PL424

4 CHANNEL VEHICLE LOOP DETECTOR

SYSTEM DESIGN GUIDE

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1. INTRODUCTION

The PL424 has been designed to be compatible with Procon's PROLOGIC SERIES modules.

The PROLOGIC SERIES is based around an innovative modular PLC system which provides a simple low cost solution for distributed I/O requirements where control is required.

The PROLOGIC system consists of Digital and Analog Input and Output modules which are plugged together on a DIN rail.

The first module is the CPU or interface module. This module connects the Ethernet network to the internal bus which communicates with the I/O modules. This module also provides power to the I/O modules.

The modules communicate using the high-speed built-in communications bus. A 32bit ARM CPU is used in the modules to provide high speed data processing and fast communication turnaround times.

All PROLOGIC modules plug directly onto an industry standard DIN rail. All modules have a minimum isolation of 1000VAC rms between the field and logic.

The modules have been equipped with status led's which are used to indicate the status of the Inputs or outputs. This visual indication assists with fault finding and diagnostics.

2. AN OVERVIEW OF THE PL424

The PL424 is a 4-channel din rail mounted inductive loop detector designed to operate in conjunction with Procon's PL series modules.

The PL424 can operate as a standard 4 channel detector. The detector uses loop multiplexing to prevent crosstalk between adjacent loops and is easy to set-up and install.

The built-in high-speed communications allow access to internal parameters such as loop input status, loop fault status and counters, speed, length, and occupancy.

Typical applications in the traffic environment include: traffic control (traffic lights), toll systems, vehicle counting and vehicle classification by speed and length.

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 of 1 minute to 1 hour.

- **Selectable Sensitivity using internal registers**.
  Sensitivity settings are available for each loop to allow flexibility in configuration.
  Sensitivity is set by changing the loop sensitivity registers for each loop, maximum sensitivity is achieved by setting the register value to 2 which corresponds to 0.02%. The table below lists common sensitivity settings.

(Integer_Value × 0.01% DL/L).

2	High	-	0.02%	8		-	0.08%
3		-	0.03%	16		-	0.16%
4		-	0.04%	32	Low	-	0.32%
6		-	0.06%				

- **Switch selectable Frequency**.
  Two frequency settings are available to prevent cross-talk between adjacent loops. The frequency can be changed using dip-switches 1 and 2 on the side of the module.

PROLOGIC MODULE SELECTION TABLE

MODEL	MODULE TYPE
I/O MODULES	
PL16DI	16 DIGITAL INPUT MODULE INCLUDING COUNTERS
PL16DI-110	16 DIGITAL INPUT MODULE INCLUDING COUNTERS (110VAC I/P)
PL16DI-220	16 DIGITAL INPUT MODULE INCLUDING COUNTERS (220VAC I/P)
PL16DO	16 DIGITAL OUTPUT MODULE
PL4RO	4 RELAY OUTPUT MODULE
PL8DIO	8 DIGITAL INPUT / 8 DIGITAL OUTPUT MODULE
PL12RO	12 RELAY OUTPUT MODULE
PL8AI/I	8 ANALOG INPUT 0 - 20mA / 4 - 20mA
PL8AI/V	8 ANALOG INPUT 0 - 5V / 1 - 5V / 0 - 10V / 2 - 10V
PL8AI/I ISO	8 ANALOG INPUT 0 - 20mA / 4 - 20mA / ±20mA FULLY ISOLATED
PL8AI/V ISO	8 ANALOG INPUT 0 - 1V / 0 - 10V / ±1V / ±10V FULLY ISOLATED
PL8TC	8 THERMOCOUPLE INPUT MODULE INCL. 0 - 50mV & ±100mV I/P
PL8TCISO	8 TC INPUT MODULE INCL. 0 - 50mV & ±100mV I/P FULLY ISOLATED
PL6RTD	6 RTD INPUT MODULE - PT100, Ni120, PT1000, Ni1000, Ni1000LG & Ohms
PLDAIO	2 RTD I/P, 2 ANALOG INPUT 0(4) - 20mA / 0(2) - 10V, 1 ANALOG OUTPUT 0(4) - 20mA / 0(2) - 10V, 4 DIGITAL INPUTS, 2 DIGITAL OUTPUTS
PLDAIO2	2 ANALOG INPUT 0 - 20mA / 0 - 10V, 2 ANALOG OUTPUT 0 - 20mA, 4 DIGITAL INPUTS, 4 DIGITAL OUTPUTS
PL8AO	8 ANALOG OUTPUT MODULE 0(4) – 20mA
PL8VO	8 ANALOG OUTPUT MODULE 0(2) – 10V
DETECTOR MODULES	
PL424	4 CHANNEL VEHICLE LOOP DETECTOR
CONVERTER	
PL100	Ethernet Interface
PLC CPU	
PL101	PLC CPU Module with Ethernet, RS232 and RS485

