

# Ultra-Low Platform Cart System

🔊 Automatic guided vehicle, Cart, Ultra-low-platform

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## Abstract

We developed an ultra-low-platform Automated Guided Vehicle (AGV) called “U-CART.” It can go under a commercial basket cart and with the electric up-and-down catch pin, it can make the coupling with a basket cart and carry the cart. There are two types: U-CART S and U-CART L. U-CART S offers forward and simplified reverse maneuvering. U-CART L uses two drive units and offers forward/reverse moving, traversing, and spin-turns. Both models demonstrate the most compact and low-platform level in the Japanese AGV industry. The body height measures (170mm) and the vehicle width (348mm), therefore, U-CART can go under any basket cart available in the market without changing the cart’s platform height level and can convert to AGV with minimum modifications. It also comes with high power as it can pull the cart at maximum 1300kg. Further, with simple system configuration, stops can be arranged at a maximum of 200 stations and a maximum 200 crossing points.

## 1. Preface

Since our first release of the Automated Guided Vehicle (AGV) in 1983, we developed the ACB Series in 1987 which is the standard truck series; and then in 2000, the 2ACB Series capable of omni-directional maneuvering was developed. These products met the needs of our customers in the work of handling materials.

Recently at the manufacturing sites, there are requests from customers who want to build their own material handling systems in order to realize the efficient material-moving systems by incremental daily improvements. To meet such demands, we developed an affordable, flexible, easy-to-use, and simple AGV unit called “MCAT” and released it in 2005. If this MCAT is put under any wheeled cart designed and manufactured by a customer, it can convert to an automated guided cart as the AGV.

This paper introduces the newly developed U-CART, the ultra-low-platform cart system, which is an applied product of MCAT. It can go under any commercial basket cart or an existing customer’s cart; and with the electric up-and-down catch pin, it can make the coupling of basket cart automatically and can move the cart.

When this U-CART is in use, other carts available on market can be converted to the AGVs with minimal modification. In addition, a single U-CART can pull and move multiple carts.

## 2. Major Specifications

U-CART introduced here is an AGV that follows a

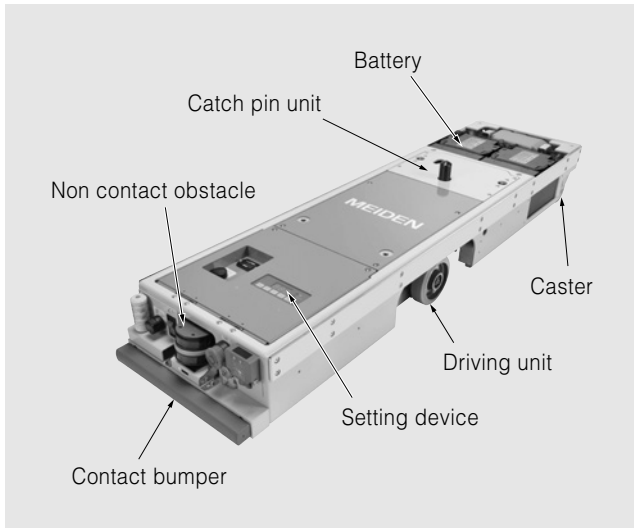
guide path taped on the floor. There are two types: U-CART S and U-CART L. U-CART S is equipped with a drive unit and can move forward and backward in a simple manner. U-CART L is equipped with double-drive units and it can move in every direction including traversing. Each model has high-speed type and low-speed type. A total of four types are available. Fig. 1 shows an external appearance of U-CART L.

The front side of U-CART is equipped with a non-contact obstacle detector to avoid collision and a bumper. This part of U-CART is also equipped with a power switch, a manual operator switch for a catch pin, and a signal receiver of an optical remote controller.

