Applications of INVT EC100 Elevator intelligent integrated machines

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Abstrct: Due to the continuous progress of human civilization, more and higher buildings have been established, and human beings invented elevators as the transportation of electrical energy to achieve vertical displacement – elevator to avoid the climbing tied. While with the rapid development of human civilization, people need more and more on the elevator. The elevator not only be used in vertical displacement of electrical energy, but also are required to have a high level of efficiency, comfort and intelligence. Elevator intelligent integrated machines (typical INVT products: EC100 Elevator intelligent integrated machines) are the inevitable trend of elevator development because it can meet all serious needs of modern people.

Key words: elevators, intelligent integrated machines and EC100

1. Introduction

Before the elevator intelligent integrated machines, there are 4 steps of elevator developments:

Ø Elevators controlled by hardware circuit of relays and contactors:

The elevator began in the middle of the last century. At that time, the science and technology is relatively backward, it is necessary to use some hardware such as relays and contactors to control the elevator. But the structure is complicate and hard to operate in tall buildings.

Ø Elevators controlled by PLC and inverters:

The 80’s of the last century, PLC is invented and rapidly used in the elevator industry and brought the rapid development and popularization of elevators. But in this control mode, it is necessary to write and debug the PLC program in different floor control and the whole cycle is long. All these disadvantages limit the elevator development.

Figure 1 Control cabinet of PLC and inverter

Ø Elevators controlled by special controller and inverters:

In the end of last century, special elevator controller has been in the market. All parameters relative to the elevator are in the control chip, so it is necessary only to modify the relative parameters for different elevators. The controller is the turning point in the development history, but it also have following disadvantages: 1. the terminal user needs to know the function and principle of the controller and inverter and the installation and commissioning is complicate; 2. because the controller needs the cooperation of inverter, if faults occur, it is hard to judge the fault causes.

Figure 2 Special controller and inverter

Ø Elevator intelligent integrated machines:

Finally, elevator intelligent integrated machines went into the market. The elevator is integrated on the control board, all paremeters of conrollller and inverter are combined to enhence the intelligent functions(parallel control, group control, system monitoring and system limit and so on) and make up the disvantaged of the elevetor controller. It is on the way of modern elevator development and leads a new direction in the furture.

Figure 3 EC100 Elevator intelligent integrated machines and solutions

2 Characterizes of EC100 Elevator intelligent integrated machines

EC100 elevator intelligent integrated machine is the new intelligent elevator control system with drive technology, control technology and network communication technology. Applying advanced frequency vector control technology, intelligent elevator control technology, network communication technology, our products integrate drive, control and management of the elevator to improve the safety and reliability, operation, economy and individual design.

Main features:

- Integrated design, simple wiring and easy debugging
- The highest floor: 64th floor Max. speed: 6m/s
- Distance control principle
- Automatic identification running of low floor station
- Advanced starting compensation of non-load sensor
- Synchronous and asynchronous master; Static and dynamic self-tuning function
- Vector control
- Encoder interface of synchronous and asynchronous master
- CAN serial communication
- Automatic car position correction
- Single-phase AC220V low voltage aid function
- LED displaying and operation, compatible manual controller and PC debugging software
- Multiple safety protection; meet the standards of EN81 and GB7588
- EMC meet C3 standards
- Various safety design
- Intelligent, network-based control group control, as much as 8

Figure 4 Application sites of EC100 Elevator intelligent integrated machines

3 Client site

Taking an application of Turkey client in the 12-floor building as the example, the article illustrates the detailed requirements:

- There are two elevators in the building, and required parallel intelligent control;
- Need to support 24V incremental tractor encoders;
- No noise during the elevator starting and stopping and no shock to the car;
- If the elevator is not used in 2 minutes, it turns to the energy-saving mode, and the lights and fans in the elevator are turned off automatically;
- Automatic returning to the base floor: if the elevator is not used in 30 minutes, elevator A will be back to 1 base floor and elevator B will be back to 7 base floors.

Elevator parameters are shown in table 1:

Table 1

Motor parameters	
Rated power	7.5KW
Rated frequency	50HZ
Rated speed	1460rmp
Rated voltage	380V
Rated current	17A
Encoder parameters	
Encoder type	24V incremental
Encoder resolution	1024
Tractor parameters	
rated speed of the elevator	1.75m/s
Max. speed of the elevator	1.75m/s
Max. output frequency	50HZ
Tractor diameter	400mm
Speed ratio	1
Suspension ratio of the tractor rope	2

4 System principle and control solution

4.1 System principle

Four parts:

- Ø Machine room: includes elevator control cabinet and the elevator tractor;
- Ø hoistway and pit: includes guide rail, cable and sensor;
- Ø car: includes car roof control box, car body, command board, display board and door
- Ø Hall: hall display board and the hall door

Elevator system principle diagram:

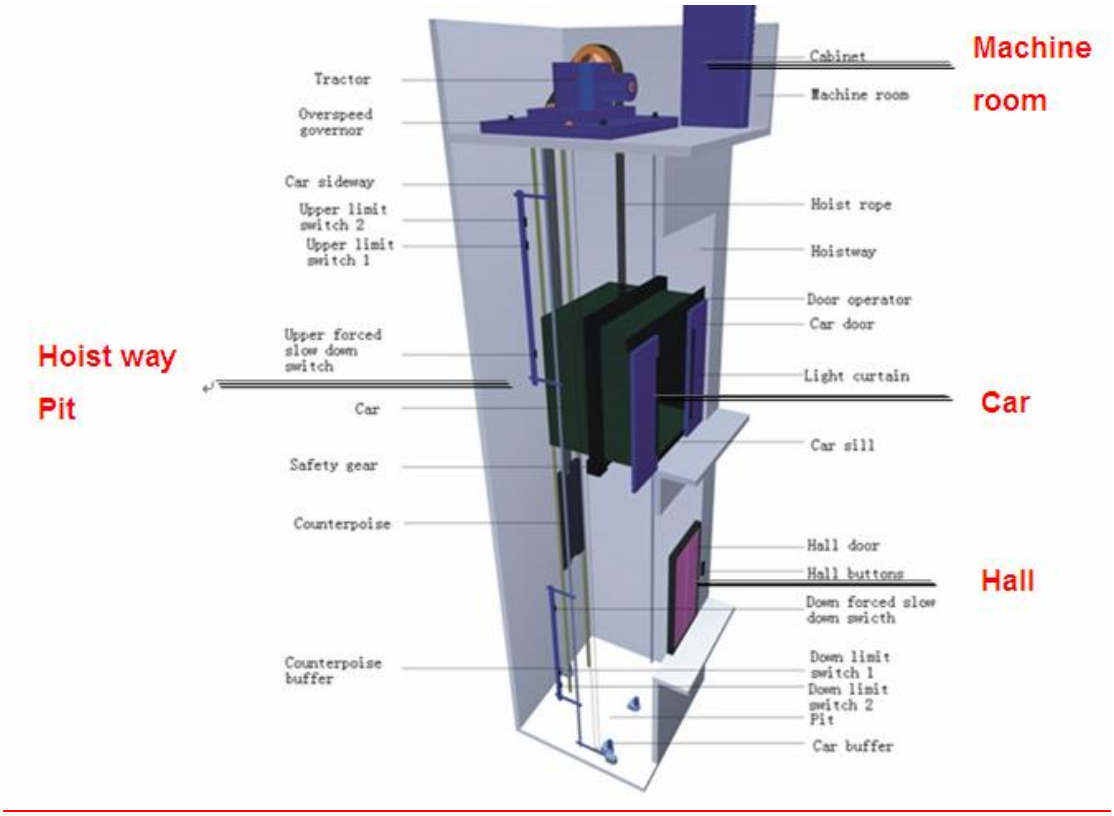


Figure 5 Elevator system principle diagram

4.2 Control solutions

- Ø The control cabinet drives the tractor and make the car go up and down repeatly in the hoistway through steel ropes;
- Ø During the car goes up and down in the hoistway, the car floor is feedbacked through the leveling sensor. The force deceleration sensor, position limit sensor and limit sensor ensure the safety during the operation;
- Ø The control box on the car roof makes the communication between control cabinet and car available. The command required in the car is sent the control board, and display the real-time floor position and elevator. EC 100 will process the commands

and drives the tractor;

Ø The outside caller controls the communication between the control cabinet and the call box. It sends the recorded commands to the control cabinet, displays the car floor and elevator state. EC100 will process the commands and drives the tractor to run.

Wiring of the control circuit:

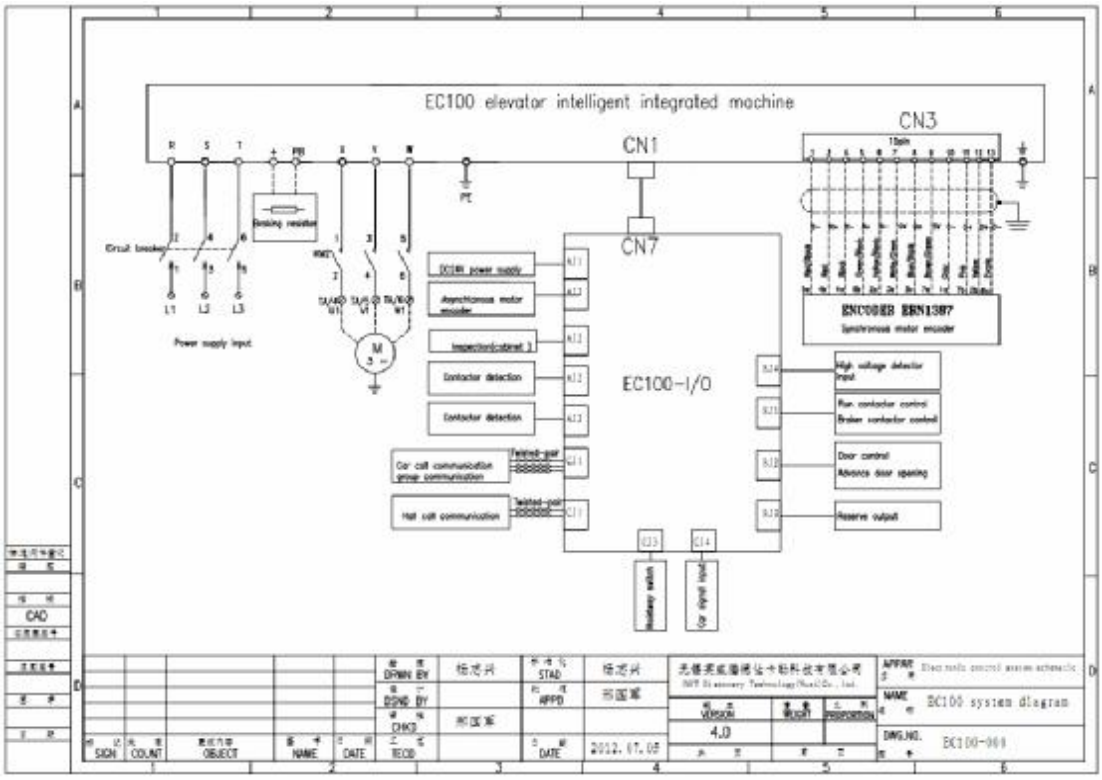


Figure 6 Electric wiring

5 Commissioning steps

5.1 Check the wiring before powering on

Ø Check the wiring of 3 phase inlet between the power and the control cabinet;

Ø Check the wiring between the braking coil and the control cabinet;

Ø Check the wiring3 phase inlet between the motor and the control cabinet;

Ø Check the wiring between the master encoder and the control cabinet;

Ø Check whether the safety circuit is switched on;

Ø Check whether the locking circuit is switched on;

Ø Check the wiring on the car top is correct;

Ø Check the logic of maintenance circuit is correct;

Ø Check the wiring of door power and signal is correct;

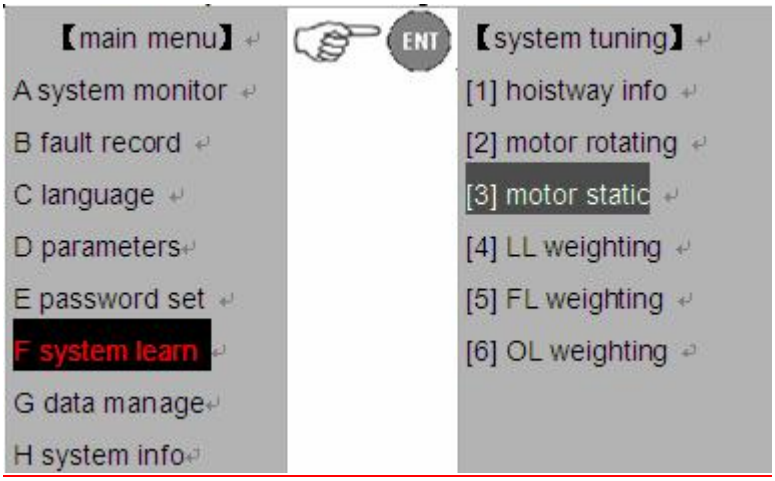
Ø Check the wiring of car CAN-BUS communication circuit is correct;

Ø Check the wiring of hoistway CAN-BUS communication circuit is correct.

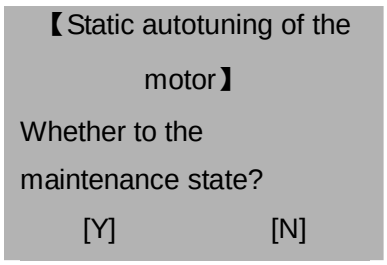
5.2 Parameters setting after powering on of the control cabinet

Function code	Description	Setting range【default】
P0_00	Speed control mode	0~2【1】
P0_01	Rated speed of the elevator	0.100~6.000m/s【1.750】
P0_02	Max. speed of the elevator	0.100~P0_01m/s【1.750】
P0_03	Max. output speed	10.00~400.00Hz【50.00】
P0_04	Diameter of the traction sheave	100~2000mm【400】
P0_05	Speed reducing ratio	1.00~100.00【1.0】
P0_06	Suspension ratio of the hoisting rope	1~8【2】
P0_07	Carrier frequency setting	1.0~16.0kHz【8.0】
P0_08	Running direction	0~1【0】

5.3 Static autotuning of tractors



Begin static autotuning of the motor:



Select [Y] and press to confirm:

【Static autotuning of the motor】
Whether to begin the autotuning?

