11. Instruction Manual of Data Processing Application

11.1 Purpose

This application is designed to create a list-format CSV data by processing outputs from the Data Analysis and Loacation application. The application is capable of performing the following two processing:

(1) Tabulation processing: manipulate the outputs from the Data Analysis and Location setting application.
(2) Coupling: combines together the output of the tabulation process.

11.2 Input and Output Data

The data used by and output by this application is as described in Table 11.1.

Table 11.1 Input and Output Data of the Data Processing Application

Tabulation/Coupling	Input Data	Description	Output Data
Tabulation	P_***.csv	Output from the Location Setting Application	DPP_***.csv
	R3_***.csv	Output from the Data Analysis application(rutting)	
	C3_***.csv	Output from the Data Analysis application(cracking)	
	S3_***.csv	Output from the Data Analysis application(IRI data)	
Coupling	DPP_***.csv	Output from the Data Processing application	***.csv

11.3 Equipment

Equipment required for this application is as described in Table 11.2.

Table 11.2 List of Equipment

Equipment	Image	Notes
Computer		
External hard drive (HDD)		External hard drive containing data (HDD)
This Application		
Road information resources		Field survey, field notes, drawings, official documents and others.

11.4 Interface and Contents

(1) Tabulation Processing

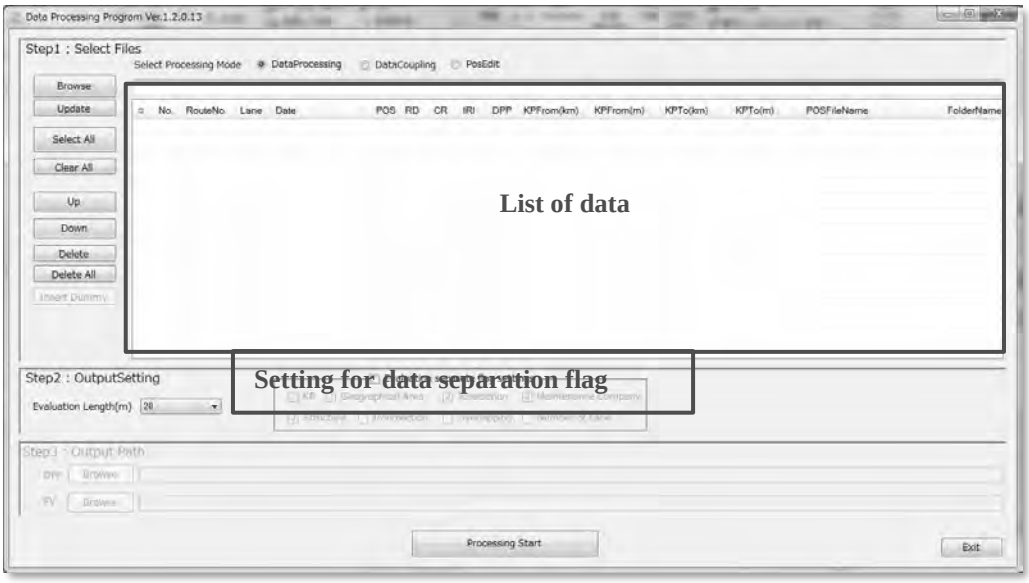
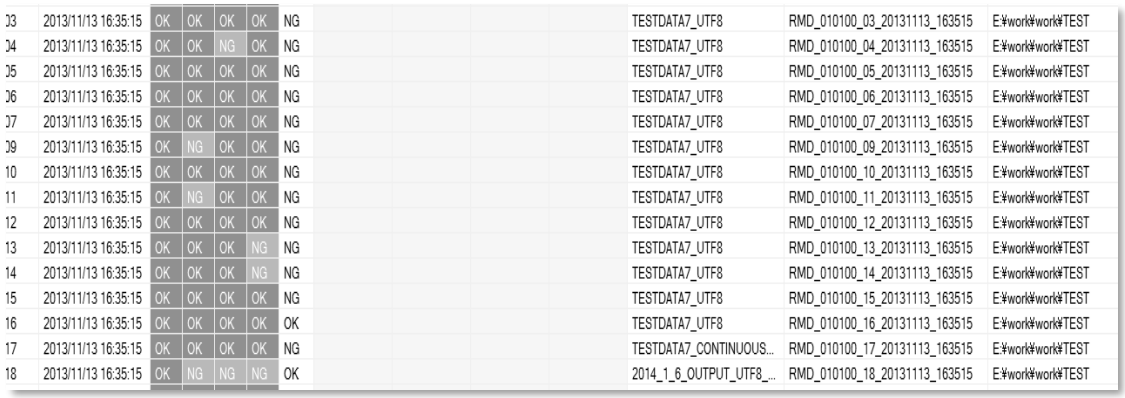


Figure 11.1 Main Menu of the Tabulation Process

Table 11.3 Features of the Main Menu of the Tabulation Processing

Item	Description	Notes
Step1 : Select Files	Select the target file for the tabulation processing	
Select Process Mode	Switch between processing modes	Processing: tabulation processing Coupling: coupling processing PosEdit:Position edit processing
Browse	Displays the folder selection dialog.	-
Text Box	Displays the selected folder path.	Direct input or drag & drop.
List	Displays the list of analysis folders in the selected folder.	Drag & drop accepted. See Figure 11.2 and Table 11.4.
Update	Updates the entire list of records to the latest status	-
Select All	Selects all records valid for processing.	-
Clear All	Deselects the entire record.	-
Up	Moves the selected record up.	Multiple selection is allowed.
Down	Moves the selected record down.	Multiple selection is allowed.
Delete	Deletes the selected record from the list.	Multiple selection is allowed.
Delete All	Deletes all of the records from the list.	-
Insert Dummy		Not used for the tabulation processing.

Step2:Output Setting	Performs settings for the tabulation.	
Evaluation Length	Specifies the evaluation unit for tabulation.	-
Data separation flag setting	Selects the item to separate records.	See Figure 11.3 and Table 11.5
Step3:Output Folder		Not used for tabulation
Browse	-	-
Text box	-	-
Processing Start	Begin processing	-
End	Exit the application.	-



03	2013/11/13 16:35:15	OK	OK	OK	OK	NG		TESTDATA7_UTF8	RMD_010100_03_20131113_163515	E:¥work¥work¥TEST
04	2013/11/13 16:35:15	OK	OK	NG	OK	NG		TESTDATA7_UTF8	RMD_010100_04_20131113_163515	E:¥work¥work¥TEST
05	2013/11/13 16:35:15	OK	OK	OK	OK	NG		TESTDATA7_UTF8	RMD_010100_05_20131113_163515	E:¥work¥work¥TEST
06	2013/11/13 16:35:15	OK	OK	OK	OK	NG		TESTDATA7_UTF8	RMD_010100_06_20131113_163515	E:¥work¥work¥TEST
07	2013/11/13 16:35:15	OK	OK	OK	OK	NG		TESTDATA7_UTF8	RMD_010100_07_20131113_163515	E:¥work¥work¥TEST
09	2013/11/13 16:35:15	OK	NG	OK	OK	NG		TESTDATA7_UTF8	RMD_010100_09_20131113_163515	E:¥work¥work¥TEST
10	2013/11/13 16:35:15	OK	OK	OK	OK	NG		TESTDATA7_UTF8	RMD_010100_10_20131113_163515	E:¥work¥work¥TEST
11	2013/11/13 16:35:15	OK	NG	OK	OK	NG		TESTDATA7_UTF8	RMD_010100_11_20131113_163515	E:¥work¥work¥TEST
12	2013/11/13 16:35:15	OK	OK	OK	OK	NG		TESTDATA7_UTF8	RMD_010100_12_20131113_163515	E:¥work¥work¥TEST
13	2013/11/13 16:35:15	OK	OK	OK	NG	NG		TESTDATA7_UTF8	RMD_010100_13_20131113_163515	E:¥work¥work¥TEST
14	2013/11/13 16:35:15	OK	OK	OK	NG	NG		TESTDATA7_UTF8	RMD_010100_14_20131113_163515	E:¥work¥work¥TEST
15	2013/11/13 16:35:15	OK	OK	OK	OK	NG		TESTDATA7_UTF8	RMD_010100_15_20131113_163515	E:¥work¥work¥TEST
16	2013/11/13 16:35:15	OK	OK	OK	OK	OK		TESTDATA7_UTF8	RMD_010100_16_20131113_163515	E:¥work¥work¥TEST
17	2013/11/13 16:35:15	OK	OK	OK	OK	NG		TESTDATA7_CONTINUOUS...	RMD_010100_17_20131113_163515	E:¥work¥work¥TEST
18	2013/11/13 16:35:15	OK	NG	NG	NG	OK		2014_1_6_OUTPUT_UTF8_...	RMD_010100_18_20131113_163515	E:¥work¥work¥TEST

Figure 11.2 Details of the Tabulation Processing List

Table 11.4 Contents of the Tabulation Process List

Item	Description	Notes
☐ (Checkbox)	Checkbox. Used for selecting the record for the processing.	A POS file and any one of the RD, CR or IRI is necessary to enable the checkbox.
No.	Serial number, starting at 1 from the first record on the list.	-
Road No.	Road number.	Road Category (1)+Road No. (3)+Road No. Supplement (3)+Branch No. (3)
Lane	Number of traffic lanes.	-
Date	Date and time.	-
POS	"OK" is displayed when the existence of a Location Setting Application output file (P_***.csv) can be found, and "NG" is displayed when it cannot be found.	-
RD	"OK" is displayed when the Data Analysis application output (R3_***.csv) can be found, and "NG" is displayed when it cannot be found.	-
CR	"OK" is displayed when the Data Analysis application output (C3_***.csv) can be found and	-

	"NG" is displayed when it cannot be found.	
IRI	"OK" is displayed when the Data Analysis application output (S3_***.csv) can be found, and "NG" is displayed when it cannot be found.	-
DPP	"OK" is displayed when the Data Processing application output (DPP_***.csv) can be found, and "NG" is displayed when it cannot be found.	-
KPFrom(km)	Allow to directly input the station of starting point(unit:km)	The value already configured with the Location Setting Application will be overwritten. Accepts input of a numerical value in 5 digits (including a hyphen '-')
KPFrom(m)	Allow to directly input the station of starting point(unit:m)	Accepts manual input of 5 digits (including a hyphen '-')
KPTo(km)	Allow to directly input the station of ending point(unit:km)	The value already configured with the Location Setting Application will be overwritten. Accepts input of a numerical value in 5 digits (including a hyphen '-')
KPTo(m)	Allow to directly input the station of ending point(unit:m)	Accepts manual input of 5 digits (including a hyphen '-')
Folder Name	Name of folder for the record	-
Folder Path	Folder path of the record.	-

Figure 11.3 Details of the Data Separation Flag Setting Section

Table 11.5 Features of the Data Separation Flag Setting Section

Item	Description	Notes
Data separation flag setting	Selecting the checkbox allows the data separation flag settings to be changed.	-
KP	Separates the tabulation by Kilometer Posts (KP)	Required
Geographical Area	Separates by geographical area.	Required
Jurisdiction	Separates by jurisdictions.	Required
Maintenance Company	Separates by maintenance companies.	Required
Structure	Separates by structures.	Required
Intersection	Separates by intersections.	-
Overlapping	Separates by overlaps.	-

(2) Coupling Processing

<Main Menu>

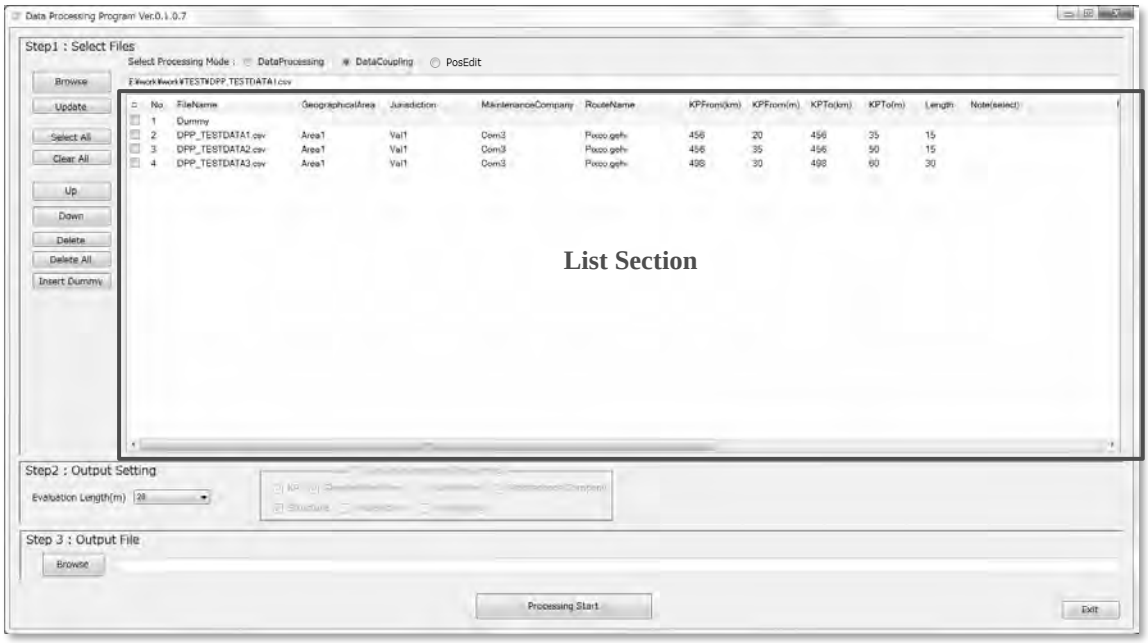


Figure 11.4 Main Menu of the Coupling Processing

Table 11.6 Features of the Main Menu of the Coupling Processing

Item	Description	Notes
Step1 : Select Files		
Select Process Mode	Switch between processing	Processing: tabulation processing Coupling: coupling processing PosEdit:Position edit processing
Browse	Displays the folder selection dialog	-
Text box	Displays the selected folder path.	Direct input or drag & drop.
List	Displays a list of tabulation files within the selected folder.	Accepts drag & drop
Update	Updates the list.	-
Select All	Selects the entire list of records.	-
Clear All	Deselects the entire list.	-
Up	Moves the selected record up.	Multiple selection is allowed.
Down	Moves the selected record down.	Multiple selection is allowed.
Delete	Deletes the selected record from the list.	Multiple selection is allowed.
Delete All	Deletes the entire set of records.	Multiple selection is allowed.
Insert Dummy	Inserts a placeholder record.	-
Step2:Output Setting		
Evaluation Length	Specifies the evaluation unit length for tabulation.	-
Data Separation Flag Setting	Not used for the coupling process.	Not used for the coupling process
Step3:Output Folder		

Browse	Opens the file storage dialog.	-
Text box	File name of the storage destination.	Direct input is accepted.
Processing Start	Begins the process	-
End	Exits the application.	-

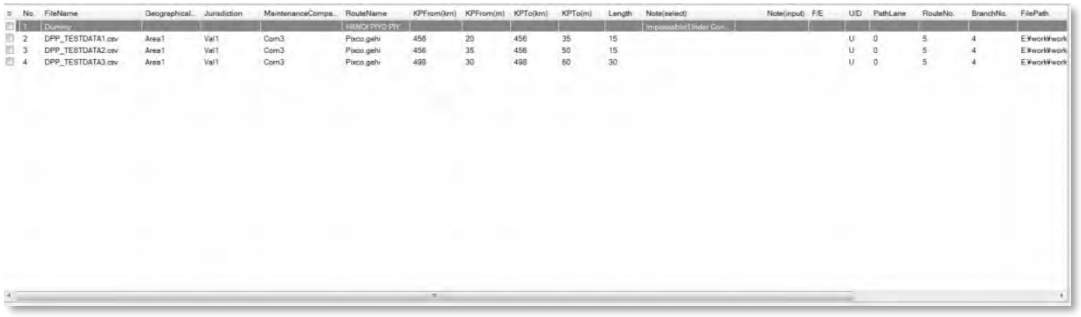


Figure 11.5 **Details of the Coupling Processing List**

Table 11.7 Contents of the Coupling Processing List

Item	Description	Notes
☐ (Checkbox)	Checkbox. Used for selecting the record to process.	-
No.	A serial number starting at 1 from the first record of the list.	-
File Name	Displays the file name	-
Geographical Area	Displays/configures the geographical area.	Select for dummy record. (required)
Jurisdiction	Displays/configures the jurisdiction.	Select for dummy record. (required0
Maintenance Company	Displays/configures the maintenance company.	Select for dummy record. (Required)
Road Name	Displays/configures the road name.	Select for dummy records. (Required)
KPFrom(km)	Displays/configures the originating Kilo Post (kilometers)	For a dummy) record, enter a 5 digit numerical value (including a hyphen '-').
KPFrom(m)	Displays/configures the originating Kilo Post (meters).	For a dummy) record, enter a 5 digit numerical value (including a hyphen '-').
KPTo(km)	Displays/configures the destination Kilo Post (kilometers)	For a dummy record, enter a 5 digit numerical value (including a hyphen '-').
KPTo(m)	Displays/configures the destination Kilo Post (meters)	For a dummy record, enter a 5 digit numerical value.
Length	Displays/configures the length of the record.	For a dummy record, enter a 5 digit numerical value (including a hyphen).
Note(select)	Configures the note for the dummy record.	Select for dummy record (Required)
Note(input)	Configures the note for the dummy record.	-
F/E	Configures the notes position of the	F:First Record

	dummy record.	E:Final Record
L/R	Displays the Left-bound/Right-bound classification.	-
Path Lane	Displays the traffic lane.	-
Road No.	Displays the road number.	-
Branch No.	Displays the branch number.	-
File Path	Displays the file path.	-

<Processing Menu>

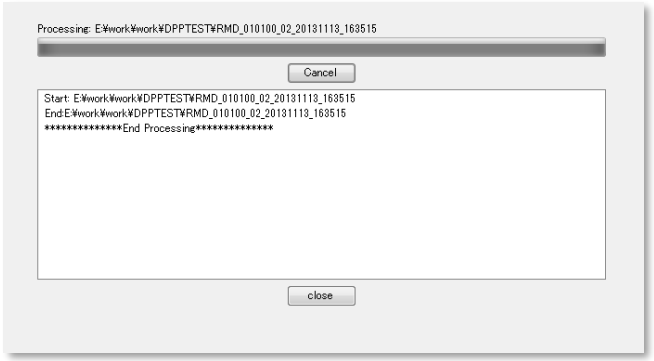


Figure 11.6 Processing Window

Table 11.8 Contents of the Processing Window

Item	Description	Notes
Text box	Displays the content of the current processing	-
Progress bar	Displays the progress of the entire processing.	-
Cancel	Interrupts the processing.	-
Process log	Displays the log of the current processing.	-
Close	Closes the window.	This item is enabled only when the entire processing is complete, or when Cancel is selected.

11.5 Operation Procedure

(1) Workflow for the Tabulation Processing

The workflow of the tabulation processing is as described in Figure 11.7.

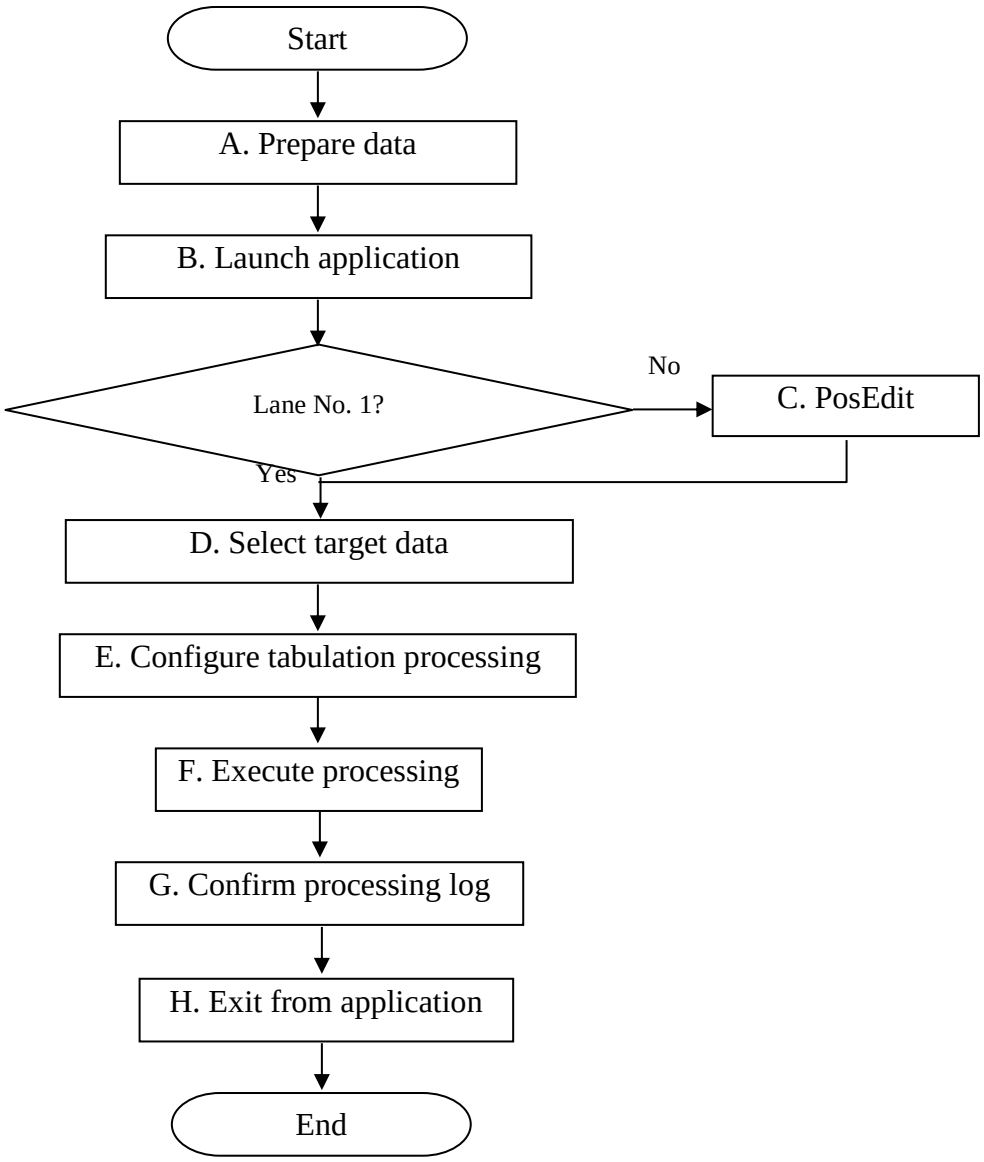


Figure 11.7 Workflow

(2) Procedure for the Tabulation Processing

A. Prepare Data

Copy the following data to the analysis data folder (RMD_***): cracking data (CS3_***.csv), rutting data (R3_***.csv) and surface flatness data (S3_***.csv) output from the Data Analysis application and the output from the Location Setting Application (P_***.csv).

B. Launch the Application

Double click the icon shown below to launch the application.

Figure 11.8 Icon of the Application

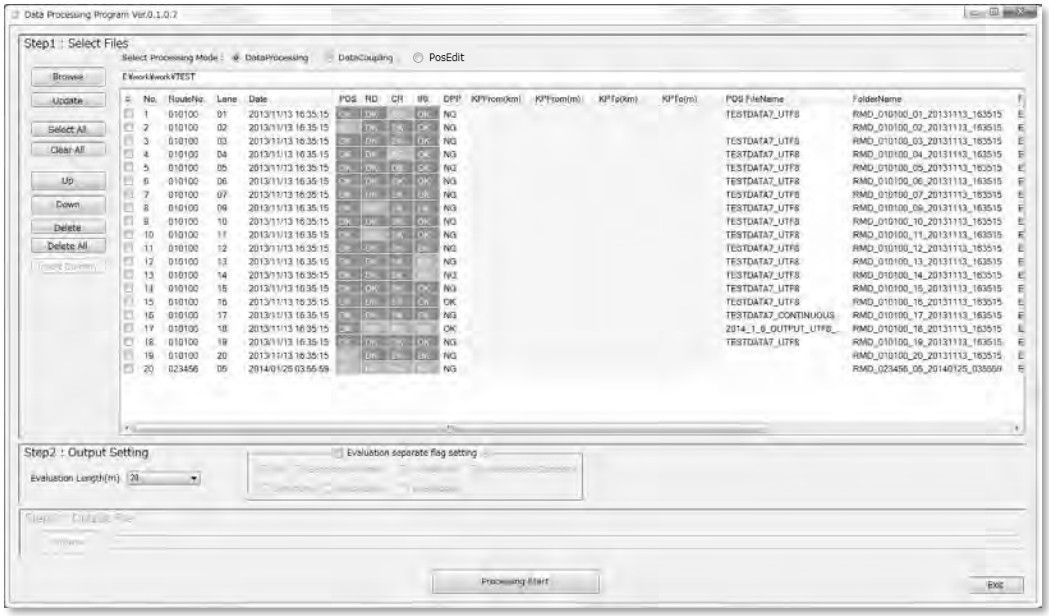


Figure 11.9 Launching the Application

C. PosEdit

In case of multiple lane section, the survey is conducted in each lane . Data processing work shall be done lane by lane. To keep compatibility of the position between adjacent lanes, the data of 2nd lane and 3rd lane is prepared with same attributes of location information as 1st lane.

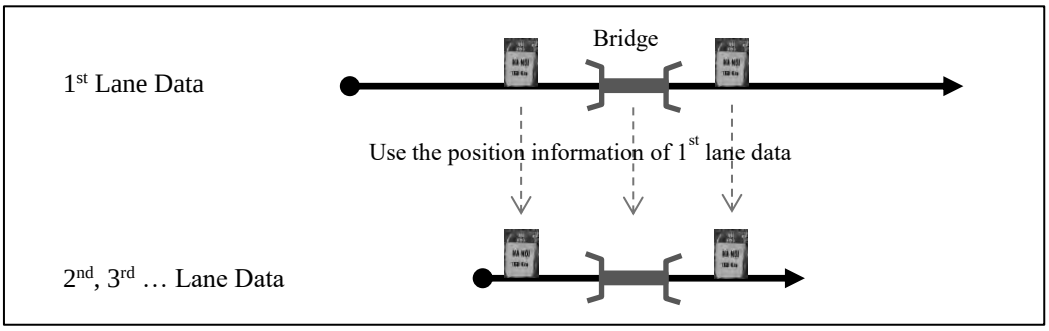


Figure 11.10 PosEdit overview

The procedure of the operation of "PosEdit" show from 1) to 10).

The procedure to make the position file of 2nd lane is following. The next files are used in PosEdit.
- Position file of 1st lane (P_******.csv)
- Output file from the data analysis application of 2nd lane (C_******.csv)

1) To copy the position file on 1st lane to saved folder of analyzed data of 2nd lane.

2) To rename the copied position file of 1st lane. The file name is same with the output file name as 6 digit.

   Ex: The name of output file name of 2nd lane; C_123456.csv

   The name of copied position file; P_123456.csv

3) To start Data Processing Application

   Double click the icon of application to launch the application.

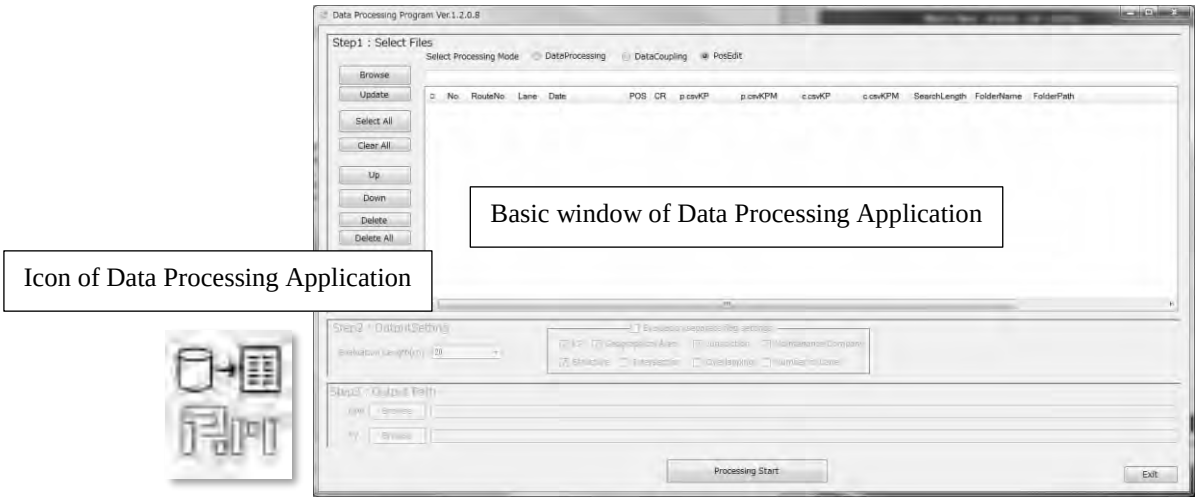


Figure 11.11 The icon and basic window of Data Processing Application

4) To select the "PosEdit" in the window of Data Processing Application.

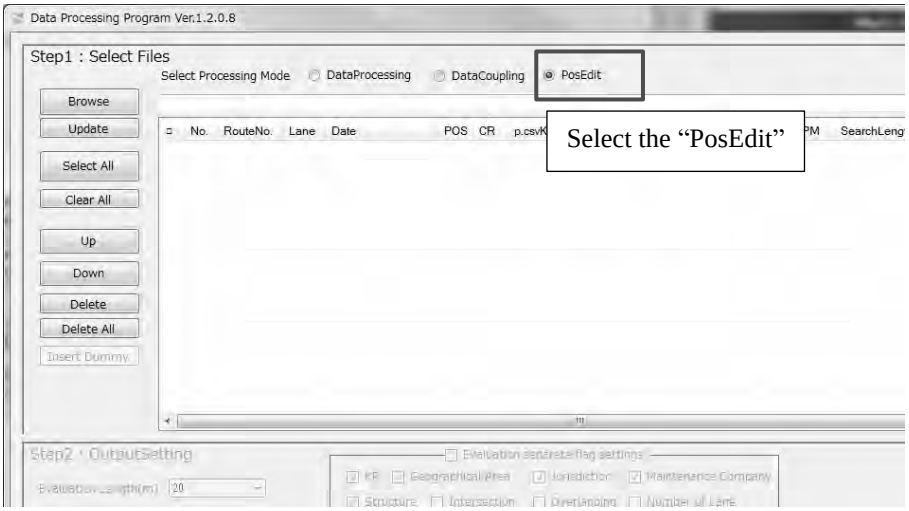


Figure 11.12 Selection of "PosEdit"

5) To click “Brows” and select the folder where saved analyzed data.

Figure 11.13 Selection of target data

6) To select for making the 2nd lane on the displayed list and input the KP number of start point to input box of application.

For example following case, operator input the KP number as below figure.
- Start point of 1st lane: 51km+140m
- Start point of 2nd lane: 51km+410m

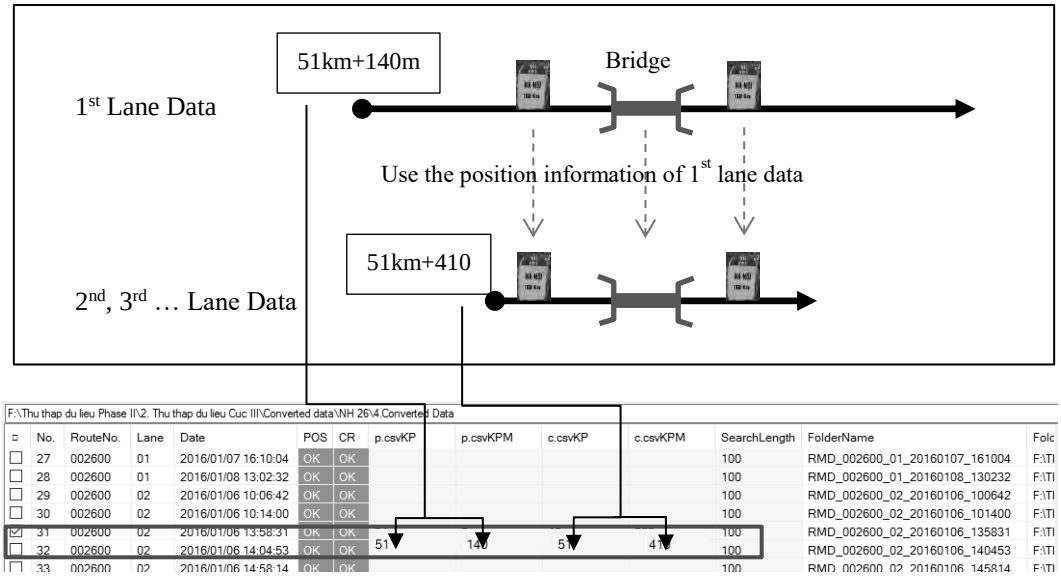


Figure 11.14 Input the KP number into the PosEdit (In case the start point are different)

If the start point of 1st and 2nd lane is same, operator input the same number to input box of application. And operator should input “0” into “Search length”.

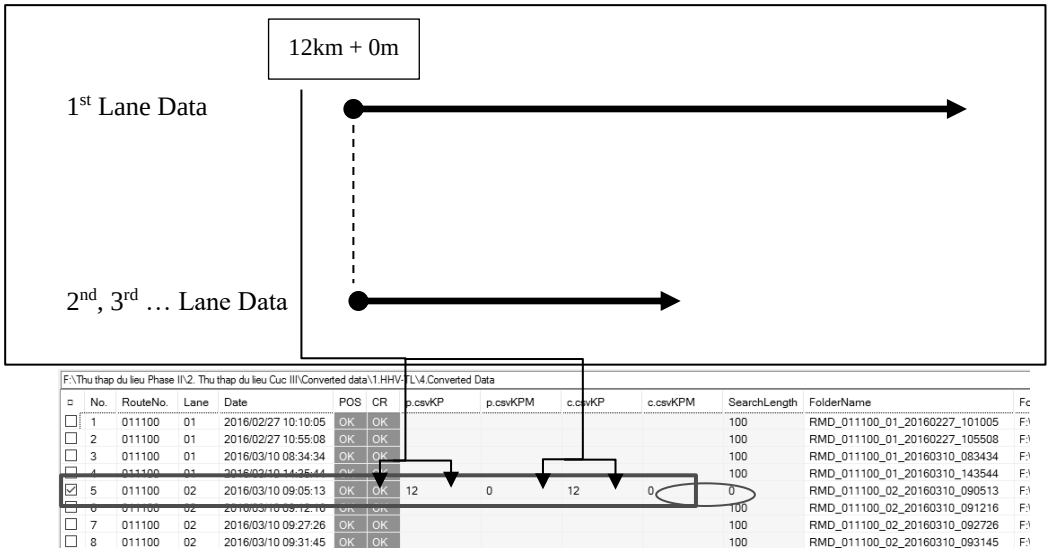


Figure 11.15 Input the KP number into the PosEdit (In case the start point are same)

7) To click "Processing Start" and start the processing

After complete the processing, copied position file of 1st lane will be changed to position file of 2nd lane. The end position automatically determined from the distance information of "C_******.csv".

