



IFOY Award 2014 Automated Guided Vehicles

**Auto Pallet Mover
EKS 210a and ERC 215a**

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1 Jungheinrich Auto Pallet Mover

The newest generation of the automated guided vehicle system, the portfolio of the Jungheinrich Auto Pallet Mover, has been submitted for the 'Automated Guided Vehicles' category. The programme comprises the EKS 210a, an automated guided vehicle at the core of Jungheinrich picking and the ERC 215a, an automated stacker truck.

What is a Jungheinrich Auto Pallet Mover?

The Auto Pallet Mover (APM) is the automated guided vehicle system (AGV-S) from Jungheinrich. At the core of the Auto Pallet Mover system are Jungheinrich's production forklift trucks which are automated for use as an automated guided vehicle system. The advantage of this is that the company's many years of experience in and testing the standard trucks can be incorporated into the automated guided vehicle system. In addition to the automation, a comprehensive safety package is installed which permits simultaneous operation with manual trucks and pedestrians.

Jungheinrich standard vehicle



Auto Pallet Mover- an AGV based on Jungheinrich production trucks

The Auto Pallet Mover enables standardised transport orders to be executed efficiently. Regular transport orders can thus be automated in many companies, from production to the warehouse, from the warehouse to the shipping area etc., for example. Use of the Auto Pallet Mover enables such transports to be undertaken without the additional deployment of staff. The individual transports are structured for this and entered into the transport matrix for the Auto Pallet Mover system. The APM handles the transports punctually, efficiently and with millimetre precision. This enables damage to machinery or racking to be minimised and the transport structures of the warehouse to be optimised.

Reflectors, which are easily adhered in the warehouse without any additional constructional measures, provide orientation. The 3 point navigation guarantees that the device knows its exact position at all times.

Changing or adding new routes can be executed with little effort. New processes/process steps can be integrated in the warehouse layout with little additional expenditure. The customer is therefore guaranteed flexibility at all times.

2 Truck types

There are various fields of application for the devices. Both models have general advantages. They include:

- Innovative 3-phase AC technology with energy recovery
- Low operating costs
- Active energy and battery management
- Sensors for recording the environment
- Comprehensive safety package
- Compact, robust construction
- Optional sensors for adjusting the Auto Pallet Mover to individual customer requirements/uses

The Auto Pallet Movers can, unlike other automated guided vehicle systems, be used in asynchronous balanced mode with manual trucks and pedestrians without any problems. This means that they can be integrated in the active operations of a company and another limited automatic system area does not need to be provided for this. The personal protection system will reliably detect if a person or an object is found in the warning field of the APM. The device slows down and the APM reliably stops in front of the obstacle as soon as the obstacle is found in the protective field. The Auto Pallet Mover will only resume once the object has been removed from the security field.

The Auto Pallet Mover can be used not only in connection with an upstream warehouse management system, such as Jungheinrich WMS (Warehouse Management System).

The Auto Pallet Mover's connection via JH Logistics Interface, a piece of company middleware, also enables connections to an existing customer system to be used. It is possible to use a stand alone system if the customer does not desire a connection to an upstream system or does not have such an upstream system, however. This intelligence can be realised quickly without any problems by using sensors and/or buttons. The fields of application are determined internally and individual fields are shown subsequently in the respective operation. It is thus possible to design the suitable application for the customer's system.

EKS 210a

The EKS 210a is a transport system with no operator based on the order picker route. The vehicle is distinguished by its long battery runtime of over 16 hours, according to usage, and the adjustable FEM forks. Thanks to the long battery runtime, charging or changing is only required very rarely during use. The cantilever FEM forks mean that not only standard load aids but also special load aids can be transported. These include not only load aids with particular dimensions, but also certain load aids for special applications, such as dositainers and special mesh boxes. The FEM forks can therefore also be set to the relevant width for the load aid. The Auto Pallet Mover should however transport a certain type of dimension by default, as otherwise it is necessary to set the forks manually during operation.

The personal protection system built in to the vehicle in the drive and load directions limits the speed in each direction to 1.5 m/s.