[Y] [N]

Select [Y] and press to confirm:

【Static autotuning of the motor】
Autotuning

If successful, then display:

【Static autotuning of the motor】
Successful

After the autotuning, make the elevator go up and down in maintenance state and check the operation direction of the elevator.

5.4 Parameters setting of the motor

Ø Set the floor parameters:

Function code	Description	Setting range【default】
A1_01	Total floor setting	2~64【11】
A1_02	Basement setting	0~10【1】
A1_03	Fire landing setting	0~E0.01【1】
A1_04	Park floor	0~E0.01【1】
A1_05	Base floor setting	0~E0.01【2】 Note: according to the clients needs, set elevator A to be 2 and elevator B to be 8.

Ø Set the logic of I/O board

Definition	Up limit	Down limit	High speed up	High speed	Medium speed	Medium speed	Low speed	Low speed

			forced deceleration signal	down forced deceleration signal	up forced deceleration signal	down forced deceleration signal	up forced deceleration signal	down forced deceleration signal
NO 0/NC 1	1	1	0	0	0	0	1	1
Definition	Safety contactor detection	Middle door area	Down door area	Up door area	Inspection down signal	Inspection up signal	Inspection signal	Emergency electrical action
NO 0/NC 1	0	0	0	0	0	0	1	1
Definition	Safety relay detection	UPS input signal	Fire action signal	Motor thermal protection	Braking travel switch detection	Braking contactor detection	Drive output contactor detection	Door lock contactor detection
NO 0/NC 1	0	0	0	0	1	1	1	0
Definition	Self-definition input 3	Self-definition input 2	Self-definition input 1	Advanced opening adhesion	Advanced opening feedback	Hardware enabling	Hall door lock high voltage detection	Car door lock high voltage detection
NO 0/NC 1	0	0	0	0	0	0	0	0

Ø Set the logic of car top

Definition	Front door beam	Closing input signal Closing input signal	Opening input signal Opening input signal	Door closed	Door open	OL	DD	Attendant
NO 0/NC 1	1	0	0	1	1	1	0	0
Definition	Closing button for fire fighters	Rear door closed	Rear door open	Independent running	Front/rear door switching	Rear door beam	Full load	Light load

NO 0/NC 1	0	0	0	0	0	0	0	0

5.5 Hoistway autotuning

Ø Before autotuning

a. Ensure the up/down limit safety switch of the hositway is in the right position and the switch action is valid

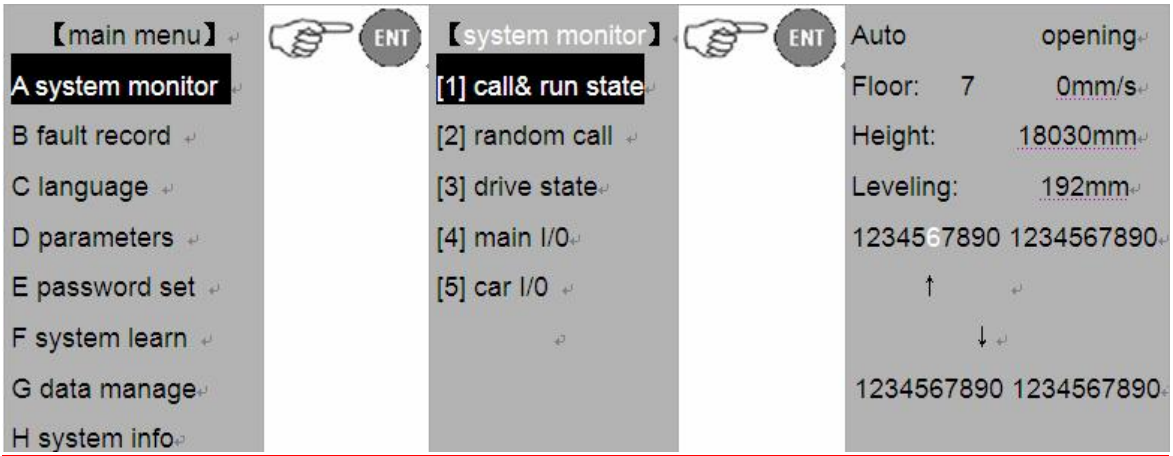
b. Ensure the up/down limit switch is in the right position and the switch action is valid

c. Ensure the up/down forced deceleration switch is in the right position and the switch action is valid