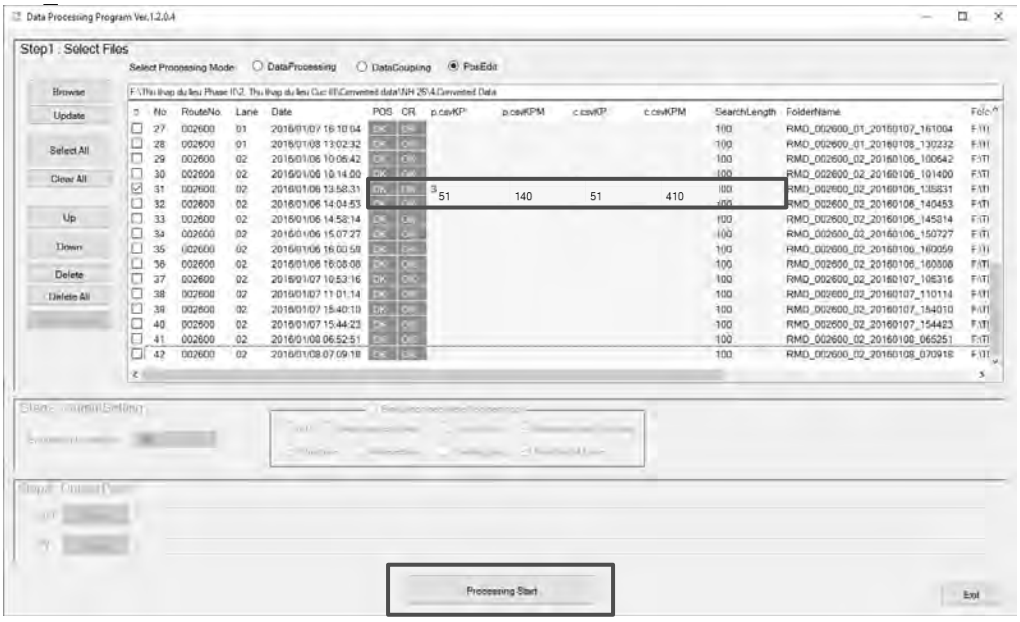


Figure 11.16 "Processing Start" button

D. Select the Target Data

From [Select Processing Mode] in application window, select [Data Processing].

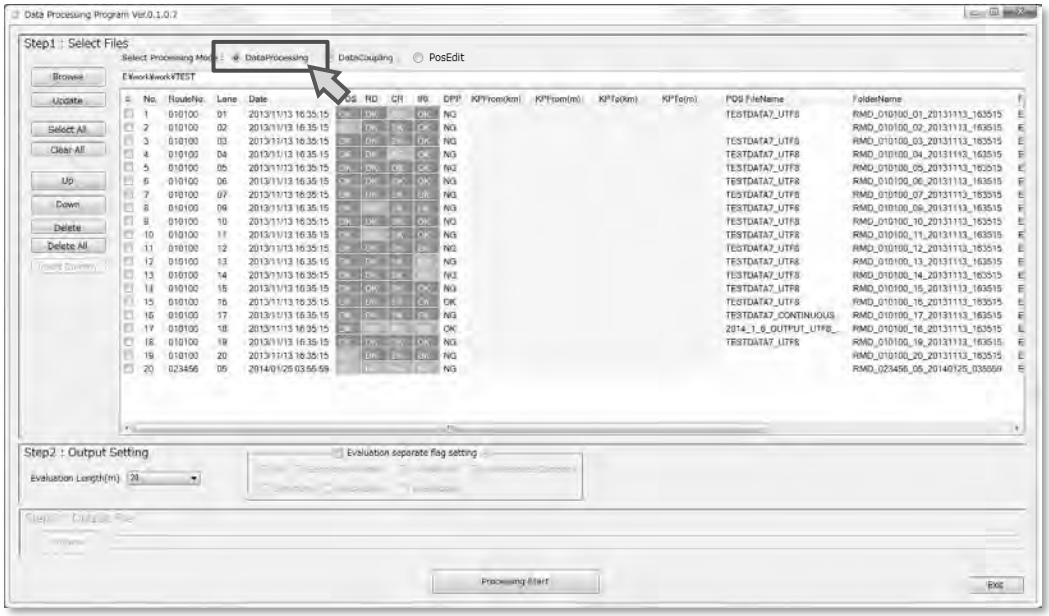


Figure 11.17 Slect data processing function

From the main menu of the launched application, click the [Browse] button and select the folder containing the analysis data folder (RMD_***) created in step [A. Prepare Data].

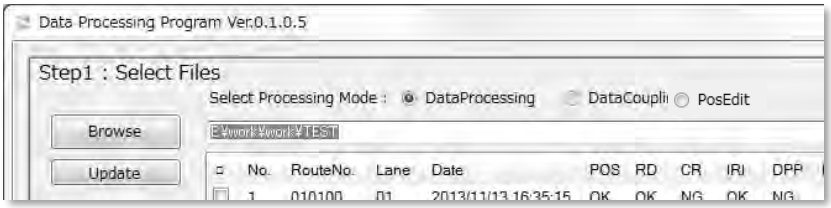


Figure 11.18 Selecting the Data Folder

Click the checkbox for the data to perform the tabulation processing. Here, as seen in Figure 11.20 , the POS column and at least one of the remaining three columns (RD, CR, and IRI), shown in the blue box, must indicate [OK] for the application to accept the data as a valid data to process.

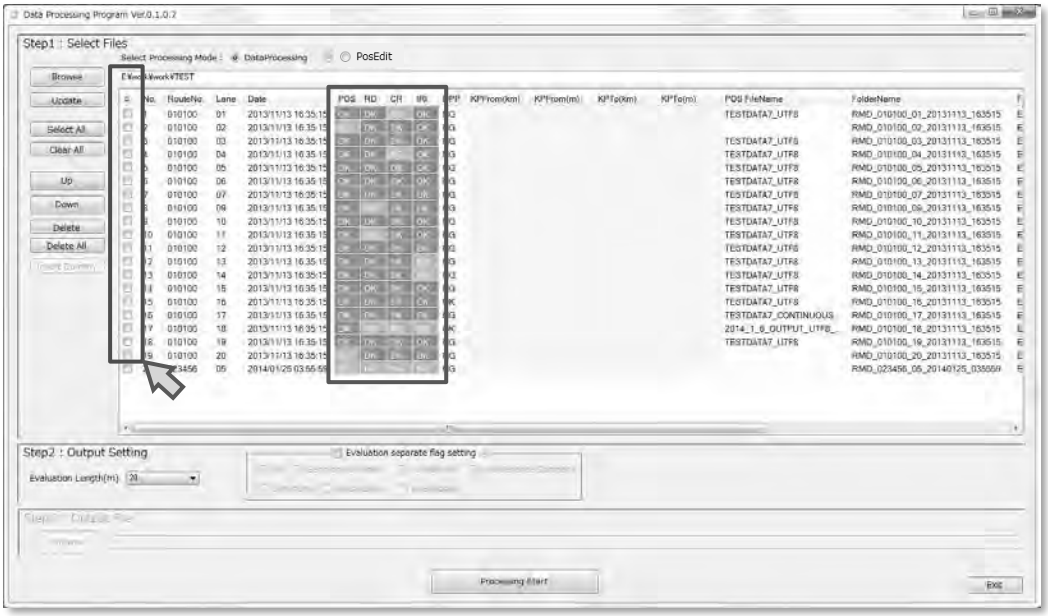


Figure 11.19 Selecting the Target Data

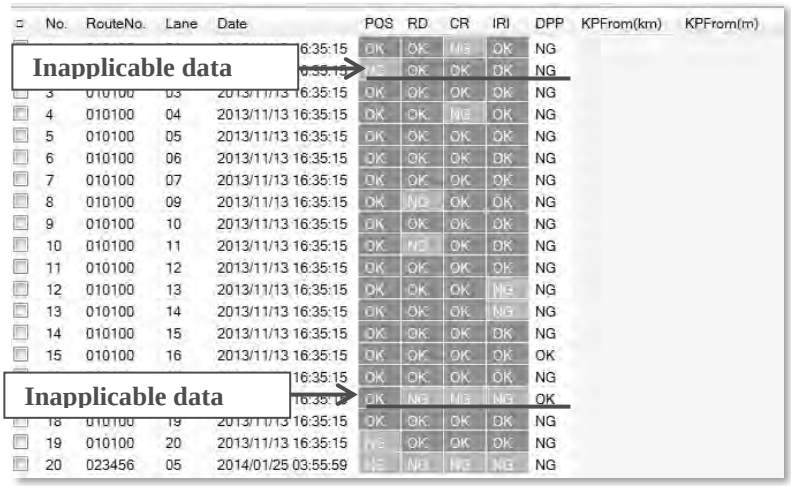


Figure 11.20 Example of Inapplicable Data

Tips-1 Use Drag & Drop to Specify

The target data can be selected by drag & drop.

Figure 11.21 Specifying a Folder Using Drag & Drop

Enter the originating station number of the target data by specifying the KP (km) and KP (m) values following the format shown in the examples of Table 11.9.

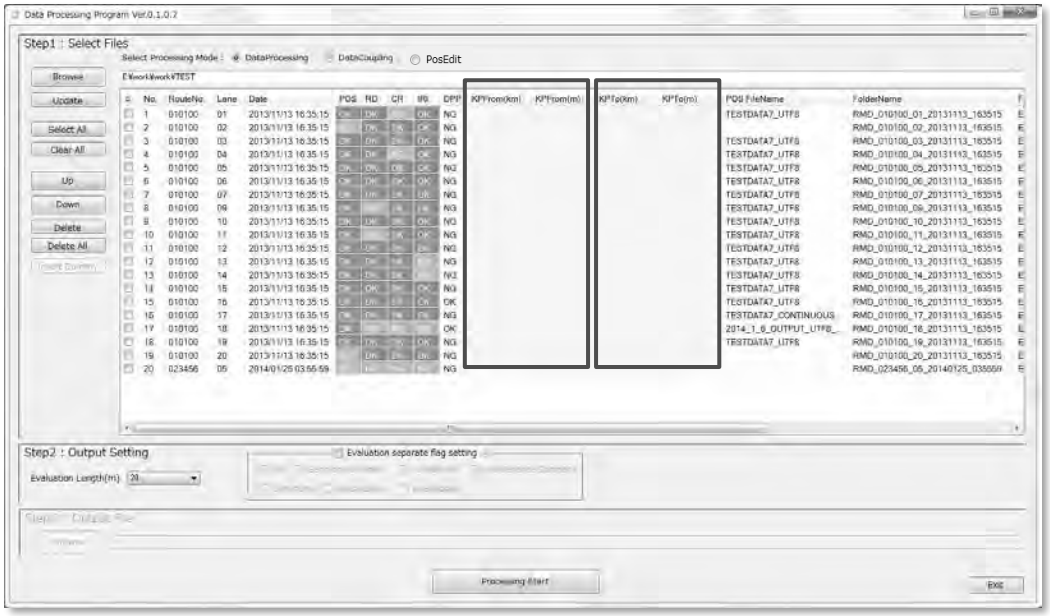


Figure 11.22 Entering of KP (km) and KP (m)

Table 11.9 Example of KP(km) and KP(m) Input

Station No.	KPFrom(km) KPTo(km)	KPFrom(m) KPTo(m)
0kp+0m	0	0
34kp+240m	34	240
120kp+1040m	120	1040
-0kp+500m	-0	500

E. Configure the Tabulation Processing

Select the evaluation unit length from the [Evaluation Length] pulldown list.

Figure 11.23 Setting of the Evaluation Unit Length

Next, configure how to separate the data. Item numbers 1 to 5 of Table 11.10 must always have the checkbox selected.

Figure 11.24 Details of Data Separation Flag Setting

Table 11.10 Contents of the Data Separation Flag Setting

No.	Item	Description	Notes
1	KP	Separates the tabulation by Kilo Posts.	Required
2	Geographical Area	Separates the tabulation by geographical areas.	Required
3	Jurisdiction	Separates the tabulation by jurisdictions.	Required
4	Maintenance Company	Separates the tabulation by maintenance companies.	Required
5	Structure	Separates the tabulation by structures	Required
6	Intersection	Separates the tabulation by intersections	-
7	Overlapping	Separates the tabulation by overlaps.	-

F. Execution of the Processing

Click on the [Processing Start] button to execute the processing.

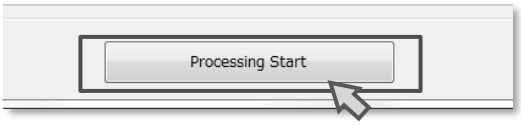


Figure 11.25 Processing Start Button

G. Confirm Processing Log

Confirm that there are no errors generated and click on the [Close] button.

If an error has occurred, “Error” will be displayed. Any files displayed as “Error” during the execution of the processing are not processed and thus must be verified.

Figure 11.26 Processing Window

G. Exit the Application

Click on the [Exit] button to exit from the application.

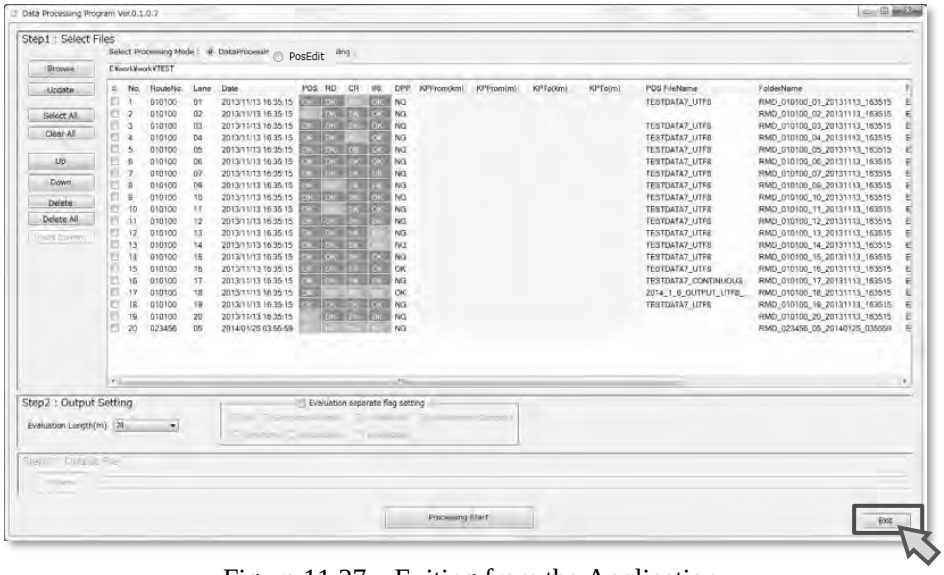


Figure 11.27 Exiting from the Application

(3) Workflow for the Coupling Processing

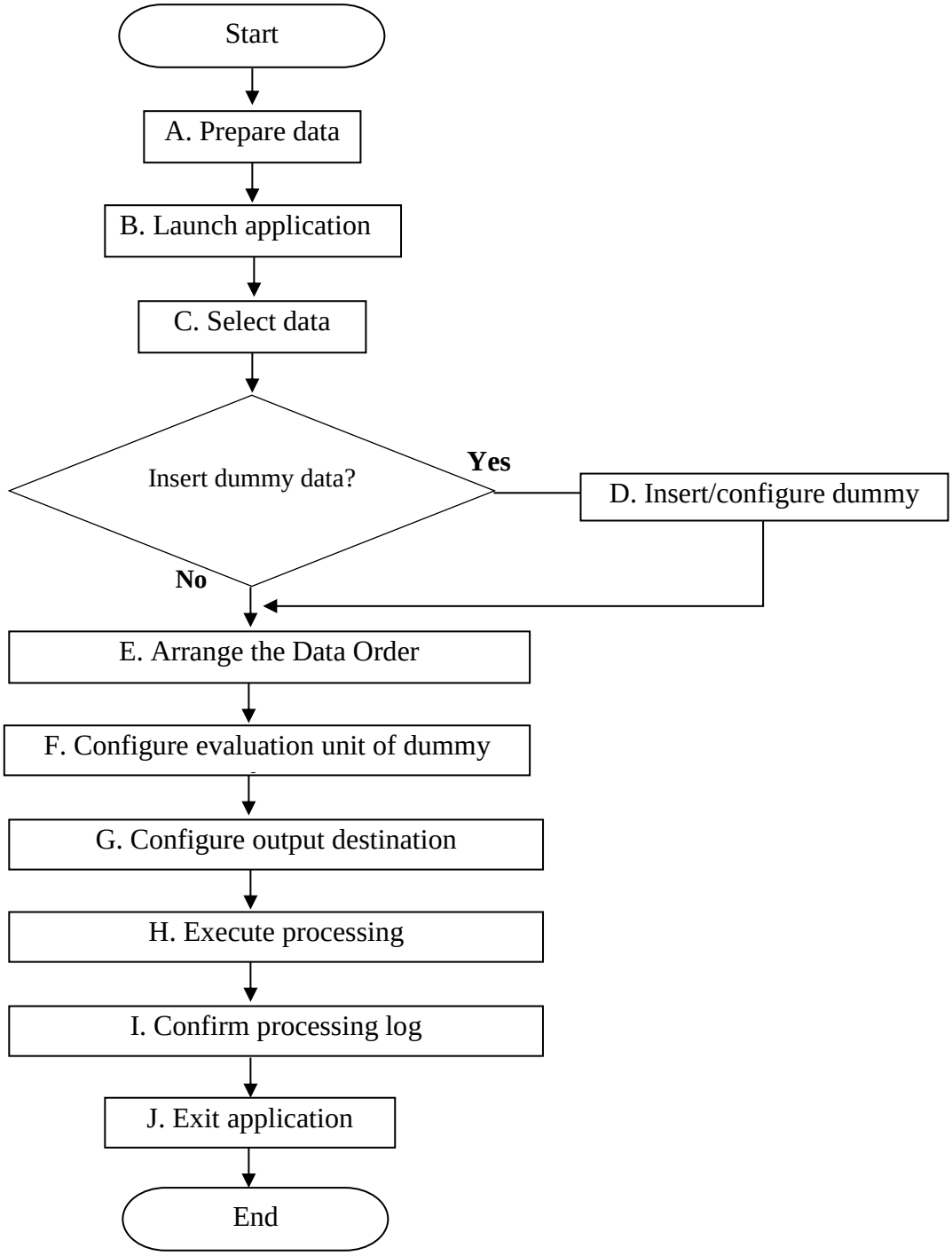


Figure 11.28 Workflow

(4) Procedure for the Coupling Processing

A. Prepare Data
Prepare the output of the Data Processing application (DPP_***.csv) for the data coupling.

B. Launch the Application
Double click the following icon to launch the application.

Figure 11.29 Icon of the Application

From [Select Processing Mode], select [DataCoupling].

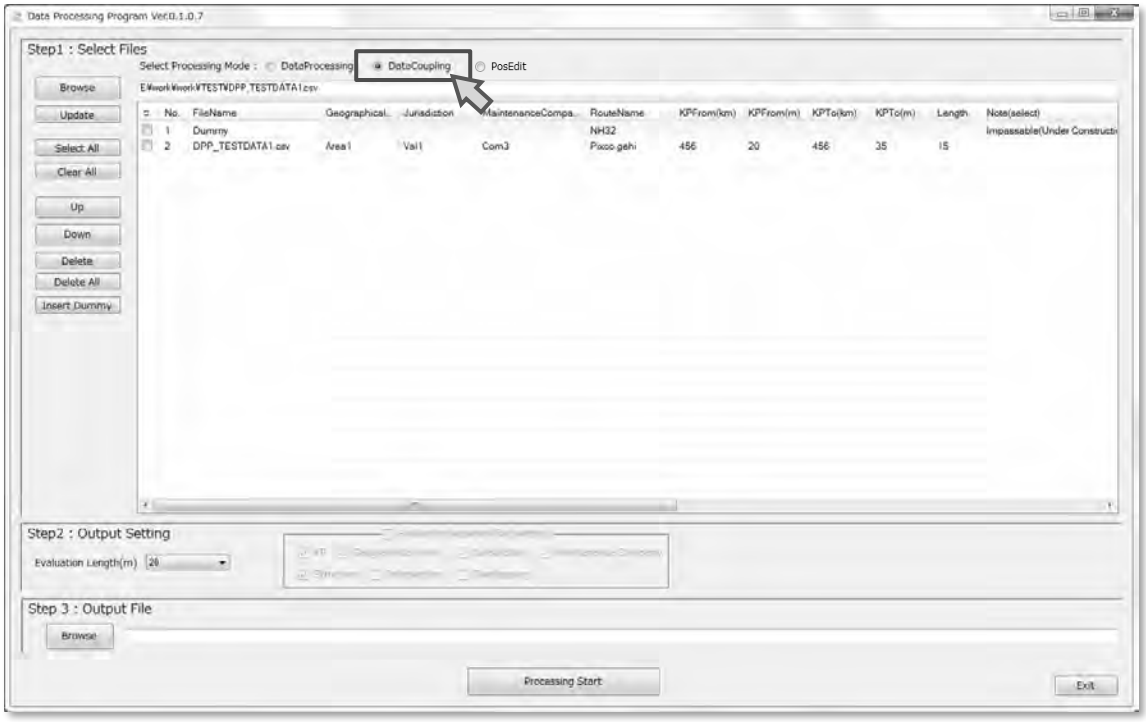
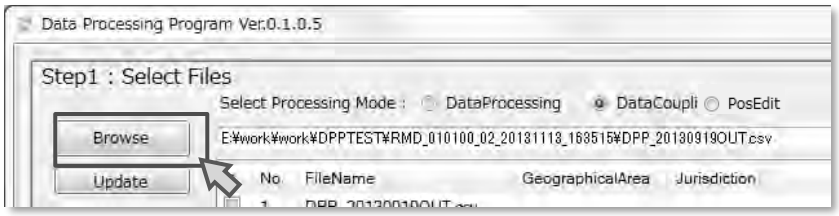


Figure 11.30 Launching of the Application

C. Select Data

From the main menu of the launched application, click on the [Browse] button and specify the tabulation output data (DPP_***.csv) prepared in Step [A. Prepare Data]. Multiple data can be selected.



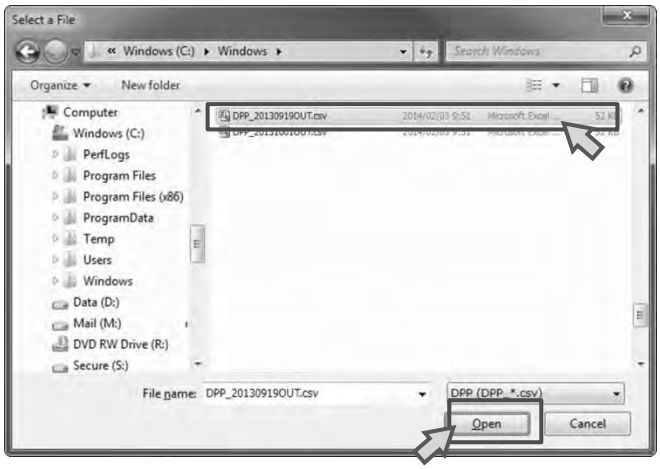


Figure 11.31 Selecting the Data

D. Insert/Configure Dummy Data

Dummy data (placeholder data) should be created when the regular road is blocked and cannot be traveled due to road constructions or an international border area or for other reasons.

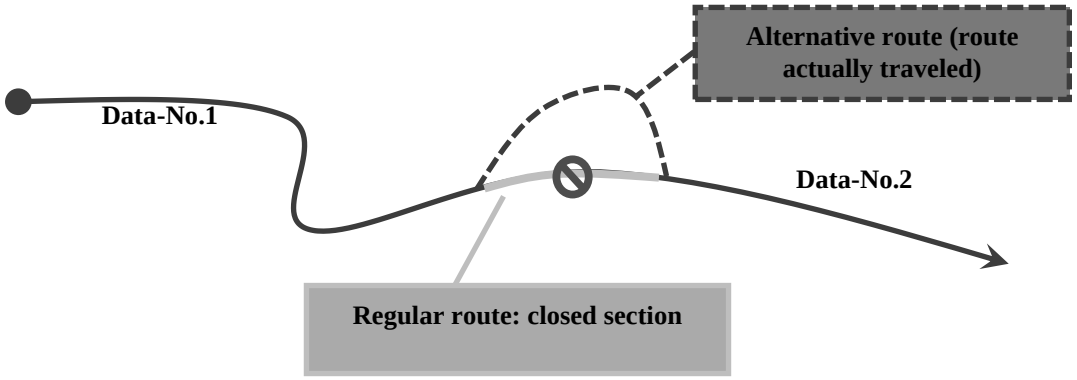


Figure 11.32 Example of a Situation Requiring a Dummy Data

To insert a dummy data to fill between data sets to couple, click on the [Insert Dummy] button as seen in Figure 11.33. The dummy data will be inserted in the place of the currently selected record, and if no record is selected, the dummy data will be inserted at the very bottom of the list.

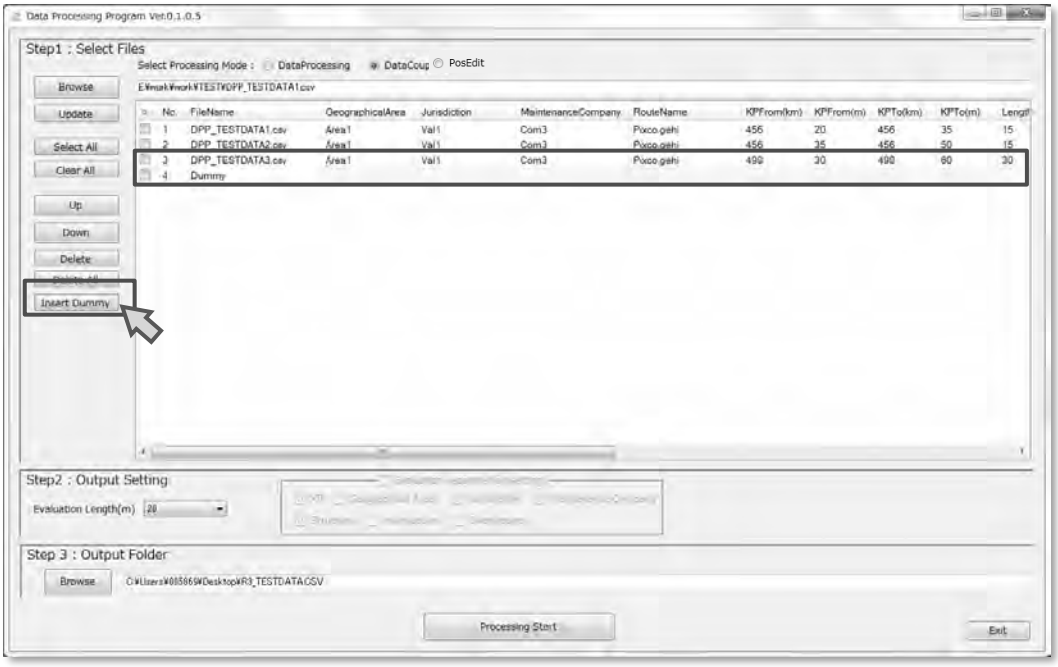


Figure 11.33 Inserting a Dummy Data

A dummy data must have the items listed in Table 11.11 configured. Click on the yellow cell show in Table 11.11 to configure the items.

Table 11.11 Contents of the Dummy Data Setting Items

No.	Item	Description	Notes
1	Geographical Area	Sets the geographical area.	Selection is required.
2	Jurisdiction	Sets the jurisdiction.	Selection is required.
3	Maintenance Company	Sets the maintenance company.	Selection is required.
4	Road Name	Sets the road name.	Selection is required.
5	KPFrom(km)	Sets the originating Kilo Post station number for the dummy section.	Required. Enter a numerical value (including a hyphen '-') in 5 digits.
6	KPFrom(m)	Sets the distance from the originating Kilo Post station number for the dummy section.	Required. Enter a numerical value (including a hyphen '-') in 5 digits.
7	KPTo(km)	Sets the ending Kilo Post station number for the dummy section.	Required. Enter a numerical value (including a hyphen '-') in 5 digits.
8	KPTo(m)	Sets the distance from the ending Kilo Post station number for the dummy section.	Required. Enter a numerical value (including a hyphen '-') in 5 digits.
9	Length	Sets the length of the record.	Required. Enter a numerical value in 5 digits.
10	Note(select)	Configures the note for the dummy record.	Select for dummy record (Required)
11	Note(input)	Configures the note for the dummy record.	-
12	F/E	Configures the notes position of the dummy record.	-

E. Arrange the Data Order

Data coupling is performed in the order of the list. Select a row to change the order of (multiple rows can be selected) and click on the [Up] or [Down] buttons shown in the below figure to move its location within the list.

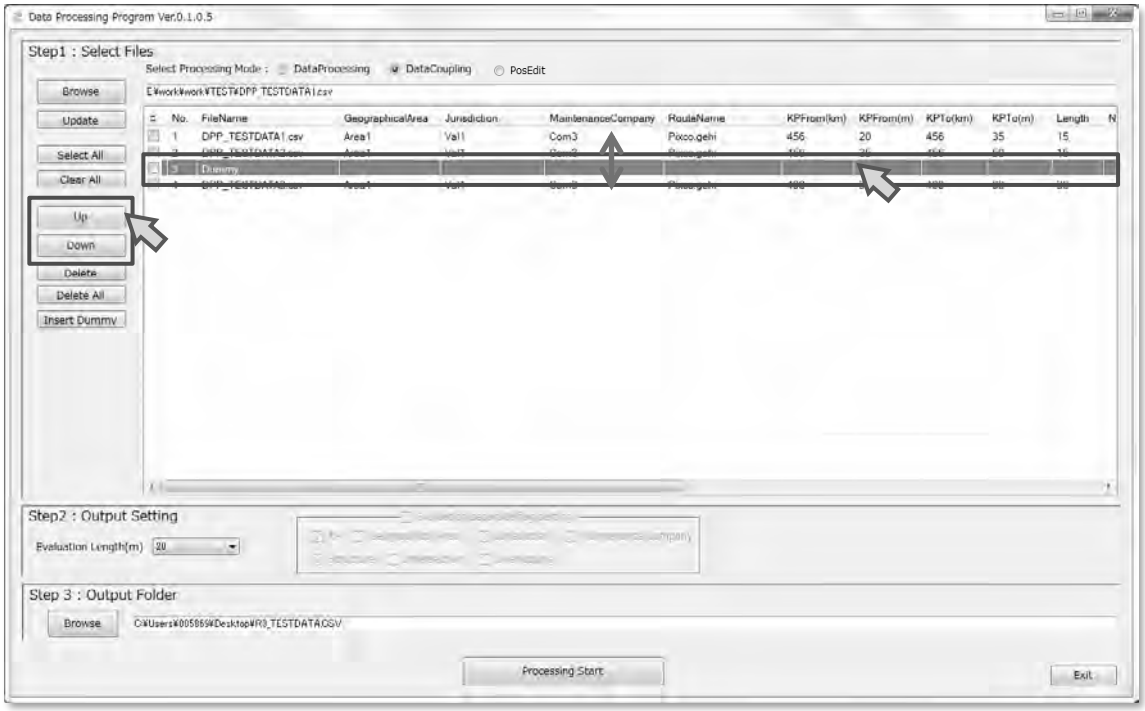


Figure 11.34 Moving Dummy Data

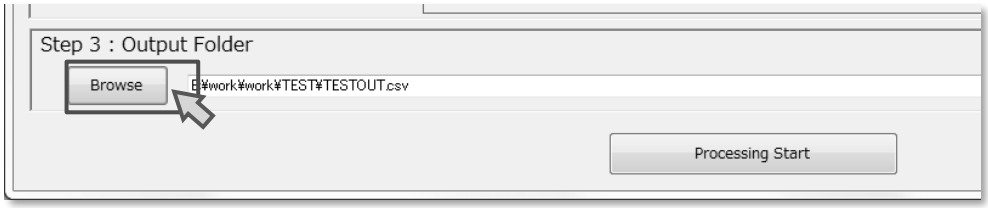
F. Configure the Evaluation Unit of the Dummy Data

Select the [Evaluation Length (m)] from the [Step2:OutputSetting] section.

Figure 11.35 Setting the Evaluation Length

G. Configure Output Destination

Define the output file name. Click on the [Browse] button from the [Step3: Output Folder] section.



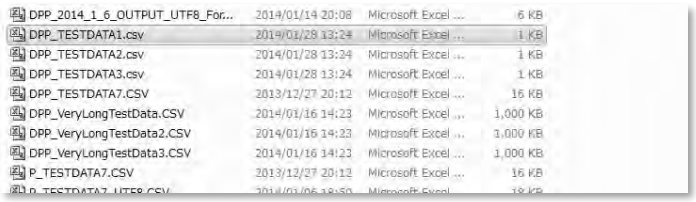


Figure 11.36 Selecting Data

H. Execute Processing

Click on the [Processing Start] button.

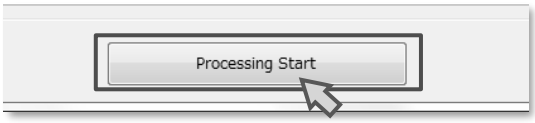


Figure 11.37 Processing Start Button

I. Confirm Processing Log.

Confirm that there are no errors generated and click on the [Close] button.

If an error has occurred, “Error” will be displayed. Any files displayed as “Error” during the execution of the processing are not processed and thus must be verified.

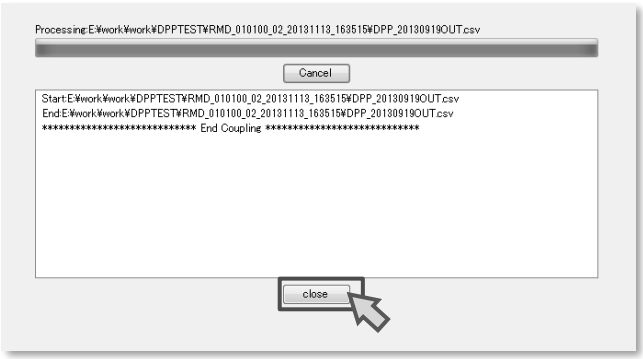


Figure 11.38 Processing Window

J. Exit the Application

Click on the [Exit] button and exit from the application.

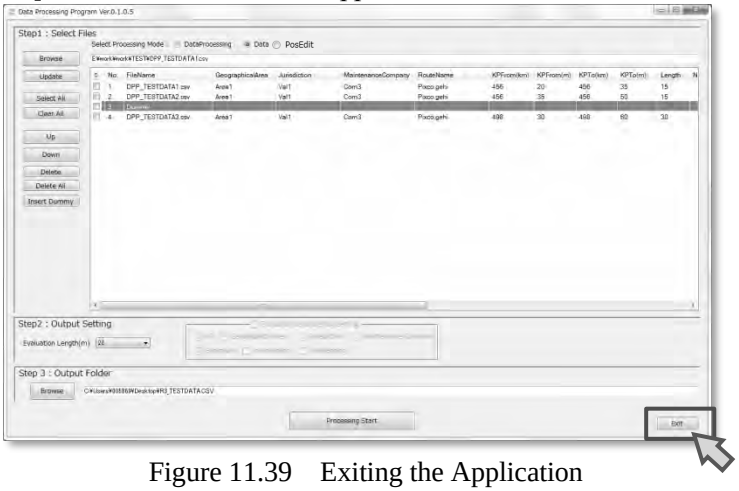


Figure 11.39 Exiting the Application

12. Instructiuon Manual of Assembling

12.1 Introduction

(1) Overview of inspection vehicle

Road inspection vehicle is created by attaching the specialized measurement equipment on a normal HIACE car. The set of specialized measurement equipment is so compact, therefor it can be easily delivered to users. Below figure showed the main parts of inspection car.

