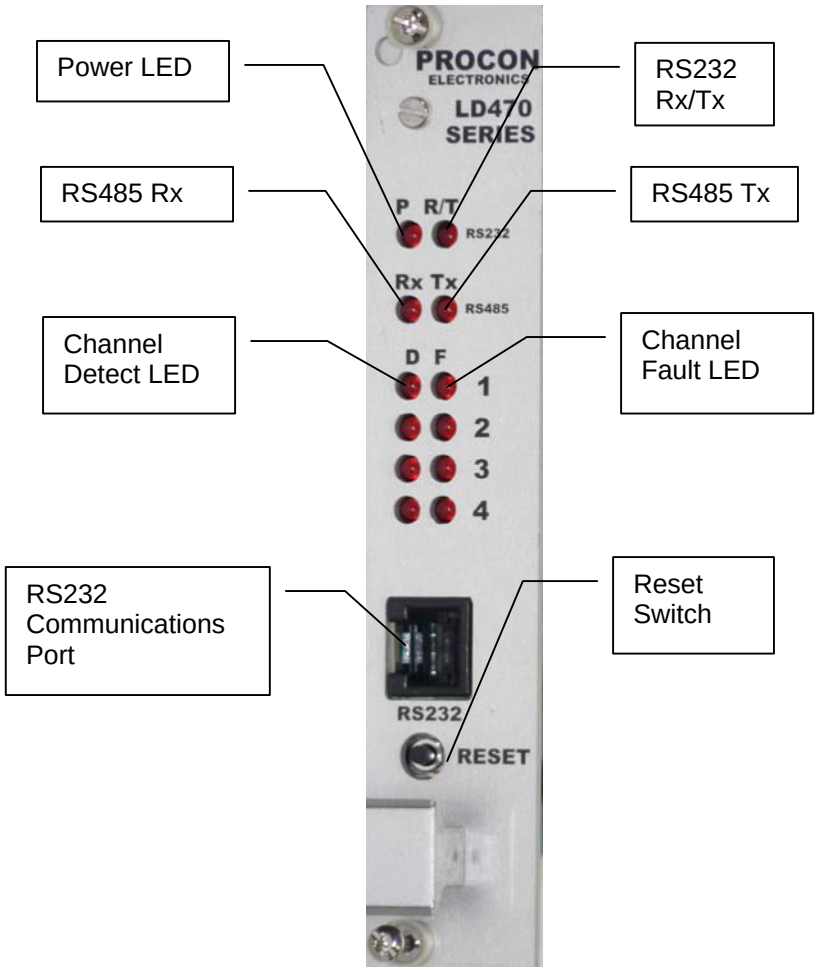
TERMINAL	FUNCTION	TERMINAL	FUNCTION
2a	CH3 Loop Input	2c	CH1 Loop Input
4a	CH3 Loop Input	4c	CH1 Loop Input
6a	-	6c	Fault Output +ve
8a	CH3 Output +ve	8c	0V
10a	-	10c	RESET
12a	Earth	12c	Earth
14a	CH3 Output -ve	14c	CH4 Output +ve
16a	CH2 Output +ve	16c	CH1 Output +ve
18a	CH2 Output -ve	18c	CH1 Output -ve
20a	-	20c	-
22a	RS485 Comms +	22c	-
24a	RS485 Comms -	24c	CH4 Output -ve
26a	CH2 Loop Input	26c	CH4 Loop Input
28a	CH2 Loop Input	28c	CH4 Loop Input
30a	+24 VDC	30c	+24 VDC
32a	0V	32c	0V

The outputs are in the normal condition when the LD470 is powered, there is no vehicle on the loop and there is no loop fault.

