Warning systems for dangerous road sections

"COPS@road® and COPS@rail®"
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COPS systems d.o.o.
Slovenja vas 65g
2288 Hajdina
Slovenia

T: +386 31 366 169
E: info@cops-systems.com
I: www.cops-systems.com

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1. General description

COPS@road is a modular active warning system consisting of a large number of units which, using illuminated traffic signs with variable content, improves the safety of dangerous and low-visibility road sections, such as intersections, sharp bends, tunnels, etc. Using a multitude of detectors, the system identifies the presence or proximity of a dangerous situation and alerts the traffic participants to the potential danger of collision using light signals.

Individual COPS@road system units communicate with each other via RF connection, which enables efficient modular configuration of the system according to the needs of a specific traffic segment.

The COPS@road system is connected to the control server via the embedded GSM/GPRS modem, to which it provides information on the status of individual components, the operation of the entire safety system, and traffic statistics (traffic density, vehicle speed, etc.).

Power supply from solar energy ensures easy installation with low investment costs.

2. Components of the COPS@road system

The COPS@road system consists of various units in the form of traffic signs with variable content, independent or in combination with highly reflective boards, and remote detection units. Some typical products are shown in figure 1.

The most common version of the COPS@road unit is in the form of a contrast panel with a permanent traffic sign and a built-in module with yellow flashers (design with the KTC marking in Figure 1) or with a variable light sign (ADT). Some examples of this kind of modules are shown in Figure 2.
The installed module consists of detection, communication, power supply components and light display. An example of a KTC unit with a built-in blinkers module with external elements is shown in Figure 3.

With the installation of any permanent traffic sign, both KTC and ADT units are suitable for most traffic locations, as presented in different cases in Chapter 3. For some specific traffic situations, additional units are available, such as CSD-11 (general warning sign - a triangle with an exclamation point with added yellow blinkers), DMC (remote detector or repeater unit) and PHC (your speed sign). These units are described in more detail below.

**CSD-11**
The illuminated general warning sign in the shape of a triangle with an exclamation point (1101 or I-25) is suitable for traffic locations where additional warning is needed. In all cases, a supplementary sign is added to the CSD-11 unit, explaining the type of danger.
The CSD-11 unit display is adapted for two-stage operation with yellow blinkers. This means that in the presence of real danger (which is detected by COPS@road on the basis of the event detection) indicated on the supplementary board, the triangle with an exclamation point begins to blink, otherwise the participant will be alerted about approaching the potentially dangerous traffic location only via yellow blinkers.

**DMC**

The remote detector unit is useful in various cases:
- for remote detection of traffic participants on the road and other traffic routes
- for remote detection of various stationary and moving objects (flooded road, wildlife on fixed paths approaching the road, etc.)
- as a repeater unit for increasing the RF signal reach between remote units of the COPS@road system
- as an camera radar unit. In this implementation, the DMC unit is equipped with a camera which stores the photos on a remote server and informs the operator of the events by e-mail.

**PHC**

The PHC unit is basically a speed indicator that can be used within COPS@road, i.e. in conjunction with other units, or as an independent unit for slowing traffic and recording traffic statistics. The unit is fully compliant with the latest DRSI directives for speed warning displays (colour combinations based on measured speed, maximum speed limit, etc.).

The PHC unit is available in two versions; basic with a speed monitor, and a larger version with a built-in traffic sign indicating a speed limit (the PHC unit in Figure 1).

In all presented units, the surface of the light displays is treated with a special technology process and is coated with materials with extremely low reflectivity (with an absorption coefficient about 0.98), thus providing extremely high contrast and good visibility of the light signals in different environments.
weather conditions and surface illuminations. Adequate visibility is also provided by the active adjustment of the intensity of the light signals, which adjusts the intensity of the light emitted in a continuous way in relation to the external illumination.

3. Examples of traffic sections

The choice of COPS@road unit, the location of the installation and the mode of operation all depend on the specific needs and requirements of the traffic segment in question. The following describes some typical layouts and operating modes.

**Crossroads**

An example of a vehicle approaching the crossroads on a priority road:

*Figure 6: Operation of the COPS@road system when a vehicle is approaching the crossroads on a priority road*

Example of simultaneous approach of vehicles on priority and side roads:
The operation of COPS@road described above has the effect of increasing traffic safety at two levels; it reduces the possibility of collision from the side road, and slows down the speed of vehicles on the priority road. Reducing the speed of traffic on the priority road is also carried out in two ways - by signalling the merging of vehicles from the side road and by warning drivers of speeding, even when there are no vehicles on the side road.