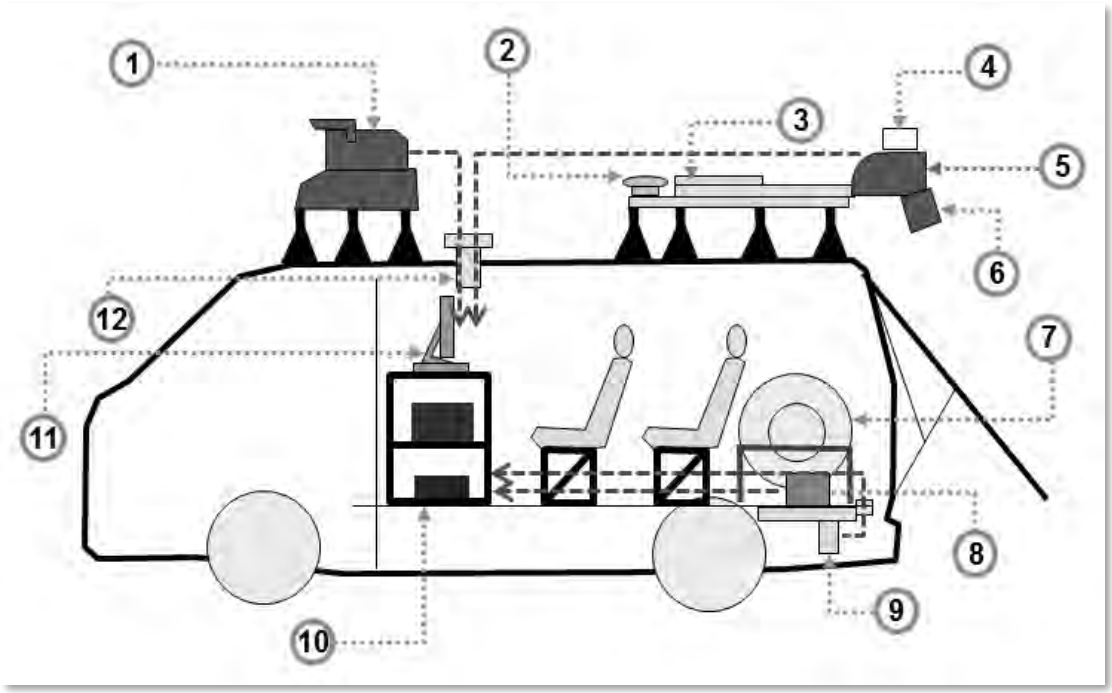
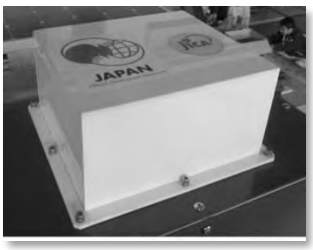
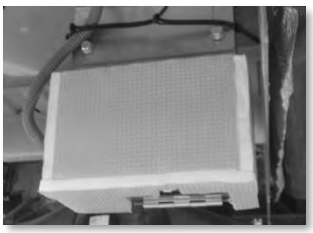
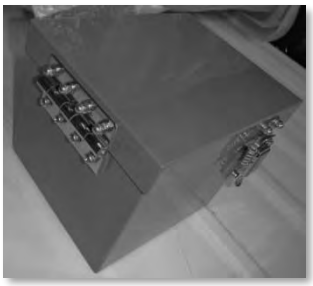


Figure 12.1 Overview of inspection vehicle

Table 12.1 List of main parts

No.	Equipment	Image
1	Camera for front image	
2	GPS	

3	Solar panel	
4	IMU	
5	Laser scanner	
6	Camera for road image	
7	Spare wheel and its frame	
8	Sub battery	
9	Laser displacement sensor	

10	Rack and divices inside	
11	Monitors	
12	Duct	

(2) List of assembling works

1. Removing unused seats and the roof of the car
2. Removing the spare tire
3. Attaching the rope to limit the opening of hatchback door
4. Drilling hole on the roof
5. Attaching the duct of cable
6. Drilling hole on floor for cable of Laser Displacement Sensor
7. Setting up the rack for devices
8. Attaching the equipment inside vehicle into the rack
9. Setting up Front Platform and camera for front image
10. Setting up Rear Platform
11. Attaching Front Platform on the roof
12. Attaching Rear Platform on the roof
13. Fixing the rack on the floor
14. Fixing the case of sub battery
15. Attaching the Laser Displacement Sensor
16. Attaching the GPS on rear platform
17. Attaching the cameras for road image to the rear platform
18. Fixing the spare tyre
19. Attaching the cable of equipment outside vehicle
20. Attaching the cable of equipment inside vehicle
21. Setting up the transfer system form vehicle (Cable of Speed Pulse, main battery and ACC)

22. Fixing the cable of equipment outside vehicle
23. Fixing the cable of equipment inside vehicle

12.2 Preparation works on the Hiace car

(1) Removing unused seats and the roof of the car

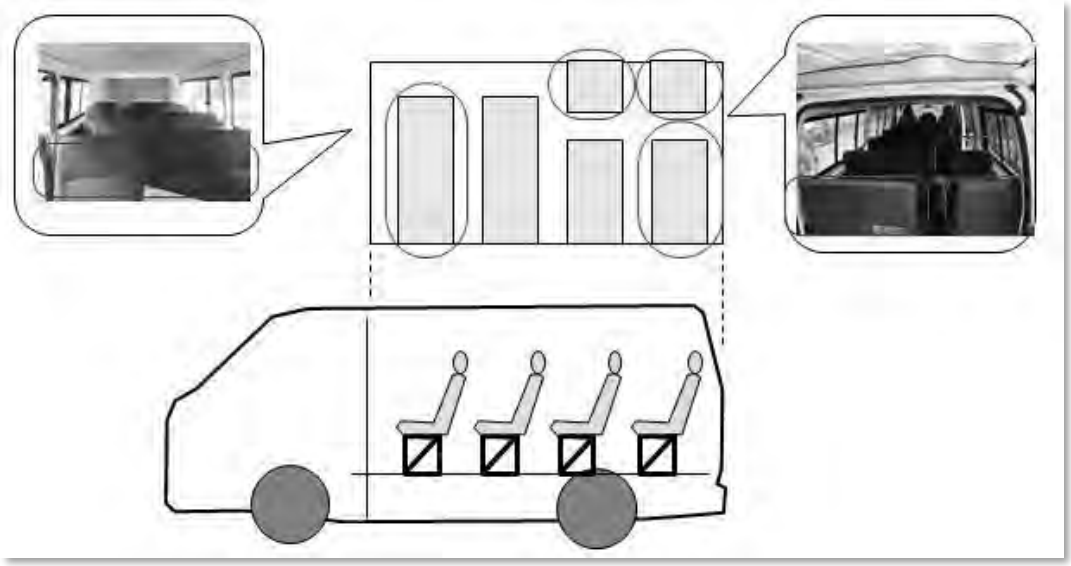


Figure 12.2 Diagram of removing unused seats

- Remove unused seats that were highlighted by red circle
- Move 2 remaining seat rows backward 15 cm. Notice that the displacement distance shall be adjusted in order to provide operators with comfotableness during survey time.
- Remove the roof of the car

(2) Removing the spare wheel

- Remove the spare wheel attached on underfloor of car
- Define new position and design the frame for spare wheel

Figure 12.3 Spare wheel and its frame

(3) Attaching the rope to limit the opening of hatchback door

- Check the opening of hatchback door to make sure that the rear door does not hit the camera for road images when it's opened
- Attaching the rope to limit the opening of rear door

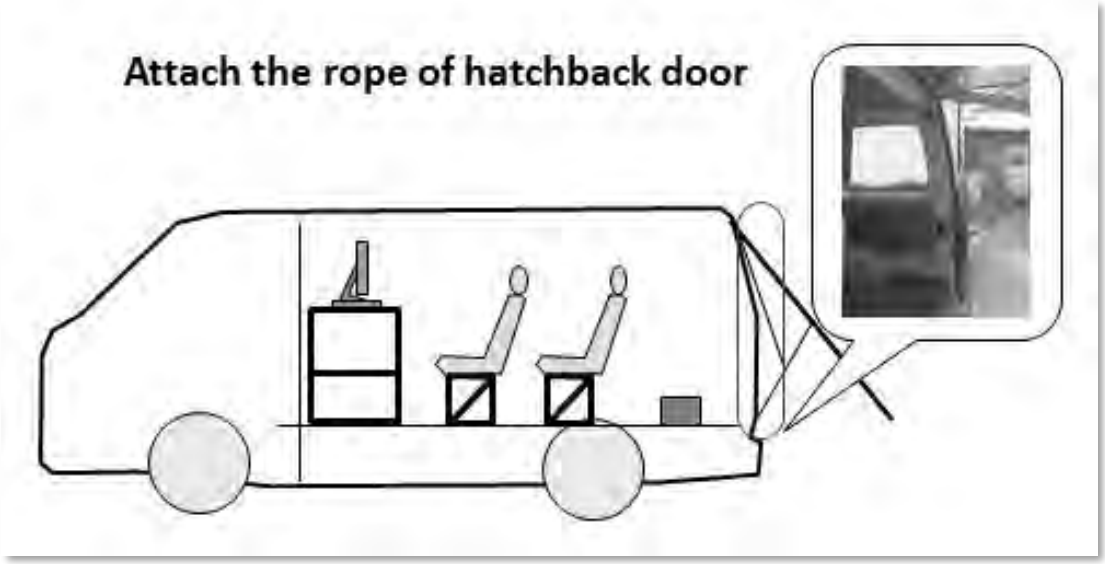


Figure 12.4 Attaching the rope to limit the opening of the rear door

(4) Drilling the hole on the roof of the car and attach the duct

- Define the position of the hole on the roof of the car
- Make a hole at defined position
- Attach the duct to the hole. Cover the gap between the duct and the hole by silicon in order to prevent rain water coming into the car.

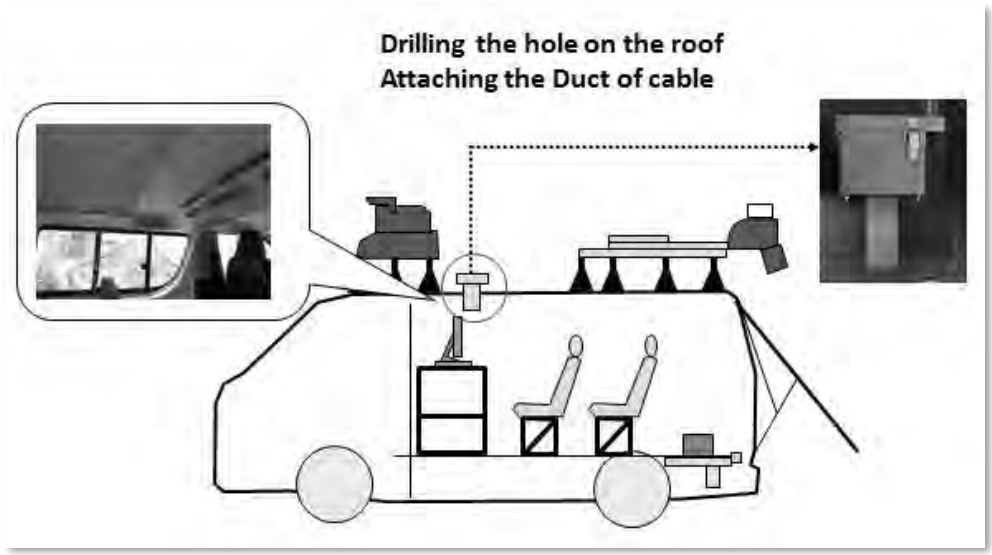


Figure 12.5 Drill the hole and attach the duct

(5) Drilling a hole on floor for cable of laser displacement sensor

- Drill a hole on floor of the car for cable of laser displacement sensor

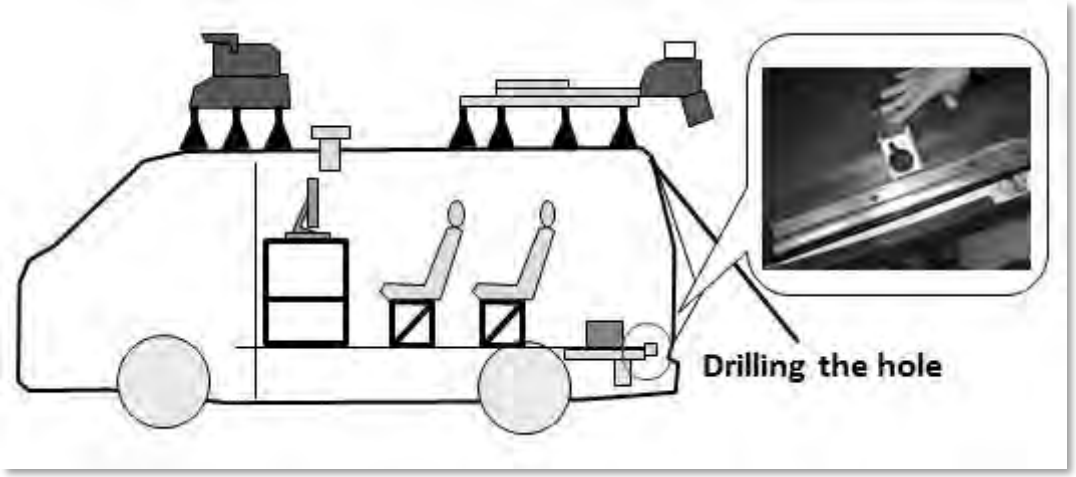


Figure 12.6 Drill the hole for cable of laser displacement sensor

12.3 Preparing and setting up the equipment outside the car

(1) Setting up the rack for devices

- Arrange the tool and equipment
- Set up the rack for devices
- Put the devices into the rack
- Set up the monitors to the rack

Figure 12.7 Setting up the rack

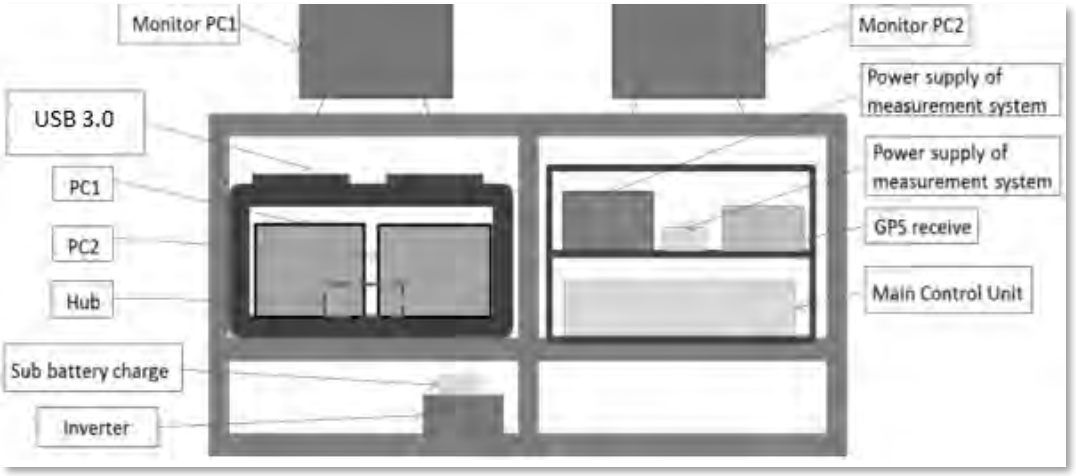


Figure 12.8 Devices in the rack

12.4 Setting up front platform and camera for front image

- Arrange whole parts of front platform
- Set up the front platform

Figure 12.9 Setting up the front platform

- Attach the camera for front image on the front platform

Figure 12.10 Attach the camera for front image on the front platform

- Attach the legs to front platform

Figure 12.11 Attach the legs to front platform

12.5 Setting up rear platform

- Attach the cross bars to rear platform

Figure 12.12 Attach the cross bars to platform

- Attach the Laser scanner to rear platform. Center of laser scanner shall be in alignment with the center line of rear platform

Figure 12.13 Attach the Laser scanner to rear platform

- Attach the IMU box to rear platform

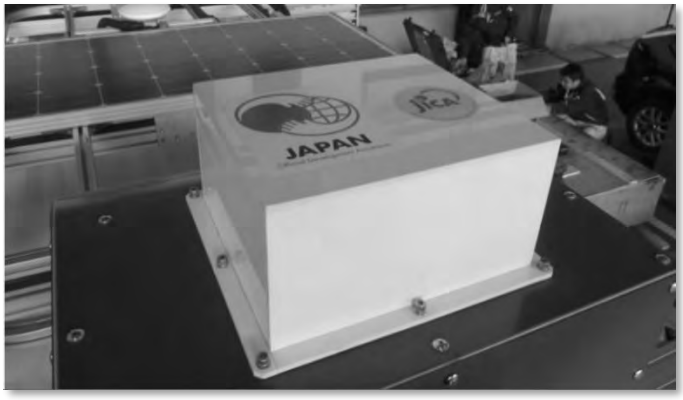


Figure 12.14 Attach the IMU box to rear platform

- Attach the legs to rear platform

Figure 12.15 Attach the legs to rear platform

12.6 Attaching and fixing equipment on the car

(1) Attaching front and rear platfrom on the car

- Attach the front and rear platform on the car
- Fix the platform after adjusting the their position

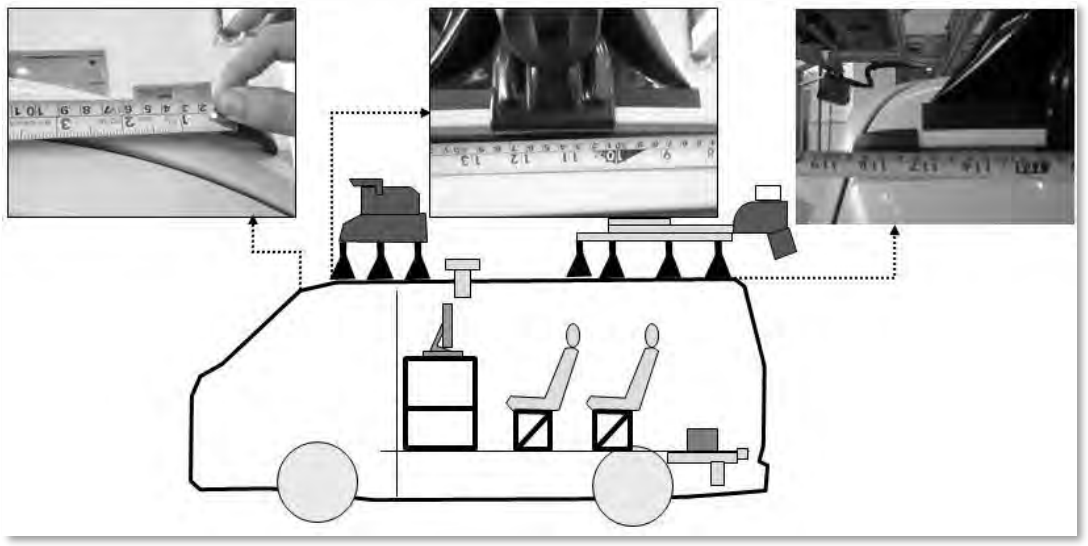


Figure 12.16 Attach the front and rear platform on the car

(2) Fixing the rack on the floor of the car

- Define the position of the rack on the car and the positions of drill holes
- Drill the holes on the floor as marked
- Put the rack on the floor again then fix it

Figure 12.17 Fixing the rack on the car

(3) Fixing the case of sub battery on the floor

- Fixing the case of sub battery on the floor

Figure 12.18 Fixing the case of sub battery on the floor

(4) Attaching the Laser displacement sensor

- Attach the platform of laser displacement sensor on the underfloor of car. The height between LDS and the ground is 30 cm.
- Attach the laser displacement sensor on its platform
- Attach the thermal insulation plate

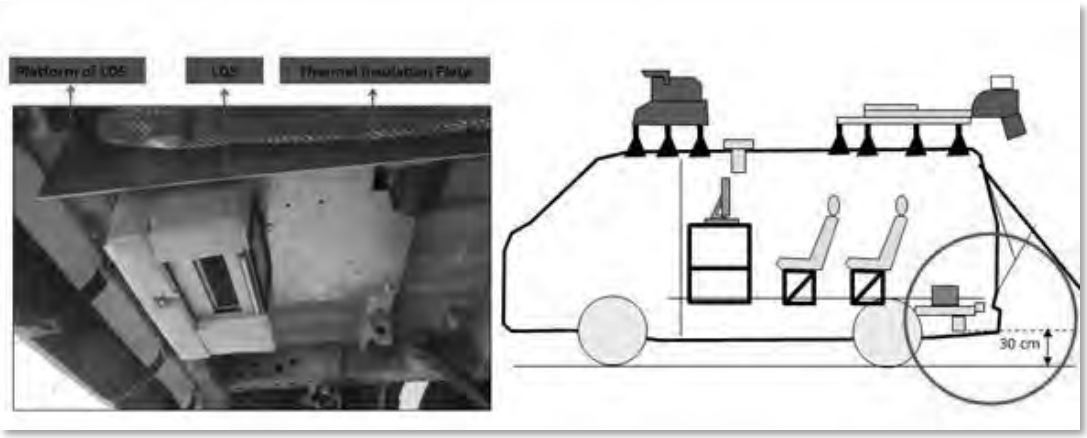


Figure 12.19 The platform of LDS, LDS, thermal insulation plate

(5) Attaching the GPS on the rear platform

- Attach the frame of GPS on the rear platform
- Attach the GPS on its frame
- Attach the GPS antenna

Figure 12.20 GPS and GPS antenna

(6) Attach the cameras for road image to the rear platform

- Cover the cables of cameras for road image by corrugation cable
- Attach the cameras for road image to the rear platform

Figure 12.21 Attach cameras for road image to the rear platform

(7) Fixing the spare wheel

- Fix the frame of spare wheel on the floor
- Fix the spare wheel to its frame

Figure 12.22 Fix the spare wheel to its frame

(8) Fixing the tool box

- Fixing the tool box on the floor

Figure 12.23 Fixing the tool box on the floors

12.7 Connecting and fixing the cables

(1) Connecting cable to Laser scanner (LS)

- Connecting cable to LS
- Cover the cable of LS by corrugation cable
- Fix the cable to the rear platform

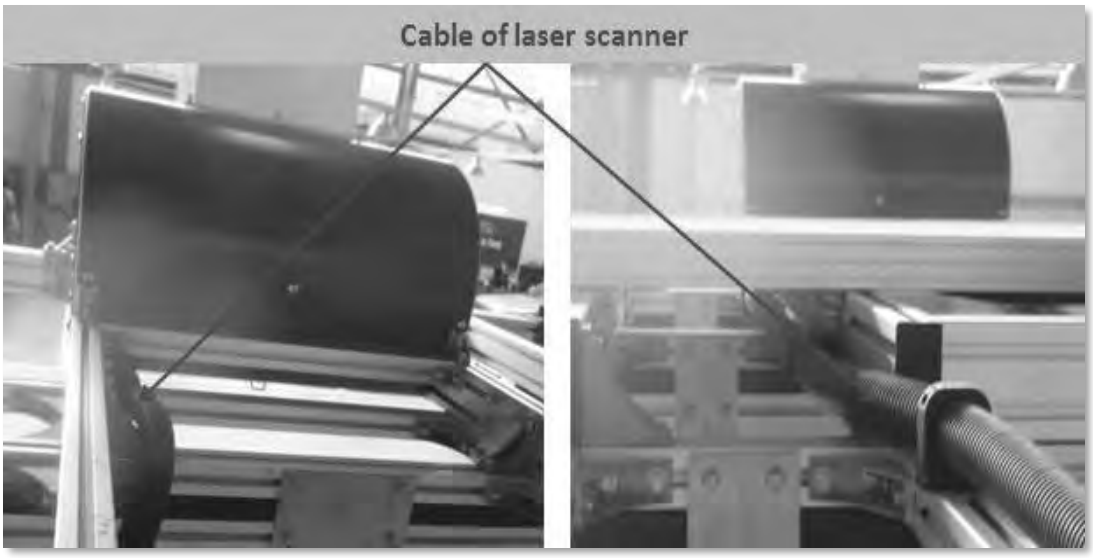


Figure 12.24 Connecting and fixing the cable of laser scanner

(2) Fixing cable of camera for road images

- Fixing cable of camera for road images to rear platform

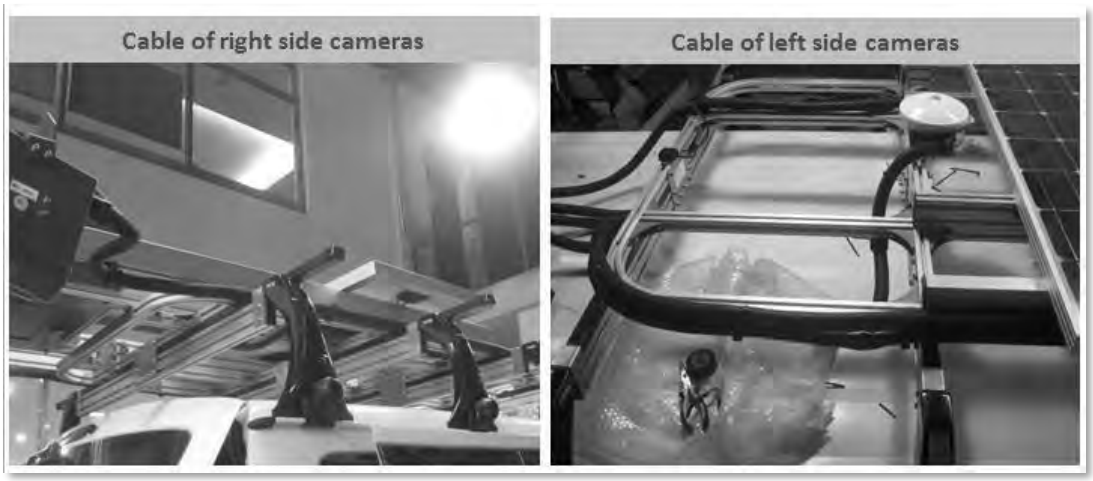


Figure 12.25 Fixing cable of camera for road images to rear platform

(3) Connecting cable to GPS

- Connect cable to GPS
- Cover the cable of GPS by corrugation cable
- Fix the cable to rear platform

Figure 12.26 Connecting and fixing the cable of GPS

(4) Connecting cable to solar panel

- Connect cable to solar panel
- Cover the cable of solar panel by corrugation cable
- Fix the cable to rear platform

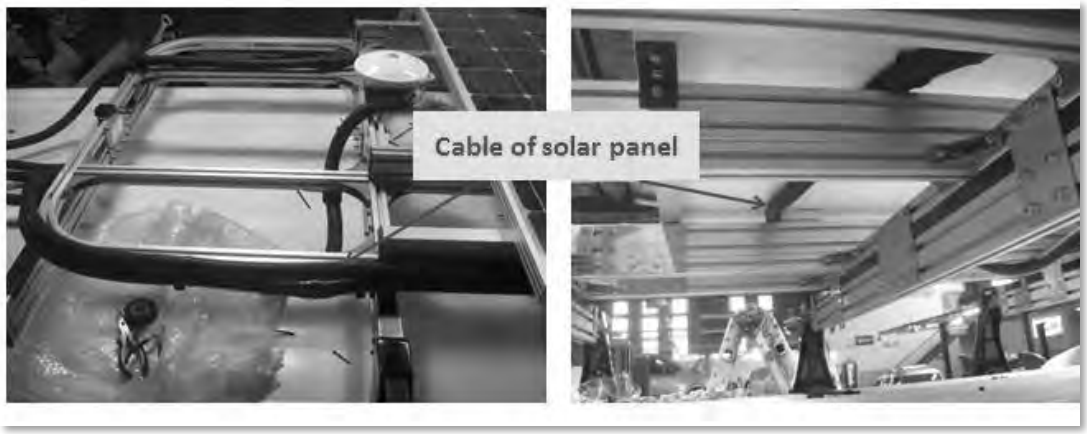


Figure 12.27 Connecting and fixing the cable of solar panel

(5) Connecting cable to laser displacement sensor (LDS)

- Connecting cable to laser displacement sensor
- Cover the cable of LDS by corrugation cable
- Wiring and fixing the cable to the roof of car

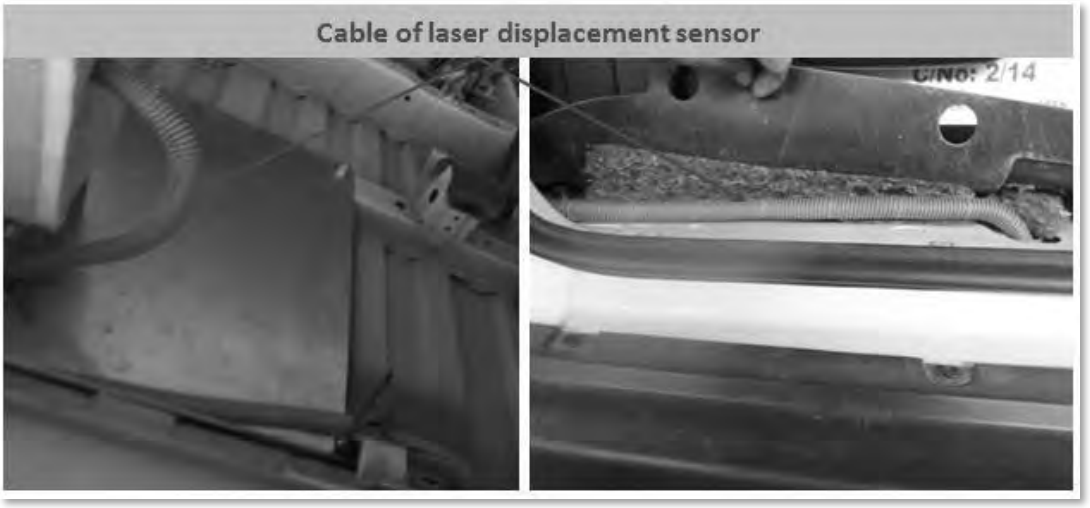


Figure 12.28 Connecting and fixing the cable of LDS

(6) Connecting cable to sub battery

- Connecting cable to sub battery. Avoid to wrongly connect polarities
- Cover the cable of sub battery by corrugation cable
- Wiring and fixing the cable

Figure 12.29 Connecting cable to sub battery

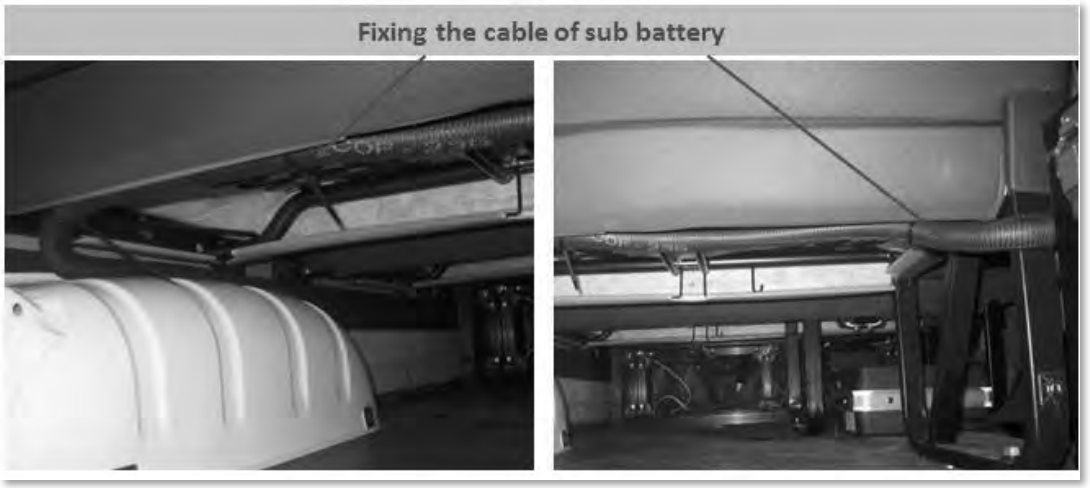


Figure 12.30 Wiring and fixing the cable

(7) Connecting cable to sub battery charger, main battery and inverter

- Connect cable to sub battery charger, main battery and inverter
- Cover the cables by corrugation cable

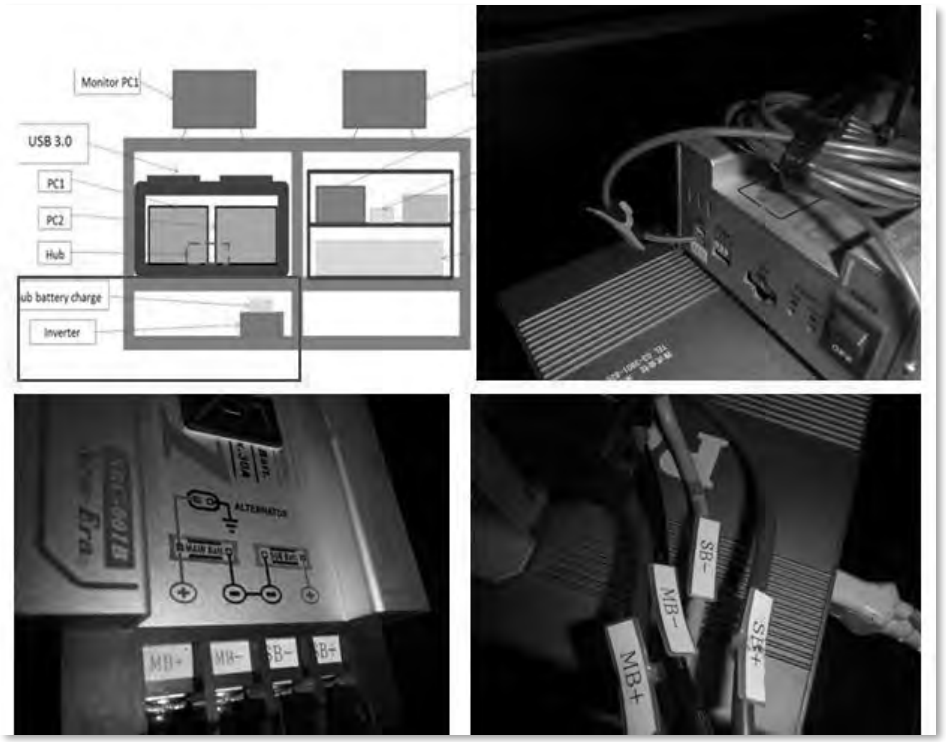


Figure 12.31 Connecting cable to sub battery charger, main battery and inverter (1)

