FVD-L

Magnetoresistive Vehicle Detection Sensor

Features

- **Magnetoresistive sensor PNP+NPN (bipolar)**
- **3-dimensional presence detection for vehicles and large ferrous objects**
- **Substitutes inductive loops and other vehicle detection systems**
- **No need for potentiometer nor external controller**
- **Easy to install and mount in pavement, cement, cobbles, etc.**
- **2 LED indicators: status (green) output (red/yellow)**
- **Protection degree IP-69K; NEMA 6P**
- **Protected against short-circuit**
- **Compact design and reduced dimensions: 77 x 19 x 7.5 mm**

Operation principle

The FVD-L sensor uses a passive sensing technology to detect large ferrous objects. The sensor measures the change in the Earth's natural magnetic field (ambient magnetic field) caused by the introduction of a ferromagnetic object. The FVD-L sensor provides a direct replacement for inductive loop systems, and needs no external frequency box. For best performance, mount the sensor below-grade, in the center of the traffic lane, but it also may be mounted above-ground.

Theory of Operation
The sensor uses three mutually perpendicular magnetoresistive transducers. Each transducer detects magnetic field changes along one axis. By incorporating three sensing elements, maximum sensor sensitivity is achieved.

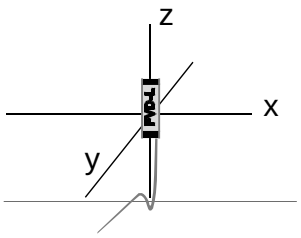
A ferrous object will alter the local (ambient) magnetic field surrounding the object. The magnitude of this magnetic field change is dependent both on the object (its size, shape, orientation, and composition) and on the ambient magnetic field (its strength and orientation).

During a simple programming procedure, the sensor measures the ambient magnetic field. When a large ferrous object (for example, a truck, automobile, or rail car) alters that magnetic field, the sensor detects the magnetic field changes (anomalies). When the degree of magnetic field change reaches the sensor's threshold, the sensor's discrete outputs switch.

Sensor Field of View and Range
The sensor range depends on three variables:
1. The local magnetic environment (including nearby ferrous material)
2. The magnetic properties of the object to be sensed
3. Sensor settings.

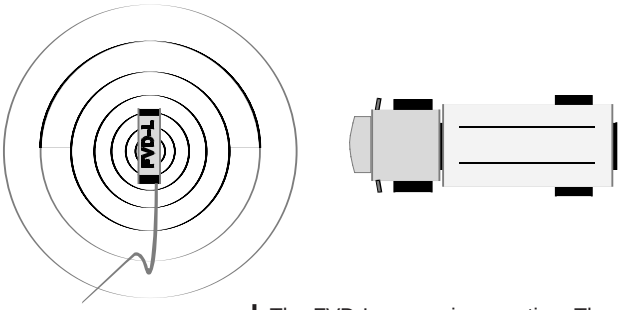
The FVD-L can detect changes in the ambient magnetic field in all directions. As with other sensors, the range will depend on the target. The strong disturbance of a large ferrous object decreases as distance from the sensor increases, and the magnitude and shape of the disturbance is dependent on the object's shape and content.

The sensor can be programmed to react to magnetic field disturbances of greater or lesser intensity, using two adjustments: background condition and sensitivity level. Once background condition and sensitivity level are set, and both settings are stored in non-volatile memory, the sensor is ready to detect the target object.



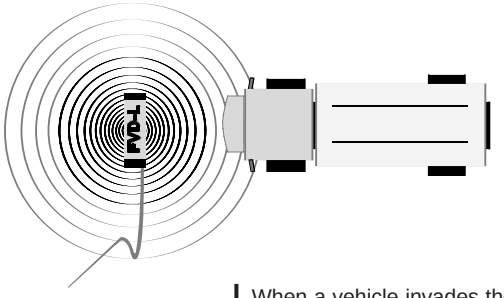
3-dimensional detection

The FVD-L sensor detects changes in the magnetic properties of the environment along three axis X, Y, Z



Signal OFF

The FVD-L sensor is operating. There is no vehicle within its detection area, thus the magnetic properties of the environment remain unaltered and the output is OFF



Signal ON

When a vehicle invades the detection area of the sensor, it modifies the magnetic field properties around the sensor. If this modification reaches the sensitivity threshold, the sensor's output triggers

Figure 1. Operating principle overview

Below-Grade installation

Optimally, the FVD-L should be mounted in the center of the traffic line. The axles of the vehicles provide the most effective and most repeatable magnetic field changes. When replacing an inductive loop, the geometric center of the failed loop is typically a good location for mounting.