The EKS 210a offers the following advantages:



- More than 16 hours battery runtime (depending on application)
- Maximum load 1.5 t depending on lift height
- Cantilever FEM forks
- Adjustable fork width
- 1.5 m/s in both directions of travel
- Max. lift height 3,000mm

The EKS 210a is already equipped with an extensive safety package as standard:



The side sensors monitor the outer edges of the vehicle. This means that objects to the side of the vehicle can be detected. The cabin safety protects the truck from people travelling within it without authorisation. If a person is on the operator platform, the automation is turned off independently, and the vehicle can only be used manually as a standard vehicle and not a transport system without operator. The load sensor monitors the status of the vehicle (loaded/ unloaded). This is an additional way to monitor transports. If the load sensor detects that there is no load on the forks, although according to the transport order the forks should be loaded, an error message is transferred to the upstream system. This error must be checked manually and can also be rectified manually. Once the order with the error has been acknowledged/ deleted, the Auto Pallet Mover finds the next order and automatically continues working.

The sensor curtain is an optional safety sensor. It is only integrated if requested by the customer and required by the customer project. It is used to detect objects that are not detected by the personal protection sensor because they are above or below the detection level of the personal protection sensor, and hence avoids collisions with these objects. This scanner is not used for personal protection in the traditional sense but rather for additional security. It acts in a similar way to an air bag: It may not be able to prevent an accident but will restrict its effects as the truck speed is reduced.

ERC 215a

The ERC 215a is a transport system without operator based on a Jungheinrich Electric Stacker Truck. The ERC 215a is distinguished by its compact construction and a lift height of 4,000 mm. Thanks to the compact construction, routes in restricted layouts can be carried out effortlessly. Thanks to the lift height of 4,000 mm, lines on the second racking level can also be reached.

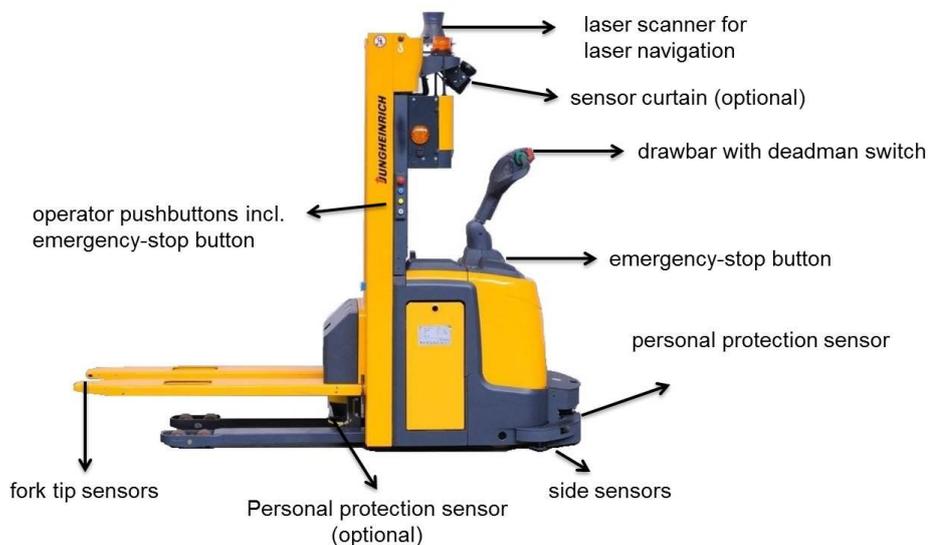
The APM type ERC 215a is available in two versions: with and without personal protection sensors in the load direction. The difference between these two versions is the capacity, which is 1.5t in the load direction without personal protection system (PPS) and 1.3t in the load direction with personal protection systems, and the speed, which is reduced from 1.5 m/s to 0.3 m/s in the load direction without personal protection system in the load direction. So that the rear space is monitored even without personal protection, sensors are built in to the fork tips to monitor the rear space. This does not fulfil any personal protection class, but reduces the speed in the load direction.

In summary, the ERC 215a is distinguished by the following points:



- 8 hours battery runtime (average duration, depending on application)
- Maximum load 1.5 t (with PSA in load direction 1.3t) depending on lift height
- 1.5 m/s in drive direction, 0.3 m/s in load direction (with PSA in load direction: 1.5 m/s in both directions of travel)
- Max. lift height 4,000mm
- Fork tip sensors

The ERC 215a is equipped with the following safety sensors as standard:



As for the Auto Pallet Mover type EKS 210a, the sides of the vehicle are also monitored by side sensors. These provide the customer with an additional security for the sides of the vehicle. In addition, on curved routes, obstacles can be detected reliably.