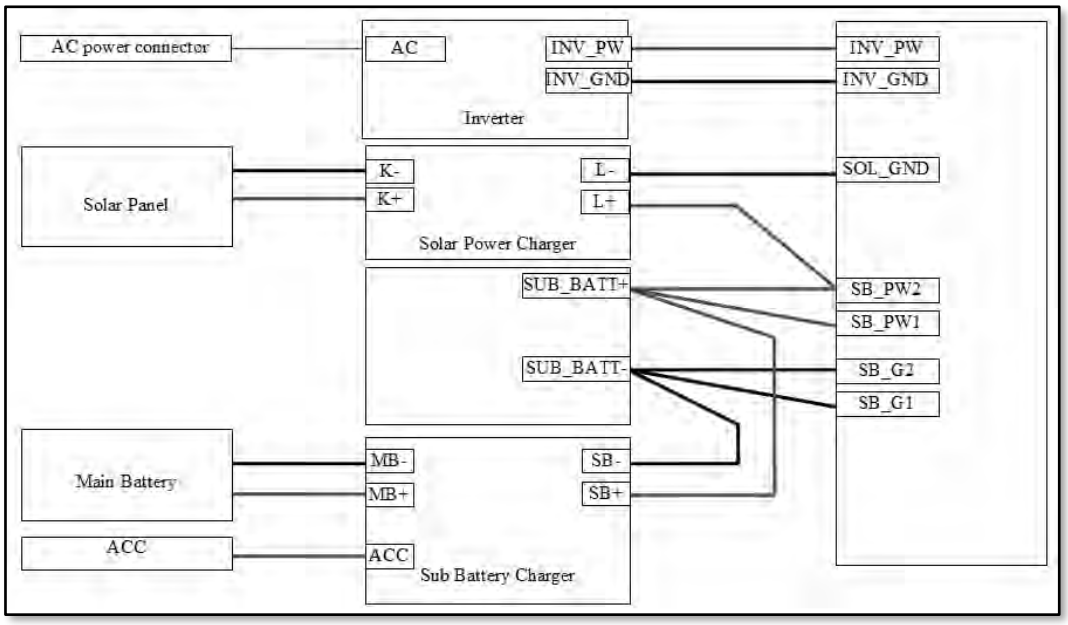


Figure 12.32 Connecting cable to sub battery charger, main battery and inverter (2)

Connecting cable to camera for front image

- Connect cable to camera for front image
- Cover the cable of camera for front image by corrugation cable
- Fix the cable to the front platform

Figure 12.33 Connecting and fixing cable of camera for front image

(8) Wiring the cables from outside to inside of the car

- o After fixing whole cables, wire the outside cables into the car via the duct
- o After wiring the cables into the car, fix the cables

Figure 12.34 Wiring the cables from outside to inside of the car

(9) Defining the cables of speed pulse and ACC

- o Remove the cover at steering wheel
- o Find the cables of speed pulse and ACC
- o Stick the labels for each cable

Figure 12.35 Stick labels for the cables

- o Connect the cable of speed pulse and ACC to the system

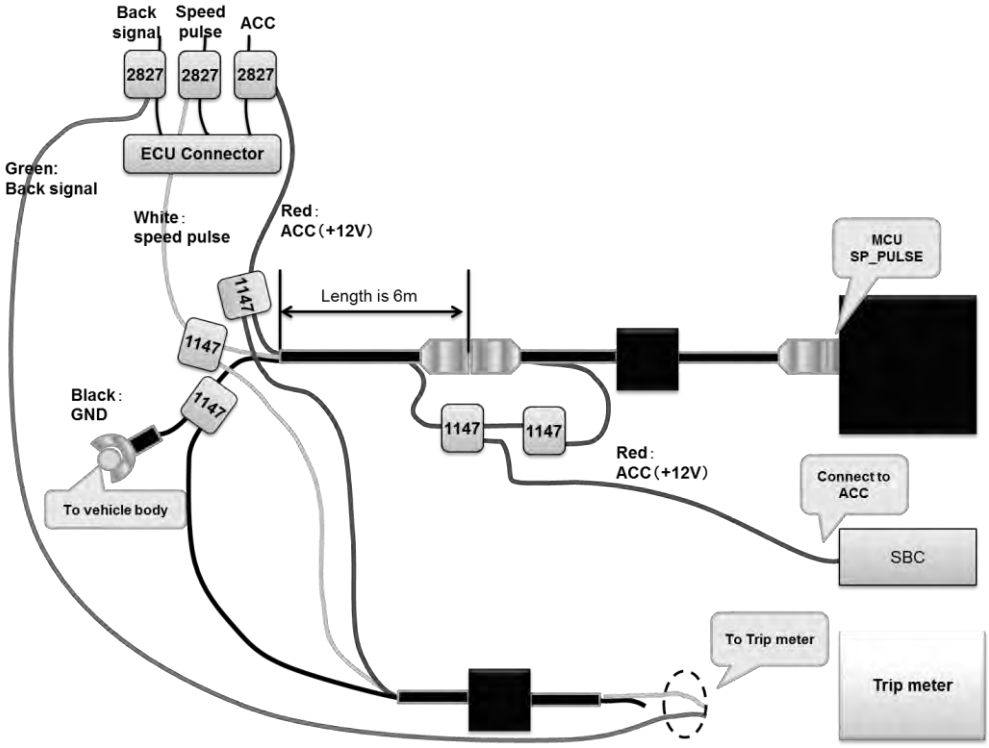


Figure 12.36 Diagram of connecting the cable of pulse and ACC to the system

- Install speed panel of the car then check the signal of the cables by digital multimeter. When the rear wheel moving check whether there is signal (the number on screen of digital multimeter would change) or not.

  - ✓ If could not find the signal, check the cables and connection again.
  - ✓ If signal is good, fix the cable then install the cover again.

Figure 12.37 Digial multimeter

(10) Connecting and fixing the cables inside the car

- Connecting the cables of outside equipment to the devices in the rack. To conduct this process users can refer to apendix No.1 to No.4
- Sorting and fixing the cables to the rack

Figure 12.38 Sorting and fixing the cables to the rack

- Cover the back of the rack by 2 black plates
- Install the roof of the car then clean up inside the car.

12.8 Reviewing the assembling works

- Check whole the screws and bolts again to make sure that whole equipment was installed reliably.
- Execute the system to make sure that whole cables were connected correctly
- Clean up inside and outside the vehicle.

13. Instruction Manual of Calibration

13.1 Introduction

This manual describes the procedures for performing calibration on REAL Mini. Please read this document carefully and perform adjustments following the procedures described.

13.2 Types of Calibration

The following calibrations are performed for REAL Mini:

1) Camera for front image: focus
2) Camera for road image: focus, iris, angle of view correction
3) Laser scanner: measuring position
4) Laser displacement sensor: base height
5) IMU: coefficient
6) Distance: distance calibration value

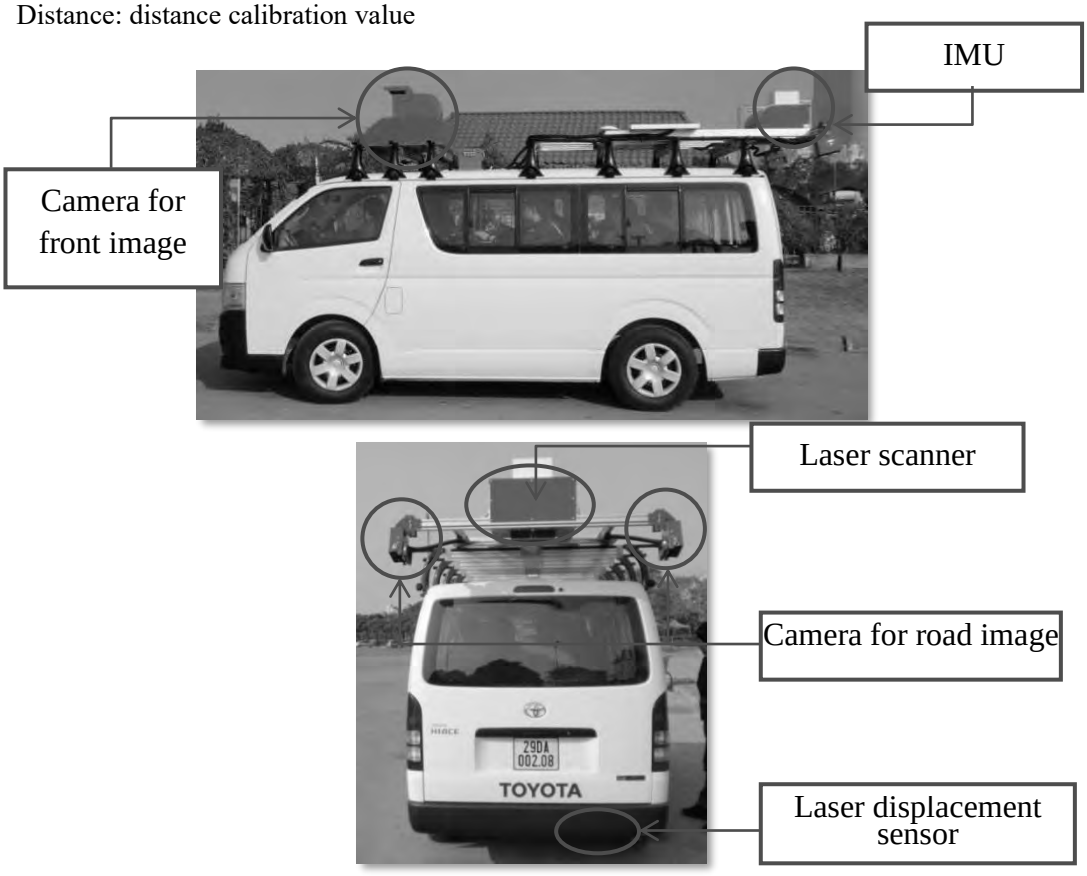


Figure 13.1 Equipment Names

13.3 Calibration Area

Calibration procedures should be performed in areas described in Table 13.1.

Table 13.1 Conditions for Calibration Areas

Item	Conditions
Camera for front image	・ The area is clear of traffic. ・ The area offers a clear view that is not obstructed by structures and the subject matter is nearby.
Camera for road image	・ The area is clear of traffic. ・ The area offers enough room behind the vehicle. ・ The area is dim.
Laser scanner	・ The area is clear of traffic. ・ The area offers enough room behind the vehicle. ・ The area is dim.
Laser displacement sensor	・ The vehicle can be parked in the area.
IMU	・ The area is an open area. ・ The area has no ceiling.
Distance	・ The area has very little traffic. ・ A linear line of 1km can be secured.

13.4 Camera for front image

Adjust the focus of the lens so that the camera can capture exact images. Adjusting of the lens should be performed when the vehicle is changed or when the camera is mounted.

・ How to adjust

(1) Equipment

Tools (screwdriver)

(2) Procedures

1) Setup

Remove the camera case.

Figure 13.2 Removing of the Camera Case

Remove the iris controller so that the focus ring is accessible.

Figure 13.3 Removing the Iris Controller

Startup the measuring system and launch the application. Select [FORWARD VIEW] from the Measuring menu on PC1 and display the enlarged view of the forward image.

Figure 13.4 Application Screens (left: PC1 application; right: enlarged view)

2) Focus adjustment

While one person turns the focus ring, the other person checks the enlarged view. Fix the focus ring at the position where the image is in sharp focus.

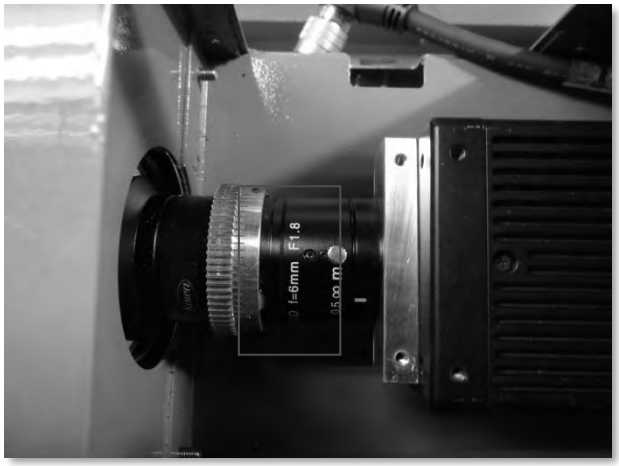


Figure 13.5 Focus Ring of the Camera Lens

This completes the adjustment for the camera for front image. Mount the iris controller on the camera and place the case back on.

13.5 Camaera for road image

The cameras for road image should adjust the focus, iris and angle of view.

(1) Focusing the Lens and Iris

To allow the camera for road image to capture an exact image, the focus of the lens and iris should be adjusted. Perform these adjustments when the vehicle is changed or when the camera is mounted (i.e. when the angle of view of the camera for road image is changed).

・ How to adjust

A. Equipment

Hex wrench

B. Procedure

1) Setup

Remove the camera case so that the focus and iris rings can be accessed.

Figure 13.6 Where to Remove the Camera Case

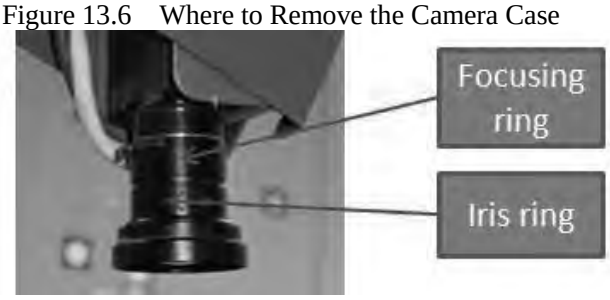


Figure 13.7 Positions of the Focus Ring and Iris Ring

2) Startup the vehicle system in "Test Mode"

Select [Setting] from the Main Menu of the Measuring Application on PC1, then enter the value "30" to the [Test Speed] field and select the checkbox for [Test Mode]. Select [OK] and return to the Main Menu and continue on to the standard steps to display the Measuring menu. Confirm that the camera image is displayed to the [REAL Mini] application on PC2.

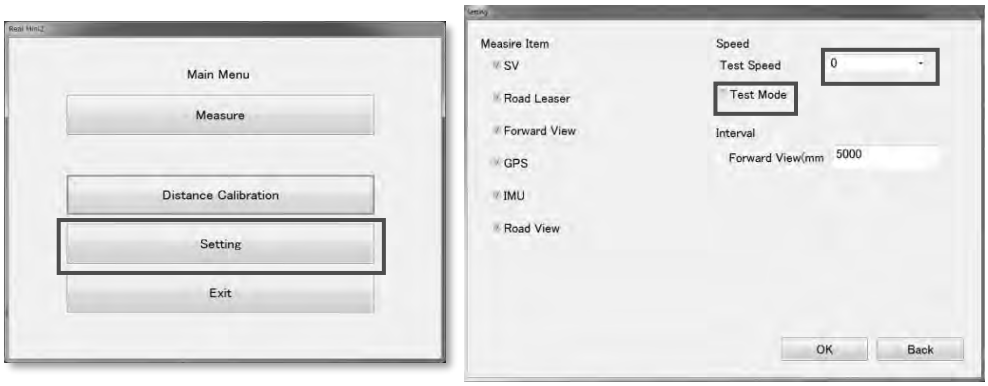


Figure 13.8 Test Mode Setting Menu

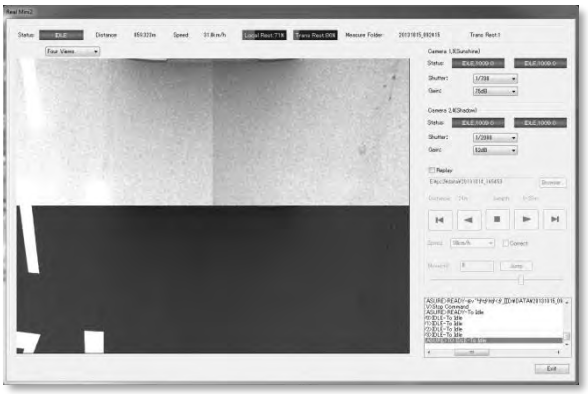


Figure 13.9 PC2 Application Menu

3) Focus adjustment

While one person turns the focus ring, another person checks the image on the Measuring menu. Fix the focus ring at the place where the image is in sharp focus. Repeat the same for the 4 cameras to adjust each of their focus.

4) Iris adjustment

Fix the iris ring at the 1/4 mark. Tweak the iris so that the side-to-side images on the Measuring menu have the same exposure. Once it is confirmed that the images have the same exposure, fix the iris ring.

This completes the procedures for adjusting the focus and iris. Place the case back to its original position.

(2) Angle of View Correction

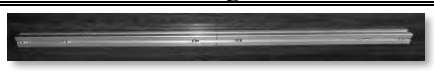
First, gather data required for correcting the angle of view of the image captured by the camera for road image. Perform this when the vehicle is changed or when the camera is mounted (i.e. the angle of view of the camera for road image is changed).

・

・ How to adjust

A. Equipment

Table 13.2 List of Equipment (No.1)

Name of Equipment	Image	Notes
Calibration frame		1 unit

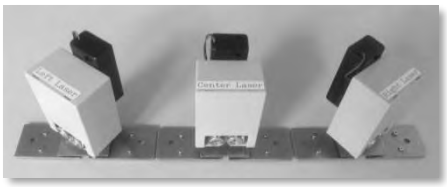
Laser oscillator		3 units (Left laser, Center laser, Right laser) Each laser requires one 9-volt (006P) battery.
L-shaped mounting bracket		2 pieces A metal bracket to connect the calibration frame and vehicle rack.
Nuts		12 pieces
Mounting screws and washers		12 pieces each. Use M6 screws.

Table 13.3 List of Equipment (No.2)

Name of Equipment	Image	Notes
Tweaking screws		20 pieces. 1.5mm hex socket bolt.
Tools		1.5mm hex key 6mm hex key 7mm wrench
Front calibration board (vertical) (Calibration Board Vertical1)		1 unit
Front calibration board (corner) (Calibration Board Corner1)		2 units

Table 13.4 List of Equipment (No.3)

Name of Equipment	Image	Notes
Rear calibration board (vertical) (Calibration Board Vertical2)		1 unit
Rear calibration board (corner) (Calibration Board Corner2)		2 units
Plumb bob		Including the plumb line.

B. Workflow

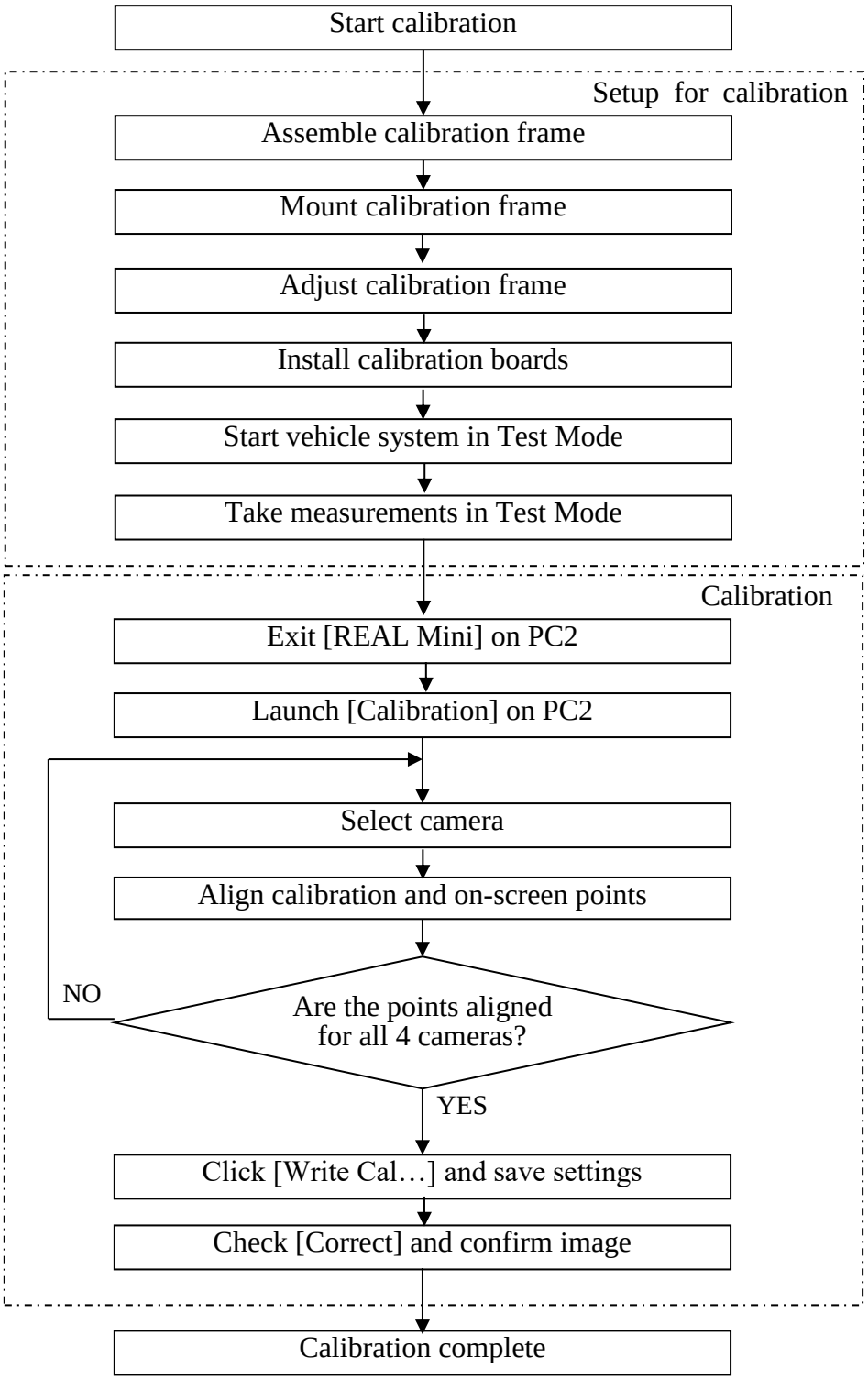


Figure 13.10 Workflow

C. Finished View

Figure 13.11 shows the finished image of the mounted calibration frame.

Figure 13.11 Mounted Calibration Frame

Figure 13.12 shows the finished image where the calibration boards are installed.

Figure 13.12 Installed Calibration Boards

D. Setting up for the calibration

1) Assemble the calibration frame

Attach the L-shaped brackets to the calibration frame.

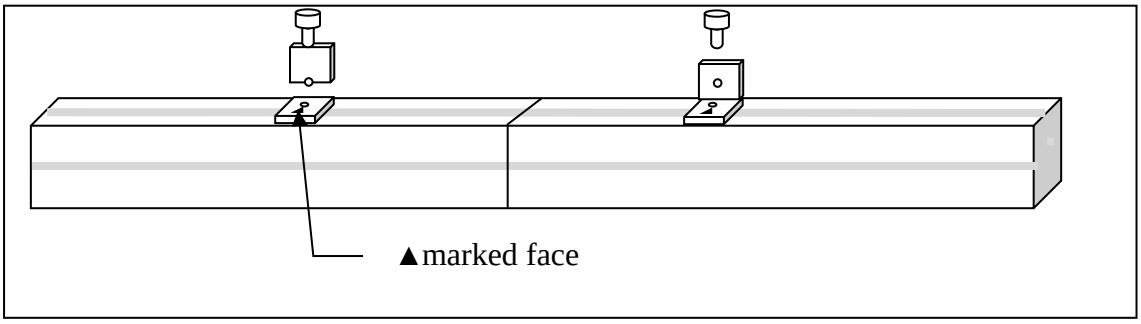


Figure 13.13 Attaching the L-shaped Brackets

Fix the nut and mount the laser oscillators (3 units).

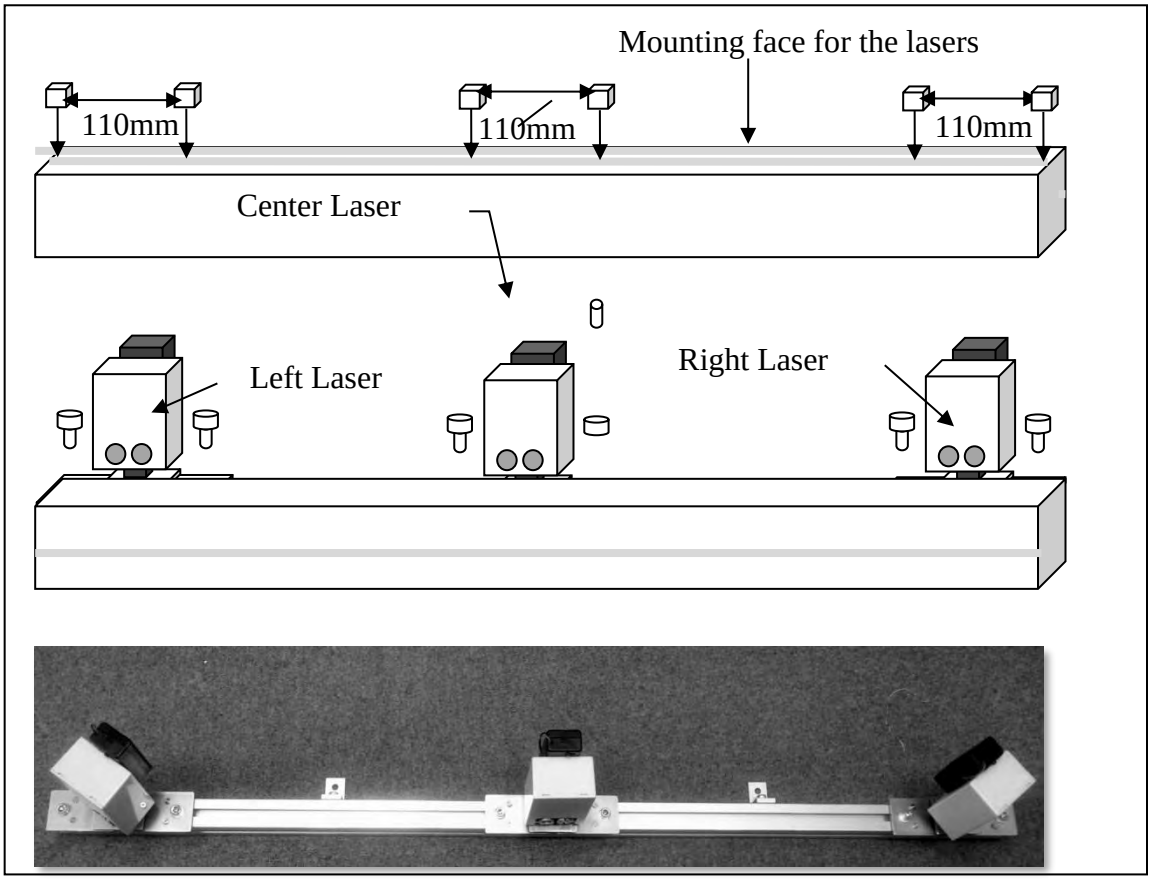


Figure 13.14 Mounting the Laser Oscillators

2) Mount the calibration frame

Attach nuts to the right and left sides of the rear platform.

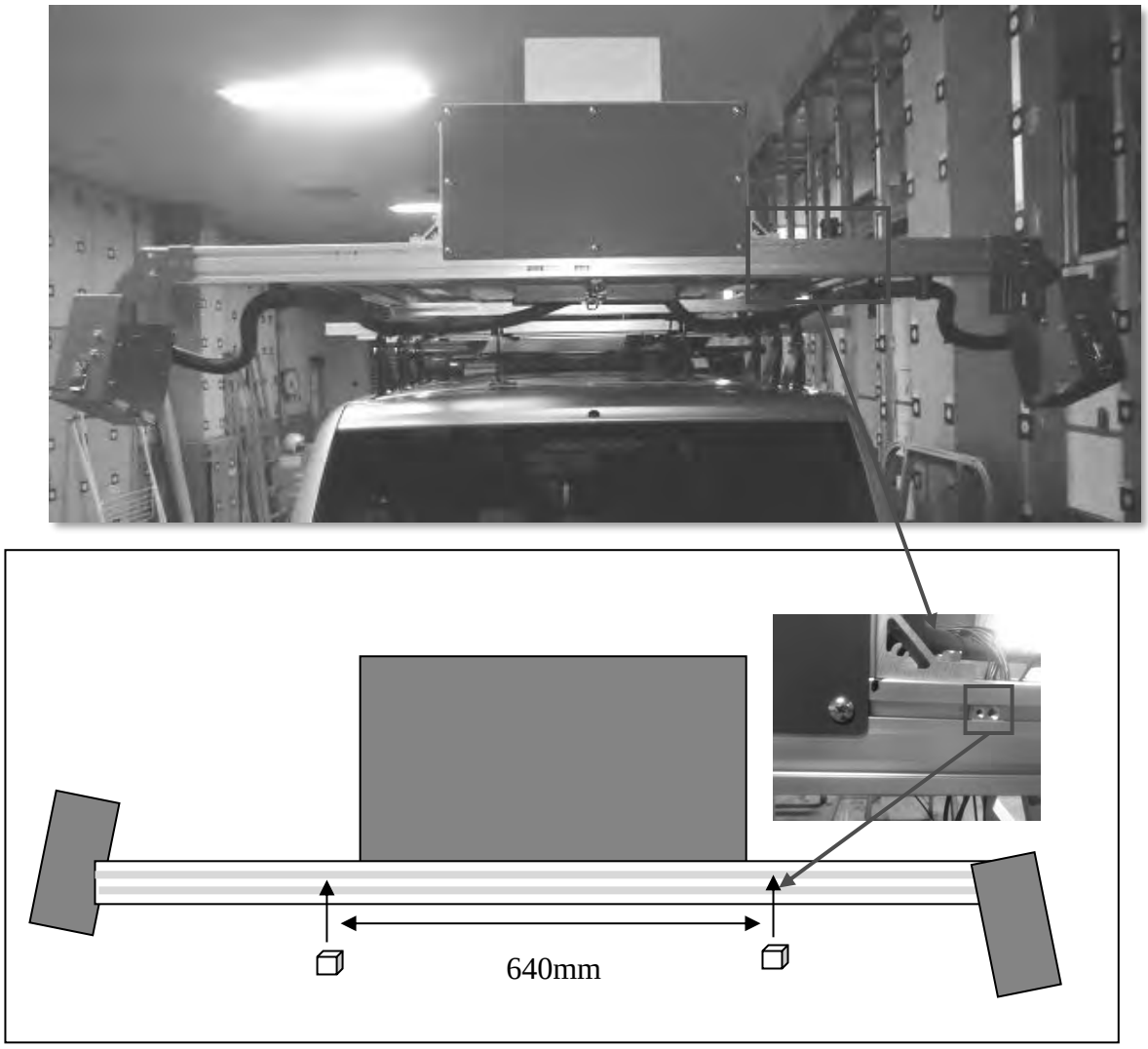


Figure 13.15 Attaching the Nuts to the Rear Platform

Make sure that there are no gaps between the rear platform and the calibration frame when mounting. The center of the calibration frame should be aligned with the center of the vehicle.

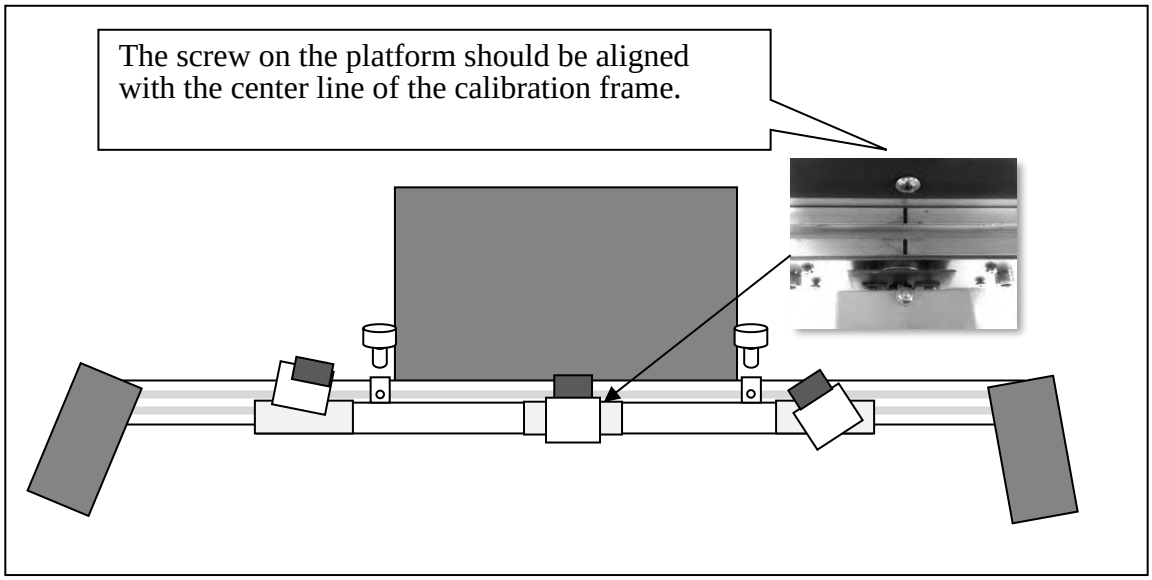


Figure 13.16 Mounting the Calibration Frame

Open the hatches of the left and right cameras and laser scanner in the center.

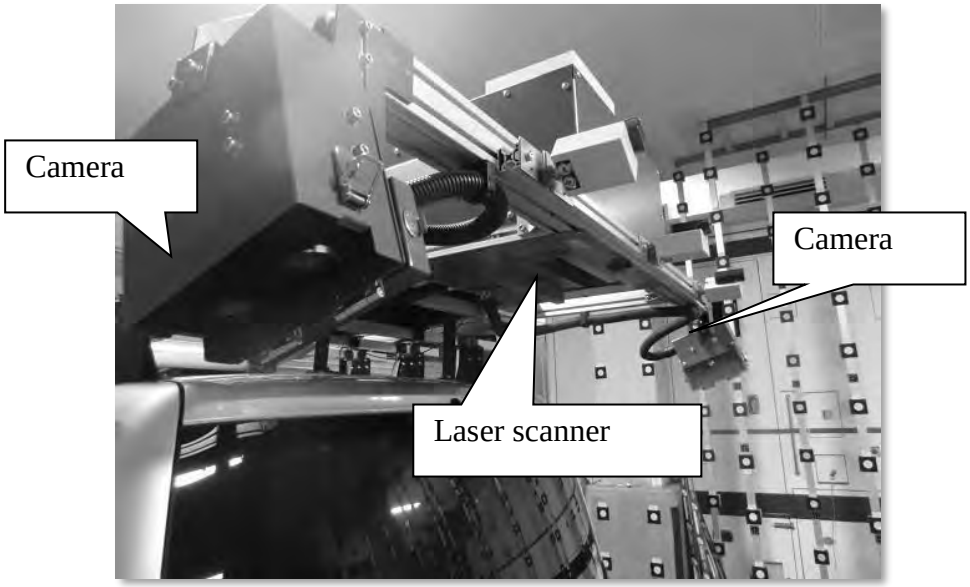


Figure 13.17 Positions of the Camera and Laser Scanner Hatches

3) Adjust the calibration frame

Drop the plumb line with the plumb bob attached to its end from the left side of the base of the Center Laser. Mark the position the plumb bob points to.