2.4 LOOP INSTALLATION GUIDE

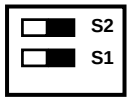
1. The loop and feeder should be made from insulated copper wire with a minimum cross-sectional area of 1.5mm^2. The feeder should be twisted with at least 20 turns per metre. Joints in the wire are not recommended and must be soldered and made waterproof. Faulty joints could lead to incorrect operation of the detector. Feeders which may pick up electrical noise should use screened cable, with the screen earthed at the detector.
2. The loop should be either square or rectangular in shape with a minimum distance of 1 metre between opposite sides. Normally 3 turns of wire are used in the loop. Large loops with a circumference of greater than 10 metres should use 2 turns while small loops with a circumference of less than 6 metres should use 4 turns. When two loops are used in close proximity to each other it is recommended that 3 turns are used in one and 4 turns in the other to prevent cross-talk.
3. Cross-talk is a term used to describe the interference between two adjacent loops. To avoid incorrect operation of the detector, the loops on different detector units should be at least 2 metres apart and on different frequency settings.
4. For loop installation, slots should be cut in the road using a masonry cutting tool. A 45^o cut should be made across the corners to prevent damage to the wire on the corners. The slot should be about 4mm wide and 30mm to 50mm deep. Remember to extend the slot from one of the corners to the road-side to accommodate the feeder.
5. Best results are obtained when a single length of wire is used with no joints. This may be achieved by running the wire from the detector to the loop, around the loop for 3 turns and then back to the detector. The feeder portion of the wire is then twisted. Remember that twisting the feeder will shorten its length, so ensure a long enough feeder wire is used.
6. After the loop and feeder wires have been placed in the slot, the slot is filled with an epoxy compound or bitumen filler.