Power Supply

The APM is powered by lead PzS batteries. Depending on the type of vehicle and the corresponding battery size, different charging cycles are necessary. With the APM type ERC 215a, a one shift operation without recharging is possible, and the APM type EKS210a even allows a 2 shift operation.

In order to ensure energy supply, there are three different possibilities:

1. Charging the inbuilt battery directly at the battery charging device

This is generally used during off shifts, as the charging time for a vehicle battery, depending on the device, is between 7.5 and 13 hours (less with electrolyte circulation). Charging times and battery/ charging device combinations apply as for normal series devices. In multishift operation, a vehicle must temporarily be taken out of the system for recharging.

2. Charging the battery outside of the vehicle with a battery change

At a specific battery charge status, the vehicle automatically moves to a battery change station. An employee then changes the battery manually, and the APM vehicle continues working after the battery exchange and reintroduction into the system. The downtime for the charging cycle depends on the speed and attentiveness of the employee (approx. 5 min for an experienced employee). For this alternative, a spare battery and a changing stand are needed in addition to the vehicle battery and charging device.

3. Automatic recharging with NiCd batteries

For this, the APM systems uses a charging station with suspended loop contacts. The APM positions itself underneath the stationary contacts and automatically attaches itself to the charging device via a charging plate.

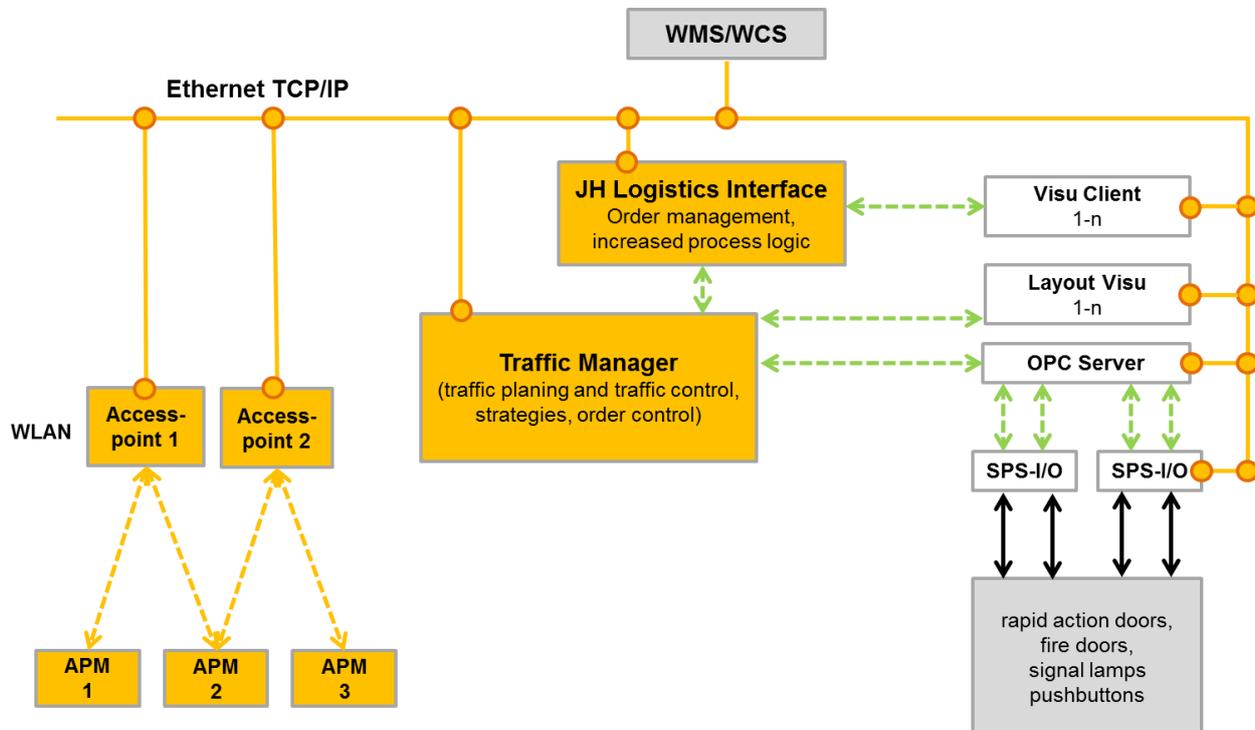
The vehicles remain in continuous operation for approximately 50 minutes, then move automatically to these recharging stations. Once attached, the batteries are charged for approximately 10 minutes. As the vehicles are charged during operational time, it is necessary to have more vehicles in op-