For applications at the “side” of the traffic line, consideration must be made for movement of metallic objects within a short distance of the sensor on the side opposite the traffic line, even if the activity is not visible.

The FVD-L sensor’s narrow housing allows it to be mounted in pavement, within a single saw cut 1cm wide. Once the sensor is placed, remove the loose particles from the gap and fill it with rubber (but not too hot), or pavement sealant. Do not fill the saw cut with heated asphalt. Work the sealant around the sensor and cable with a thin object, to eliminate any trapped gaps. The cable is a special one that will resists to any kind of cover material (hot or cold). Ideal depth is 10 cm.

To remove the FVD-L, simply pull the sensor cable straight up, from the control cabinet end. This will pull the cable, the cured sealant and the sensor from the saw cut.

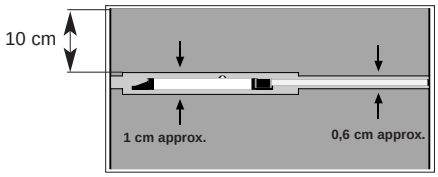


Figure 2. Sensor placed in a saw cut in pavement

Above-Grade installation

NOTE: For optimal performance in detecting vehicles, mount the FVD-L below-grade, in the center of the traffic lane. In applications where the sensor must be mounted to the side of the vehicle traffic lane (e.g., in a kiosk, menu board or gate control box), make sure that no other moving metal objects can affect the FVD-L sensor.

The FVD-L is a “non-directional” detector; the sensor can be mounted in any position without affecting its sensing properties. Select a location as close as possible to the vehicle(s) to be detected. Using the end cap mounting holes, mount to any desired surface (e.g. cement or metal).

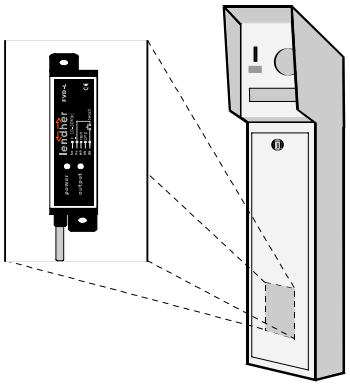


Figure 3. Example of installation above-ground

Sensitivity Level and sensitivity gain factor

The FVD-L has 6 levels of sensitivity (level 1 being the less sensitive and level 6 the most sensitive). The sensitivity variation from one level to the next is determined by a Gain Factor Multiplier set by default. The ratio of sensitivity gain along the sensitivity scale is described in the table below.

The absolute sensitivity of the sensor is dependent on local magnetic environment, magnetic properties of the object to be sensed and the sensor settings. Therefore, there are a great amount of programming possibilities to refine the detection properties of the sensor. Consult SAM Automation for further information. By default the sensor is set to detection level 5. This means that the sensitivity gain at a given distance is twice as large as for a level 3 sensitivity. The graphics below illustrate the behaviour of the sensitivity for two different levels whether the FVD-L sensor is placed on the side of the car or buried below-grade.

Note that the sensitivity gain is not homogenous as the vehicle approaches or goes passed the sensor, particularly when the sensor is placed below the traffic lane. This is due to the fact that the vehicle itself is not an homogenous metal body; there are parts like the engine -normally placed on the front of the vehicle- or the axles that have a greater impact on the magnetic field around the sensor.