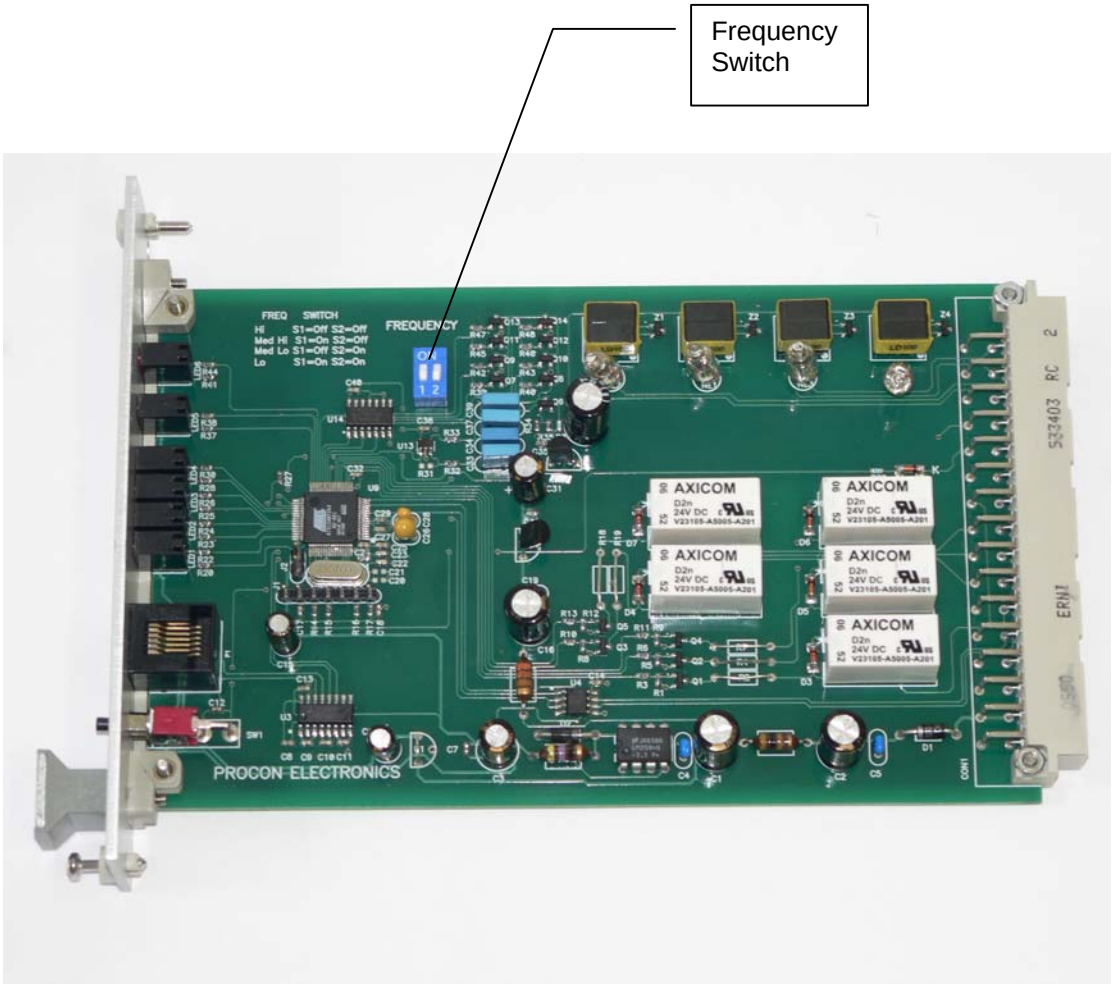
2.5 LD470 Front Panel



3. SWITCH SETTINGS

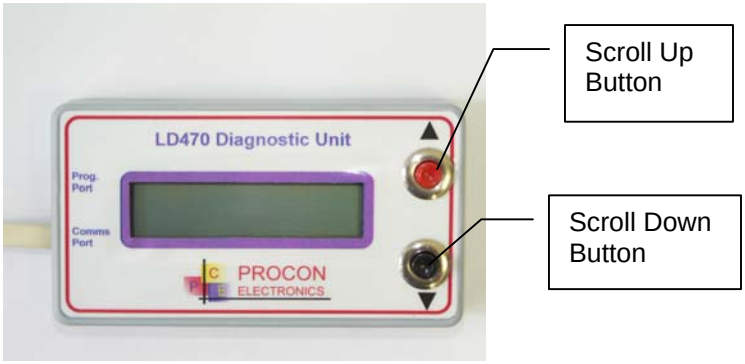
Frequency	ON	OFF
High	-	S1/S2
Med. High	S1	S2
Med. Low	S2	S1
Low	S1/S2	-





4. Diagnostic Unit

The LD470 diagnostic unit plugs into the RS232 communications port on the front panel of the detector unit. The diagnostic unit gets power from the LD470 and is automatically switched on when plugged into the LD470.



4.1 Using the diagnostic unit.

The up and down scroll buttons are used to scroll through the menu items.

To edit a value you must perform the following sequence:

1. Push both buttons at the same time. The least significant digit will start flashing to indicate the unit is in edit mode. If the digit does not flash then either the buttons were not pushed together or the data cannot be edited because it is read only.
2. Use the scroll down button to increment the value of the digit.
3. Use the scroll up button to advance to the next digit.
4. When the correct value has been entered, push both of the buttons together to enter and save the value. If the entered value changes to another value different from the value entered, this means that the entered value was out of range and has been undated with a default value.

4.2 Configuring the LD470.

The following sections describe the data that can be configured or read by the diagnostic unit.

1. Ch1 Sensitivity: 0.02% to 10.00% where 10.00% = Channel Disabled.
2. Ch2 Sensitivity: 0.02% to 10.00% where 10.00% = Channel Disabled.
3. Ch3 Sensitivity: 0.02% to 10.00% where 10.00% = Channel Disabled.
4. Ch4 Sensitivity: 0.02% to 10.00% where 10.00% = Channel Disabled.
5. Ch1 Undetect Sensitivity: 0.01% to 9.99%. Cannot be larger than Sensitivity.
6. Ch2 Undetect Sensitivity: 0.01% to 9.99%. Cannot be larger than Sensitivity.
7. Ch3 Undetect Sensitivity: 0.01% to 9.99%. Cannot be larger than Sensitivity.
8. Ch4 Undetect Sensitivity: 0.01% to 9.99%. Cannot be larger than Sensitivity.
9. Ch1 On Filter (Delay): 10ms to 65535ms.
10. Ch2 On Filter (Delay): 10ms to 65535ms.
11. Ch3 On Filter (Delay): 10ms to 65535ms.
12. Ch4 On Filter (Delay): 10ms to 65535ms.
13. Ch1 Extend: 4ms to 65535ms.
14. Ch2 Extend: 4ms to 65535ms.
15. Ch3 Extend: 4ms to 65535ms.
16. Ch4 Extend: 4ms to 65535ms.