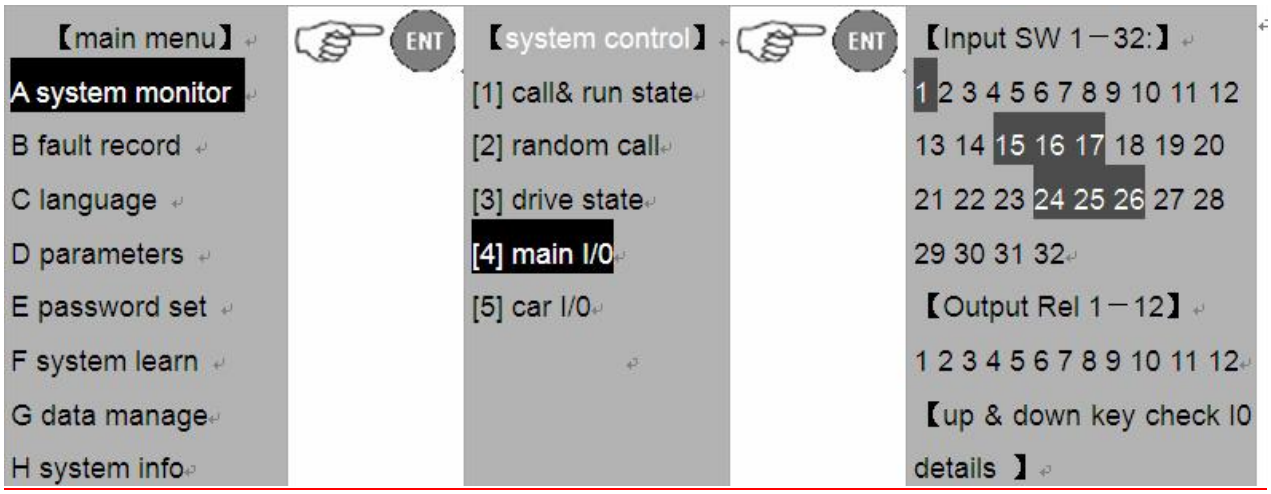
Terminal force deceleration switch: when elevator speed≤1.75m/s, it is necessary to install SDS1 and SUS1; when 1.75m/s＜elevator speed≤2m/s, it is necessary to install SDS2 and SUS2 additionally; when elevator＞2m/s, it is necessary to install SDS3 and SUS3 additionally. The distance between each switch and terminal leveling position corresponds to the deceleration distance of each speed step.

d. Ensure wiring of the display board is reliable and correct.

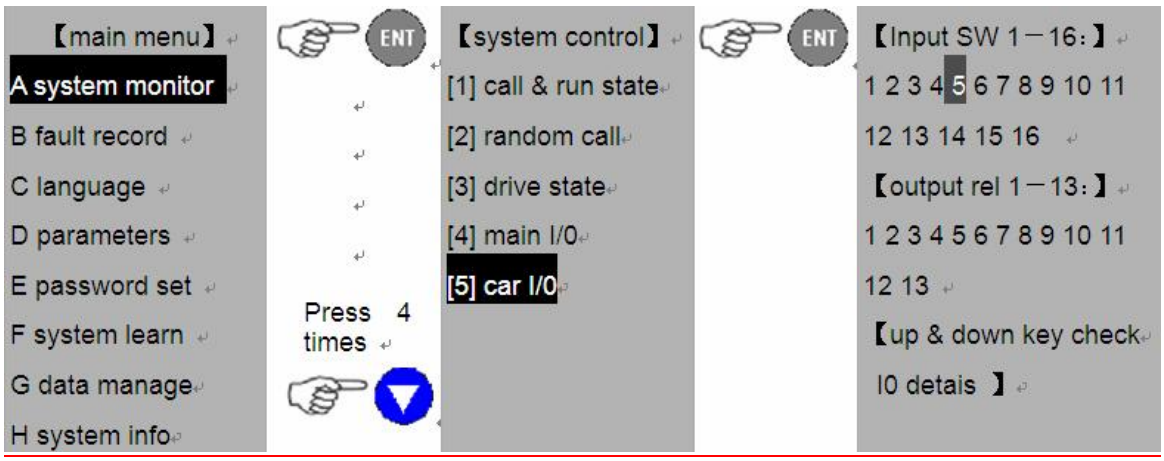
e. Check the up/down operation. Observe the speed and height feedback through the below interface, if abnormal, find and solve the problem.