In this way, all participants are alerted to the potential danger of collision, which, even in the event of any failure to comply with the traffic regulations of some participants, shortens the reaction time of the other participants due to increased attention.

The described functionality of the COPS@road system is particularly effective in the case of a limited field of view between traffic participants.

**Various low-visibility road sections**

Figure 8 shows some additional examples of the installation of the COPS@road system to display warnings of potentially dangerous proximity of traffic participants in low-visibility road sections.

An unlimited number of units can be connected to the COPS@road system. Objects such as buildings, trees, etc., in most cases do not interfere with communication between units. In extreme cases, where there are large objects connected over greater distances, an additional repeater unit is included in the system, which provides the transmission of signals around the barrier or for overcoming signals over long distances. The maximum distance in the open field of view between two units is 1000 m in line-of-sight conditions.
Figure 8: Examples of fitting different low-visibility sections with COPS@road systems
3.1. COPS@rail

This is a special version of the COPS@road system, which is used for unsecured level crossings (railway crossings secured by the St. Andrew's cross). The COPS@rail system basically includes two KTC units.

Different versions of the COPS@Rail

An example of equipping an unsecured level crossing with the COPS@rail system just before the crossing

The customized COPS@rail system uses a one-stage warning method, with the alert being activated when the traffic participant approaches the level crossing regardless of the presence of train, warning the participant to proceed with caution when approaching a dangerous traffic section.

The program algorithm of the COPS@rail system determines whether the participant is adjusting the speed while approaching the level crossing, and in case of not detecting a slowdown, the flashing frequency is increased, which adds to the warning about the approaching dangerous site.
4. Diagnostics, control and management of COPS@road

During the installation of the COPS@road system, a parameter set-up (detector sensitivity, speed measurement range of vehicles, etc.) is remotely performed on a PC via the "COPS Control Manager" user interface, depending on the specifics of each segment. At the same time, the "COPS Control Manager" environment performs state diagnostics and controls the functionality of the individual components and the entire system.

![Figure 9: The "COPS Control Manager" User Interface](image)

Further control of the operation, management and acquisition of traffic statistics is carried out through the "COPS Control Server" server control system, which communicates with all individual subscriber or manager COPS@road systems via GSM/GPRS connection.

The COPS@road system records the following parameters, sent periodically at 60-minute intervals to the central control system:

- accuracy of the operation of the detectors
- status of the power supply system and the battery
- the operation of individual lighting elements of the display
- physical state of system components (change in position, damage, removal, etc.)
- road section statistics (traffic density, vehicle speed, speed reduction after switching on warning signals, number of potentially dangerous situations, etc.)

On the other side, the "COPS Control Server" server control system captures and archives the sent data and informs control personnel about critical events via SMS and e-mail.

The client can access traffic data via the web interface (example in Figure 10).
5. Implementation

It is possible to connect the system to an independent power supply, to solar power or to the electricity network, if it is nearby. In both cases, the system is equipped with a battery that ensures system operation in the event of a failure of the primary power source. No major construction work is required; it is necessary to provide only the supporting pillar of the appropriate diameter (depending on the size and weight of the unit), which can be installed by the client or the contractor. In the event of the installation of COPS@road units on an existing structure (above the existing traffic sign, on street lighting, etc.), no additional work is required by the client. All additional load-bearing construction (extension bars, etc.) is provided by the contractor.

Field work is estimated at one business days (depending on the complexity of the system and weather conditions), which includes installation and commissioning of the system and testing. Further intensive control of the operation is carried out for a further 7 days, which takes place both remotely and with an overview of the operation of the system on site.

After installation, the company will carry out a presentation of the operation of the system to the responsible persons in the field of traffic.
Annex A - Frequently asked questions

1. *Is the COPS@road system suitable for vehicle counting and classification?*
   The COPS@road system is optimized for detecting traffic participants and warning about the potential danger of a collision and speeding. The standard equipment of the COPS@road system enables the recording of an estimated traffic density in an accuracy class of 20%. The system also does not provide reliable identification of the type of vehicle (cars, trucks, etc.). For additional counting and classification purposes, the COPS@road system can be equipped with the appropriate detectors, and for other general purposes, the company offers other dedicated solutions.