17. Ch1 Presence time: 2min to 65535min.
18. Ch2 Presence time: 2min to 65535min.
19. Ch3 Presence time: 2min to 65535min.
20. Ch4 Presence time: 2min to 65535min.
21. Ch1 Pulse time: 100ms to 65535ms.
22. Ch2 Pulse time: 100ms to 65535ms.
23. Ch3 Pulse time: 100ms to 65535ms.
24. Ch4 Pulse time: 100ms to 65535ms.
25. Ch1 Mode: 0 = presence, 1 = pulse.
26. Ch2 Mode: 0 = presence, 1 = pulse.
27. Ch3 Mode: 0 = presence, 1 = pulse.
28. Ch4 Mode: 0 = presence, 1 = pulse.
29. RS485 Stop Bits: 1 or 2.
30. RS485 Parity: 0 = none, 1 = even, 2 = odd.
31. RS485 Baud Rate: 2400, 4800, 9600, 19200, 38400, 57600, 11520.
32. Occupancy Time: 1sec to 65535sec.
33. Loop Spacing: For speed measurement. 0.1m to 10.0m
34. Direction Logic Pulse Time: 1ms to 65535ms.
35. LD470 Mode: 0 = Normal. +1 change to direction logic. +2 modbus operates relays.
36. RS485 Node ID: Address 0 to 253.

4.3 Reading data from the LD470.

The following registers give information relating to the channels.

1. Ch1 DL/L: The actual change in loop inductance as a vehicle moves over loop 1.
2. Ch2 DL/L: The actual change in loop inductance as a vehicle moves over loop 2.
3. Ch3 DL/L: The actual change in loop inductance as a vehicle moves over loop 3.
4. Ch4 DL/L: The actual change in loop inductance as a vehicle moves over loop 4.
5. Ch1 Frequency: The frequency of the loop1 will change as the inductance changes.
6. Ch2 Frequency: The frequency of the loop2 will change as the inductance changes.
7. Ch3 Frequency: The frequency of the loop3 will change as the inductance changes.
8. Ch4 Frequency: The frequency of the loop4 will change as the inductance changes.
9. Ch1 Counter: 0 to 4294967295 (32 bit).
10. Ch2 Counter: 0 to 4294967295 (32 bit).
11. Ch3 Counter: 0 to 4294967295 (32 bit).
12. Ch4 Counter: 0 to 4294967295 (32 bit).
13. Ch1 Occupation: The amount of time loop 1 was occupied %.
14. Ch2 Occupation: The amount of time loop 2 was occupied %.
15. Ch3 Occupation: The amount of time loop 3 was occupied %.
16. Ch4 Occupation: The amount of time loop 4 was occupied %.
17. Speed 1&2: The speed of the last vehicle that traveled from loop1 to loop2.
18. Speed 3&4: The speed of the last vehicle that traveled from loop3 to loop4.

5. DATA ADDESSES

The data in the module is stored in registers. These registers are accessed over the network using the MODBUS communication protocol.

The MODBUS mode used is the **RTU** mode with the following RS232 set-up:

BAUD RATE	19200
DATA BITS	8
PARITY	NONE
STOP BITS	1

Note: Due to the limited buffer memory size in the LD470, the Modbus message length must be limited to 100 consecutive read or write registers.

There are 4 types of variables which can be accessed from the module. The LD470 module has one or more of these data variables.

Type	Start Address	Variable
1	00001	Digital Outputs
2	10001	Digital Inputs
3	30001	Input registers (Analog/Counters)
4	40001	Output registers (Analog/Counters)