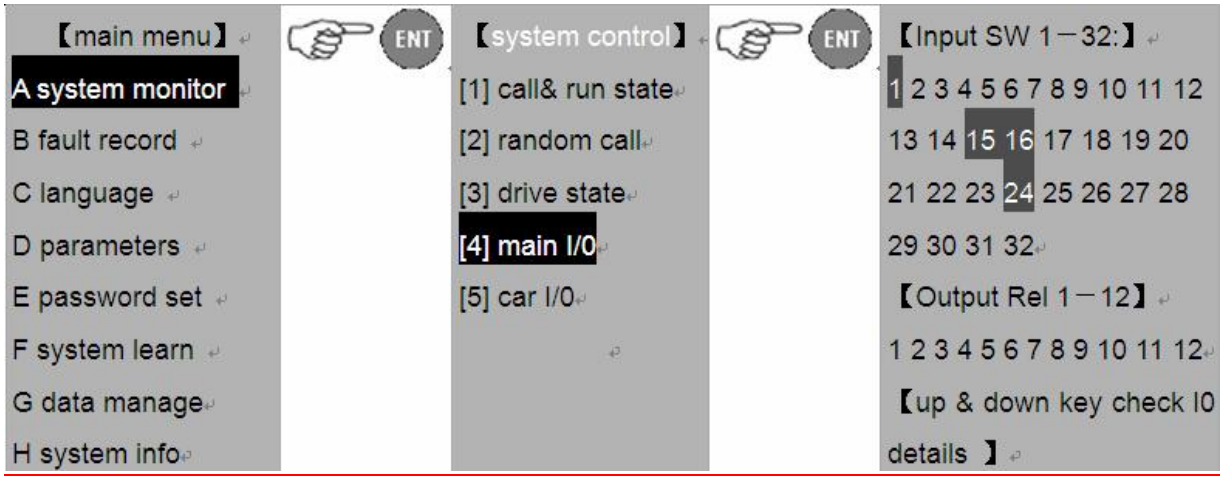
f. When the elevator runs to the door area of the bottom floor, after stopping, observe the input point on the I/O board of main controller (take the elevator of rated speed≤1.75m/s), if not, check the site wiring and logic setting.



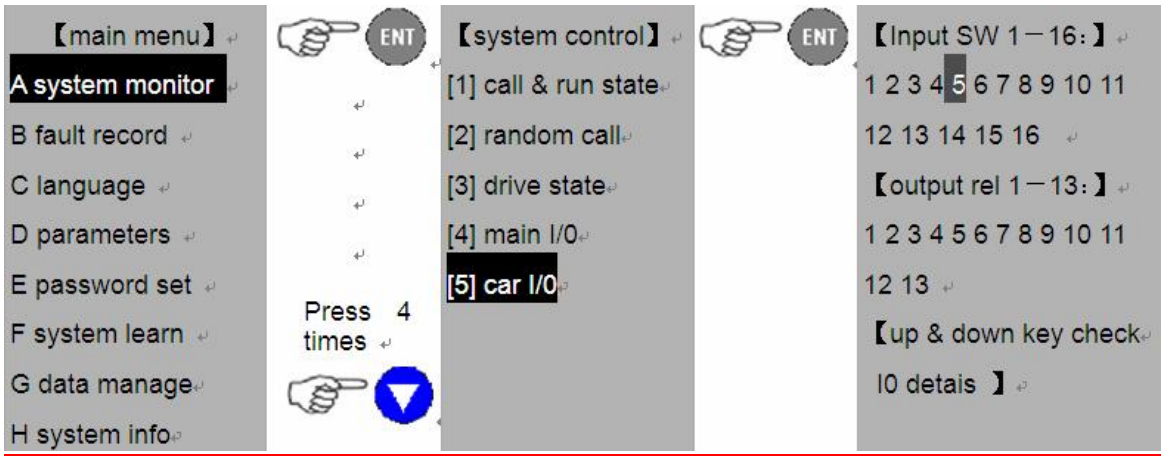
Observe the input point on the DC01 board of car controller (take the elevator of rated speed≤1.75m/s), if not, check the site wiring and logic setting.



g. Turn the elevator to normal state, after the elevator open the door totally, observe the input point on the I/O board of main controller (take the elevator of rated speed≤1.75m/s), if not, check the site wiring and logic setting.