eration in order to compensate for the charging time. As the recharging time is only 10 minutes, a different recharging station is not needed for each vehicle. The reference point here is one recharging station for 3 APM vehicles.

3 The Auto Pallet Mover System

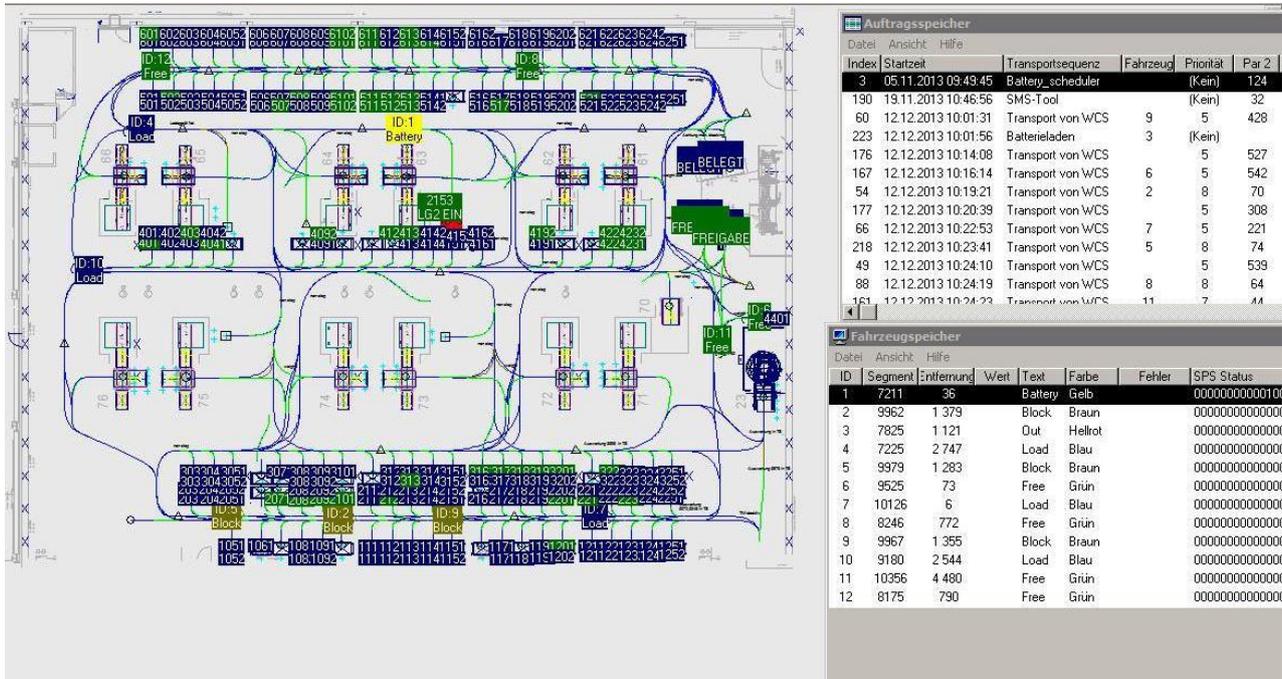
The expression Auto Pallet Mover-System (APM-System) designates the entire system of the Auto Pallet Mover. This term includes not only the Auto Pallet Movers, but also the Traffic Manager, the Visu Client, the connected unit of the PLC (programmable logic control system) and the reflectors, i.e. the stationary navigation elements of the Auto Pallet Mover. Optionally, a upstream system, such as a warehouse management/ control system can be connected to Traffic Manager. The following image sets out the individual components and the relations between them:



The Auto Pallet Mover System

Traffic Manager is the central element of the APM system. Here, the vehicles are controlled and their processes are optimised on the basis of the layout and warehouse strategy provided. Via Traffic Manager, any desired number of APMs from various areas can be connected. The communication between the software and the APM is carried out via WLAN. Depending on the network strength and coverage, either the customer WLAN can be used, or a new network can be installed. For the visualisation, controlling and management of the site, generally at least one Visu Client is provided, although more can be

added as required. The Visu Client is used to visualise the APM system. This visualisation allows the status of an APM, its location and orders on the APM system to be seen in one place.



View of Visu Client

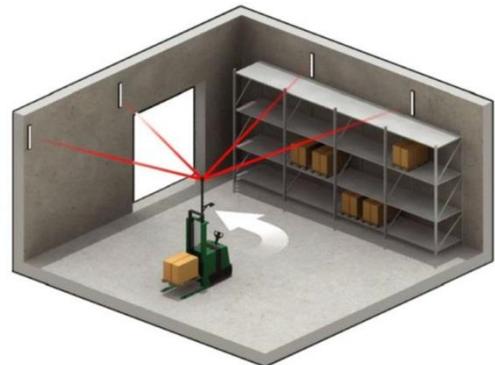
Input and output modules can be connected to the SPS units, for example to open a high-speed door automatically, trigger or detect an order (request button), or the information that a pallet is ready for collection ('Occupied Sensor').

The system is scalable, meaning that at any time further components or vehicles can be added. It is also possible to run several vehicles of different types in one APM system i.e. if there are no space restrictions, an ERC 215a and an EKS 210a can be connected on the same layout without any problems, and be moved to the same stations and depots.

The site can also be extended easily. By installing new reflectors and inputting their measurements into the layout, warehouse expansions are possible very quickly. Individual stations on the existing layout can be added to the layout quickly with some small adjustments to the layout, or they can be changed.

Laser navigation

The trucks orient themselves in the warehouse using laser navigation. For this purpose, adhesive reflectors are attached to mounting profiles throughout the area accessible by the APM. These form an orientation grid for the APM. The reflectors are fastened to walls, pillars and the warehouse construction. Jungheinrich creates a complete installation layout for this, the specifications of which make installation easy.



Laser navigation offers major advantages in comparison with other processes such as magnetic spots or induction loops. Changes to routes or the layout can be flexibly adapted at any time in the existing reflector area via software without the need for structural alterations to the warehouse. The calibrated reflectors provide this system with maximum precision and ensure that it is mostly resistant to external influences such as light, other reflective materials (e.g. window panes) or a changing warehouse environment. If individual reflectors/ reflector panels are ripped as a result of manual movements of existing fittings, these can be replaced easily and without any problems. The defective reflector is removed manually from the previous site and calibrated in the layout by the vehicle.

4 Applications

General Uses

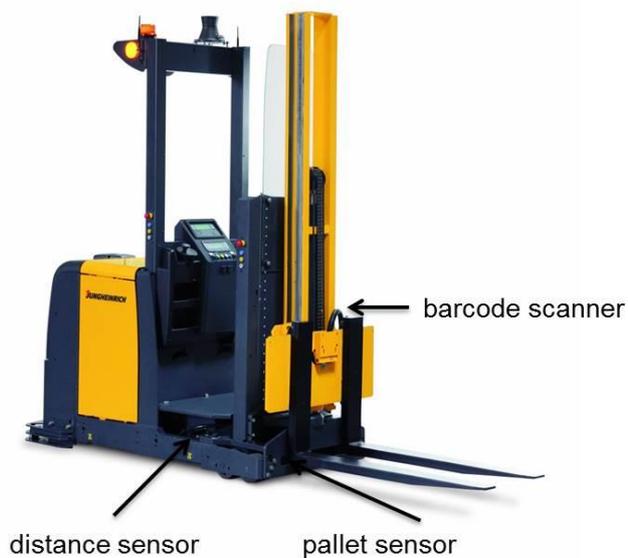
The general use of a Auto Pallet Mover is to cover standardised transport orders in a warehouse. The Auto Pallet Mover is not suitable for use in refrigerated warehouses or outdoor areas. It can take standardised load aids for materials handling systems, cantilevers, floor spaces, heavy duty conveyors, Pick&Drop stations and racks (limited to maximum height) and deliver to exactly these places. This has the advantage that these standardised transports in one or multishift operation no longer have to be carried out manually by warehouse employees. Employees can therefore be used for special transport or other, more profitable tasks. Thanks to the extensive security package, damage to transported goods and the warehouse itself and its fixtures is reduced to a minimum. This security package means that use in automated warehouses and mixed operation with manual forklifts and pedestrians is possible. Thanks to the laser navigation, expensive floor work is unnecessary, allowing the implementation of a system during ongoing operation.