5.1 LD470 (MODULE TYPE = 36)

Modbus Address	Register Name	Low Limit	High Limit	Access	Comments
10001	Loop1 Fault	0	1	R	Read Loop 1 Fault Status
10002	Loop1 Output	0	1	R	Read Loop 1 Detect Status
10003	Loop2 Fault	0	1	R	Read Loop 2 Fault Status
10004	Loop2 Output	0	1	R	Read Loop 2 Detect Status
10005	Loop3 Fault	0	1	R	Read Loop 3 Fault Status
10006	Loop3 Output	0	1	R	Read Loop 3 Detect Status
10007	Loop4 Fault	0	1	R	Read Loop 4 Fault Status
10008	Loop4 Output	0	1	R	Read Loop 4 Detect Status
00009	Relay 1 Output	0	1	R/W	Write/Read Relay 1 Output
00010	Relay 2 Output	0	1	R/W	Write/Read Relay 2 Output
00011	Relay 3 Output	0	1	R/W	Write/Read Relay 3 Output
00012	Relay 4 Output	0	1	R/W	Write/Read Relay 4 Output
30001	S/W Version / Module Type	N/A	N/A	R	High Byte = Software Version Low Byte = 36
40002	Digital I/O	N/A	N/A	R/W	Digital Outputs in lower 8 bits. 8 - 1. Relays in upper bits. 12 - 9.
30011	CH1 DL/L	-1000	+1000	R	Change in Loop inductance X 0.01%
30012	CH1 Frequency MSB	15000	125000	R	Loop Frequency. MSB and LSB combine to give a 32 bit value X 0.001 KHz.
30013	CH1 Frequency LSB	"	"	R	"
40014	CH1 Counter MSB	0	65535	R/W	Counter MSB and LSB combine to give a 32 bit Value.
40015	CH1 Counter LSB	0	65535	R/W	Counter with range 0 to 4294967295. Write to clear or preset.
30016	CH1 Occupation	0	100	R	Loop Occupation Time %
30021	CH2 DL/L	-1000	+1000	R	Change in Loop inductance X 0.01%
30022	CH2 Frequency MSB	15000	125000	R	Loop Frequency. MSB and LSB combine to give a 32 bit value X 0.001 KHz.
30023	CH2 Frequency LSB	"	"	R	"
40024	CH2 Counter MSB	0	65535	R/W	Counter MSB and LSB combine to give a 32 bit Value.
40025	CH2 Counter LSB	0	65535	R/W	Counter with range 0 to 4294967295. Write to clear or preset.
30026	CH2 Occupation	0	100	R	Loop Occupation Time %
30031	CH3 DL/L	-1000	+1000	R	Change in Loop inductance X 0.01%
30032	CH3 Frequency MSB	15000	125000	R	Loop Frequency. MSB and LSB combine to give a 32 bit value X 0.001 KHz.

30033	CH3 Frequency LSB	“	“	R	"
40034	CH3 Counter MSB	0	65535	R/W	Counter MSB and LSB combine to give a 32 bit Value.
40035	CH3 Counter LSB	0	65535	R/W	Counter with range 0 to 4294967295. Write to clear or preset.
30036	CH3 Occupation	0	100	R	Loop Occupation Time %
30041	CH4 DL/L	-1000	+1000	R	Change in Loop inductance X 0.01%
30042	CH4 Frequency MSB	15000	125000	R	Loop Frequency. MSB and LSB combine to give a 32 bit value X 0.001 KHz.
30043	CH4 Frequency LSB	“	“	R	"
40044	CH4 Counter MSB	0	65535	R/W	Counter MSB and LSB combine to give a 32 bit Value.
40045	CH4 Counter LSB	0	65535	R/W	Counter with range 0 to 4294967295. Write to clear or preset.
30046	CH4 Occupation	0	100	R	Loop Occupation Time %
30051	Speed 1&2	0	65535	R	Speed calculated from loop1 & 2 (Km/hr)
30052	Speed 3&4	0	65535	R	Speed calculated from loop3 & 4 (Km/hr)
40101	RS485 Node ID	0	253	R/W	Read/Write Module ID (DEFAULT = 254)
40102	Detector Mode	0	3	R/W	Read/Write Mode
40103	Direction Logic Pulse Duration	0	65535	R/W	milliseconds
40104	Loop Spacing	0	255	R/W	Distance between leading edge of loops for speed measurement. Eg: 20 = 2.0 metres
40105	Occupancy Period	0	65535	R/W	Occupancy sample period in seconds
40121	RS485 Baud Rate	2400	11520	R/W	2400, 4800, 9600, 19200, 38400,57600,115200
40122	RS485 Parity	0	2	R/W	0 = none, 1 = even, 2 = odd
40123	RS485 Stop Bits	1	2	R/W	1 = 1 stop bit, 2 = 2 stop bits
40131	CH1 detect Sensitivity	2	255	R/W	Detector sensitivity X 0.01% DL/L
40132	CH1 undetect Sensitivity	1	255	R/W	Detector undetect sensitivity X 0.01% DL/L
40133	CH1 On Filter	10	65535	R/W	Detect Time X 0.001 seconds
40134	CH1 Extend	10	65535	R/W	UnDetect Time X 0.001 seconds
40135	CH1 Presence Time	1	65535	R/W	Presence time in seconds.
40136	CH1 Pulse Time	10	65535	R/W	Pulse duration X 0.001 seconds
40137	CH1 Mode	0	1	R/W	0 = presence, 1 = pulse
40141	CH2 detect Sensitivity	2	255	R/W	Detector sensitivity X 0.01% DL/L
40142	CH2 undetect Sensitivity	1	255	R/W	Detector undetect sensitivity X 0.01% DL/L
40143	CH2 On Filter	10	65535	R/W	Detect Time X 0.001 seconds