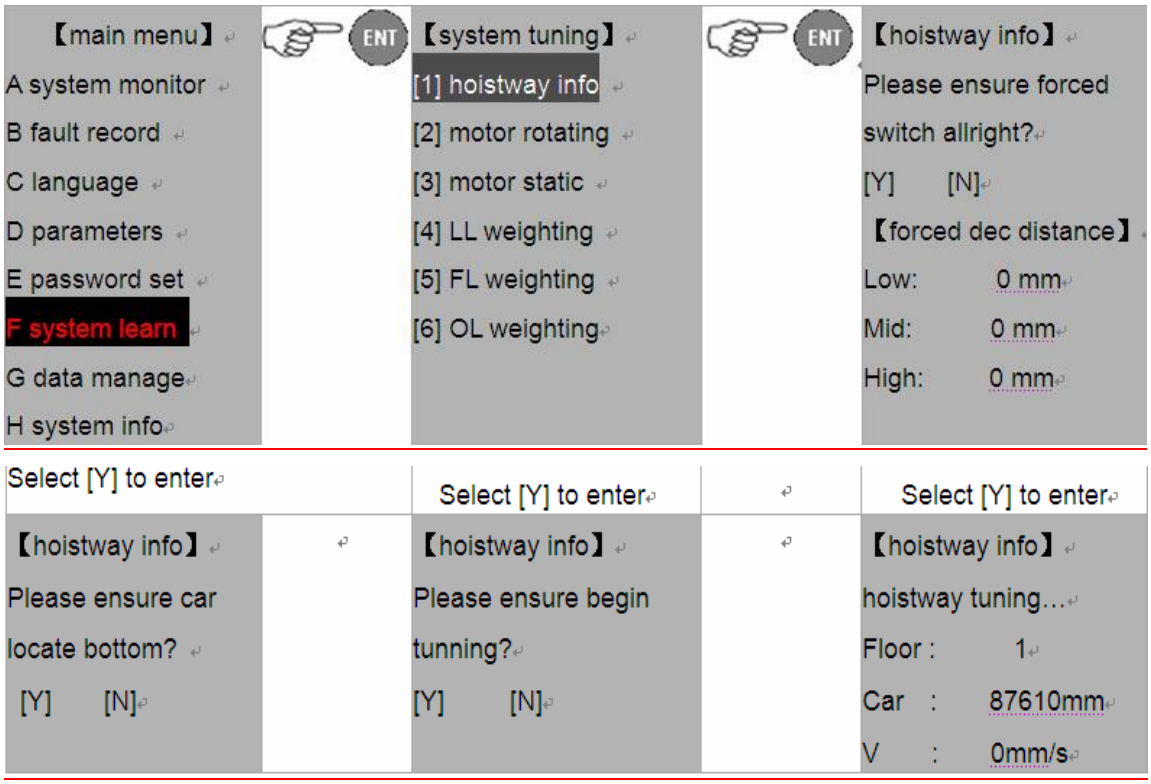


Observe the input point on the DC01 board of car controller (take the elevator of rated speed≤1.75m/s), if not, check the site wiring and logic setting.

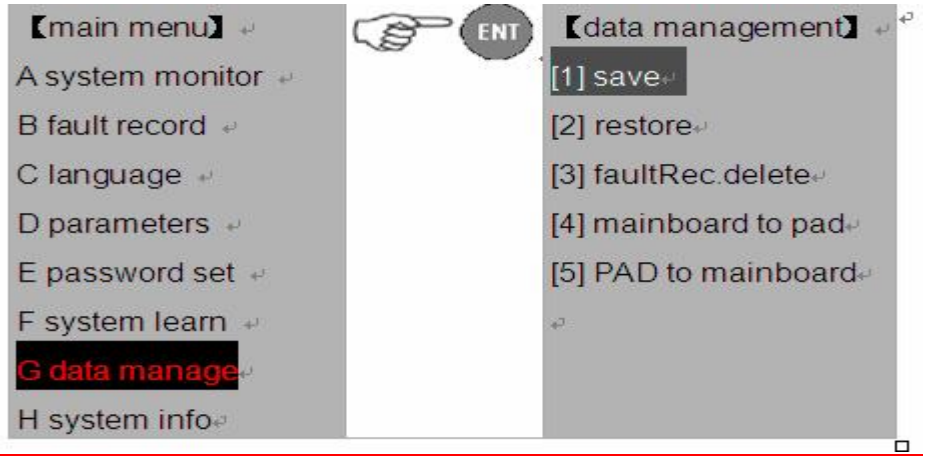


Ø Autotuning

Check the door area of the elevator at the bottom floor; force the deceleration switch, door signal to act at low speed (SDS1 off and SMDZ on). And then enter into the autotuning menu through the operation panel.



Press the up maintenance button. If not any fault, the elevator will begin hoistway autotuning at the specific speed (no need to press the button all the time during the autotuning). The elevator will stop until it runs to the top door area. If the operation screen display the autotuning is successful, then the autotuning is finished and the data will be saved after entering following interface.



Ø Fault reasons

a. Because the force deceleration switch has no valid action, note the action of SDS1 and SUS1 when the elevator is at the door area of the bottom floor. The two switches at the middle position do not act (SDS1 and SUS1 on). If not, please check the switch position and the wiring.

b. If the magnetic isolation (light isolation) boards at the door area are not sufficient or their installation positions are not correct, please note the changes of SMDZ signal consists with the main parameters, total floor numbers and the reality or not.

c. Incorrect setting of NO/NC of the magnetic switch in door area. If SMDZ is on when the door is in the door area, then set the logic of door signal as NO. If SMDZ is on when the door is in the door area, then set the logic of door signal as NC.

5.6 Test the operation in automatic mode

Call through operation panel when the elevator is in the automatic mode. Firstly call at single floor and then call at each two floors and multiple floors to check whether the elevator runs normally.

5.7 Comfortability

Motor noise, low torque and vibration may occur if the motor runs at a low speed, but modifying the parameters can settle these problems.