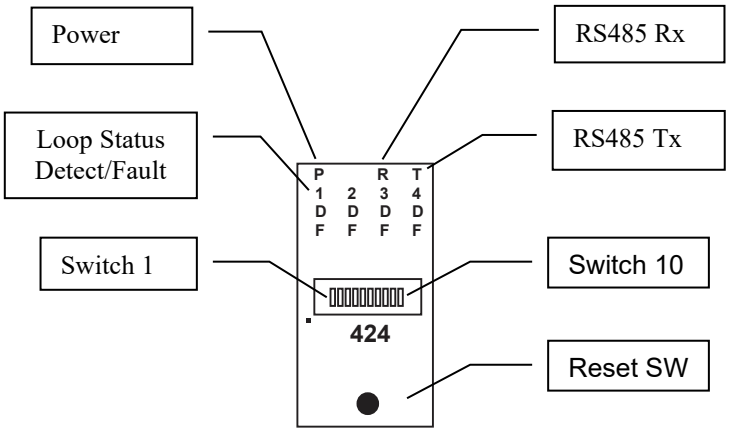
3. Technical Specifications of PL424

3.1 SPECIFICATIONS

Power Supply	Logic Supply Voltage	Supplied from PL100/PL101 Power Bus 12 – 24V dc
	Logic Supply Power	0.3VA
Loop Inputs	Number of Loop Inputs	4
	Detector Tuning Range	15 – 1500 uH
	Loop Protection	Loop isolation transformer, zener diode and Gas Arrestor protection on loop inputs
Frequency	Dip-switches on side of module	Two step adjustable (changes frequency of all loops)
Sensitivity	Set in internal registers	0.02% dL/L to 1% dL/L
Presence Time	Set in internal registers	1 minute to 1 hour
Response Time	Turn On Time Turn Off Time	Adjustable default 40ms +/- 2ms Adjustable default 40ms +/- 2ms
Drift Compensation	Environment tracking	0.1% dL/L per minute
Temperature	Operating Temperature.	-40°C to + 80°C
	Storage Temperature	-40°C to + 85°C
	Humidity	up to 95% non condensing
Dimensions	97mm X 22.6 X 97.5mm HxWxD	
Connectors	Logic Power and Comms.	32 PIN Double Sided DIN Connector
	Inputs	8 Way screw connector on front

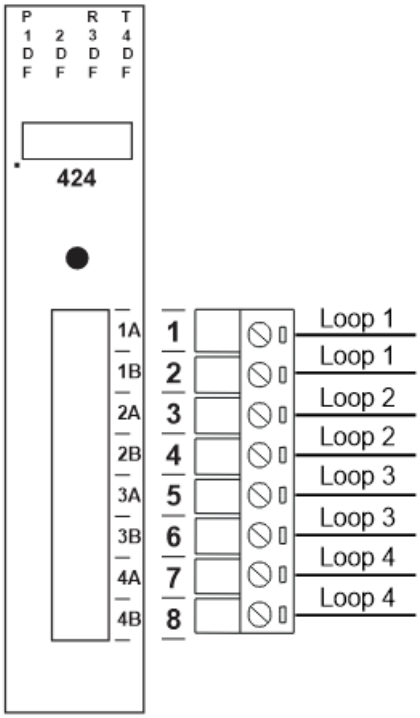
3.2 STATUS INDICATORS

Power: Flashes to indicate the CPU is running.
RS485 Rx: Flashes to indicate the unit has received a valid Modbus message.
RS485 Tx: Flashes to indicate the unit has sent a Modbus message.
Loop Status: Detect (**D**): off = no vehicle detected, on = vehicle detected
Fault (**F**): off = no loop fault, on = loop fault



4. WIRING

The following diagram shows how the loop inputs are connected to the detector.