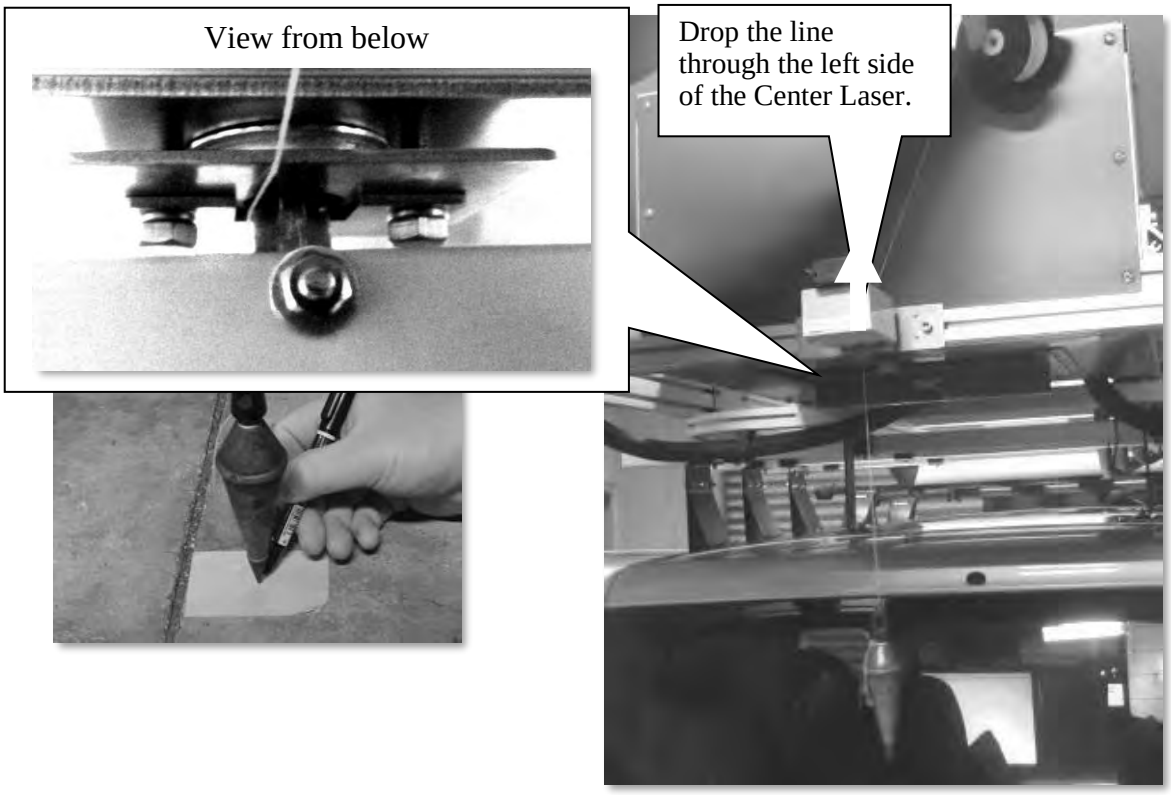


Figure 13.18 Defining the Position Using the Plumb Bob

Turn the power of the laser oscillators on. Once the power is turned, be careful not to look directly into the laser source of the laser oscillators.

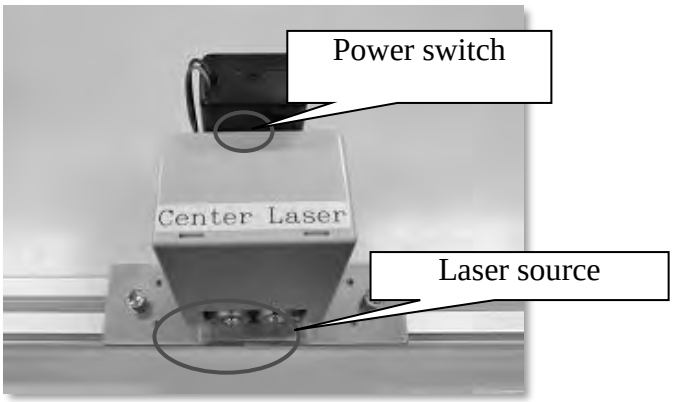


Figure 13.19 Power Switch on the Laser Oscillator

If there is no laser emission, replace the battery.

Figure 13.20 Removing the Battery Cover of the Laser Oscillator

Figure 13.21 9-Volt Battery (006P) for the Laser Oscillator

Adjust the center position of the Center Laser based on the mark indicated on the road surface by changing yaw and pitch of the Center Laser(5mm horizontally, 20mm vertically)

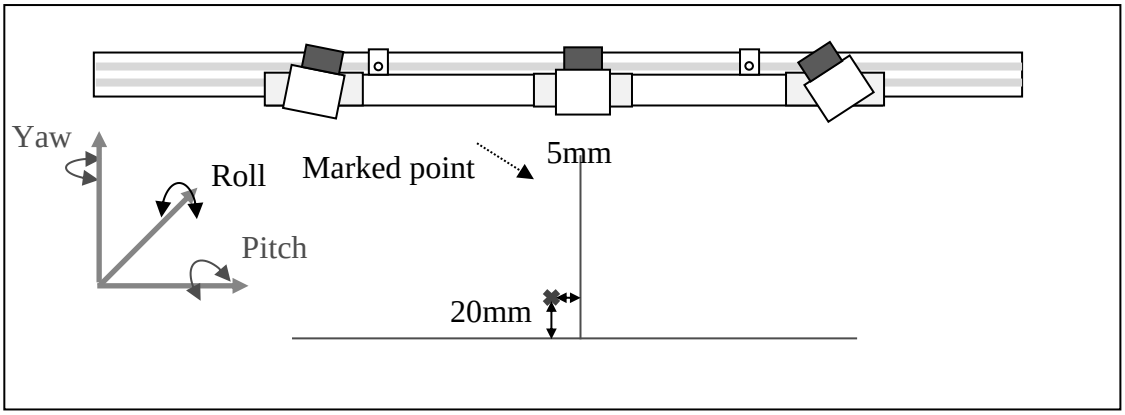


Figure 13.22 Adjusting the center positon of the Center Laser

Align the vertical line of the calibration board to the vertical laser line emitted from the Center Laser to check that the crosshair of the Center Laser creates square (90 degrees) lines. If the lines do not cross at a 90 degrees angle, use the tweaking screw to tune the angle (Roll and Pitch).

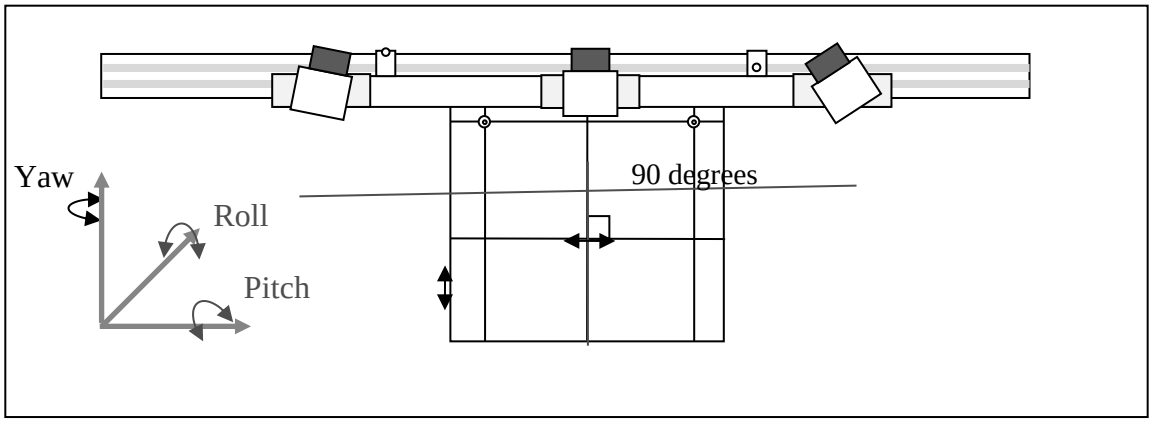


Figure 13.23 Confirming the Angle of the Center Laser

Turn the power on for the Left Laser and Right Laser. Adjust the roll so that the distance from the Center Laser's crosshair to the Left Laser and Right Laser is 1900mm respectively.

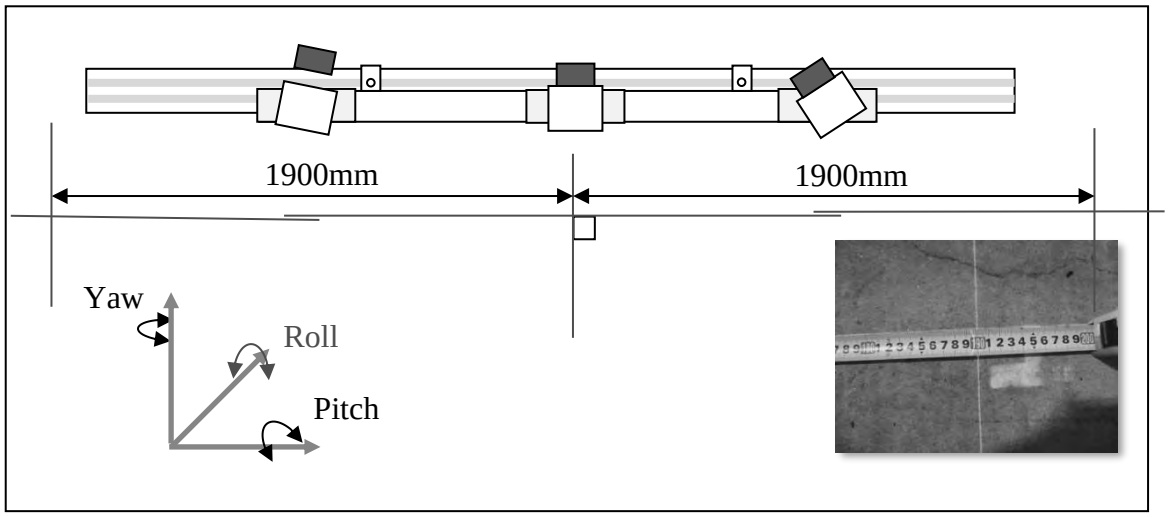


Figure 13.24 Positioning of the Left Laser and Right Laser (horizontal direction)

Adjust the pitch and yaw of the Left Laser and Right Laser so that they align with the horizontal axis of the Center Laser.

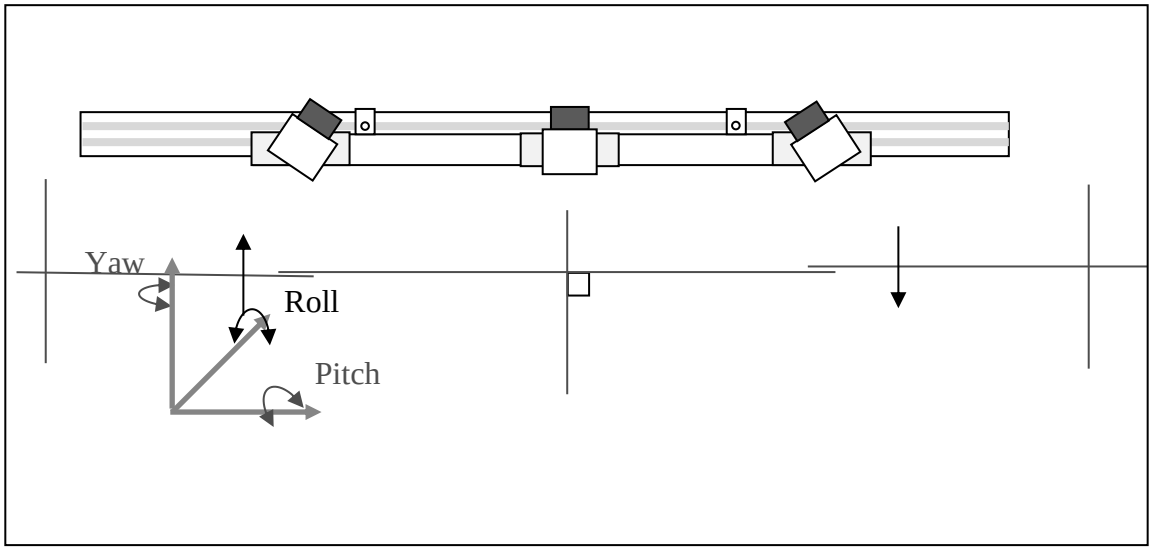


Figure 13.25 Adjusting the Yaw and Pitch of the Left Laser and Right Laser

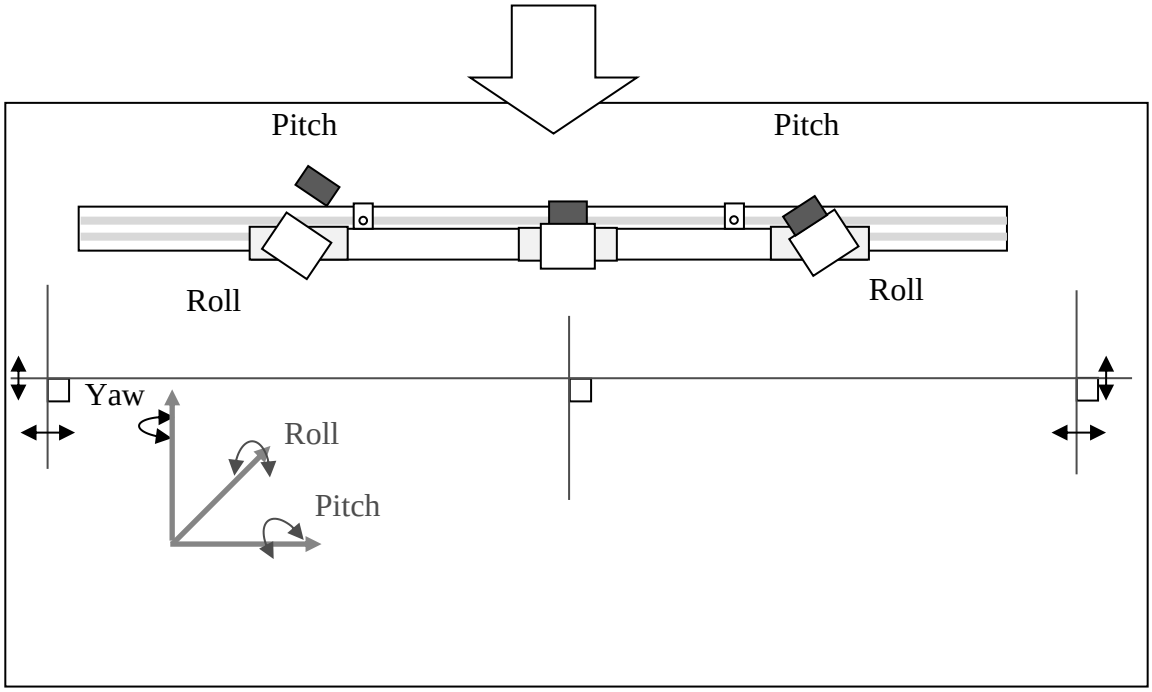


Figure 13.26 Adjusting the Roll and Pitch of the Left Laser and Right Laser

[How to adjust the angles]

- Names of angles on the laser oscillator

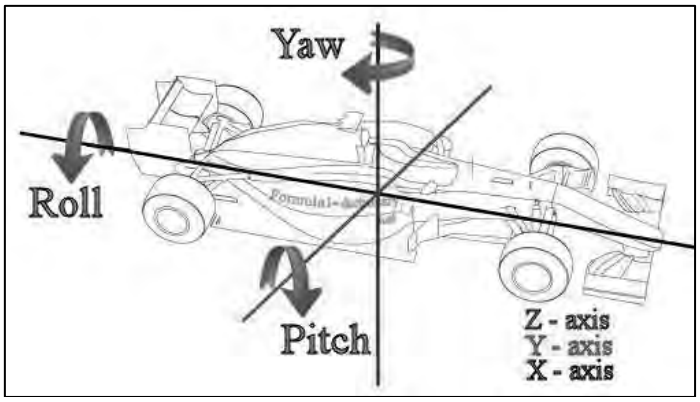


Figure 13.27 What is Roll , Pitch and Yaw
(http://www.formula1-dictionary.net/motions_of_f1_car.html)

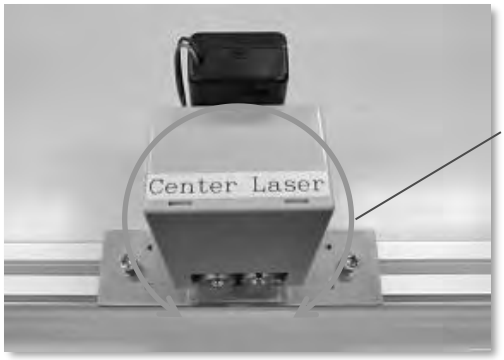


Figure 13.28 Names of Calibration Angles 1

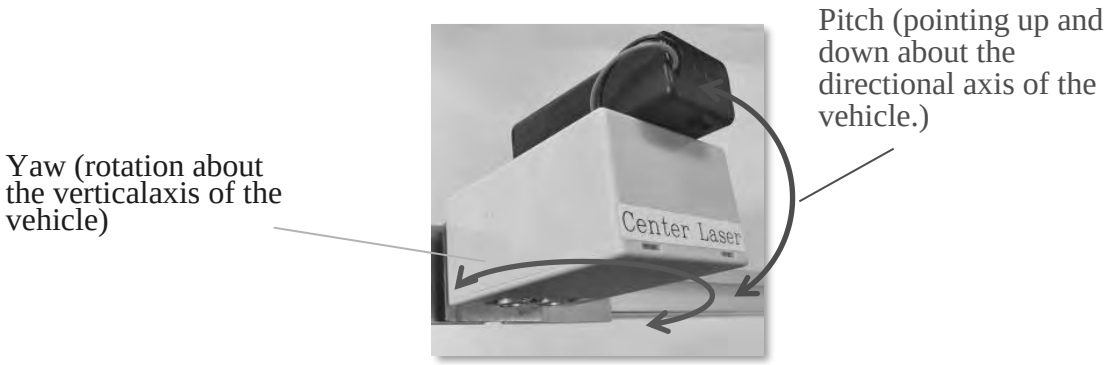


Figure 13.29 Names of Calibration Angles 2

- Adjusting the roll angle

Loosen the screws at the base of the Center Laser on both sides (right and left) and rotate the laser oscillator to tweak the yaw angle. Once the roll angle is set, fasten the screw back into place.

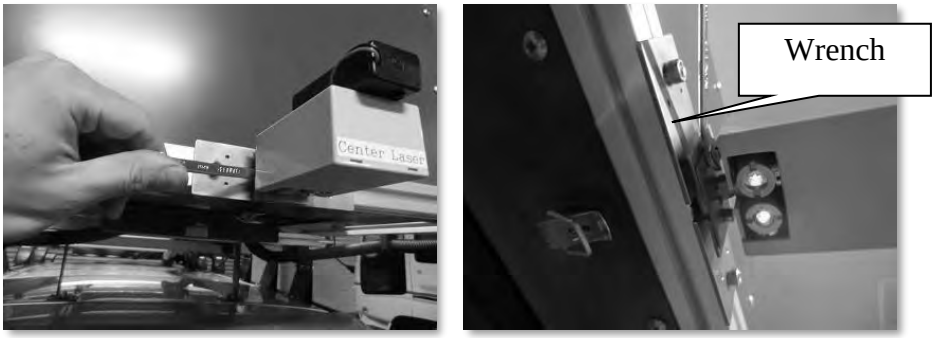


Figure 13.30 Adjusting Parts for Roll Angle

・ Adjusting the pitch

The pitch is adjusted using the tweaking screws located on both sides (right and left sides) of the laser oscillator. Tighten the top screw and loosen the bottom screw to make the pitch angle smaller (i.e. the laser is positioned closer to the vehicle). Reversely, loosen the top screw and tighten the bottom screw to make the pitch angle wider (i.e. the laser is positioned farther away from the vehicle).

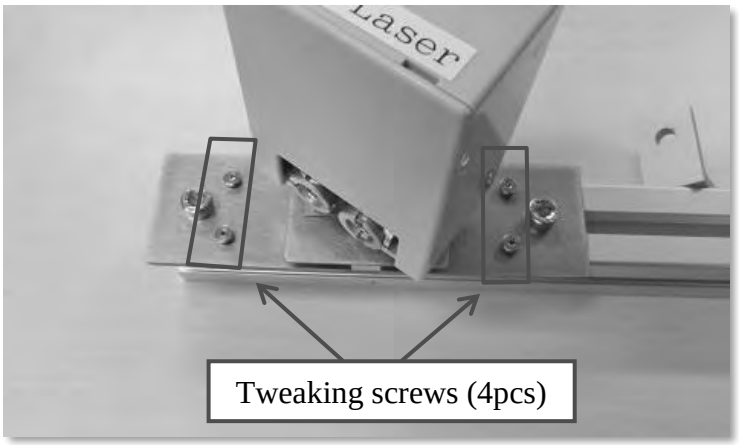


Figure 13.31 Adjusting Parts for Pitch Angle

・ Adjusting the yaw angle

The yaw angle is adjusted using the tweaking screws and mounting screws on located on the right and left of the laser oscillator. Tightening the right tweaking screw and loosening the left tweaking screw will cause the laser to rotate to the right (to the vehicle's direction). Reversely, loosening the right tweaking screw and tightening the left tweaking screw make the yaw angle rotate to the left (to the vehicle's direction).

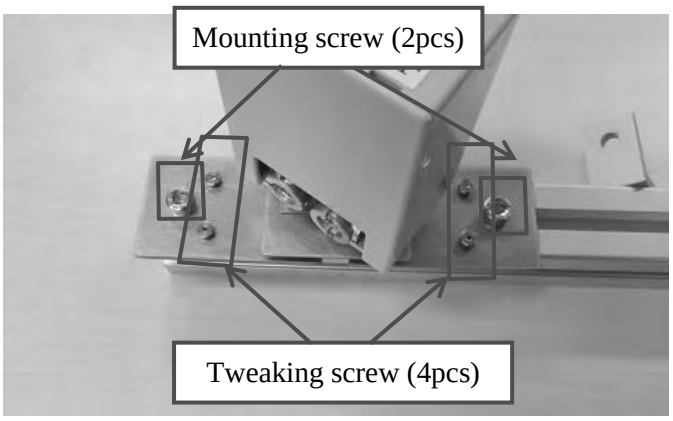


Figure 13.32 Adjustment Parts for yaw Angle

4) Install the calibration boards

Install the calibration boards so that they are in alignment with the lasers. Align the crosshair of the calibration board with the crosshair of the laser. Make sure that the crosshair of each laser is creating an angle of 90 degrees.

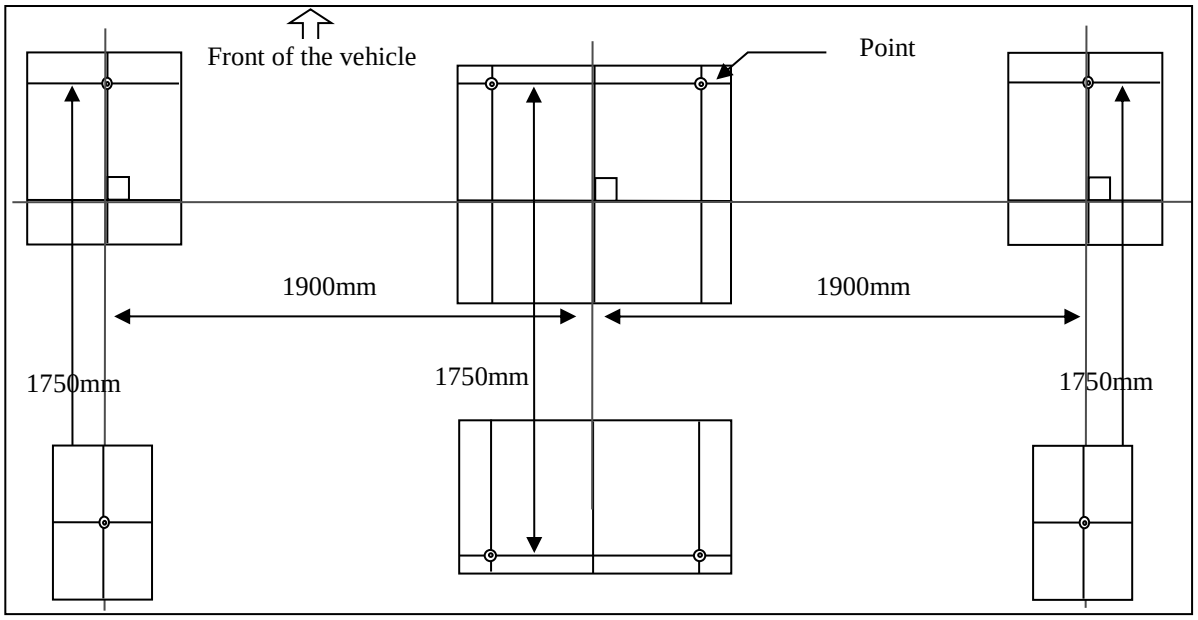


Figure 13.33 Positions of the Calibration Boards

5) Start the vehicle system in Test Mode

Select the [Setting] option from the Main Menu of the Measuring Application on PC1 and enter the value "30" to the [Test Speed] field. Select the checkbox for [Test Mode] and click on the [OK] button. Return to the Main Menu and display the Measuring menu as normally. Confirm that the camera image is displayed to [REAL Mini] on PC2.

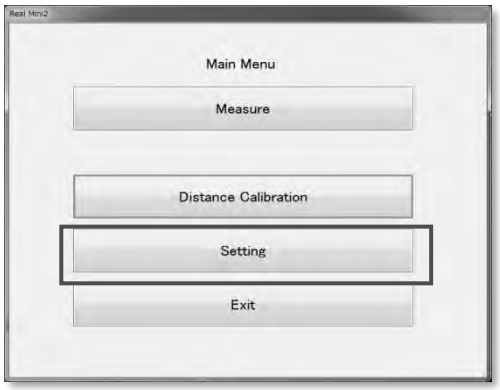


Figure 13.34 Button of the [Setting] Option on the Application's Main Menu

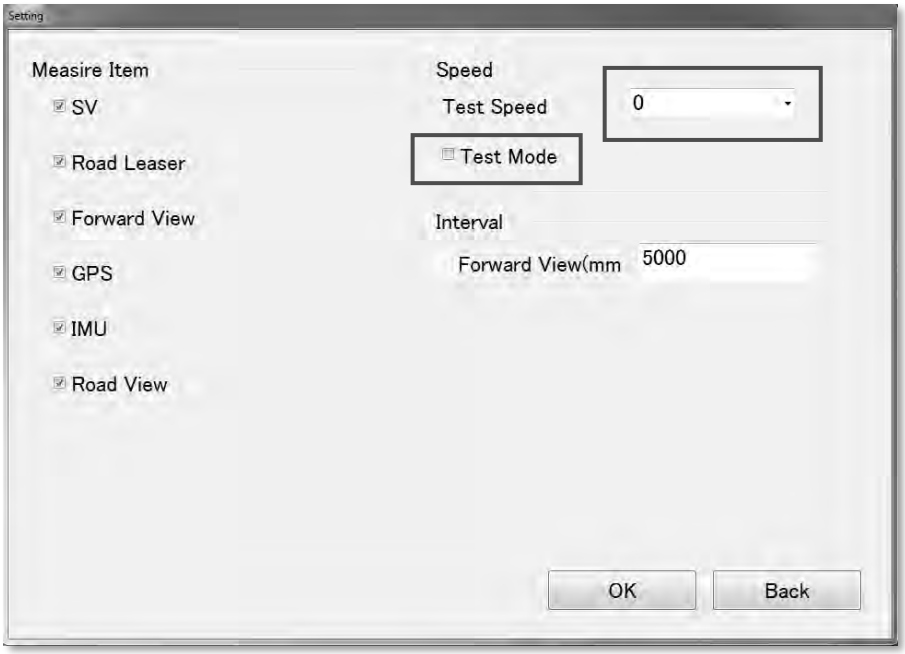


Figure 13.35 [Test Speed] and [Test Mode] Fields on the Application's Menu Window

Adjust the camera for road image's angle of view and confirm that all the points of the calibration boards (6 points for each camera) are displayed to PC2, the right and left angles of view are the same, and the angles of view for the day and night cameras are the same.

Figure 13.36 Example of a Menu Window on PC2

6) Measure using the Test Mode

Begin measuring by operating the white button on the control box, and after measuring for some tens of seconds, hold down the red button to stop the measuring. (For more information on how to take measurements, please refer to the operation manual for REAL Mini).

Figure 13.37 Control Box (Left: Start Button [white]; Right: Stop Button [red])

E. Calibration

1) Exit from the [REAL Mini2] application on PC2.

Exit the [REAL Mini2] application on PC2.

2) Launch the [Calibration] application on PC2

Once the [REAL Mini2] application is exited, launch the [Calibration] application from the desktop of PC2. Make sure that the application name indicated on the application's window reads "Calibration Mode".

Select the checkbox for [Replay] and click on the [Browser…] button and select the measured calibration image.

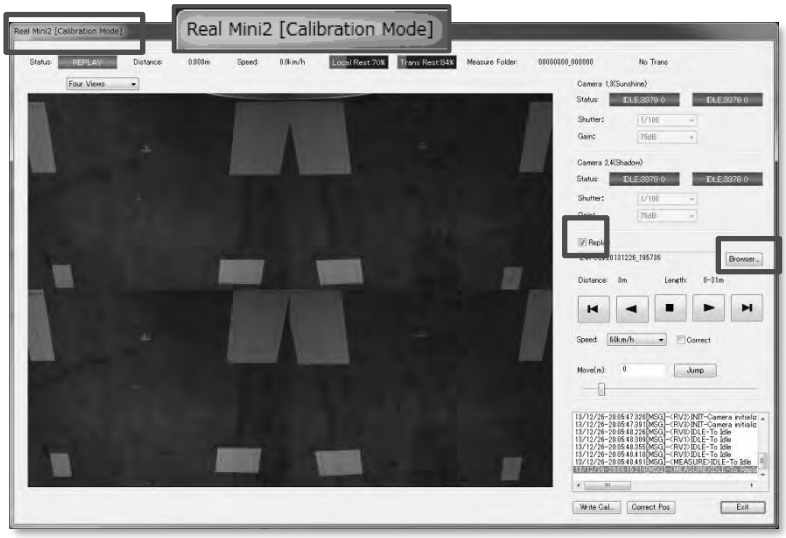


Figure 13.38 Menu of the Calibration Application

3) Configure the calibration points for each camera

Switch between the four cameras using the pull down menu and confirm that all 6 points are displayed inside the screen for each camera image.