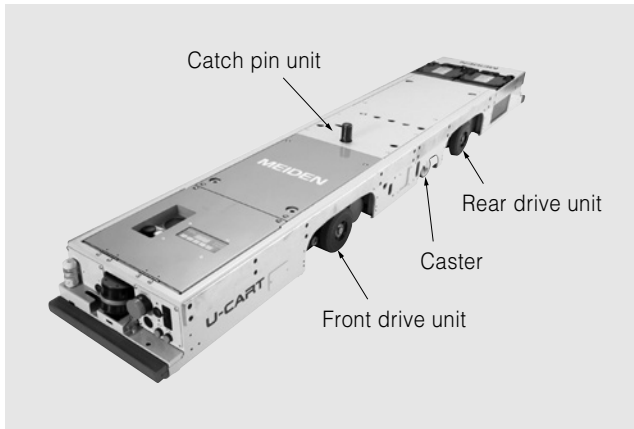


**Fig. 1 U-CART L (while delivering)**

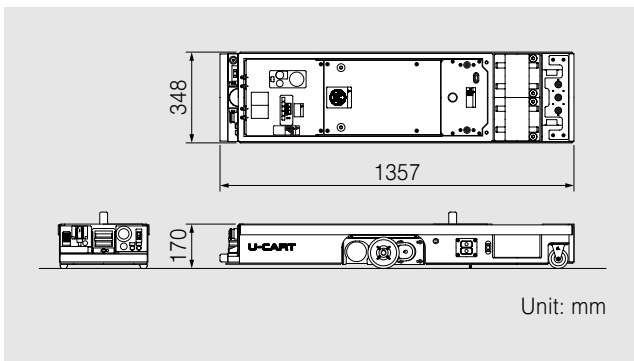
An external appearance of U-CART L is shown.



**Fig. 2 U-CART S**  
This is the basic type that features a single drive unit and forward movement only. More functions can be added if an optional unit is mounted.

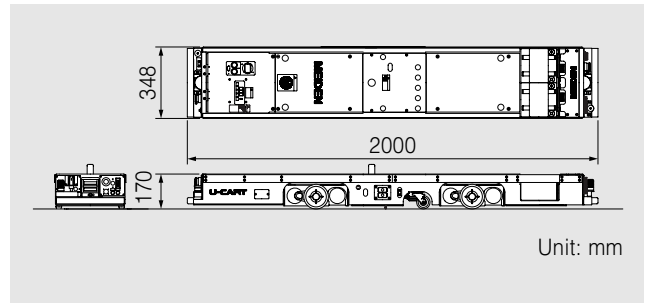


**Fig. 3 U-CART L**  
This is the basic type for the double-drive unit that can move to every direction and offers high-speed specifications.



**Fig. 4 External Dimensions of U-CART S**  
The machine height of 170mm and the body width of 348mm are the world smallest and thinnest dimensions of an AGV. These dimensions are common to both high-speed and high-load types of U-CARTs.

These units enable U-CART to go under the basket cart and perform the necessary operation. On the back, there is a selection unit from which the operator can select the destination, etc. Inside the unit, there are a control unit, a catch pin unit, and a storage battery unit.



**Fig. 5 External Dimensions of U-CART L**  
The high-speed type has a machine height of 170mm and a body width of 348mm. These dimensions are common to the unit of single-driving types. The high-load type has a machine height of 202mm.

**Table 1 Major Specifications**

A remarkable compact size has been realized with a machine height of 170mm and a body width of 348mm. A total of 4 types have been standardized.

| Specifications           | U-CART S (FWS system)                                 |                | U-CART L (TWTS system)                                    |                     |
|--------------------------|---|----------------|---|---------------------|
|                          | High-speed type                                       | High-load type | High-speed type   | High-load type      |
| Guide system             | Magnetic  |                |   |                     |
| Driving/steering system  | Differential steering system and front wheel drive    |                | Differential steering system and four-wheel drive         |                     |
| Moving direction         | Forward movement<br>Simple reverse traveling (option) |                | Forward/reverse movement<br>Traversing/spin-turn (option) |                     |
| Goal carrying mass (kg)  | 300   | 800            | 600   | 1300                |
| Max. thrust force (N)    | 250   | 550            | 500   | 1100                |
| Max. Speed (m/min)       | 60  | 30             | 60  | 30                  |
| Machine size (mm)        | W348 × H170 × L1357                                   |                | W348 × H170 × L2000                                       | W348 × H202 × L2000 |
| Min. turning radius (mm) | 650   |                | 600   |                     |
| Stop accuracy (mm)       | ±10 (single body)                                     |                |   |                     |
| Grade ability            | 2/100 (5m continuous)                                 |                |   |                     |

U-CART S has a fixed caster on the backside. U-CART L has a universal caster between the two drive units.

Figs. 2 and 3 each show external appearances of U-CART S and L. Figs. 4 and 5 show the respective external dimensions. Table 1 shows the major specifications.