5. COMMUNICATIONS SETTINGS

The data in the module is stored in 16 bit registers. These registers are accessed over the network using the MODBUS RTU communication protocol.

5.1 NODE ID TABLE

The following table assists with the setting up of DIP switches on the front of the module for the required NODE ID. The Default Node ID is 254 (SW 1-7 = off).

SWITCH	FUNCTION	DESCRIPTION
1	NODE ID +1	Node ID's from 0 to 127 are set up using switches 1 to 7
2	NODE ID +2	"
3	NODE ID +4	"
4	NODE ID +8	"
5	NODE ID +16	"
6	NODE ID +32	"
7	NODE ID +64	"
8	-	Not Used.
9	-	Not Used.
10	BAUD RATE	Must be ON.

5.2 MODBUS REGISTER TYPES

There are 4 types of variables which can be accessed from the module. The PL424 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)

6. PL424 Data Registers (MODULE TYPE = 125)

Modbus Address	Register Name	Low Limit	High Limit	Access	Default Setting	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 = 33
40002	Digital I/O	N/A	N/A	R/W	-	Digital Outputs in lower 8 bits. 8 - 1. Relays in upper bits. 12 - 9.
30003	Speed 1&2	0	65535	R	-	Speed calculated from loop1 & 2 (Km/hr)
30004	Speed 3&4	0	65535	R	-	Speed calculated from loop3 & 4 (Km/hr)
30005	Length 1	0	65535	R	-	Length of vehicle calculated from loop1 & 2 (metres)
30006	Length 2	0	65535	R	-	Length of vehicle calculated from loop3 & 4 (metres)
30011	Delta 1	0	65535	R	-	Change in loop1 inductance *(Integer_Value × 0.01% DL/L)*
30012	Loop Frequency 1	0	65535	R	-	Loop1 frequency (xx.xxx kHz)
40014	Counter 1	0	65535	R/W	0	Counter with range 0 to 65535
30016	Occupancy 1	0	100	R	-	Occupancy of loop 1 in %
30021	Delta 2	0	65535	R	-	Change in loop2 inductance *(Integer_Value × 0.01% DL/L)*
30022	Loop Frequency 2	0	65535	R	R	Loop2 frequency (xx.xxx kHz)
40024	Counter 2	0	65535	R/W	0	Counter with range 0 to 65535
30026	Occupancy 2	0	100	R	-	Occupancy of loop 2 in %
30031	Delta 3	0	65535	R	-	Change in loop3 inductance *(Integer_Value × 0.01% DL/L)*
30032	Loop Frequency 3	0	65535	R	-	Loop3 frequency (xx.xxx kHz)
40034	Counter 3	0	65535	R/W	0	Counter with range 0 to 65535
30036	Occupancy 3	0	100	R	-	Occupancy of loop 3 in %
30041	Delta 4	0	65535	R	-	Change in loop4 inductance *(Value × 0.01% DL/L)*
30042	Loop Frequency 4	0	65535	R	-	Loop4 frequency (xx.xxx kHz)
40044	Counter 4	0	65535	R/W	0	Counter with range 0 to 65535