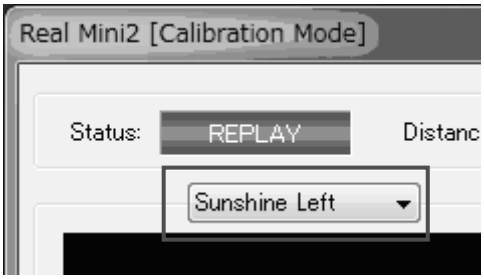
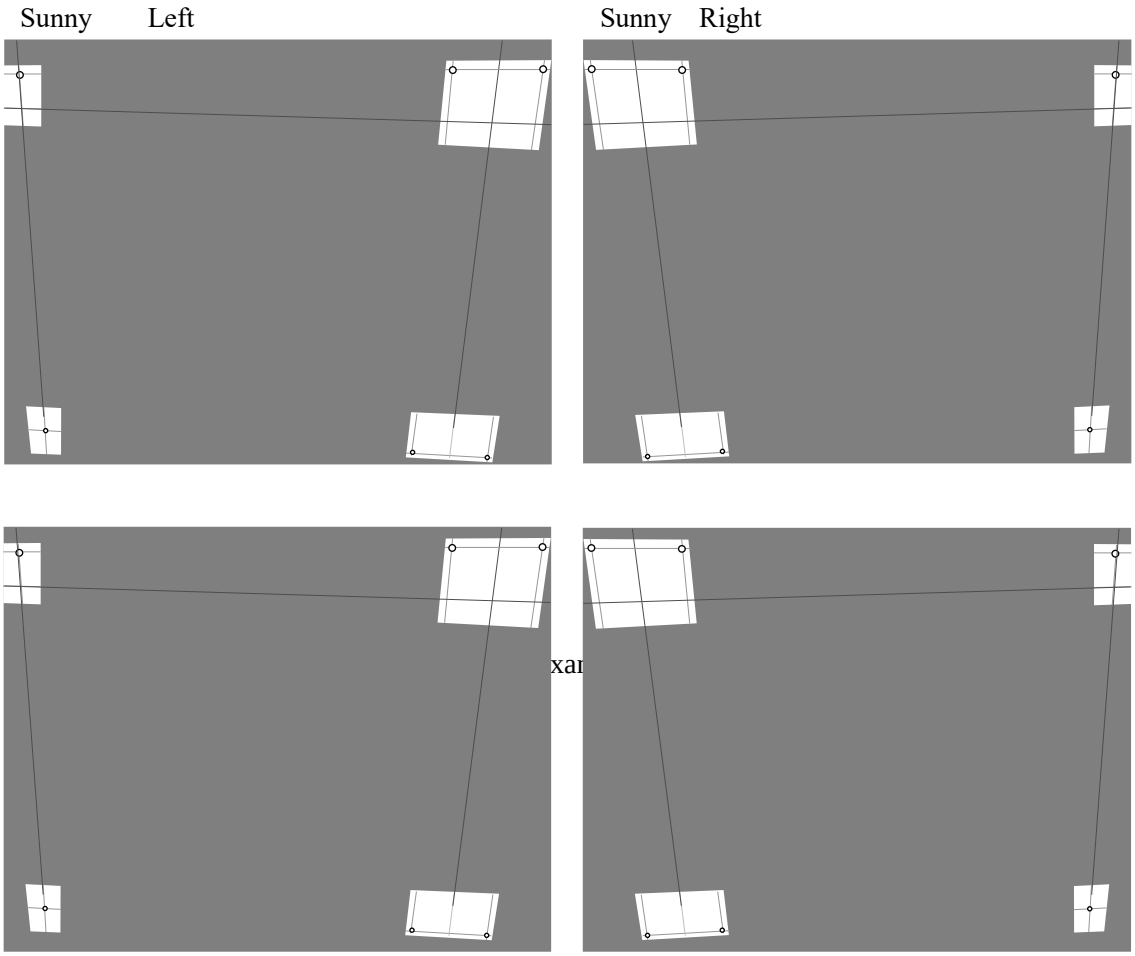
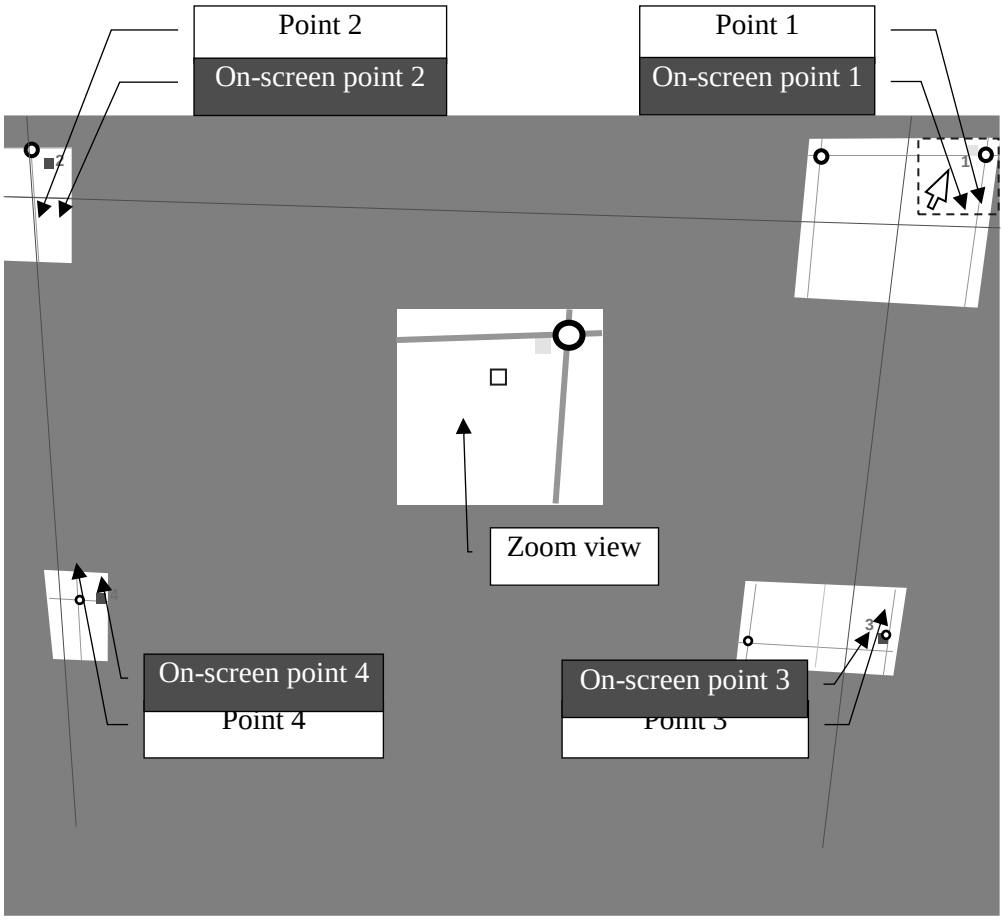


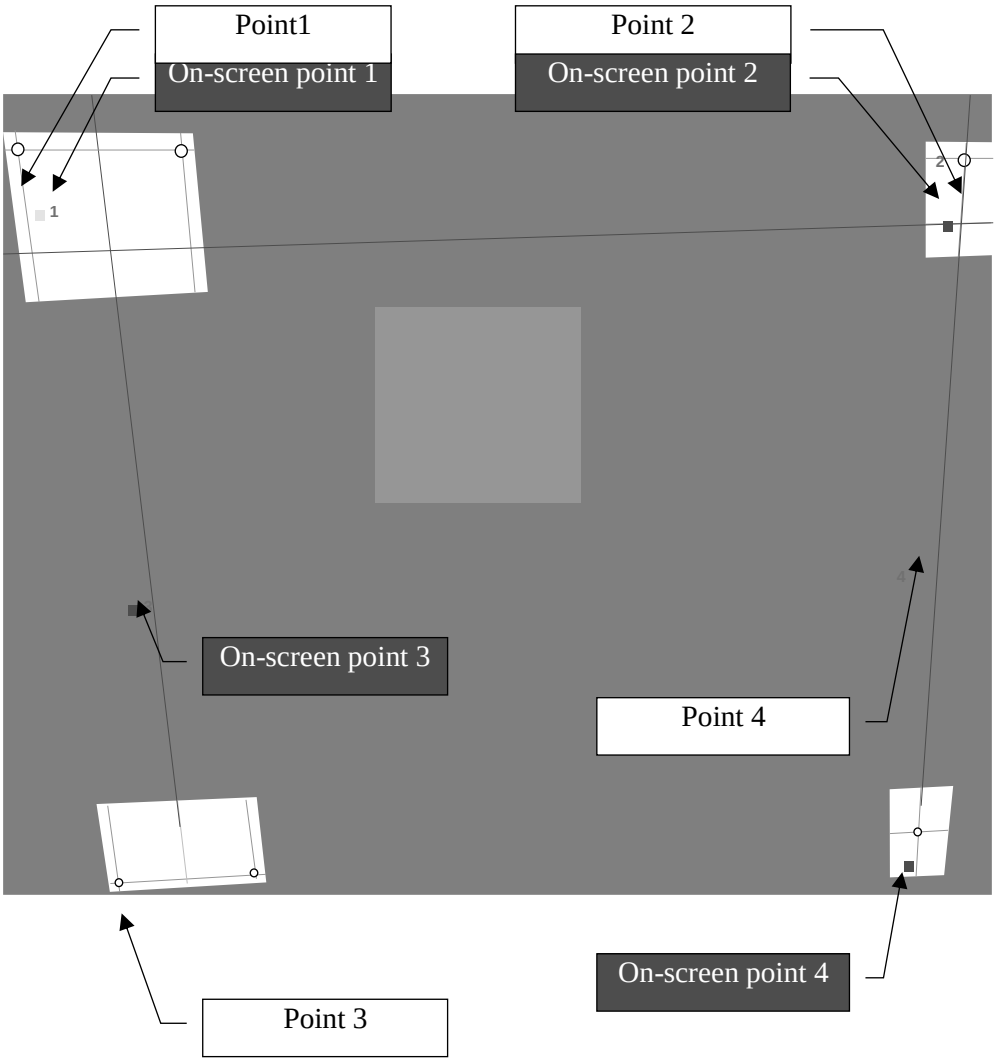
Figure 13.39 Location of the Pull down Menu



Align points 1, 2, 3, and 4 of the calibration board in the image with the on-screen points 1, 2, 3, and 4. Left-drag an on-screen point so that it is aligned with the corresponding point in the image. A zoom view is always displayed at the center of the image. Use the zoom view as a guide to align each point as accurately as possible. The position of a point can be tweaked using the arrow keys (“↑”, “↓”, “→”, “←”) on the keyboard.



From the pull down menu, select the next camera and perform the same operation to align the points. The image on the right will show the points horizontally opposite from the left image, but the procedure to align the points stays the same.



4) Save the settings

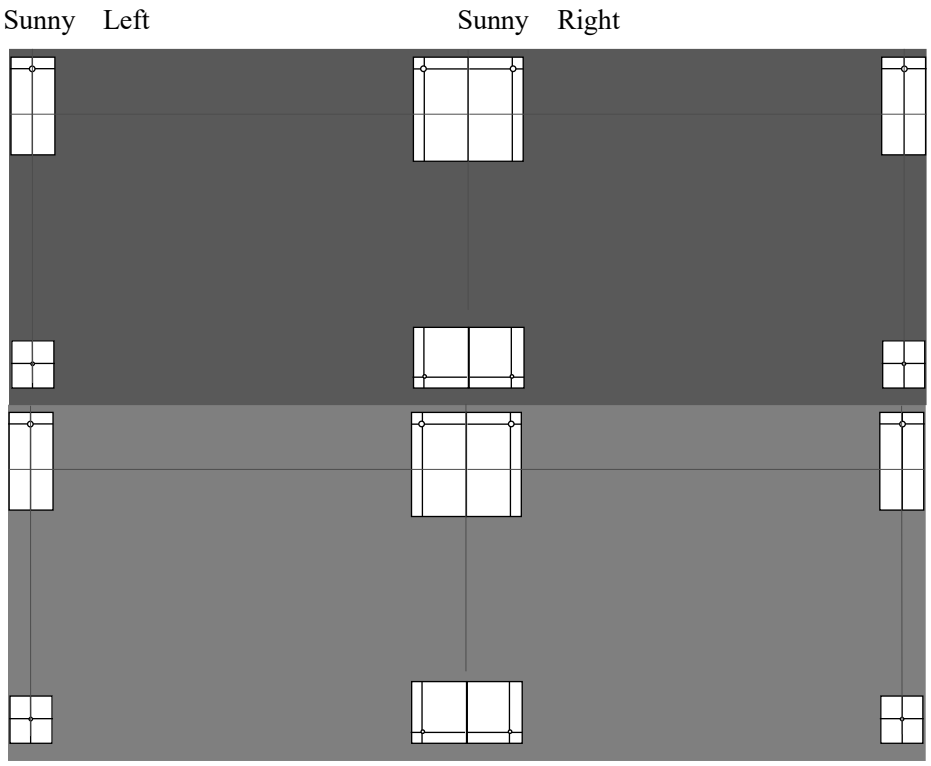
Once the points for all four screens are aligned, save the contents by clicking on the [Write Cal…] button.

Figure 13.43 Location of the [Write Cal…] Button in the Calibration Application

5) Confirm setting

Once the setting is saved, select [Four Views] from the pull down menu and display the four images. Select the [Correct] checkbox and confirm that the perspective transformation is performed properly (i.e. all of the images are transferred into bird's eye view). If the transformation is not performed properly, configure the calibration points of each camera once again.

Figure 13.44 Location of the [Correct] Button in the Calibration Application



The calibration process is now complete. Remove the calibration frame and calibration boards.

F. Caution

When performing calibration, please make sure that:

- Calibration is performed on a leveled, flat area.
- An open area of 4 meters wide and 2 meters long is secured at the rear of the vehicle when calibration is performed.

- The vehicle is neither boarded nor unloaded during calibration (differences in weight will affect the calibration results).
- Do not look directly at the laser beam emitted from the laser oscillator.
- When the calibration is complete, make sure that the calibration frame is removed (do not drive the vehicle with the calibration frame mounted).
- Once the calibration boards are installed into place, do not move them until the calibration is complete.
-

13.6 Laser Scanner

In order to define the positioning between the laser scanner and the road surface image, measuring position of the laser scanner is required. When the vehicle is changed or when the positioning between the camera for road image is changed (change in angle of view or when the camera is re-mounted), perform this step. Note that the procedure up to the adjusting of the calibration frame is the same as section 5.2 Angle of View Correction. Therefore, it is recommended to perform the calibration of the laser scanner together with the correction of angle of view for efficiency.

- How to adjust

(1) Equipment

Table 13.5 List of Equipment (No.1)

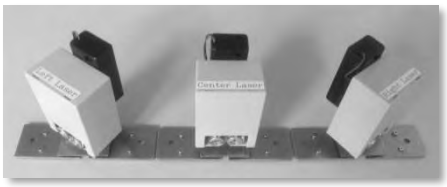
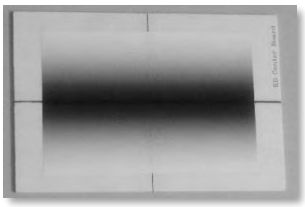
Name of Equipment	Image	Notes
Calibration frame		1 unit
Laser oscillator		3 units (Left Laser, Center Laser, Right Laser) Each requires one 9-volt battery (006P)
L-shaped mounting bracket		2 pieces A metal bracket to connect the calibration frame and the rack.
Nut		12 pieces
Mounting screws and washers		12 pieces each. Use M6 screws

Table 13.6 List of Equipment (No.2)

Name of Equipment	Image	Notes
Tweaking screw		20 pieces 1.5mm hex socket bolt

Tools	 	1.5mm hex key 6mm hex key 7mm wrench
Front calibration board (vertical) (Calibration Board Vertical1)		1 unit
Plumb bob		Including the plumb line.
Laser scanner center board (RD Center board)		1 unit
Infrared scope		1 unit Uses four AA batteries.

(2) Procedure

A. Assemble the calibration frame

Please see the section discussing the assembling of the calibration frame in [5.2 Angle of View Correction].

B. Mount the calibration frame

Please see section discussing mounting of the calibration frame in [5.2 Angle of View Correction].

C. Adjust the calibration frame

Please see section discussing the adjusting of the calibration frame [5.2 Angle of View Correction].

D. Install the center board for the laser scanner

Install the center board for the laser scanner (RD Center board) so that it is in alignment with the vertical and horizontal lines of the Center Laser.

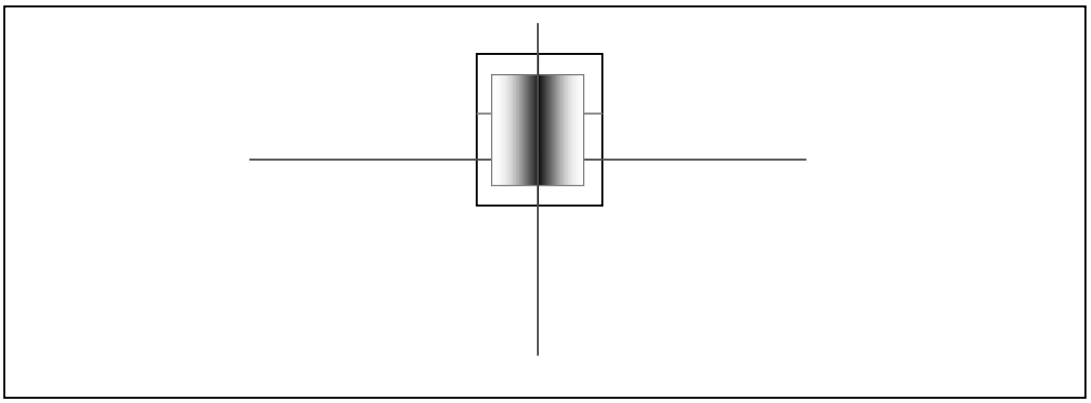


Figure 13.46 Positioning of the Center Board of the Laser Scanner

1) Measure the horizontal offset of the laser scanner

Launch the Measuring System so that measuring is enabled. Select the [View] option under [Maintenance] on PC1and display the options menu for the laser scanner. The distance from the center to the area where the luminance deteriorates is the horizontal offset of the laser scanner. The distance is read using the grid marks on the horizontal axis (one grid interval is 10mm). Write the value of the horizontal offset in a notebook and remove the laser scanner center board.

Figure 13.47 PC1 Application Menu and Maintenance Menu

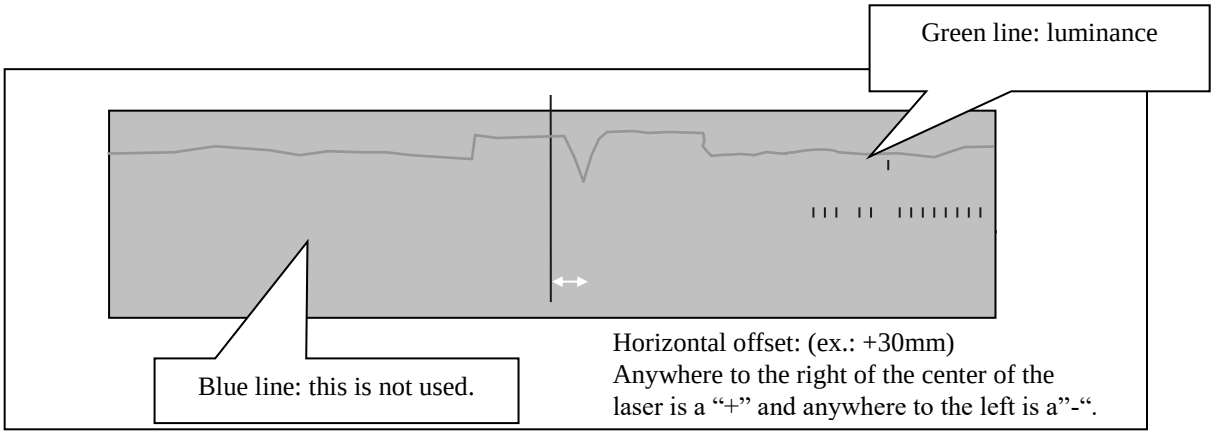


Figure 13.48 Example of the View Window of the Laser Scanner

2) Measure the vertical offset of the laser scanner

Turn the power of the infrared scope and check that the laser line is visible (laser line is not visible without the infrared scope).
If the power does not turn on, replace the batteries.

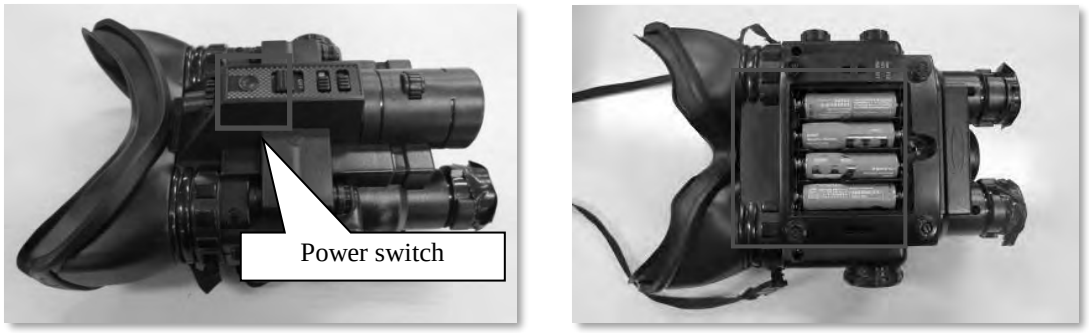


Figure 13.49 Position of the Power Switch and Batteries for the Infrared Scope

Align the front calibration board with the crosshair of the Center Laser. Using the infrared scope, confirm the position of the laser scanner. The distance from the center of the laser scanner to the horizontal line of a point is the vertical offset. Manually measure the vertical offset using a measuring tape and record the value in a notebook.

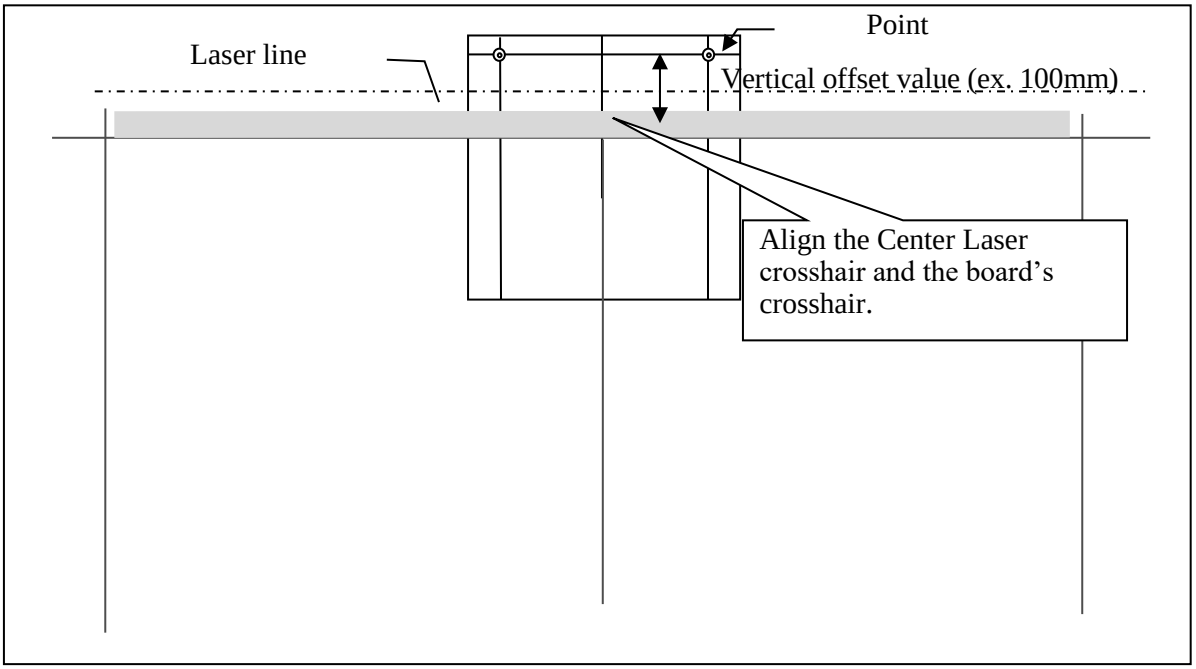


Figure 13.50 Positioning of the Calibration Board

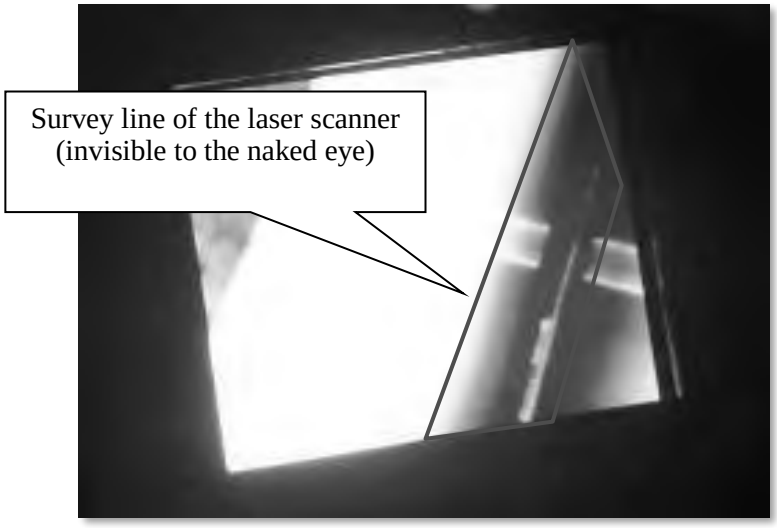


Figure 13.51 Example of a View from an Infrared Scope

3) Register the offset values

Select the [Maintenance] option on PC1 and display the Maintenance menu. Enter the horizontal and vertical offset values measured in section 5) and 6) respectively. Select the [Back] button and exit from the maintenance menu.

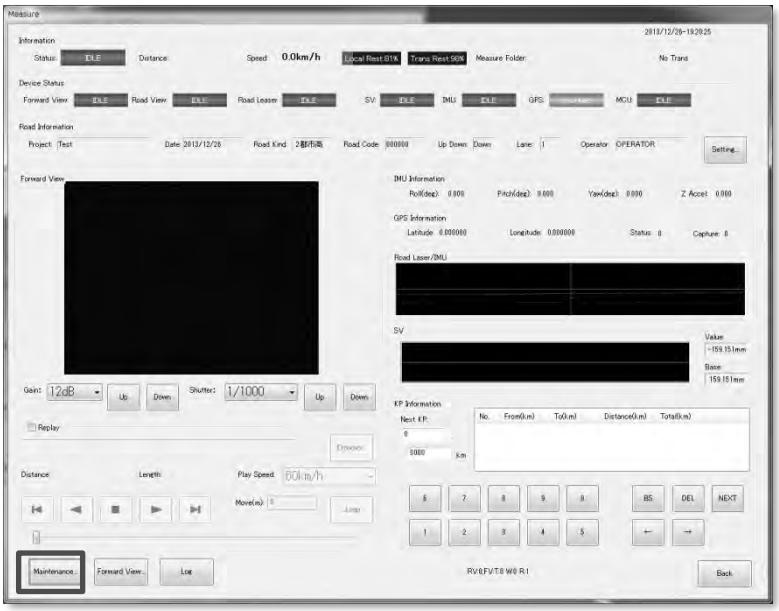


Figure 13.52 Location of the [Maintenance…] Button on the PC1 Application

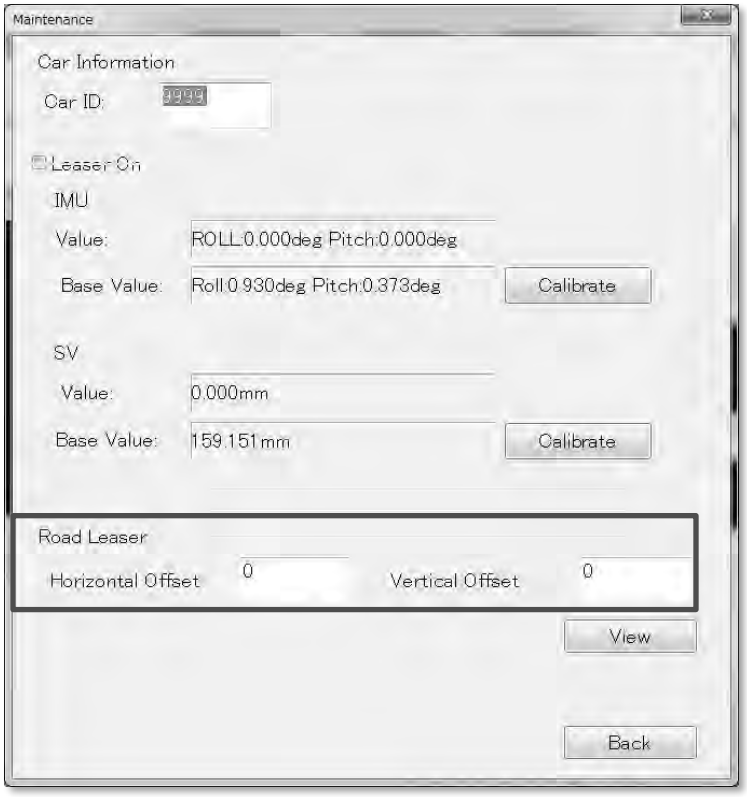


Figure 13.53 Location to Enter the Horizontal and Vertical Offsets

The laser scanner calibration is now complete. Clear the area and put away the equipment used for calibration.

E. Caution

During calibration, make sure that the vehicle is located indoors and is not exposed to direct sunlight. (Under direct sunlight, the infrared scope cannot catch the survey lines of the laser scanner).

13.7 Laser Displacement Sensor

The laser displacement sensor measures the distance from the ground and configures the base value. Perform this procedure when the vehicle or tire is changed, or when equipment is re-installed.

- How to adjust

(1) Set up

Launch the Measuring System so that measuring is enabled. Select the [Maintenance] option on PC1 and display the Maintenance menu.

Figure 13.54 PC 1 Application Menu and Maintenance Menu

(2) Measure the base height

Ensure that the same number of persons as at the time of measurement is onboard the vehicle, and select the [Calibrate] option and measure the base value. Select the [Back] button to exit from the measuring.

Figure 13.55 Location of the [Calibrate] Button on the Maintenance Menu

The adjustment of the laser displacement sensor is complete.

13.8 IMU

To correct the magnetometer of the IMU, perform calibration of the magnetometer. Because the calibration requires the vehicle to travel in a circle, this procedure should be performed in an open area. Also, the said area should not have any ceilings.

Figure 13.56 Example of Magnetometer Calibration Area (Hanoi)

- How to adjust

(1) Setup

While the vehicle is in a complete stop, turn the power on for both PC1 and the control unit.. Startup the [NAV-VIEW] application installed on PC1. From the [Setup] menu, select [Port] and specify the COM port and connect the IMU.

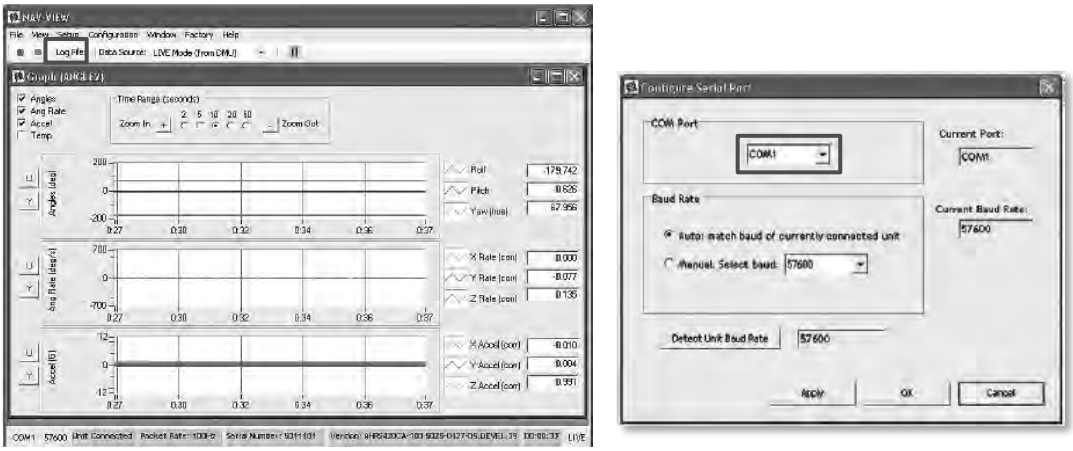


Figure 13.57 Main Menu of and Port Setting Menu of NAV-VIEW

(2) Magnetometer calibration

From the [Configuration] dropdown menu, select [Mag Alignment] and then, select the [Start] button. As the magnetometer calibration begins, the screen as shown below will be displayed. Follow the instructions displayed.

Continue to travel in a slow, steady circle until a prompt notifying that the calibration is complete is displayed.

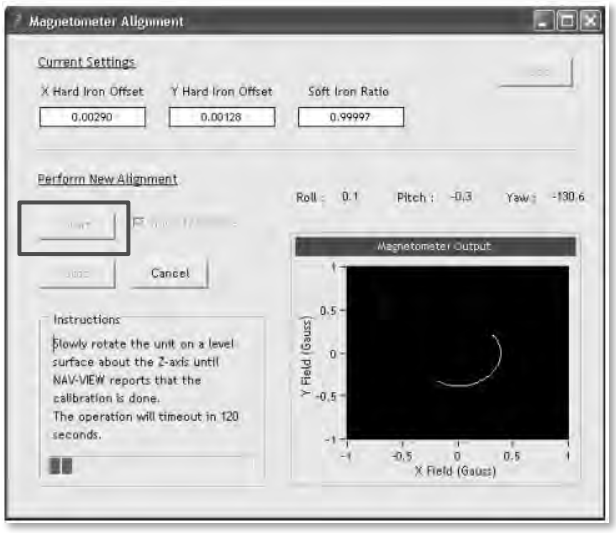


Figure 13.58 Mag Alignment Menu

When the rotation completes, the calibration coefficient is displayed. The affects of iron are also indicated. Check that the offset for X and Y are 0.1 or less for each, and that the Soft Iron Ratio is 0.95 or lower. If the results do not meet the control values, perform the calibration once again.

Click on the [Apply] button and save the calibration value to the IMU.

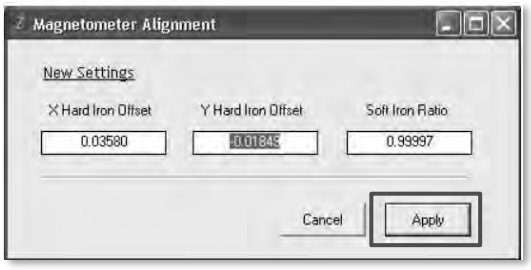


Figure 13.59 Mag Alignment Results Menu

The calibration of the magnetometer of the IMU is complete.

13.9 Distance coefficient

Calibration is performed to calculate the distance calibration value of the vehicle speed pulse output from the vehicle. Calibration is performed at every linear 1km section manually measured.

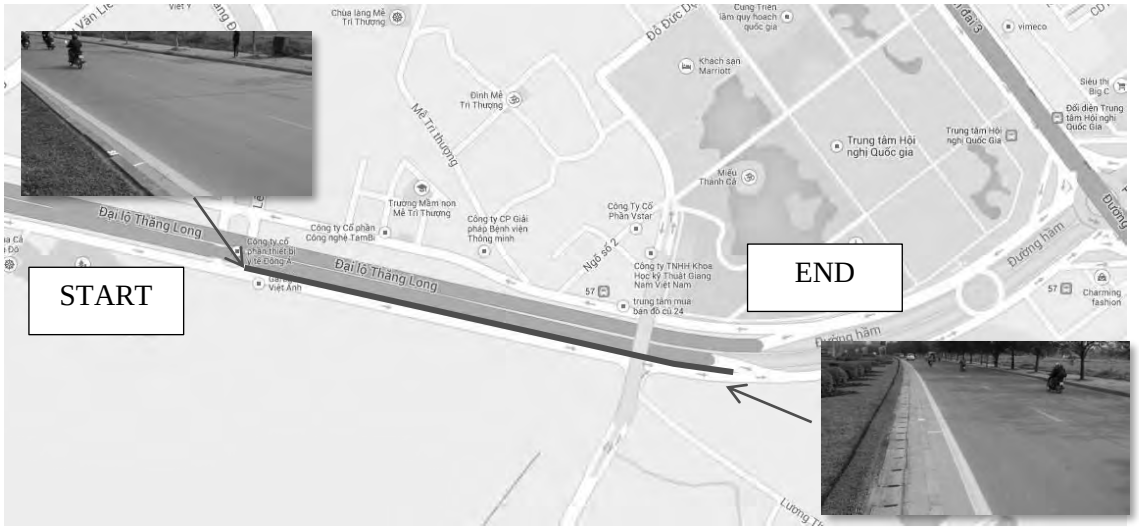


Figure 13.60 Example of Distance Calibration Area (Hanoi)

- How to adjust

(1) Setup

Launch the Measuring System.

Display the Distance Calibration Menu from the Measuring Application on PC1, and check that the [Status] is indicating [Idle].

Enter the mileage.

(normally, enter "1000" as calibration is performed every 1000m).

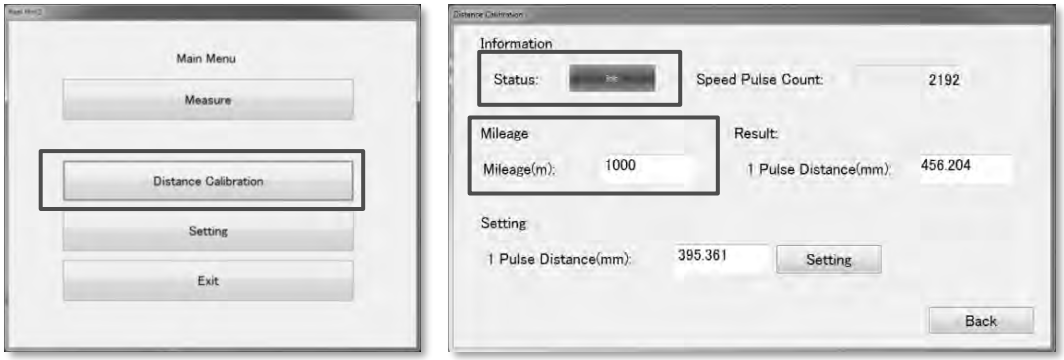


Figure 13.61 Distance Calibration Menu

(2) Distance calibration

Navigate to the measuring location and press the start button (the white button on the control box) at the measuring start point to begin measurement. During measurement, [Measure] is indicated to the [Status] field. Push the stop button (red button on the control box) at the measuring end point to stop the measurement.

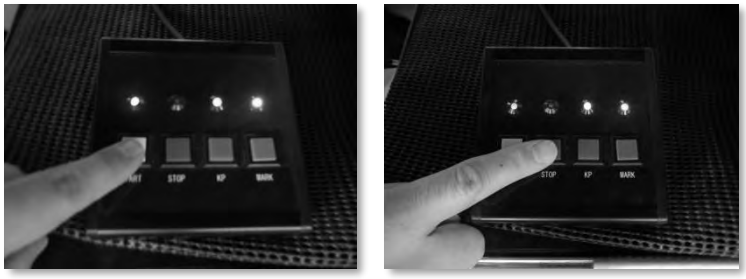


Figure 13.62 Control Box (Left: Start Button [white]; Right: Stop Button [red])

The distance for one pulse is displayed to the [Result] field. The distance calibration requires three sets of measurements which are compared and assessed. If the differences of the three measurements are within 1 to 2 pulses, it is regarded as normal. The average value of the three sets of measurements becomes the distance calibration value. However, if values of from the three sets of measurements are diverse, measuring must be performed again until a difference of 1 to 2 pulses among the three sets of data is achieved.
Once the distance calibration value is determined, enter the value and click on [Setting] to save the results.