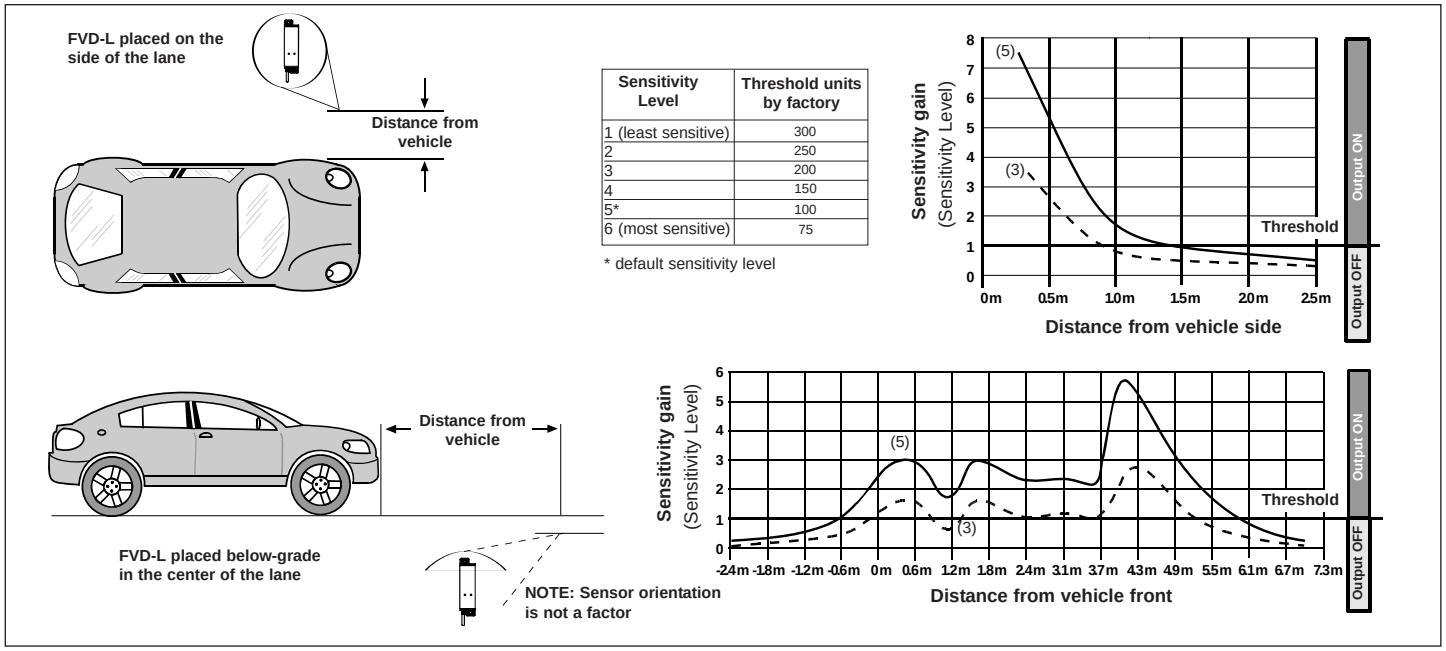


Figure 4. Operating principle overview

Sensor configuration

The sensor is configured via its grey Remote wire. The grey wire is always active and the sensor may be re-taught at any time. For optimum performance, fixture the sensor so that it will not move either during or following configuration. Programming pulses may be executed by connecting the sensor's grey wire to sensor's common (blue wire) with a normally open mechanical button connected between them, or as a low (< 2V dc) signal from a programmable logic controller (PLC). When a PLC is used for configuration, the pulses are acknowledged via the sensor output signal. The sensor has 6 levels of sensitivity, being level 1 the less sensitive and level 6 the most sensitive (the sensitivity level set by default is 5). Once the sensor has been taught, it will keep the configuration settings, even if there is a power cut.

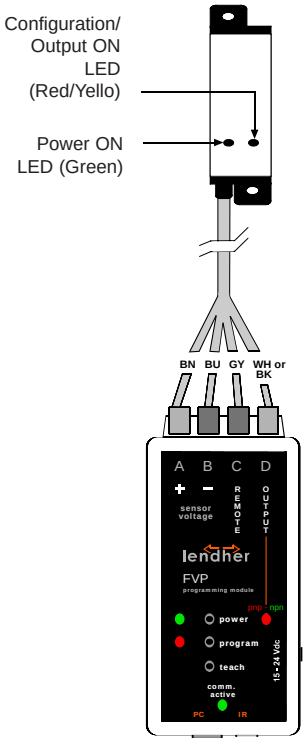


Figure 5. Programming connections using FVP portable module

Set Background Condition (No Vehicle Present)

	Configuration	Result
Set Background	- Remove all temporary metal objects from the sensing area. - Single-pulse the remote wire. 	- Sensor learns background. - Output LED flashes approx. 12 times, while background is taught. - Sensor returns to RUN mode.

