CLEARSY

Safety Solutions Designer

KPVA

INDEPENDENT SYSTEM CONTROL OF SPEED TRAIN; INSTALLED IN MANY LINES IN PARIS

TECHNICAL DATA CLEARSY

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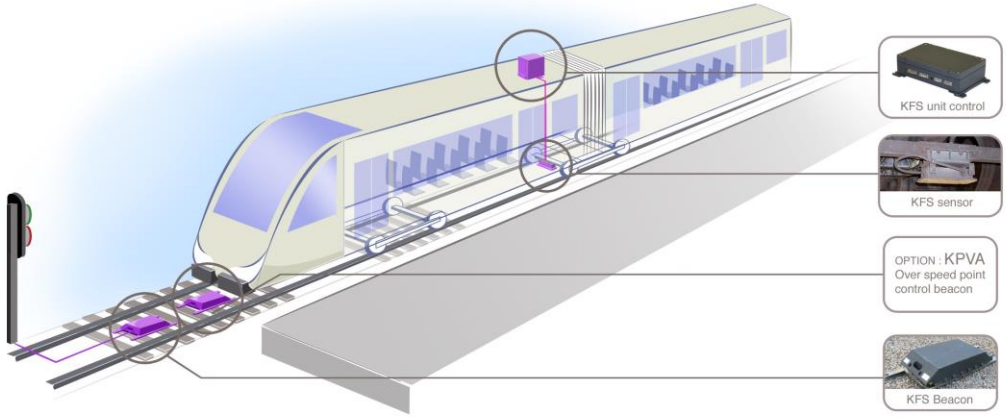
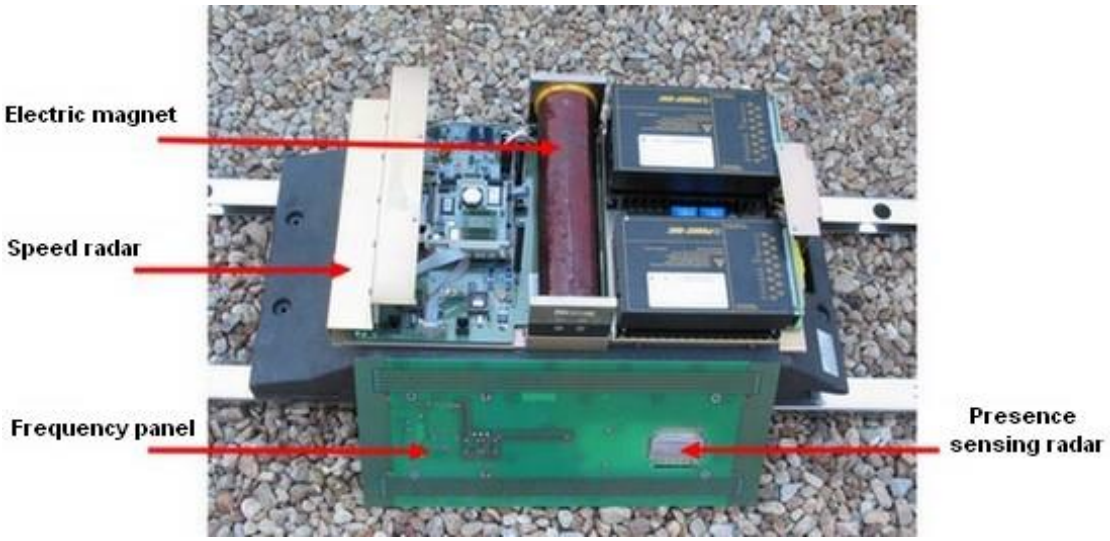
Client : *RATP*
Lines : *many lines in Paris*
Number of item : *300*
Year Implemented : *2004*

FRANCE

KPVA

The RATP has equipped all of its subway lines with a point control (K) independent speed system further to the derailing in 2000 of a subway train at the Notre Dame de Lorette station. There are currently 300 KPVA track antennas in service on the Paris subway system in certain zones considered critical. The KPVA is an system that is integrated into a track antenna installed on the track and that measures the train's speed with a DOPPLER radar and stops it if it exceeds the speed allowed with an onboard RPS system. KPVA advantages include its speedy operations, low cost and significant reliability.
The KPVA track antenna is protected by an RATP patent.





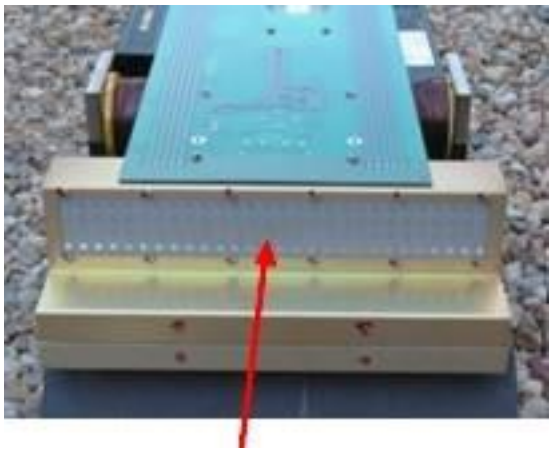
■ ***The KPVA on its base***

SPEED MEASUREMENT RADAR

When a radar points at a moving target, the frequency of the reflected wave is out of phase with the emission. This difference (Doppler shift) depends on the speed of the target. This Doppler shift also depends on the direction in which the target is moving in relation to the radar beam.
A radar is composed of the following items:

- A microwave part, a transmitter and a receiver,
- Signal treatment to measure the Doppler shift and thereby estimate the speed of the target's movement.