Modbus Address	Register Name	Low Limit	High Limit	Access	Default Setting	Comments
30046	Occupancy 4	0	100	R	-	Occupancy of loop 4 in %
30100	DIP Switch	0	127	R	-	Module 10-way DIP switch settings in binary
40102	Mode	0	2	R/W	0	
40103	DirLogic Pulse Time	0	65535	R/W	R/W	Direction Logic Pulse Time *(Integer_Value × 10 milli seconds)*
40104	Loop Spacing	0	255	R/W	20	Distance between leading edge of loops for speed measurement *(Integer_Value × 0.1 metres)*
40105	Loop Width	0	255	R/W	10	Distance between leading edge to trailing edge of loop for length calc. *(Integer_Value × 0.1 metres)*
40121	Baud Rate	1	57600	R/W	1	Communication Baud Rate (Default = 1)
40122	Parity	0	2	R/W	0	Parity: 0=none, 1=even, 2=odd
40123	Stop Bit	1	2	R/W	1	Stop bit: 1=1 stop bit, 2=2 stop bits
40131	Sensitivity 1	2	65535	R/W	3	Detect sensitivity 1 *(Integer_Value × 0.01% DL/L)*
40132	UnDet Sens 1	1	65534	R/W	2	Un-Detect Sensitivity 1 *(Integer_Value × 0.01% DL/L)*
40133	Filter 1	0	65535	R/W	16	Filter 1 *(Integer_Value × 2 milli seconds)*
40134	Extend 1	0	65535	R/W	8	Extend 1 *(Integer_Value × 2 milli seconds)*
40135	Pres Time 1	0	65535	R/W	1	Presence time 1 *(Integer_Value × 1 minute)*
40136	Pulse Time 1	0	65535	R/W	R/W	Pulse time 1 *(Integer_Value × 1 milli seconds)*
40137	Mode 1	0	1	R/W	R/W	Presence/Pulse: 1=Puls, 0=Pres
40141	Sensitivity 2	2	65535	R/W	3	Detect sensitivity 2 *(Integer_Value × 0.01% DL/L)*
40142	UnDet Sens 2	1	65534	R/W	2	Un-Detect Sensitivity 2 *(Integer_Value × 0.01% DL/L)*
40143	Filter 2	0	65535	R/W	16	Filter 2 *(Integer_Value × 2 milli seconds)*
40144	Extend 2	0	65535	R/W	8	Extend 2 *(Integer_Value × 2 milli seconds)*
40145	Pres Time 2	0	65535	R/W	1	Presence time 2 *(Integer_Value × 1 minute)*
40146	Pulse Time 2	0	65535	R/W	R/W	Pulse time 2 *(Integer_Value × 1 milli seconds)*
40147	Mode 2	0	1	R/W	R/W	Presence/Pulse: 1=Puls, 0=Pres
40151	Sensitivity 3	2	65535	R/W	3	Detect sensitivity 3 *(Integer_Value × 0.01% DL/L)*
40152	UnDet Sens 3	1	65534	R/W	2	Un-Detect Sensitivity 3 *(Integer_Value × 0.01% DL/L)*
40153	Filter 3	0	65535	R/W	16	Filter 3 *(Integer_Value × 2 milli seconds)*
40154	Extend 3	0	65535	R/W	8	Extend 3 *(Integer_Value × 2 milli seconds)*
40155	Pres Time 3	0	65535	R/W	1	Presence time 3 *(Integer_Value × 1 minute)*
40156	Pulse Time 3	0	65535	R/W	R/W	Pulse time 3 *(Integer_Value × 1 milli seconds)*
40157	Mode 3	0	1	R/W	R/W	Presence/Pulse: 1=Puls, 0=Pres
40161	Sensitivity 4	2	65535	R/W	3	Detect sensitivity 4 *(Integer_Value × 0.01% DL/L)*
40162	UnDet Sens 4	1	65534	R/W	2	Un-Detect Sensitivity 4 *(Integer_Value × 0.01% DL/L)*
40163	Filter 4	0	65535	R/W	16	Filter 4 *(Integer_Value × 2 milli seconds)*
40164	Extend 4	0	65535	R/W	8	Extend 4 *(Integer_Value × 2 milli seconds)*
40165	Pres Time 4	0	65535	R/W	1	Presence time 4 *(Integer_Value × 1 minute)*
40166	Pulse Time 4	0	65535	R/W	R/W	Pulse time 4 *(Integer_Value × 1 milli seconds)*
40167	Mode 4	0	1	R/W	R/W	Presence/Pulse: 1=Puls, 0=Pres

Note: Registers in Light Grey not implemented in this application.

6.1 Speed Measurement

The PL424 uses loops 1-2 as a pair for the first speed measurement and loops 3-4 as a second pair for the second 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 metres for example, if the leading edges of the two loops are 2.0 metres apart, then the value 20 must be entered into this register. The further the distance between the loops, the less the error.

6.2 Length Measurement

The length is calculated by measuring the length of time from the vehicle entering the loop to the vehicle exiting the loop. This requires the loop width to be entered into Modbus register 40105. The units are x 0.1m. A typical value would be 10 which means that the loop is 1.0m wide.

7. 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 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.