Function code	Description	Setting range 【default】	Recommended setting value
P4_00	ASR low speed proportion gain	0~100【40】	25

P4_01	ASR low speed integral time	0.01~10.00s【0.50】	0.50
P4_02	Speed detection low speed filtrate times	0~9【0】	0
P4_03	Switch low point frequency	0.00Hz~P4_07 【2.00】	2.00
P4_04	ASR high speed proportion gain	0~100【40】	20
P4_05	ASR high speed integral time	0.01~10.00s【0.60】	0.60
P4_06	Speed detection high speed filtrate times	0~9【0】	0
P4_07	Switch high point frequency	P4_03~P0_03 【5.00】	5.00
Function code	Description	Setting range 【default】	Recommended setting value
P4_08	ACR proportional gain P	0~65535【2000】	2000(synchronous master) 1000(asynchronous master)
P4_09	ACR integral gain I	0~65535【1000】	1000(synchronous master) 600(asynchronous master)
Function code	Description	Setting range 【default】	Recommended setting value
P4_14	Load compensation enabling	0~1【1】	1(synchronous master) 0(asynchronous master)
P4_15	Load compensation time	0.000~5.000s 【0.700】	0.700

P4_16	Reducing time of load compensation	0.000~5.000s 【0.300】	0.300
Function code	Description	Setting range 【default】	Recommended setting value
P4_17	ASR proportional gain	0~100【30】	30
P4_18	ASR integral time	0.01~10.00s【0.16】	0.160
P4_21	Current compensation coefficient	0~2000【1500】	1500

5.8 Leveling adjustment

The last step is leveling adjustment. The leveling position attained from the leveling sensor is not accurate generally, so it is necessary to adjust, modify the leveling parameters and correct the position of leveling sensor.

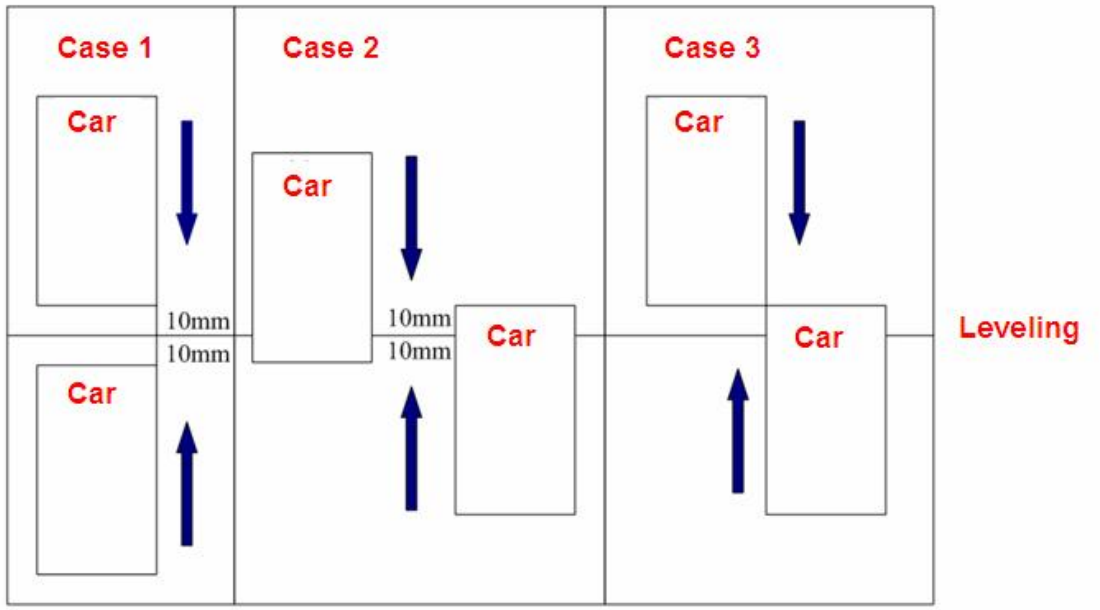
Start the elevator in automatic mode and observe the leveling state in each floor:

1: Increase P1_14 by 10mm, from the default value 50mm to 60mm if the elevator stops 10mm below the leveling position during up running or 10mm above the leveling position during down running;

2: Reduce P1_14 by 10mm, from the default value 50mm to 40mm if the elevator stops 10mm above the leveling position during up running or 10mm below the leveling position during down running;

3: If the elevator stops at the same position during up/down running other than the leveling position, the leveling position is accurate, but it is necessary to adjust the leveling sensor.

Commissioning method:



Figure

6. Conclusion

Compared with the traditional methods, the elevator intelligent integrated machines have following advantages:

- Low cost: lower than the method of traditional elevator controllers and inverters;
- Easy installation: no wiring of traditional method and save the space of control cabinet;
- One-site service: no judge when the fault of controllers and inverters occurs

It conforms to the development trend of elevator industry, and is the future development direction.

Reference:

[1] *Operational manual for EC100 elevator intelligent integrated machine*