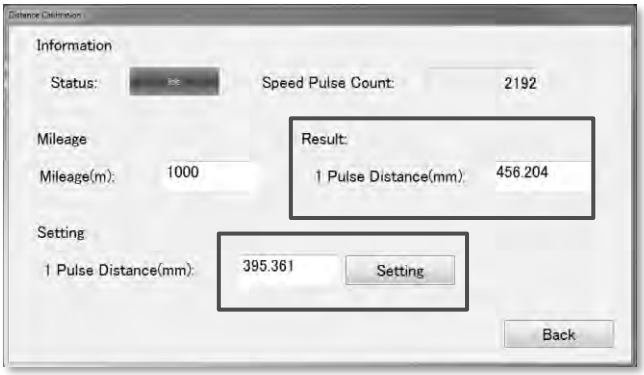


Figure 13.63 Distance Calibration Menu

(3) Confirm the distance calibration value

Once the distance calibration value is configured, measure the calibration section as normally done. Begin measuring before the starting point and press the marking button (green button) at the starting and ending points. The configured value is acceptable if the discrepancy of the measured marking interval is between -5 to +5 meters. However, if the discrepancy exceeds this range, the distance calibration procedure should be performed once again.

The distance calibration is now complete.

14. Instruction Manual of Maintenance

14.1 Purpose

Maintenance is intended to be operated safely of REAL Mini.

14.2 Timing of Maintenance

Maintenance is implemented in the morning before the survey by using the check form shown 4.

14.3 Responsible person of the Maintenance

The maintenance is carried out in all engineers to use the REAL Mini. One engineer fill in the check form. After fill in the check form, another engineer confirm the contents of the form.

14.4 Work Flow

The maintenance follow the below the work flow.

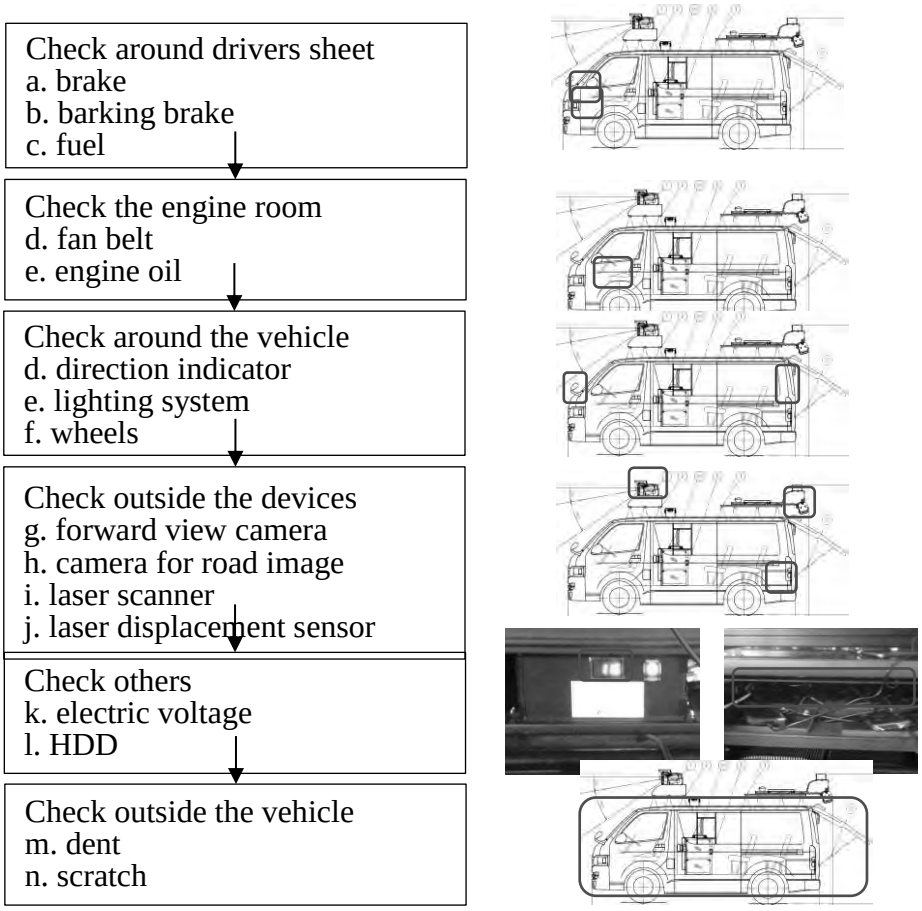


Figure 14.1 Work flow

14.5 Form of Maintenance Check List

Form of maintenance check list is shown in Figure 14.2.

PASCO
World's Leading Geospatial Group

Signiture		
. .	. .	. .

Real Mini Check Form

Check date		
Plate No.		
Name	Check	
	Driver	

	Check Point	Check Content	Check
Driver	Brake	Effectiveness	
	Parking brake	Effectiveness	
	Fuel	Remaining amount of gasoline	
Engine room	Lubrication	Engine oil	
	Fan belt	Tension	
		Damage	
Around Vehicle	Direction indicator/ lighting system	Lighting condition	
		Blinking condition	
		Damage	
	Wheels	Air pressure	
		Crack/Damage	
		Wear	
Outside divices	Forward View Camera	Open the cover	
		Clean the lens	
	Road Camera	Open the cover	
		Clean the lens	
	Laser Scanner	Open the cover	
		Clean the lens	
	Laser Displacement Sensor	Open the cover	
		Clean the window	
Others	Voltage	Power supply of measurement system	v
	HDD	Connect the HDD to PC1 and PC2	
		Foleder of PC1:PC1/data	
		Foleder of PC2:PC2/data	

Outside check

Mark : Dent Scratch

（fill into the below figure by red pen）

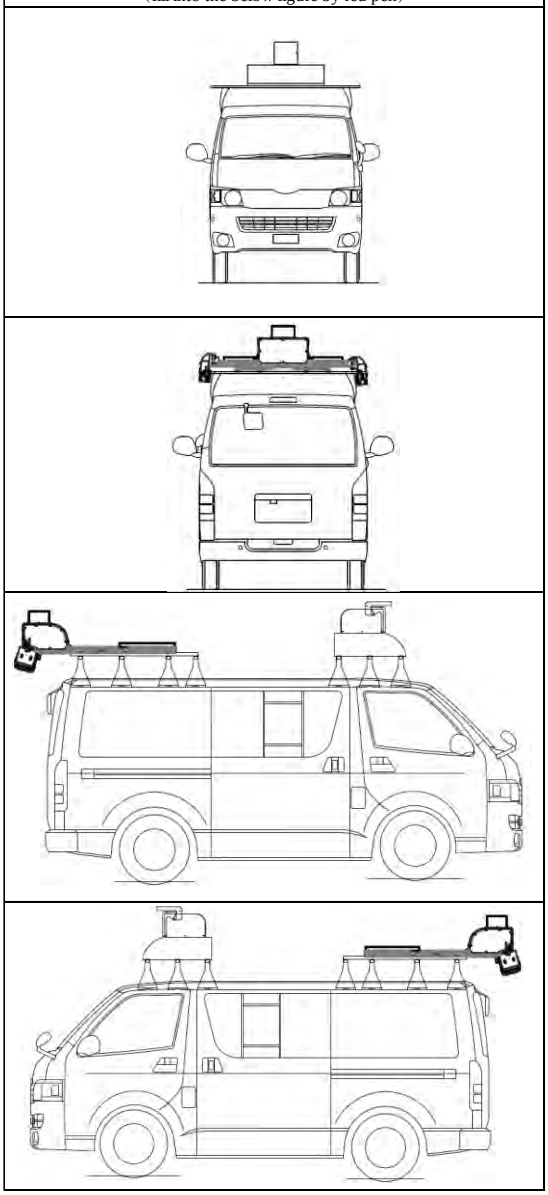


Figure 14.2 Form of Maintenance Check List

Thereafter, it shows images of the check place.

Figure 14.3 The place of Engine Room

Figure 14.4 Bend the sheets (Driver and Center sheet)

Figure 14.5 Unlock

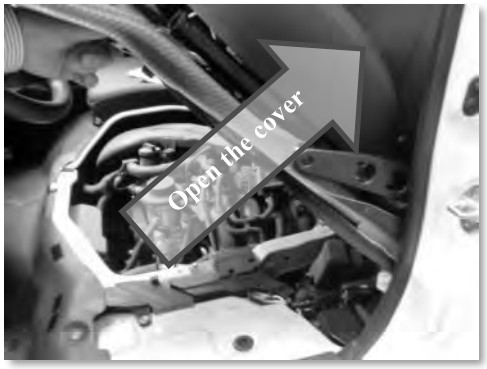


Figure 14.6 Open the Engine Room

Figure 14.7 Check the fan belt(Tension, Damage)

Figure 14.8 The place to check the Engine Oil

Figure 14.9 Pull out the Oil Level Checker

Figure 14.10 Clean up the tip of Oil Level Checker

Figure 14.11 Insert the Oil Level Checker again

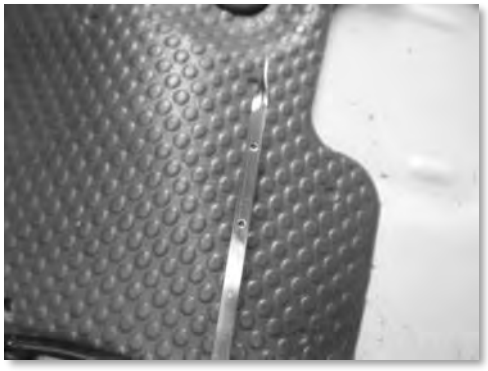


Figure 14.12 Pull out the Oil Level Checker once again and check the oil adhesion to the tip

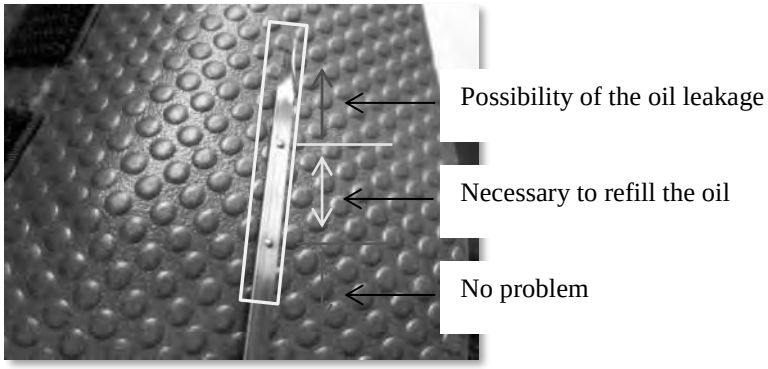


Figure 14.13 Check the remaining amount of the Engine Oil

Figure 14.14 Insert the Oil Level Checker again

Figure 14.15 Close the cover of engine room

Figure 14.16 Check the lighting of the light. Check the damage of the cover of the light

Figure 14.17 Check the brake lighting

15. Troubleshooting

15.1 Troubleshooting

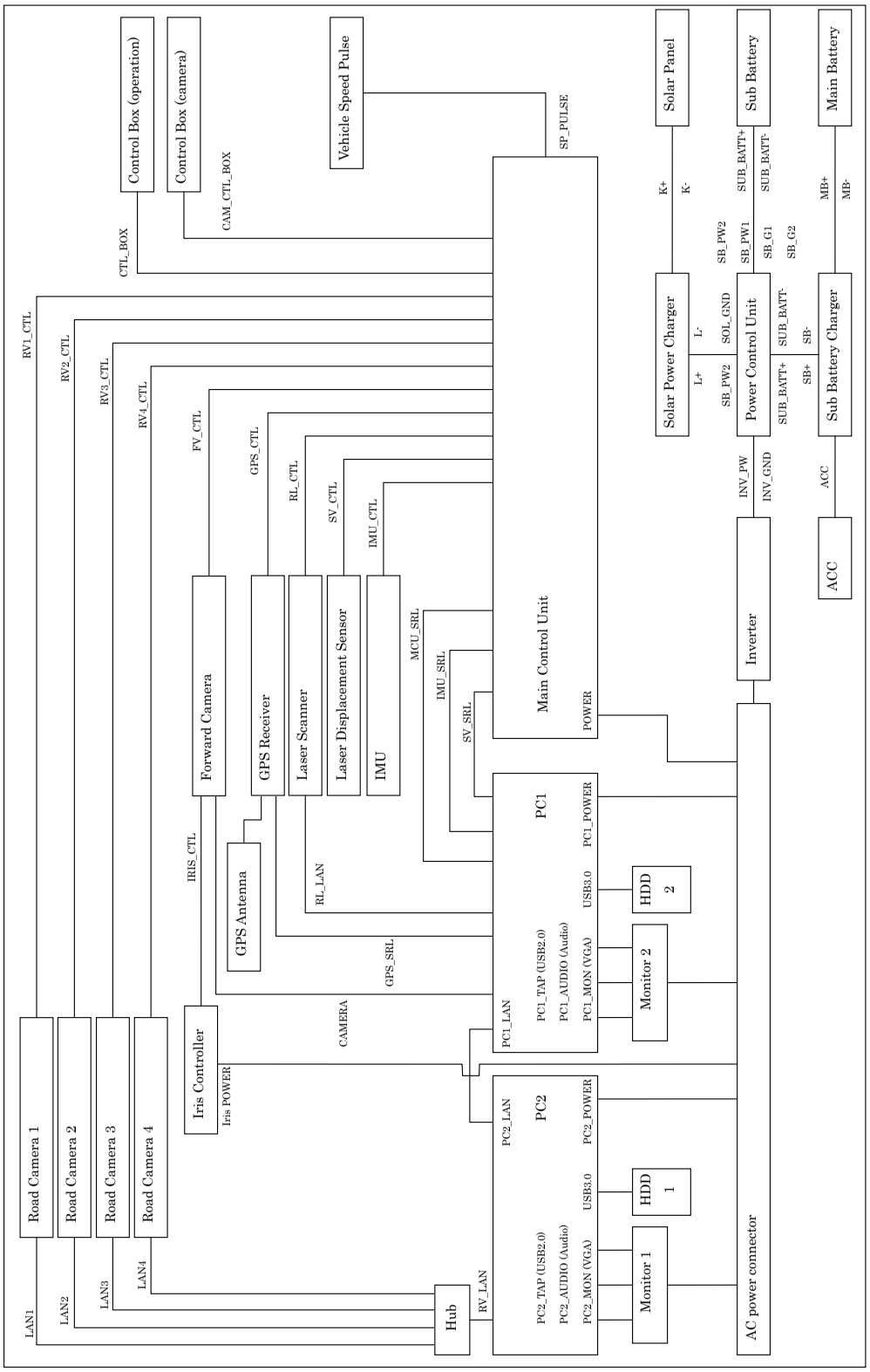
This document introduce the general troubleshooting of Pavement Condition Survey.

Table 15.1 Troubleshooting

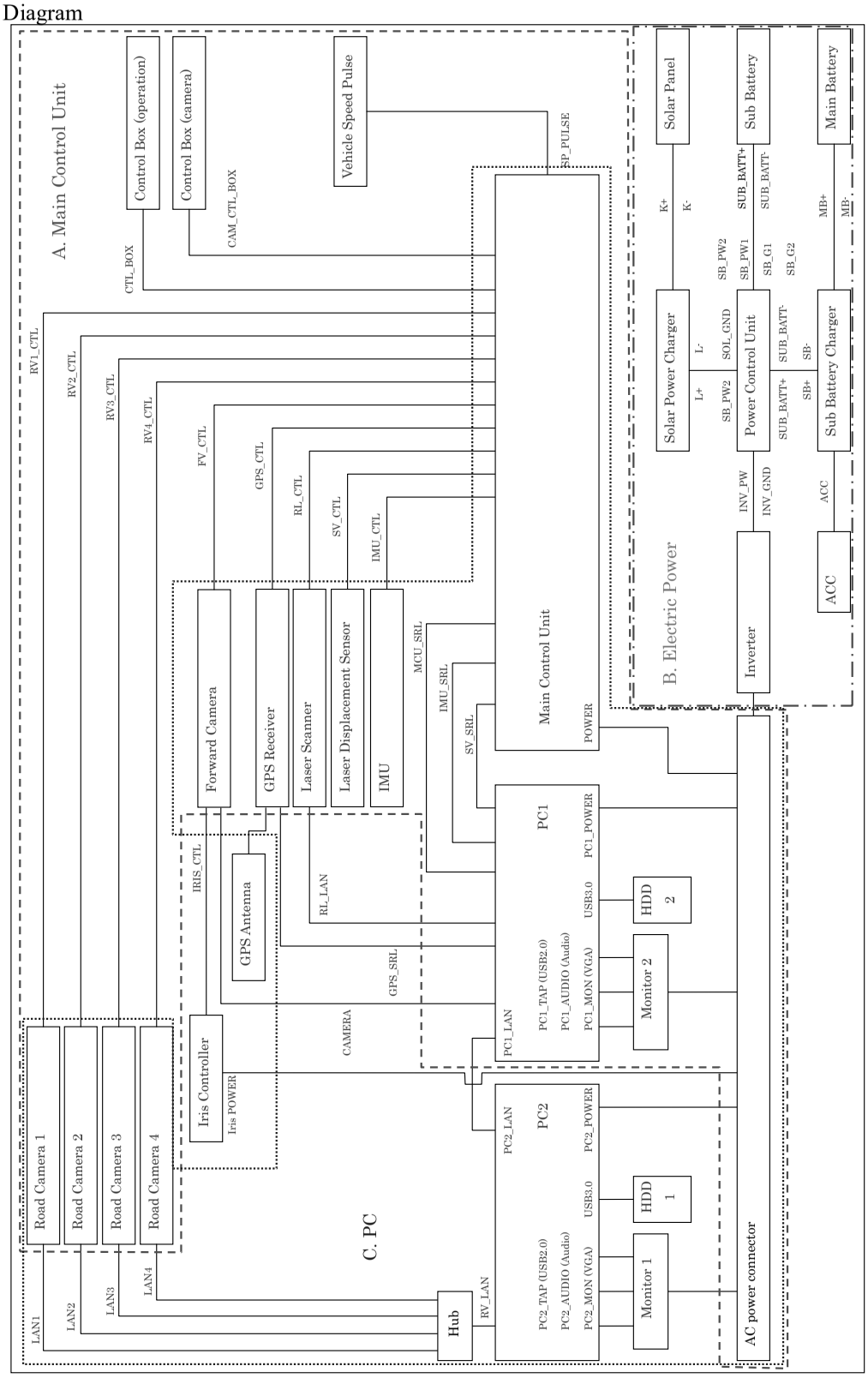
Category	Phenomenon	Causing	Solution
Trip meter	No Wifi in the iPad	Trip meter didn't connect to the electric origin	Check the connection to the electric origin
	Cannot operate the button of the Tripe meter	Unanticipated stop the application	Restart the application in the iPad
	Didn't write the data to SD card	The data capacity of SD became full	Delete the data of SD
	The battery level decrease of iPad	Disconnect the Trip meter and iPad	Connect the cable of Trip meter to iPad
REAL Mini	Not change the status to "IDLE"	Disconnect the external HDD to PC1 and PC2	Connect 2 external HDDs to PC1 and PC2, and restart the measurement application
	It doesn't change to "IDLE" connected to external HDD	Folder PC1/DATA or PC2/DATA have not been made in the external HDD	Check the folder structure in the external HDD
	Measurement stop in the middle	There is no space in the capacity of the internal HDD	Delete the data in the internal HDD(D drive/data) after finish to transfer the data to external HDD
		Out the connection of external HDD	Check USB of external HDD is plugged to the PC
	Cannot measure because voltage is reduced	Life of the battery	Change the battery to new one
	Forward view image is blurred	The lens of forward camera is dirty	Wipe the lens
	Forward view image is dark	The shutter speed of forward camera is fast	Slow down the shutter speed of forward camera
	Forward view image is bright	The shutter speed of forward camera is slow	Faster the shutter speed of forward camera
	Forward view image suddenly in black	Camera cover may close in vibration	Fix the cover use the equipment attached in the side of camera box
	Doesn't work the controller	Disconnect the cable of controller to MCU	Check the connection the cable of controller and MCU
Analysis	Analysis Application stops suddenly	Lack of free memory	Memorize the distance and run Analysis Application again
	The message "There are differences in the	Differences in the crack classification and road	Please check the LOG.TXT file and find out the place.

Category	Phenomenon	Causing	Solution
	cracks and road surface type. Please check the LOG.TXT." appears	surface type.	
Processing	Files exists in the folder but "POS", "RD", "CR", "IRI" and "DPP" indicate NG	All of file exist more than one.	Put only one "POS", "RD", "CR", "IRI" and "DPP" file in folder.
	Pavement Conditions table (output from Data Processing Application) shows strange value about "Kilometer Post (From km)"	Inputs wrong value when execute data processing.	Input same value to the "Kilometer Post" of Left bound and Right bound.
	The number of the row difference error occurs when execute the data processing	C3, R3, S3 files and P file row amount are unmatched.	Check the both output data value of rows from Analysis Application and Location Information Setting Application.

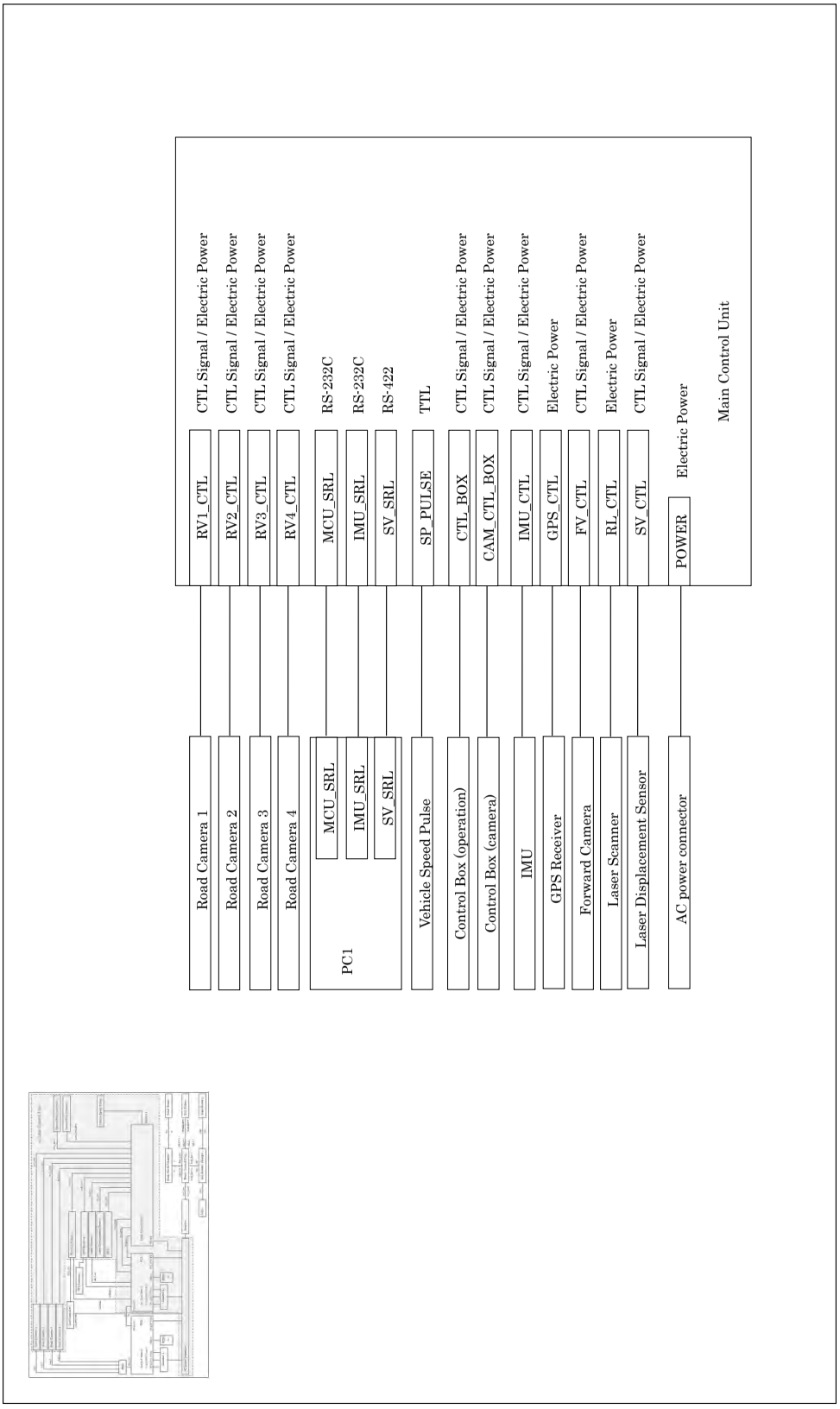
16. Wiring Diagram



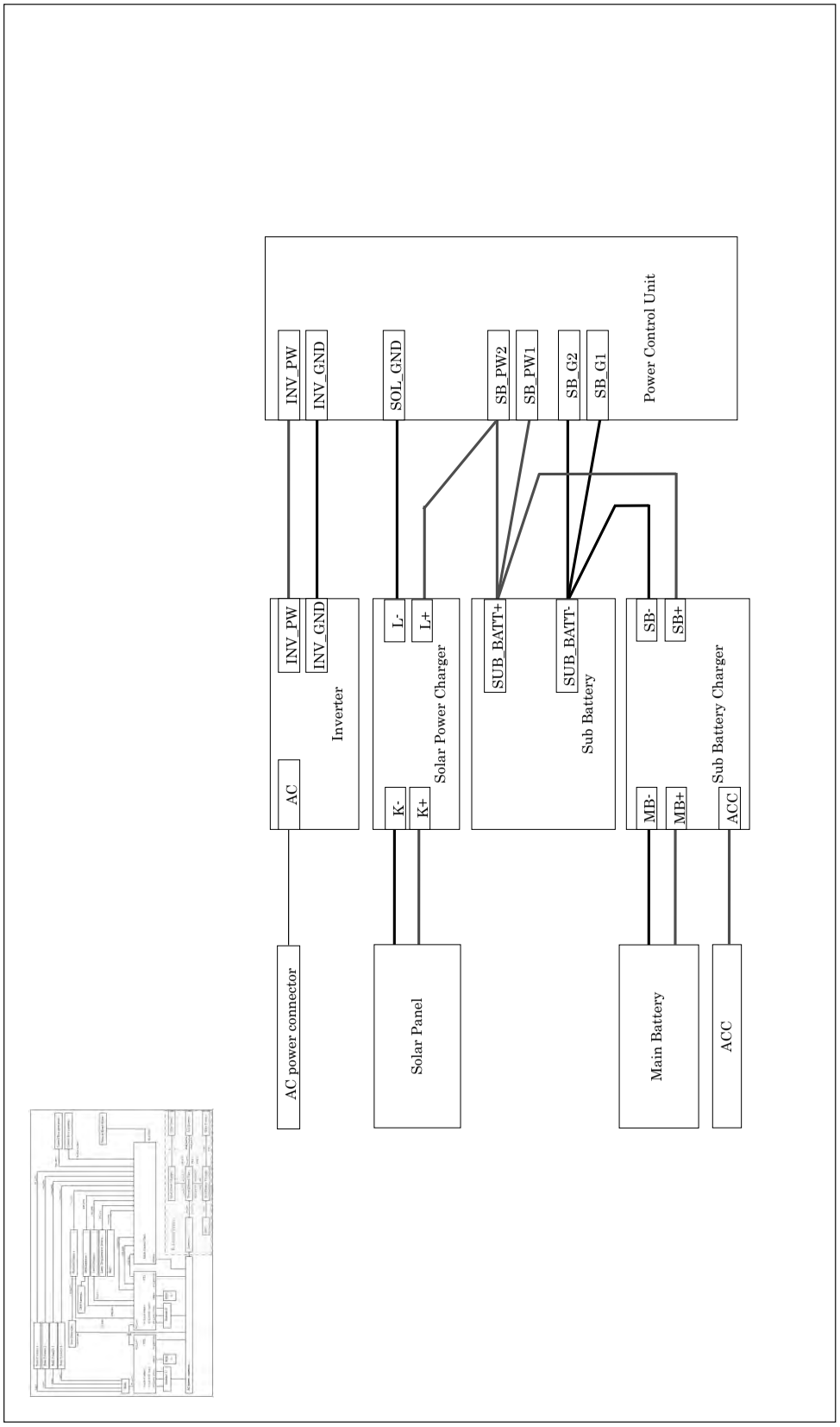
■Wiring Diagram



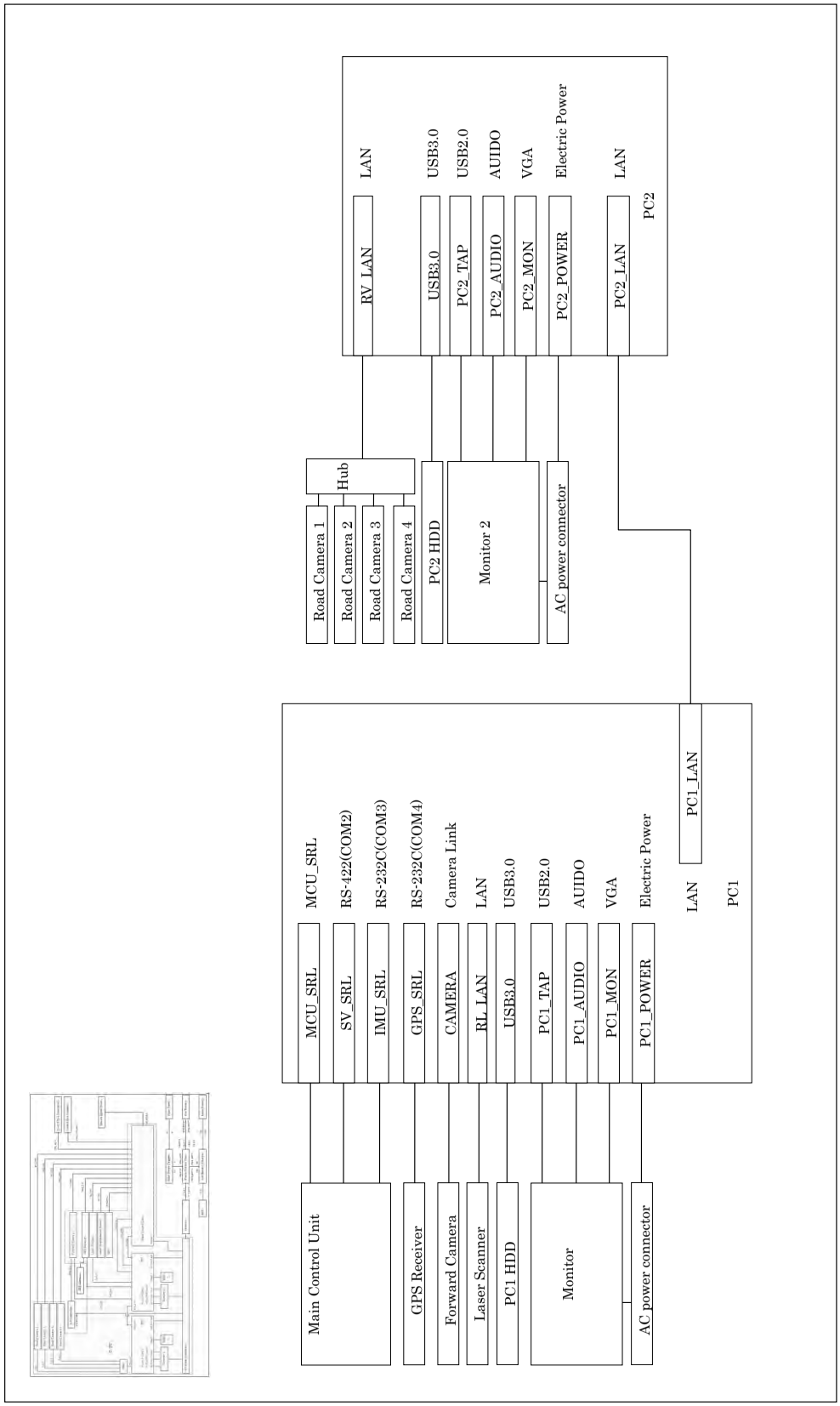
■A. Main Control Unit



■B. Electric Power



■C. PC


PC2
LAN
USB3.0
USB2.0
AUIDO
VGA
Electric Power
LAN
RV_LAN
USB3.0
PC2_TAP
PC2_AUDIO
PC2_MON
PC2_POWER
PC2_LAN
Hub
Road Camera 1
Road Camera 2
Road Camera 3
Road Camera 4
PC2 HDD
Monitor 2
AC power connector
PC1
LAN
PC1_LAN
MCU_SRL
RS-422(COM2)
RS-232C(COM3)
RS-232C(COM4)
Camera Link
LAN
USB3.0
USB2.0
AUIDO
VGA
Electric Power
MCU_SRL
SV_SRL
IMU_SRL
GPS_SRL
CAMERA
RL_LAN
USB3.0
PC1_TAP
PC1_AUDIO
PC1_MON
PC1_POWER
Main Control Unit
GPS Receiver
Forward Camera
Laser Scanner
PC1 HDD
Monitor
AC power connector

JAPAN INTERNATIONAL COOPERATION AGENCY

DIRECTORATE FOR ROADS OF VIETNAM

MINISTRY OF TRANSPORT (MOT)

THE SOCIALIST REPUBLIC OF VIETNAM

THE PROJECT FOR CAPACITY ENHANCEMENT IN ROAD MAINTENANCE PHASE II

PAVEMENT CONDITION SURVEY MANUAL

Volume 2.1.5: Data Preparation

MARCH 2018

JICA PROJECT TEAM

Record of updates

Rev.	Date	Contents change
1.00	2017.12.19	First edition

Table of Contents

List of Figure

List of Table

Glossary

Administration Database	Database of PMS data storing administrative information.
Analyzed section Table (Table-3)	The final section table prepared by PC data.
Calibration	Adjustment of devices for true value
Camera for front image	The device for measuring the front image
Camera for road image	The device for measuring the road image
Crack	Damage index based on the pavement surface crack.
End point	The end position of the target route.
Excluded section	The out of scope section for survey. For example, the section that is under construction or being transferred to the management of another agency.
IRI (International Roughness Index)	Damage index based on the longitudinal shape on the pavement surface.
KP (Kilometer post)	Positon of route. It is consist of Kilo-post station number and distance from the Kilo-post station.
Kilo-post station	A road sign on the side of the road to indicate distances from major cities.
Kilo-post station number	The number indicated on the kilo-post stations in the side of the road.
Laser displacement sensor	The device for measuring of longitudinal profile
Laser scanner	The device for measuring of transverse profile
Main control unit	The unit to control the measurement device
Marking	Marking of the start point and end point for easier recognition.
Overlapping section	A section in which two routes overlap in terms of management.
Patching	The repaired part of partially damage area (Pothole, crack, and so on).
Pavement condition	The condition of pavement surface. The pavement condition is evaluated for cracks, ruts and IRI.