**3. Features**

In order to convert the customer's basket cart under use into an AGV in a simple manner, these are following steps:

**3.1 Realizing the Compact and Ultra-Low-Platform Design**

We realized the compact design of the drive unit

by introducing the differential steering system without the steering motor. We realized the compact design of the control unit by using the high-density circuitry dedicated Printed Wiring Board (PWB). These factors produced the overall size of U-CART S, more than 50% in terms of the volumetric ratio (W348 × H170 × L1357mm) as compared with the existing model (W500 × H200 × L1600mm). In particular, the width and height were reduced substantially. This enables U-CART to tow a compact commercial basket cart (cargo of 500kg, 800mm in width) and put U-CART under the basket cart and it can make a coupling by using a catch pin and carry the cart.

On the other hand, U-CART L is equipped with the front and rear drive units, both of which follow the guide path tapes. As a result, the minimum turning radius was reduced as short as 600mm.

### 3.2 Strong Traction Force

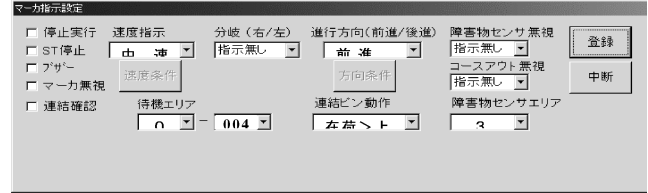
The high-load type U-CART S has a traction thrust force of 550N. It can tow about an 800kg truck. Conversely, the high-load type U-CART L has a traction thrust force of 1100N and it can tow about a 1300kg truck. In the case of the high-load type U-CART L, however, a mass is additionally added and the machine height is increased from 170mm to 202mm so that a 1100N traction thrust force can be transmitted to the road surface.

### 3.3 Easy Operation and Simple Setup

For U-CART, when the destination station number is set up and the start button is pressed, it automatically follows the guide path and stops at the destination. According to the preset destination station, the path decision occurs at the turning point. Regarding the coupling with the basket cart, the AGV checks that the basket cart is in the correct coupling position and next to the electric up-and-down catch pin; it then can make the automatic coupling and carry the cart. Once arriving at the destination, the basket cart is removed from the AGV.

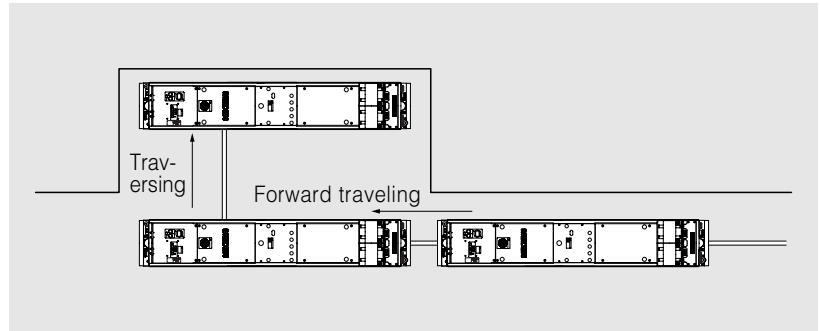
To set up the guide path, magnetic tape is laid on the surface of the floor. A guide path for U-CART can be completed by putting magnetic marks along the side of magnetic tape as a position indicator.

Then by using a personal computer, the marker setting arrangement, positions of stations and turning points, turning method, commands by each marker, etc. need to be set up. These conditions can be easily set by selecting commands from the dropdown list for each conditional item. Fig. 6 shows the marker command setup screen. The guide path arrangement is completed



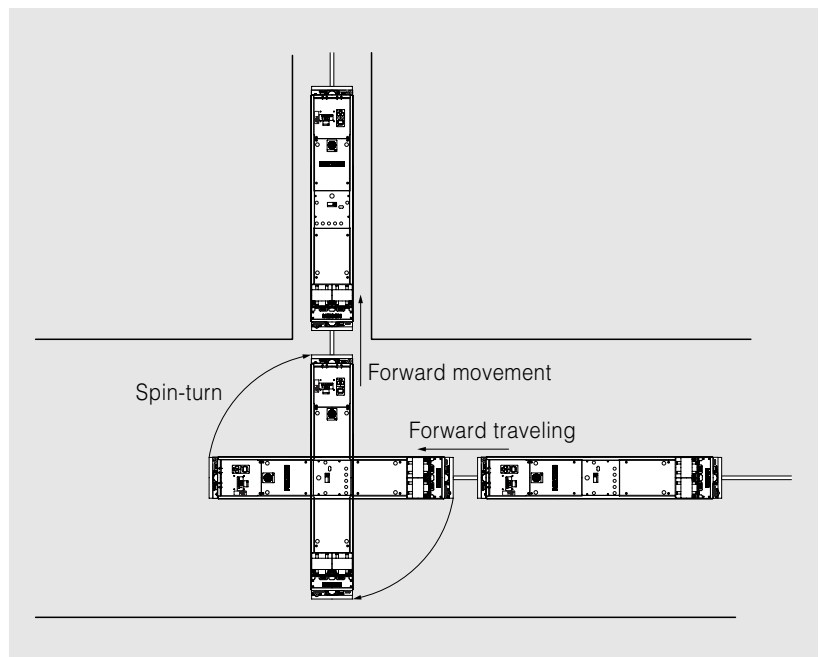
**Fig. 6 Marker Command Setup Screen**

Select each command choice from the drop-down menu and enter.