Through the adaptation of the navigation and number of vehicles to the customer's needs, it is possible to expand an APM site without any problems. The Auto Pallet Mover System can also be extended in terms of the number of sources and depots at any time, so long as travel routes and safety distances are maintained. This means that as soon as the customer defines new sources and depots, or new/ other machines should be connected, this can be covered by the Auto Pallet Mover.

Applications According to Customer Requirements

In addition to the standard use, e.g. the transport of a load aid from one place to another, additional functions can also be carried out by using various sensors on the vehicle and other options can be offered. These functions can be adapted to the needs of the customer, and following a feasibility study a quote can be provided.

The following image shows these optional sensors according to vehicle type.



Optional sensors

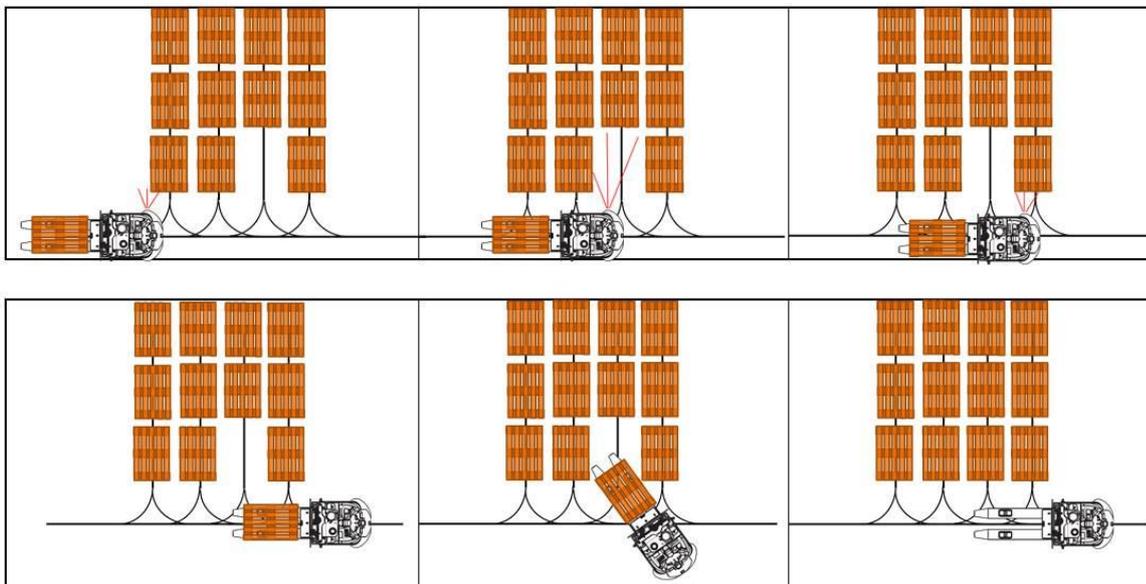
Barcode scanner

A barcode scanner can automatically scan the barcodes on a pallet. This data is sent via WLAN to a upstream host or warehouse management/ control system. The logistics interface is used for this. This allows a smooth connection with upstream systems. This software translates the individual signals of the APM system into evaluable data for the upstream system. This serves the additional space management of the individual load aid. Thanks to an oscillating mirror, the exact placement of the barcode on the pallet is no longer necessary.