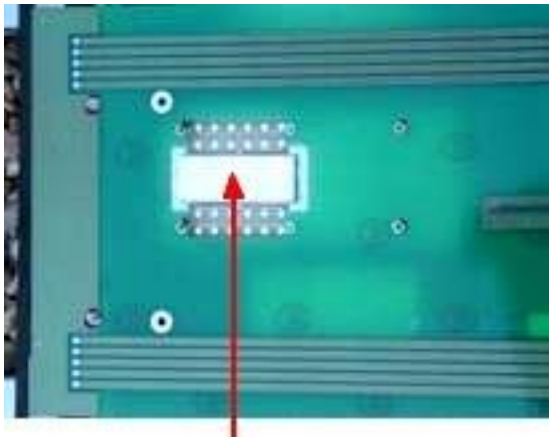
The speed measurement radar integrated into the KPVA installed on the track targets the front of the train,and detects and measures the speed of the train arriving on the relevant track.
The measurement is taken rapidly and requires less than 10 m of movement over the track.
The radar's scope can be adjusted from 0 m to approximately 25 m.
The radar must not detect trains on neighboring tracks, whether they are coming or going.
The radar complies with all the requirements of equipment installed on tracks, in particular the RATP radio frequency plan.



■ ***Speed Radar***

PRESENCE SENSING RADAR

The presence sensing radar targets upwards and detects the passing of the train above a sensor by detecting the movement of the ground crossed under the train: pipes and axles are easy to detect. It is based on a 24 GHz Doppler sensor. The variation in the power of the signal is therefore used to detect the object.

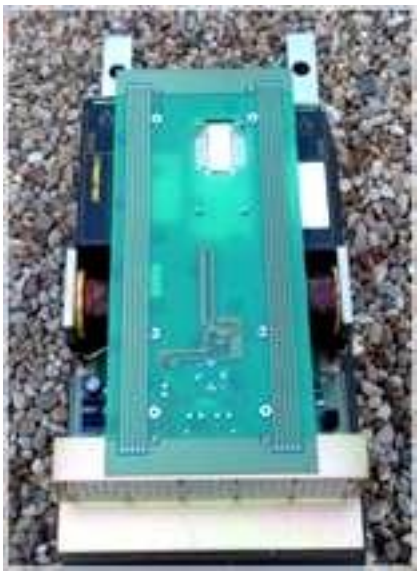


■ ***Presence sensing radar***

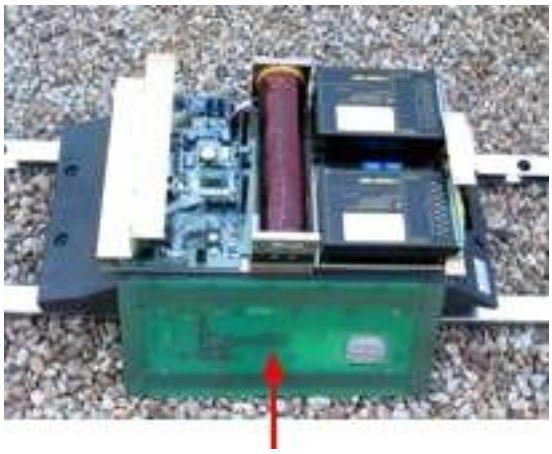
KPVA OPERATIONS

The objective of the KPVA track antenna is to ensure control in the case of an overspeed of railway rolling stock that is manually driven.
In an overspeed scenario, it must emit a magnetic field for the onboard sensor (KFS or RPS) on trains, which commands the emergency braking of the AeAu system. The KPVA is composed of two treatment chains:

- An initial chain that measures the train's speed, compares it with a system setting programmed beforehand, and transmits the fields and frequencies in the case of a potential overspeed situation
- A secondary chain that remedies a defect in the principal chain. Overspeed is no longer a measured speed, but one that is calculated and represents the train's travel time over the KPVA track antenna located between the front of the train and the onboard AeAu system sensor.