40144	CH2 Extend	10	65535	R/W	UnDetect Time X 0.001 seconds
40145	CH2 Presence Time	1	65535	R/W	Presence time in seconds.
40146	CH2 Pulse Time	10	65535	R/W	Pulse duration X 0.001 seconds
40147	CH2 Mode	0	1	R/W	0 = presence, 1 = pulse
40151	CH3 detect Sensitivity	2	255	R/W	Detector sensitivity X 0.01% DL/L
40152	CH3 undetect Sensitivity	1	255	R/W	Detector undetect sensitivity X 0.01% DL/L
40153	CH3 On Filter	10	65535	R/W	Detect Time X 0.001 seconds
40154	CH3 Extend	10	65535	R/W	UnDetect Time X 0.001 seconds
40155	CH3 Presence Time	1	65535	R/W	Presence time in seconds.
40156	CH3 Pulse Time	10	65535	R/W	Pulse duration X 0.001 seconds
40157	CH3 Mode	0	1	R/W	0 = presence, 1 = pulse
40161	CH4 detect Sensitivity	2	255	R/W	Detector sensitivity X 0.01% DL/L
40162	CH4 undetect Sensitivity	1	255	R/W	Detector undetect sensitivity X 0.01% DL/L
40163	CH4 On Filter	10	65535	R/W	Detect Time X 0.001 seconds
40164	CH4 Extend	10	65535	R/W	UnDetect Time X 0.001 seconds
40165	CH4 Presence Time	1	65535	R/W	Presence time in seconds.
40166	CH4 Pulse Time	10	65535	R/W	Pulse duration X 0.001 seconds
40167	CH4 Mode	0	1	R/W	0 = presence, 1 = pulse

5.2 LD470 Register Description

5.2.1 Read/Write Digital I/O as a Register (40002)

Address	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
40002	Det 4	Fault 4	Det 3	Fault 3	Det 2	Fault 2	Det 1	Fault 1

Address	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
40002	-	-	-	-	RLY 4	RLY 3	RLY 2	RLY 1

5.2.2 Read/Write Mode (40102)

MODE NUMBER	LD470 Operation Mode	Relay Operation
0	Detector Mode	Detector operates relays
1	Direction Logic	Detector operates relays
2	Detector Mode	Relays operated via Modbus
3	Direction Logic	Relays operated via Modbus

In the detector mode the LD470 works as a 4 channel detector. Each counter is connected to a detector output and counts up as a vehicle passes over the loop. If the relays are connected to the detector (mode 0) then the relay will give a presence output when a vehicle is on the loop.

In direction logic mode the LD470 uses counter 1 as an up/down counter for loops 1 and 2. Counter 2 is an up/down counter for loops 3 and 4. If the relays are connected to the detector (mode 1) then a pulse output will correspond to a vehicle going over the loop pair.

When the Relays are connected to the Modbus register (Mode 2 and Mode 3) they are switched on and off by writing to the corresponding Modbus address.

5.2.3 Read/Write RS485 Module ID (40101)

The LD470 will always respond to the default address 254. The LD470 will also respond to an address as programmed into register 40101.

5.2.4 Speed Measurement

The LD470 uses loop 1 and loop 2 as a pair for speed measurement. It also uses loop 3 and loop 4 as a second pair for speed measurement. The loops must be positioned so that the vehicle passes over loop 1 before loop 2. The speed is calculated from the distance between the leading edges of the loops, and the measured time taken for the vehicle to get from loop 1 to loop 2.

The Modbus register 40104 is used to enter the distance between the leading edges of the loops. This value is entered in 0.1 metre for example, if the leading edges of the two loops are 2.3 metres apart, then the value 23 must be entered into this register. The greater the distance between the loops, the less the error.

5.2.5 Occupancy Measurement

The occupancy is the length of time that a vehicle is over the loop. The occupancy is calculated over a sample period and is entered into Modbus register 40105. The units are seconds. A typical value would be 30, which means that the occupancy is sampled over a 30 second period. The occupancy is calculated as a % of the sample period. For example, if vehicles were over the loop for 15 seconds in a 30 second sample period, then the occupancy would be 50%.