Distance sensors

Another option is distance sensors on the Auto Pallet Mover. This option can locate individual warehouse spaces in a flexible segment in goods inward/ outward or in production lines. Flexible segments are lifting/ delivery stations which are equipped in such a way that the load aid is found within a specific track, but not a specific place. The APM automatically finds the next available pallet in this track

To find the individual empty spaces, if the individual lifting/ delivery stations are not defined, the distance sensors on the vehicle are used. These sensors measure the individual tracks, distances to the pallets and distances between pallets when moving past the track. This means that the status of a pallet can also be monitored in a warehouse control system/ warehouse management system.



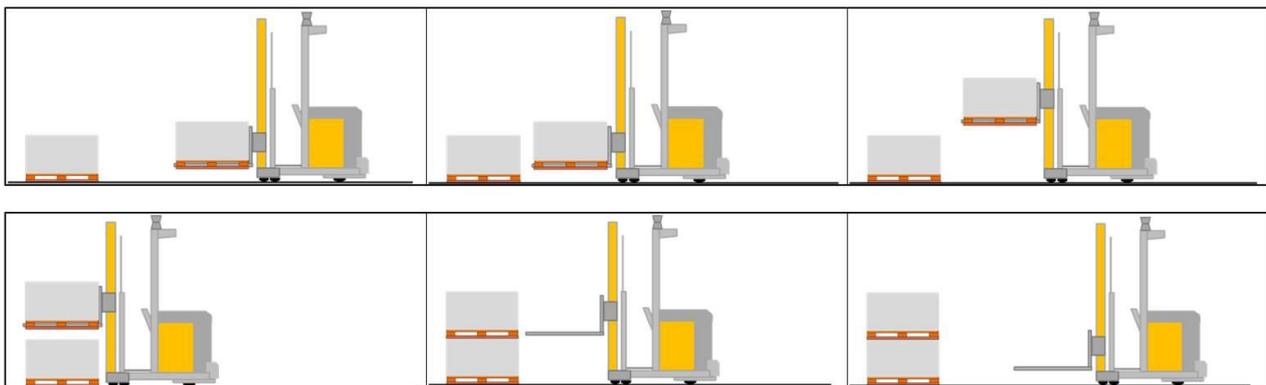
Empty Pallet Space Detection with Distance Sensors (Example ERC 215a)

As shown in the image above, there are two possible applications for this: the individual tracks can be measured when passing by and sent to an upstream system, or this can also be used for flexible delivery in a warehouse, such as a block storage warehouse. This offers the customer flexibility and the optimal fitting of the warehouse / goods inward/outward tracks.

Pallet sensors

On the fork carriage of the EKS 210a and the fork of the ERC 215a, optional sensors can be mounted to detect pallet breakages. This is checked by this sensor before entry into the load aid. If this load aid is defective, a message is sent to an upstream system.

This pallet sensor is also used for the stacking of pallets. The basis for this is that the pallets themselves are stable and stackable, and that the delivery stations are outside of a flexible segment. In this case, the individual lifting/delivery tracks are clear, i.e. the APM is told that a certain load aid should be moved to a certain goods track and stacked on the next available pallet. The APM moves to the given goods track and the pallet sensors on the vehicle and/or the personal protection sensor are used to detect the next pallet in this track. The vehicle stops in a defined distance, and the pallet is lifted. As soon as the sensor sees that the distance to the pallet has increased, it is again checked via height adjustment that this height is plausible. If both of these parameters are correct, the load aid is stacked above the existing load aid.



Stacking with a Auto Pallet Mover (Example EKS 210a)

5 Implemented Customer Sites

The newest generation of Auto Pallet Movers was presented to the public at the LogiMat in Stuttgart in February 2013. Since then, several projects have already been successfully completed. To date, the newest generation of APM system has already been put into place by the following industries:

- Automotive industry
- Colour production
- Glass and glassware manufacturing
- Food production
- Logistics
- Metalworking industry

Customers primarily use the system for:

- Outsourcing of recurrent transport orders to the Auto Pallet Mover and consequent release of employees from these tasks
- Minimising transport damages, damages to the warehouse and warehouse inventory
- Flexible expandability for new warehouse parts, and connection of further Auto Pallet Movers
- Use in mixed traffic with manual trucks and employees, therefore no major conversion work necessary in the warehouse.
- High availability of the Auto Pallet Mover and reliable processing of transport orders
- The extensive safety sensor system ensures employee safety in the APM system