■ ***General inside view***

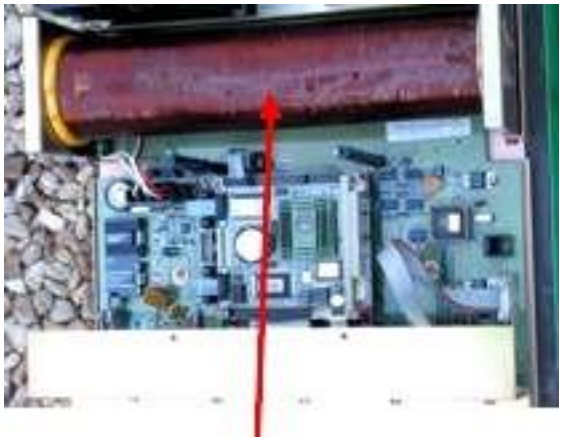


■ ***Inside view with the patented frequency frame (green plate)***

THE PRINCIPAL CHAIN

A 24 GHz Doppler effect microwave radar detects the train and measures its speed. After comparing the speed with the programmed setting, an electromagnet is fed and an F1 frequency is generated.
If the speed radar does not detect overspeed:

- The electro-magnet is activated and emits a magnetic field.
- The frequency frame emits an F1 frequency.
- The onboard KFS sensor receives the signals which, if they are transmitted together, indicate that train passage is authorized.



■ ***Electromagnet***

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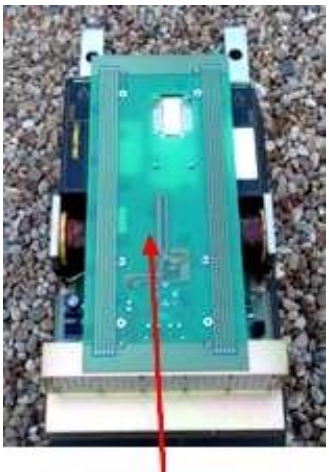
If the speed radar detects overspeed:

- The electromagnet is activated and emits a magnetic field.
- The frequency frame does not emit a frequency.
- The onboard KFS sensor receives this signal which, if it is emitted alone, indicates that train passage is not authorized.



■ ***Frequency frame (green plate)***

THE SECONDARY CHAIN

Overspeed is not a measured speed, but a calculated speed; it represents the train's travel time over the KPVA track antenna located between the front of the train and the onboard AUAE system sensor.
The speed setting is timed and is adjustable.
When the front of the train is detected by the presence radar, the electromagnet is activated and maintained for the time corresponding to the speed setting.
If the electromagnet is still active when the onboard system sensor travels over the track antenna, the train is running in excess of the setting's speed, creating an overspeed situation.
An electromagnetic field emitted by the KPVA is detected by the onboard sensor that stops the train.
If the electromagnet is no longer active when the onboard system travels over the track antenna, the train's speed is inferior to the speed setting.
The KPVA does not generate a field, and train passage is therefore authorized.

GENERAL OPERATIONS

Once the KPVA is activated, the two chains are enabled.
The principal chain is preponderant when the KPVA works normally.
Should an anomaly occur on the principal chain, the secondary chain becomes the principal chain, and the KPVA notifies this anomaly and works in fail-soft mode.
Should an anomaly occur on the secondary chain, the principal chain is preponderant, however the KPVA notifies this anomaly and works in fail-soft mode.
One can dialogue with the KPVA and configure its parameters with an RS422 link.
In addition to the main function of stopping the train in an overspeed situation, the KPVA:

- Informs and diagnoses potential breakdowns,
- If possible, reconfigures the system in the case of multiple breakdowns,
- Inhibits the system in the case of critical breakdowns (stops trains that are not in an overspeed situation),
- Informs of overspeed situations, memorizes prior overspeeds and passages,
- Remotely indicates the speeds of train passages (to the operator).

Finally, the KPVA has external outlets to connect sensors or a signal link. For example, the KPVA can be programmed so that 2 or 3 speed settings can be selected in real time depending on the state of the signals.

SAFETY AND AVAILABILITY OF THE KPVA SYSTEM

The KPVA system, associated with a KFS sensor installed on the train, is an important link in the safety chain, as it allows for automatic detection of dangerous overspeed situations in certain zones. The KPVA in and of itself is not designed to be an intrinsic safety system. If it breaks down, it does not work and is therefore transparent for trains. Safety is therefore directly tied to its availability and that of the onboard equipment. The KPVA has been designed to be highly available; as seen above, it has two treatment chains, an auto-surveillance system and an auto-reconfiguration system, all of which is associated with a remote maintenance detection system that immediately informs maintenance personnel of a breakdown.

KPVA PROGRAMMING AND MAINTENANCE

The track antenna has a USB/RS422 link that allows it to be connected to a PC. Software tools verify the proper operations of the track antenna and configure the speed setting for each site that is equipped.

An overview provides a visualization of all the equipment installed, including the related configuration.

With test equipment, PC test software allows for the track antenna to be configured in order to test various operational modes.

Finally, software reads the data history and status recorded by the track antenna.

The RS422 link allows for the programming and maintenance of all the track antennas installed on a given section with a secure hub computer located at a distance from the equipment (there are currently six track antennas set up in a network).

On the RATP sites, a manual verification is performed four times per year. The operator checks the KPVA operations and reads the data history.

Automatic KPVA verification (auto-control) is conducted on a daily basis.

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