**Fig. 7 Traversing**

In a case like the station at the backside of the dead end corner, it is difficult to approach such a station only by forward movement. The traversing movement realized the access to get there.



**Fig. 8 Spin Turn**

It is possible to enter a narrow passage. It does not require a guide path tape for spin-turn.

once the setup data is downloaded to U-CART.

### 3.4 Abundant Options

#### 3.4.1 Traversing and Spin Turn

If a traversing marker sensor and a sensor for stop position correction are additionally added to U-CART L, it can perform traversing and spin turns. Figs. 7 and 8 show the sample of traversing and spin turn movements.

Traversing movement is effective when approaching a station located at the backside of a dead-end corner. In line with the front drive unit movement, U-CART



**Fig. 9 Extension Box**

An extension box with the optional units such as an automatic battery charger, etc.

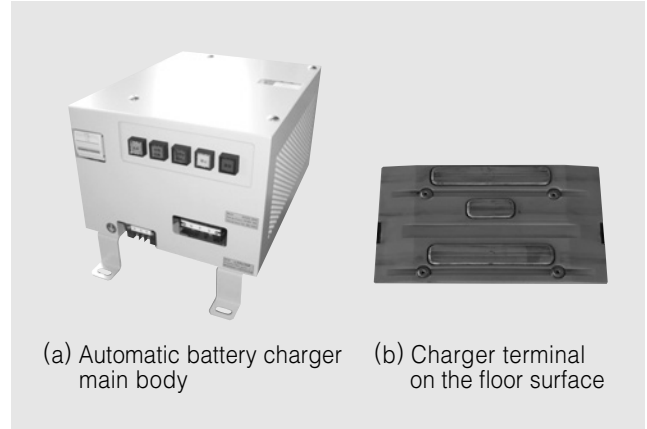
follows the guide path tape. The rear-drive unit adjusts the speed and steering angle in synch with those from the front driving unit. Using the sensor for stop position correction that U-CART detects, the forward traveling guide path tape compensates the incline of the machine caused during the traversing movement; then U-CART stops in the correct position. The spin-turn is useful when entering a different direction in a narrow path. For stoppage, the sensor for stop position correction is used in the same manner as in the case for traversing movement.

To improve safety for traversing, non contact obstacle for traversing and a side bumper are available options.

### 3.4.2 Automatic Battery Charger

When the rear part of U-CART is equipped with an extension box including charger terminals and an automatic battery charger is installed on the ground, it realizes a transportation system which could run by 24/7 without changing batteries.

The automatic battery charger uses the current-limiting type constant-voltage method and the battery voltage is always monitored to ensure the effective charging in a short amount of time. Battery charging starts when U-CART arrives at the designed charging position and the charger terminals of U-CART come in contact with the ground-level. At that time, to avoid incorrect charging with other matter by an accidental contact with the ground charger terminal, charging



**Fig. 10 Automatic Battery Charger on the Floor**

After confirming that U-CART is connected battery charging is carried out automatically. The charger terminal is provided with a safety system to prevent an error charge against the contact of any other thing it may come in contact with.

commences only when correct battery connection is confirmed to be connected.

Figs. 9 and 10 respectively show an extension box and a floor-surface automatic battery charger.

### 3.4.3 Optical Remote Controller

To manually operate U-CART, it is necessary to use an infrared optical remote controller. The optical remote controller can perform auto-manual changeover, operation of the catch pin, and start-stop operation. In case of a simple system like point-to-point transport, it does not require programming the destination station. Without operating U-CART setting unit, transportation can be started only by using an optical remote controller.

In addition to the above, other options are available such as an optical transmitter to give destination and start commands to U-CART, and a separate battery charger unit to charge replaceable batteries, etc.

## 4. Postscript

The development of U-CART realized that the customers can easily build the advanced transportation systems on their own. Going forward, we would like to improve functions and performance of U-CART further to meet the various requests and demands of our customers.

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