2. *How effective is the solar power supply system?*
   The solar power supply system is designed for completely autonomous operation. The efficiency of charging the built-in battery depends on exposure to sunlight at the selected location and on ambient temperature, which requires making the necessary measurements and adjusting the power and surface of the solar panel when installing the COPS@road warning system. After the installation, the state of the solar power system is intensively monitored for a certain period of time, so that additional optimization can be carried out if necessary. The monitoring of the state of the solar power system and the energy balance is then carried out by collecting measured data in a central control system that captures the data of individual systems via GSM/GPRS connection.

3. *How reliable is the COPS@road system?*
   The COPS@road system is not a traffic light substitution, and in no case does it authorize passage to traffic participants or otherwise affect the applicable traffic rules. For example, at an intersection where a "STOP" sign is set, the participant must stop regardless of the light signalization on the display. Therefore, the drivers themselves must ensure their own safe entry into traffic.

4. *Is traffic safety jeopardized in the event of a failure of the operation of the warning system?*
   In case of failure of the critical components, the COPS@road unit automatically communicates the resulting state to the central control system via GPS/GPRS connection, and enters the sleep mode without giving any traffic signals to traffic participants. In this way, the possible incorrect operation of the display and thus potential misleading of traffic participants is avoided.

5. *What about the sensitivity of the system to damage due to weather events (hail, lightning), vandalism etc.?*
   Protection against meteor rainfall is provided by the IP66-standard casing from high-quality materials. Only the solar panel is more exposed. Surge protection protects the system against atmospheric discharges to some extent, but complete protection in the real environment cannot be guaranteed. For this purpose, insurance is provided to cover material damage, which also applies to the case of theft and damage caused by vandalism, etc.
   With automatic diagnostics of the system and components, which also includes the detection of mechanical movement of devices and communication between the individual COPS@road unit and the central control system, it is ensured that timely information about the situation is given to the control personnel.

6. *Does the COPS@rail system alert drivers of an approaching train?*
   In order to comply with current legislation on the Slovenian market, the COPS@rail system is only available in an adapted one-stage version, where only road participants are detected. COPS@rail thus performs the task of alerting traffic participants of approaching a level crossing and, on the basis of measuring the speed of vehicles, gives further warnings in case of speeding.
Annex B - Expert and user opinions

"The COPS@road system can help reduce traffic accidents that result from reckless driving. Due to the latter, 32 people died on Slovenian roads in the last two years. Many traffic accidents also happen because of a lack of concentration, which could surely be prevented by such a system as it alerts drivers to a potential danger. I fully support this innovation."

**mag. Ivan Kapun, Head of the Traffic Police Department**

"Not only for dangerous sections, the COPS@road system is a welcome addition to any unsecured railway crossing. It also costs much less than if the crossing were handled by signalling and gates." **mag. Elvis A. Herbaj, Head of Traffic Department PU Celje**

"I do not recall any accidents happening in the last year at the crossroads where we set up the COPS@road system. Previously, this crossing was critical. We are satisfied with the installation of the system, so I would definitely recommend it to others."

**Bojan Kirbiš, Mayor of the Municipality of Starše**

"I am convinced that the device can help increase security in low-visibility sections. Low-visibility points are often black spots, and this device offers the possibility of reducing the number of these spots."

**Brane Legan, AMZS, safe driving instructor**

"On behalf of the Sector for Public Transport, and in my personal opinion, COPS@road has contributed greatly to improving road safety. We can say that the measure has improved safety by 100%, as no traffic accidents have been recorded in the last year. Before, accidents happened here at least every two months."

**Denis Kocbek, Communal and Transport Sector, Municipality of Maribor**

"I am pleased to say that since the COPS@road system has been set up, I do not recall any accidents happening, and I hope it says that way. The situation had been getting critical before, and we were constantly worried since our house is just beside this road and underpass. The townspeople are very impressed, and the drivers' culture has improved - their driving became much slower and more cautious, and there is also a notable improvement in traffic fluidity."

**Ivanka Kozlevčar, a local woman living near the underpass where the COPS@road system is located, municipality of Trebnje**

The COPS@road system in the municipality of Ribnica at the new kindergarten has been operational for one year. The traffic participants accepted the system. The townspeople we talked to had a positive opinion of the installed system and there was no negative response. The system works flawlessly at all times and we are pleased with it."

**Ladislav Mate, security, rescue and traffic management consultant, Municipality of Ribnica**

"We can confirm that no traffic accidents were recorded at the intersection of Westrova and Šegova in the year after the installation, in the effective or immediate vicinity of the COPS@road warning system. We hope it remains so in the future."

**Marko Škedelj, Assistant Commander of the Novo mesto Police Station**