Set Sensitivity Level (level 1 least sensitive, level 6 most sensitive)

	Configuration	Result
Access Sensitivity Mode	- Double-pulse the remote wire. 	- Output LED flashes 1 to 6 times every 2 seconds to indicate sensitivity level (e.g., twice indicates level 2). - When FVP is used: Sensor always begins at level 1.
Adjust Sesitivity	- To increase the sensitivity in increments, single-pulse the remote wire again; continue until desired sensitivity level is reached. 	- Output LED flashes 1 to 6 times every 2 seconds to indicate sensitivity level (e.g., twice indicates level 2).
	- Double-pulse the remote wire to save setting. 	- Sensor returns to RUN mode.
Test Operation	- Drive a vehicle past/over the sensor to trip the output. (Use a small/lightweight vehicle to ensure larger vehicles will be detected later.)	- Verify Output LED comes ON as expected.
	- Adjust the sensitivity as needed.	
Prepare for Operation	- Disconnect FVP or ther temporary switch used for configuration and connect sensor to permanent power supply / output device	

The grey wire must be put to ground when it is not connected to the Programmer, not to make antenna effect.

FVP Portable Programming Box

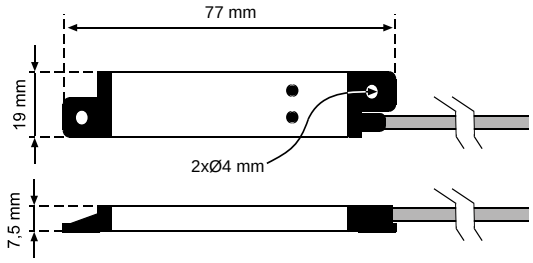
The FVP module is a valuable accessory for easily programming the FVD-L sensor. This tool is specifically designed for programming the FVD-L sensor whether it is installed above or underground. The FVP produces the signal given by the sensor at every moment through its LED indicators and allows to send pulses to the sensor for the setting procedure, when needed.

When the FVP is used, the pulses are accomplished by clicking the "teach" push button. Sensor output status is reflected by the FVP Output indicator LED. For optimum performance, fixture the sensor so that it will not move either during or following configuration. It is important to remark that this tool is not mandatory for using the sensor.

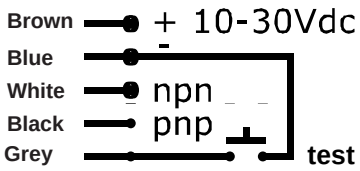
Technical Specifications

Type of detection	Passive 3-axis magnetoresistive transducer
Detection range	Adjustable range by configuration (See figure 4)
Supply voltage	10 to 30 Vdc
Output configuration	Two SPST solid-state outputs conduct when object is sensed; one NPN (current sinking) and one PNP (current sourcing)
Output current	100 mA
Output protection	Short-circuit
Output ratings	10 mA maximum (each outut) NPN saturation: <200 mV @ 10mA and <600 mV @ 100 mA; OFF-state leakage current: < 200 microamps PNP saturation: <1,2V @ 10 mA and <1,6V @ 100 mA; OFF-state leakage current: < 5 microamps
Supply protection	Reverse polarity and transient voltages
Operating conditions	-40º C to +70ºC; 100% Max. rel. humidity
Response time	20 milliseconds
Delay at Power-Up	0,5 seconds
Temperature effect	< 0,5 milligauss/ºC
Indication	2 LED: green (power), red/yellow (configuration/output)
Remote TEACH input	Impedance 12K ohms
Connections	Shielded 5-conductor polyethylene jacketed attached cable
Environmental protection	IP-69K (NEMA 6P)
Construction	Housing: anodized aluminium, End caps: PVC

Dimensions



Connections



Available types

Model	Cable length	Cable type	Supply voltage	Output type	Range
FVD-L **FVD-L-5** **FVD-L-9** **FVD-L-15** **FVD-L-30**	2 m 5 m 9 m 15 m 30 m	5-wire shielded cable with 4mm diameter polyethylene jacket	10 to 30V dc	Bipolar NPN/PNP	Range varies, depending on application and target being sensed

Accessories

FVP	Handheld portable programming box, used for configuring sensor. Battery-powered.	
FVC	Interface cable for RS-232 port on PC	