Pavement condition survey vehicle	Vehicle assembled with measurement devices.
PDCA cycle	Management cycle acronym for PLAN, DO, CHECK and ACT.
PMS	Pavement Management System.
PMS Database	Database stored for PMS dataset.
Power control unit	The Unit for supply and control the electric power to the measurement device
REAL Mini	Name of the pavement condition survey vehicle made by PASCO CORPORATION.
Rut	Damage index based on the transverse shape on the pavement surface.
Start point	The start position of the target route.
Survey plan section Table (Table-1)	Table of planned survey length
Surveyed section Table (Table-2)	Table-1 with extensions added

Acronyms

AC	Asphalt Concrete
BOT	Build-Operate-Transfer
BST	Bituminous surface treatment
CC	Cement Concrete
DPI	Department of Planning and Investment
DRVN	Directorate for Roads of Vietnam
HDD	Hard Disk Drive
IWP	In wheel path
KP	Kilometer post
MMD	Management and Maintenance Department
OWP	Out wheel path
PC data	Pavement condition data
PCS	Pavement Condition Survey
PCSV	Pavement Condition Survey Vehicle
PDOT	Provincial Department of Transport
PPC	Provincial People's Committee
QC	Quarter-Car
RMBs	Road Management Bureaus
SB	Sub Bureaus
STEICD	Science, Technology, Environment, International Cooperation Department
TOR	Terms of Reference

1. Introduction

1.1. About This Manual

Data Preparation (PCS-Vol.5) is one of six manuals comprising the suite of the documentation for pavement condition survey. Figure 1.1 shows the component of pavement condition survey manual. Pavement condition survey manual is divided into three parts, Overview, Operation manual and Technical manual. Documents to be referenced depend on the responsibility and work steps of stakeholders involved in pavement condition survey. Overview describes the basic items of survey that all stakeholders should refer to. Operation manual shows important matters to be referred to mainly when survey work managing. Technical manual indicates technical matters such as system and device operation methods, data definition and data preparation. Figure 1.2 shows the description of contents of each document.

The purpose of this manual is to certainly prepare pavement inspection data for road maintenance management in Vietnam. PC data is registered in the Pavement Management System Database (hereafter, "PMS Database") and is used for pavement maintenance planning. When create PC data, the contractor of the pavement condition survey should make data according to this manual. If there is lack of information, addition and updates by DRVN staff would be recommended.

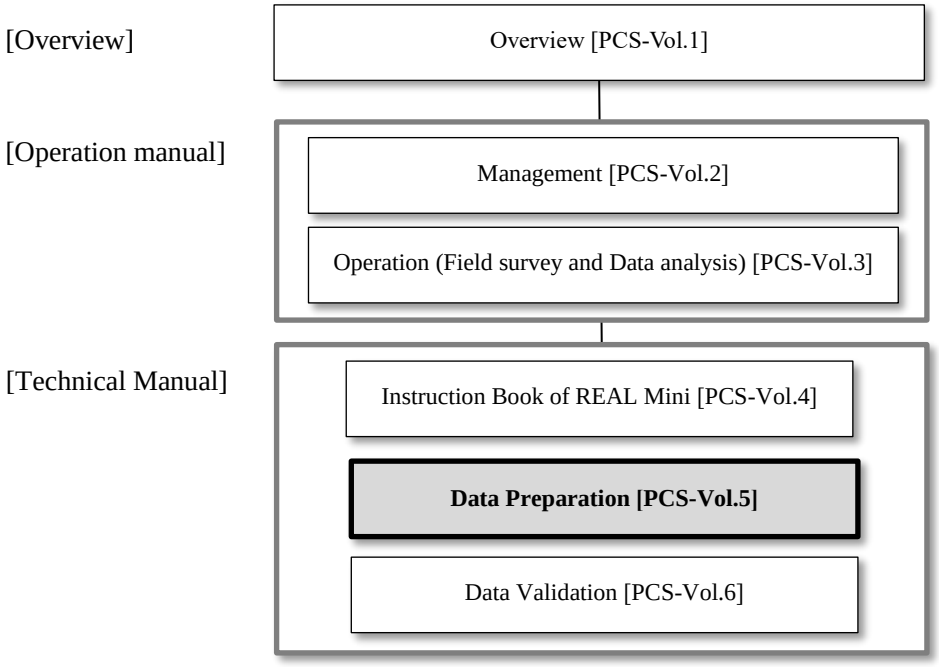


Figure 1.1 Relationship of Pavement condition survey manual

[Overview]

Overview (PCS-Vol.1]

➔ Describe the overview and measuring methods of pavement condition survey. It is a general purpose document which provides in an understanding of pavement condition survey.

[Operation manual]

Management [PCS-Vol.2]

➔ Describe the management work of road administrator on pavement condition survey. It contains all management works such as the planning, supervising, and data checking on pavement condition survey describing. It is to be used by administrator who to carry out the management of pavement condition survey.

Operation (Field survey and Data analysis) [PCS-Vol.3]

➔ Describe the survey and analysis work of survey consultant on pavement condition survey. It contains the survey and analysis rule. It is to be used by surveyor and analysis operator who to carry out the pavement condition survey.

[Technical manual]

Instruction Book of REAL Mini [PCS-Vol.4]

➔ Describe the operation procedure of REAL Mini system. It contains the operation procedure of inspection vehicle and analysis system, calibration and maintenance of the inspection vehicle and so on. It is to be used by surveyor and analysis operator whose task is to carry out the deep study for operation procedure of REAL Mini system.

Data Preparation [PCS-Vol.5]

➔ Describe the contents of pavement condition data (PC data). It contains the code definition, explanation of each item of PC data and so on.

Data Validation [PCS-Vol.6]

➔ Describe the data check procedure when creating the PC data. It is to be used by person whose task is to carry out the data check in pavement condition survey.

Figure 1.2 Contents of Pavement condition survey manual

1.2. Reference

This manual refers to the below manual and standard document as detail specification or procedure. If you need to detail information, please refer to the below manuals or documents.

・ Sample Data（Appendix 1

2. Output Data Files

In the pavement condition survey, three kinds of data, 1) Pavement Condition Data, 2) Image data with coordinates and 3) Image files as bellow table are prepared. Pavement Management System (hereafter, "PMS") requires pavement condition survey results and forward view image files

These data are registered in PMS Database and are used for display in Web-based Display System for Pavement Condition Data, for subsequent, Budget Planning module, Work Planning module etc.

Table 2.1 The list of Outputs

No.	Item	Description	File Type
1	Pavement Condition Data	List of pavement surface damage status by pavement condition survey	CSV
2	Image data with coordinates	List of front view image files linkage with coordinates	CSV
3	Image files	Front view image files	Jpg

2.1. File and Folder Structure

PC Data, Image data with coordinates, Image files are stored on a storage medium such as HDD according to the below rules.

1) File Name

・Pavement Condition Data : PCfile_RMB's_Year.csv
e.g.) RMB I, surveyed in 2017: "PCfile_RMB I_2017.csv"

・Image data with coordination : ImageFile_RMB's_Year.csv
e.g.) RMB I, Surveyed in 2017: "ImageFile_RMB I_2017.csv"

・Image file : XXXXXXXX.jpg (Sequential with 8 digits)
e.g.) First image file of NH 1: "00000001.jpg"

2) Folder Structure

Pavement Condition Data file and Image data with coordinates are stored under the root. On the other hand, Image files are stored into new created folder by "Year" - "Route" - "Direction_Lane Position".

Folder Structure	File
Root	
├ PCfile	PCfile_RMB I_2017.csv
├ ImageFile	ImageFile_RMB I_2017.csv
└ 2017 ─ RMB I ┬ NH1 ┬ Left_laen1	00000001.jpg
│ │	00000002.jpg
│ │	:
│ ├ Left_lane2	00000001.jpg
│ │	00000002.jpg
│ │	:
│ ├ Left_lane1	
│ └ Left_lane2	
│	
├ NH2 ┬ Left_lane1	
│ └ Right_lane1	
:	

Figure 2.1 Sample of Folder and Data Structure (e.g. 2017, RMB I)

3. Data Specification

3.1. Pavement Condition Data

PC Data is result of road surface damage status by pavement condition survey. Damage of road surface is evaluated by crack rate, rut depth, IRI and MCI. These evaluated data are prepared for every 100 m unit section.

3.1.1. Format of Pavement Condition Data

PC data file is prepared based on the format shown in Table 3.1 with CSV file. The Field Name of each column is inserted in the first record. (Refer to the Sample data in Appendix 1).

Table 3.1 Format of Pavement Condition Data file

No	Field_Name	Type
1	Section_ID	Text
2	Geographical_Area	Text
3	Jurisdiction	Text
4	Management_Agency	Text
5	Road_Category	Numeric
6	Road_Number	Numeric
7	Road_Number_Supplement	Numeric
8	Branch_Number	Numeric
9	Road_Name	Text
10	From_km	Numeric
11	From_m	Numeric
12	To_km	Numeric
13	To_m	Numeric
14	Section_Length	Numeric
15	Analysis_Area	Numeric
16	Structure	Text
17	Intersection	Text
18	Overlapping	Text

No	Field_Name	Type
19	Number_of_Lane_L	Numeric
20	Number_of_Lane_R	Numeric
21	Direction	Text
22	Lane_Position_Number	Numeric
23	Pavement_Type	Text
24	Condition_Year	Numeric
25	Condition_Month	Numeric
26	Cracking	Numeric
27	Patching	Numeric
28	Pothole	Numeric
29	Cracking_ratio	Numeric
30	Rutting_Max	Numeric
31	Rutting_Ave	Numeric
32	IRI	Numeric
33	MCI	Numeric
34	Peculiar	Numeric
35	Note	Text

3.1.2. Data Definition of Pavement Condition Data

The definition of each item in the PC data file is explained as below.

1) Section_ID

Section ID is an integrated unique code prepared by route, direction, lane number and KP. The Section ID cannot accept duplicated. The format of Section ID is shown in Table 3.2. (For more detail information for each, please refer to the following individual section.)

Table 3.2 Format of Section ID

Road Category	Road Number	Road Number Supplement	Branch Number	Direction	Lane position Number	(Underbar)	From Km	From M
1 digit	3 digits	3 digits	3 digits	1 digit	1 digit	(1 digit)	4 digits	5 digits

e.g.) Figure 3.1 shows one example of Section ID setting. Each number is entered according to the determined number of digits. The Direction is defined as Code ID.

Road Category: **1**

Road number: **1**

Road Number Supplement: **0**

Branch number: **1**

Direction: **Right (Code ID = 2)**

Lane Position Number: **1**

From Km+M : **12km+200m**

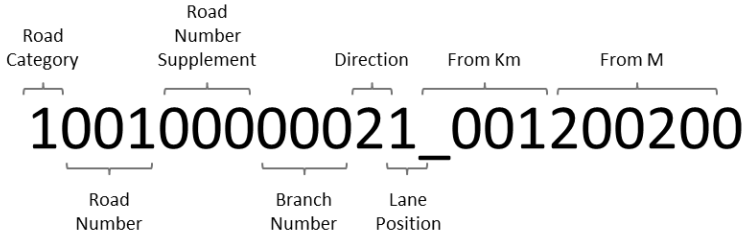


Figure 3.1 Structure of Section ID

2) Geographical_Area

Geographical Area is information indicating the regional area of the surveyed route. Based on the definition in Table 3.3, appropriate Code Name and Code ID are entered.

Table 3.3 Geographical Area

Classification	Code_Name	Code_ID
Northern Area	NORTHERN AREA	1
Northern Middle Area	NORTHERN MIDDLE AREA	2
Southern Middle Area	SOUTHERN MIDDLE AREA	3
Southern Area	SOUTHERN AREA	4

3) Jurisdiction

Jurisdiction is information indicating the management agencies of surveyed route. Based on the definition in Table 3.4, appropriate Code Name and Code ID are entered.

Table 3.4 Jurisdiction

Classification	Code_Name	Code_ID
RMB I	RMB I	10
RMB II	RMB II	20
RMB III	RMB III	30
RMB IV	RMB IV	40
Province	Province	50
Company	Company	60
Militaly	Militaly	90
Under construction	Under construction	99

4) Management_Agency

Management_Agency is information indicating the name of Sub Bureau of surveyed route. Based on the definition in Table 3.5, appropriate Code Name and Code ID are entered.

Table 3.5 Management Agency

Classification	Code_Name	Code_ID
Sub Bureau I.1	SB I.1	101
Sub Bureau I.2	SB I.2	102
Sub Bureau I.3	SB I.3	103
Sub Bureau I.4	SB I.4	104
Sub Bureau I.5	SB I.5	105
Sub Bureau I.6	SB I.6	106
Sub Bureau I.7	SB I.7	107
Sub Bureau I.8	SB I.8	108
Sub Bureau II.1	SB II.1	201
Sub Bureau II.2	SB II.2	202
Sub Bureau II.3	SB II.3	203
Sub Bureau II.4	SB II.4	204
Sub Bureau II.5	SB II.5	205
Sub Bureau II.6	SB II.6	206
Sub Bureau III.1	SB III.1	301
Sub Bureau III.2	SB III.2	302
Sub Bureau III.3	SB III.3	303

Sub Bureau III.4	SB III.4	304
Sub Bureau III.5	SB III.5	305
Sub Bureau IV.1	SB IV.1	401
Sub Bureau IV.2	SB IV.2	402
Sub Bureau IV.3	SB IV.3	403
Sub Bureau IV.4	SB IV.4	404
Sub Bureau IV.5	SB IV.5	405
Sub Bureau IV.6	SB IV.6	406
Sub Bureau IV.7	SB IV.7	407

5) Road Code

Road code has four kinds of road attribute with the following order. The Road Code with full digits (10 digits) shall been maintained only inside of the database system.

- Road Category
- Road Number
- Road Number Supplement
- Branch Number

Road Category (1 digit)	Road Number (max. 3 digit)	Road Number Supplement (max. 3digit)	Branch Number (max. 3 digit)

The Table 3.6 is showing the sample of correspondence table between Road name and code numbers. If there are not road code and road name on the table, new record for such roads shall be prepared.

Table 3.6 Road Code (Sample)

Road Category	Road Number	Road Number Supplement	Branch Number	Road Name
1	1	0	0	National Highway 1
1	1	0	2	Connecting road between NH1 with Ninh Phuc Port
1	1	0	3	National Highway 1_Branch_Old Route (Than Hoa)
1	1	0	4	National Highway 1_Branch_Old Route (Nghe An)
1	1	0	5	National Highway 1_Branch Nghe An
1	1	0	6	National Highway 1_Branch_ Ho Phong town By-pass
1	1	0	7	National Highway 1_Branch_ Ly Thai To Park
1	1	0	8	National Highway 1_Branch_Tran Hung Dao St.

・Road_Category

Road Category is the information of identification code of road category. Road category code has one digit number as shown in Table 3.7.

Table 3.7 Road Category

Classification	Code_Name	Code_ID
National Highway	NH	1
Expressway	Exp	2
Provincial Road	PR	3
Others Road	OR	4

・Road_Number

Road Number is defined for by 3 digit numbers.

- For a road of National Highway where a number is included in the route name, that number is used as the route number.
- For a road of National Highway where the route name is defined only with text, a unique number is given which start from 501 (As a sufficiently large number).
- Besides National Highways, same rules are applied.

・Road_Number_Supplement

Road_Number_Supplement identifies the alphabet code on road name as a maximum 3 digit unique number. Road number supplement is defined beginning with 10 in alphabetical order from A. The code interval is basically set to 10 in order to correspond to the index number, such as NH4H1.

The alphabet which is not used in Vietnam has no code definition, such as F, J W and Z.

Table 3.8 Road Number Supplement

Classification	Code_Name	Code_ID
A	A	10
B	B	20
C	C	30
D	D	40
E	E	50
G	G	60
H	H	70
H1	H1	71
H2	H2	72
I	I	80
K	K	90

Classification	Code_Name	Code_ID
L	L	100
M	M	110
N	N	120
O	O	130
P	P	140
Q	Q	150
R	R	160
S	S	170
T	T	180
U	U	190
V	V	200
X	X	210
Y	Y	220

・Branch_Number

Branch Number is a number given in order to manage road section when same chainage is used for multiple sections such as in the case of bypass or road split into branches/subsidiary road from the main route. It consists of 3 digits numbers. For the main road “000” branch code is used.

・Road_Name

Road_Name is the name of the road written by text.

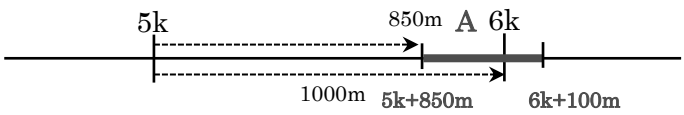
6) Kilometer Post Information

Kilometer Post Information is information indicating the position (distance) of data. Starting point is shown in From_Km and From_M. Ending point is shown in To_Km, To_M. Distance between starting point and ending point is shown in Section_Length.

Kilometer Post Information is expressed in units of 5 m. Km part has maximum 4 digits. M part has maximum 5 digits. Section_Length has maximum 5 digits.

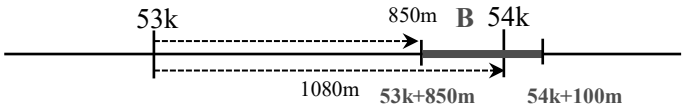
e.g.) Section A : [5k + 850m - 6k + 100m] (5kp - 6kp = 1000 m),

Section B : [53k + 850m - 54k + 100m] (53kp - 54kp = 1080m)



(Data Sample A)

From_Km,From_M,To_Km,To_M, Section_Length
5,850,5,900,50
5,900,6,0,100
6,0,6,100,100



(Data Sample B)

From_Km,From_M,To_Km,To_M, Section_Length
53,850,53,900,50
53,900,53,1000,100
53,1000,54,0,80
54,0,54,100,100

Figure 3.2 From_Km/M, To_Km/M

7) Analysis_Area

The Analysis_Area is the area of the surveyed section which is calculated by Section_Length and analysis width identified by data analysis users. It is defined as the 1 digit after the decimal point.

8) Structure

Structure is information about road structures existing in a section. The unit section of PC data is cut at the changing point of structures. The Code Name and Code ID of structures are shown in Table 3.9.

Table 3.9 Structure Code

Classification	Code_Name	Code_ID
Bridge	B	1
Tunnel	T	2
Rock shed	R	3
Rail Crossing	RC	4
Intersection	I	5
Roundabout	RA	6
Viaduct	V	7
Others	OT	99

9) Intersection

Intersection is information about intersection type into a section. The Code Name and Code ID of intersection are shown in Table 3.10.

Table 3.10 Intersection Code

Classification	Code_Name	Code_ID
Intersection	I	1
Roundabout	RA	2
Viaduct	V	3
Railway Crossing	RC	4
Toll Gate	TG	5
Others	OT	99

10) Overlapping

Overlapping is indicating that there is an overlapping section like the following cases. The Code Name and Code ID of overlapping are shown in Table 3.11.

Table 3.11 Overlapping Code

Classification	Code_Name	Code_ID
Route overlap	R	1
Left and Right bound overlap	LR	2

1) In the mutually different roads, the overlapping section is defined as the overlapping of routes.
2) In a single road, a section where the lane width is narrow and at the same time it is impossible to simultaneously travel in the direction is defined as overlapping in the direction.

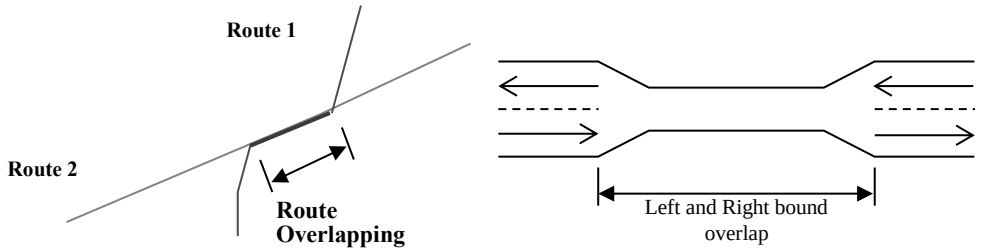


Figure 3.3 Overlapping Type

11) Number_of_lane_L, Number_of_lane_R

Number_of_lane_L/R is indicating the number of lanes in the record as an integer.

12) Direction

Direction is indicating the direction of survey. The direction in which the kilopost number

increases is defined as "Right" and the direction in which the kilopost number decreases is defined as "Left". The Code Name and Code ID of direction is shown in Table 3.12.

Table 3.12 Direction Code

Classification	Code_Name	Code_ID
Left(Up)	L	1
Right(Down)	R	2
Single	S	3

13) Lane_Position_Number

Lane Position Number is indicating the measured lane number as an integer. The lane number is given from the center to the shoulder.

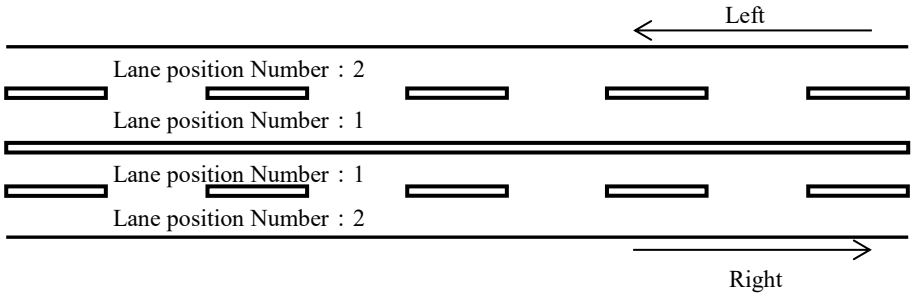


Figure 3.4 Lane Position Number

14) Pavment_Type

Pavment_Type is indicating a type of pavement in the measurement section. The unit section of PC data is cut at changing point of pavement type. The Code Name and Code Id are shown in Table 3.13.

Table 3.13 Pavement Type Code

Classification	Code_Name	Code_ID
Asphalt Concrete	AC	1
BST	B	2
Cement Concrete	CC	3
Other	Other	4
N/A	*	-1

15) Condition_Year, Condition_Month

Condition Year / Month is the measured date. The measurement year and month are defined as an integer. The format is as shown in Table 3.14.

Table 3.14 Condition Year/Month Format

Item	Format	Sample
Condition Year	YYYY	2017
Condition Month	MM	10

16) Cracking

Cracking is indicators of cracking damage on the pavement surface consisted by the following four items. The cracking ratio is calculated as first decimal place. In case of 'AC' or 'BST' for pavement type, the evaluation unit is defined in "%" and the evaluation unit for 'CC' is "m/m²". For 'Other' pavement type, the value is indicated as "-99".

- Cracking: Value of cracking ratio in section.
- Patching: Value of patching ratio in section.
- Pothole: Value of pothole ratio in section.
- Cracking_Ratio: Total value of Cracking, Patching and Pothole

17) Rutting

Rutting is indicators of the depth of roughness in the cross-section direction of the road surface. Rutting is defined by maximum value and average value in section as integers in millimeter (mm).

- Rutting_Max: Maximum value of rutting depth every 5m in section.
- Rutting_Ave: Average value of rutting depth every 5m in section.

18) IRI(International Roughness Index)

IRI is index of roughness of the longitudinally of the road surface. The unit of IRI is defined as "mm/m" in second decimal place.

19) MCI

MCI is an index that comprehensively obtained pavement condition from the three items of cracking, rutting depth (average) and IRI in first decimal place.

20) Peculiar Conditions

Peculiar condition is to identify a peculiar damage which cannot be evaluated by determined definition of pavement damage with crack interpretation way. Code number is entered in case that a peculiar condition is found within an evaluation unit range. Code number zero "0" means that there are no peculiar condition in that section. In cases that there are more than two kinds of peculiar condition are found within one evaluation unit range, the highest priority code number shall be entered.

Table 3.15 Peculiar Condition Code

Classification	Code	Priority
Broken	1	High
Unpaved	2	
Wet Condition	3	
Other Damage	4	
Invisible	5	
Under Construction	6	
N/A (Brank)	0	Low

21) Note

Special noted information such as bridge name, intersection name, etc. are written in note column.

3.2. The Image data with coordinates

Image data with coordinates is the forward image file and GPS coordinates data collected by pavement condition survey vehicle. These data are prepared in each 5 m.

3.2.1. Format of Image data with coordinates

The Image data file is prepared based on the format shown in Table 3.16. The file is prepared in CSV file format. This data has no header information. (Refer to the sample data in Appendix 1).

Table 3.16 Image data with coordination Format

No	Field_Name	Type
1	Section_ID	Numeric
2	Image_ID	Numeric
3	Road_Category	Numeric
4	Road_Number	Numeric
5	Road_Number_Supplement	Numeric
6	Branch_Number	Numeric
7	Direction	Text
8	Lane_Position_Number	Numeric
9	Latitude	Numeric
10	Longitude	Numeric
11	Height	Numeric
12	Image Path	Text

3.2.2. Data Definition of Image data with coordinates

The definition of each item of the Image data file is explained as below.

1) Section_ID

Section ID is prepared based on the definition shown in Table 3.2 with same definition as PC data. The Section ID of Image Data has not uniqueness.

2) Image_ID

Image ID is indicating order of image files within the same section ID as an integer. Figure 3.5 shows the relationship between PC data and Image data with connecting by Section ID.

Pavement Condition Data file

Section_ID	Geographic Jurisdiction	Managemer	Road_	Road_	Road	Branc	Road_Name	KirometerP	KirometerP	KirometerP	KirometerP	Section_Ler
100100000011_185100100	Southern Ar	RMB IV	SB IV.2	1	1	0	0	NATIONAL HIGHWAY 1	1851	100	1851	200	100
100100000011_185100200	Southern Ar	RMB IV	SB IV.2	1	1	0	0	NATIONAL HIGHWAY 1	1851	200	1851	300	100
100100000011_185100300	Southern Ar	RMB IV	SB IV.2	1	1	0	0	NATIONAL HIGHWAY 1	1851	300	1851	400	100
100100000011_185100400	Southern Ar	RMB IV	SB IV.2	1	1	0	0	NATIONAL HIGHWAY 1	1851	400	1851	500	100

Image Data file

Section_ID	Image_ID	Road_Cate	Road_Numb	Road_Numb	Branch_No	Direction	Lane_Posi	Latitude	Longitude	Hight	Image_Path
10010000011_185100100	1	1	1	0	0	L	1	10.94758	106.9845	59.888	Image_2016
10010000011_185100100	2	1								59.817	Image_2016
10010000011_185100100	3	1								758	Image_2016
10010000011_185100100	4	1								674	Image_2016
10010000011_185100100	5	1								594	Image_2016
10010000011_185100100	6	1								547	Image_2016
10010000011_185100100	7	1								494	Image_2016
10010000011_185100100	8									428	Image_2016
10010000011_185100100	9									344	Image_2016
10010000011_185100100	10	1								59.273	Image_2016
10010000011_185100100	11	1	1	0	0	L	1	10.94753	106.9841	59.215	Image_2016
10010000011_185100100	12	1	1	0	0	L	1	10.94753	106.984	59.134	Image_2016
10010000011_185100100	13	1	1	0	0	L	1	10.94752	106.984	59.075	Image_2016
10010000011_185100100	14	1	1	0	0	L	1	10.94752	106.984	58.998	Image_2016
10010000011_185100100	15	1	1	0	0	L	1	10.94751	106.9839	58.941	Image_2016
10010000011_185100100	16	1	1	0	0	L	1	10.94751	106.9839	58.86	Image_2016
10010000011_185100100	17	1	1	0	0	L	1	10.9475	106.9838	58.785	Image_2016
10010000011_185100100	18	1	1	0	0	L	1	10.9475	106.9838	58.7	Image_2016
10010000011_185100100	19	1	1	0	0	L	1	10.9475	106.9837	58.627	Image_2016
10010000011_185100100	20	1	1	0	0	L	1	10.94749	106.9837	58.563	Image_2016
10010000011_185100200	1	1	1	0	0	L	1	10.94749	106.9836	58.459	Image_2016
10010000011_185100200	2	1	1	0	0	L	1	10.94749	106.9836	58.393	Image_2016
10010000011_185100200	3	1	1	0	0	L	1	10.94748	106.9835	58.324	Image_2016

The same ID exists in Image file.
And Image ID is indicating order of image files within the same section ID

Figure 3.5 Relation between PC Data and Image data

3) Road Code

Road code of image data consists of Road_Category, Road_Number, Road_Number_Supplement, Branch_Number.

4) Direction

Direction is entered Code_Name from Table 3.12 with same way as PC data.

5) Lane_Position_Number

Lane Position Number is entered with same way as PC data.

6) Latitude, Longitude, Height

Latitude / Longitude are the coordinates of the position where the forward image was collected as eighth decimal place and seventh decimal place. Height is height value where the forward image was collected as third decimal place.

7) Image_Path

Image Path is indicating the stored path of image files. The definition of file and folder structure is referred in chapter 2.1. Folder structure for each fiscal year and Jpeg file name are entered.

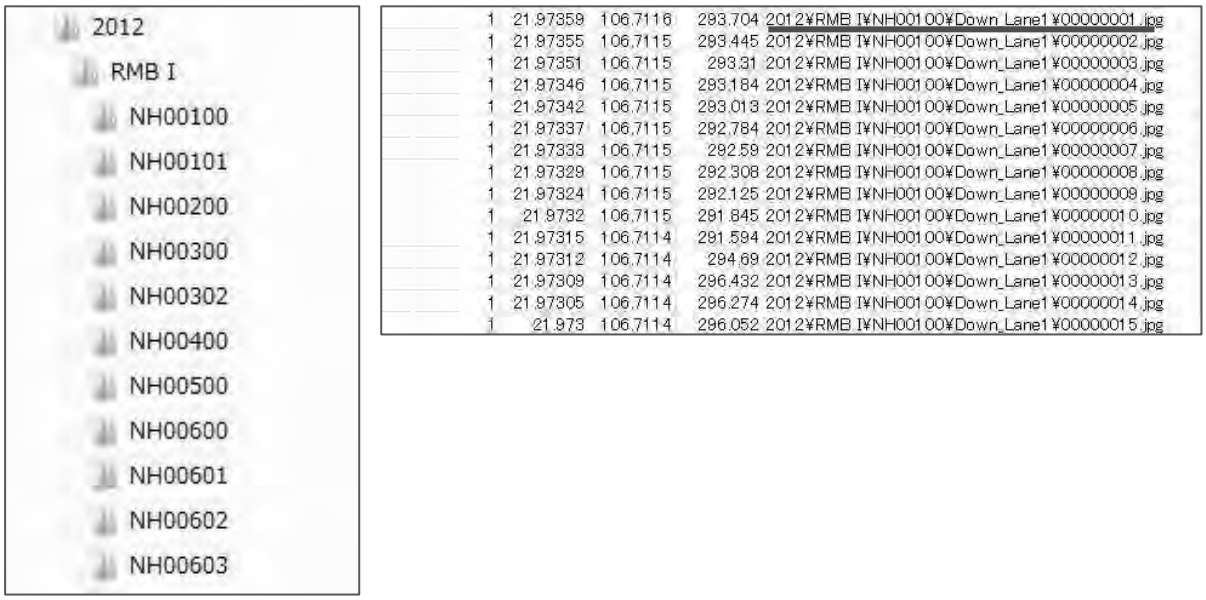


Figure 3.6 Folder Structure for Image files and Sample data of Image Path

3.3. Image file

The forward view image file in 5m interval is stored in the stored folder of the image file shown in chapter 2.1.

Appendix-1:

PC data Sample


```
Sectuion_ID,Geographical_Area,Jurisdiction,Management_Agency,Road_Category,Road_Number,Road Number Supplement,Branch_Number,Road_Name,KirometerPost_from_K,KirometerP
100200000021_003000600,Northern Area,RMB I,SB I.8,1,2,0,0,NATIONAL HIGHWAY 2,30,600,30,700,100,332.8,,,,,4,R,1,AC,2016,11,0,0,0,0,8,4,4.25,8.6,0,
100200000021_003000700,Northern Area,RMB I,SB I.8,1,2,0,0,NATIONAL HIGHWAY 2,30,700,30,800,100,336.7,,,,,4,R,1,AC,2016,11,0,0,0,0,12,6,2.33,8.1,0,
100200000021_003000800,Northern Area,RMB I,SB I.8,1,2,0,0,NATIONAL HIGHWAY 2,30,800,30,900,100,321.9,,,,,4,R,1,AC,2016,11,0,0,0,0,8,5,2.5,8.3,0,
100200000021_003000900,Northern Area,RMB I,SB I.8,1,2,0,0,NATIONAL HIGHWAY 2,30,900,31,0,25,83.9,,,,,4,R,1,AC,2016,11,0,0,0,0,9,5,2.05,8.3,0,
100200000021_003100000,Northern Area,RMB I,SB I.8,1,2,0,0,NATIONAL HIGHWAY 2,31,0,31,100,100,332.8,,,,,4,R,1,AC,2016,11,0.2,0,0,0.2,16,8,2.45,7.4,0,
100200000021_003100100,Northern Area,RMB I,SB I.8,1,2,0,0,NATIONAL HIGHWAY 2,31,100,31,200,100,337.8,,,,,4,R,1,AC,2016,11,1.6,0,0,1.6,16,9,3.17,6.4,0,
100200000021_003100200,Northern Area,RMB I,SB I.8,1,2,0,0,NATIONAL HIGHWAY 2,31,200,31,300,100,338.7,,I,,,4,R,1,AC,2016,11,0,0,0,0,22,11,4.2,7.1,0,Intersection
100200000021_003100300,Northern Area,RMB I,SB I.8,1,2,0,0,NATIONAL HIGHWAY 2,31,300,31,400,100,332.3,,,,,4,R,1,AC,2016,11,0,0,0,0,13,9,2.66,7.5,0,
100200000021_003100400,Northern Area,RMB I,SB I.8,1,2,0,0,NATIONAL HIGHWAY 2,31,400,31,500,100,334.2,,,,,4,R,1,AC,2016,11,0.1,0,0,0.1,15,10,3.21,7.3,0,
100200000021_003100500,Northern Area,RMB I,SB I.8,1,2,0,0,NATIONAL HIGHWAY 2,31,500,31,600,100,348.3,,I,,,4,R,1,AC,2016,11,0,0,0,0,14,9,2.99,7.5,0,Intersection
100200000021_003100600,Northern Area,RMB I,SB I.8,1,2,0,0,NATIONAL HIGHWAY 2,31,600,31,700,100,340.3,,,,,4,R,1,AC,2016,11,0,0,0,0,16,9,1.87,7.5,0,
100200000021_003100700,Northern Area,RMB I,SB I.8,1,2,0,0,NATIONAL HIGHWAY 2,31,700,31,800,100,330.3,,,,,4,R,1,AC,2016,11,0,0,0,0,13,9,1.85,7.5,0,
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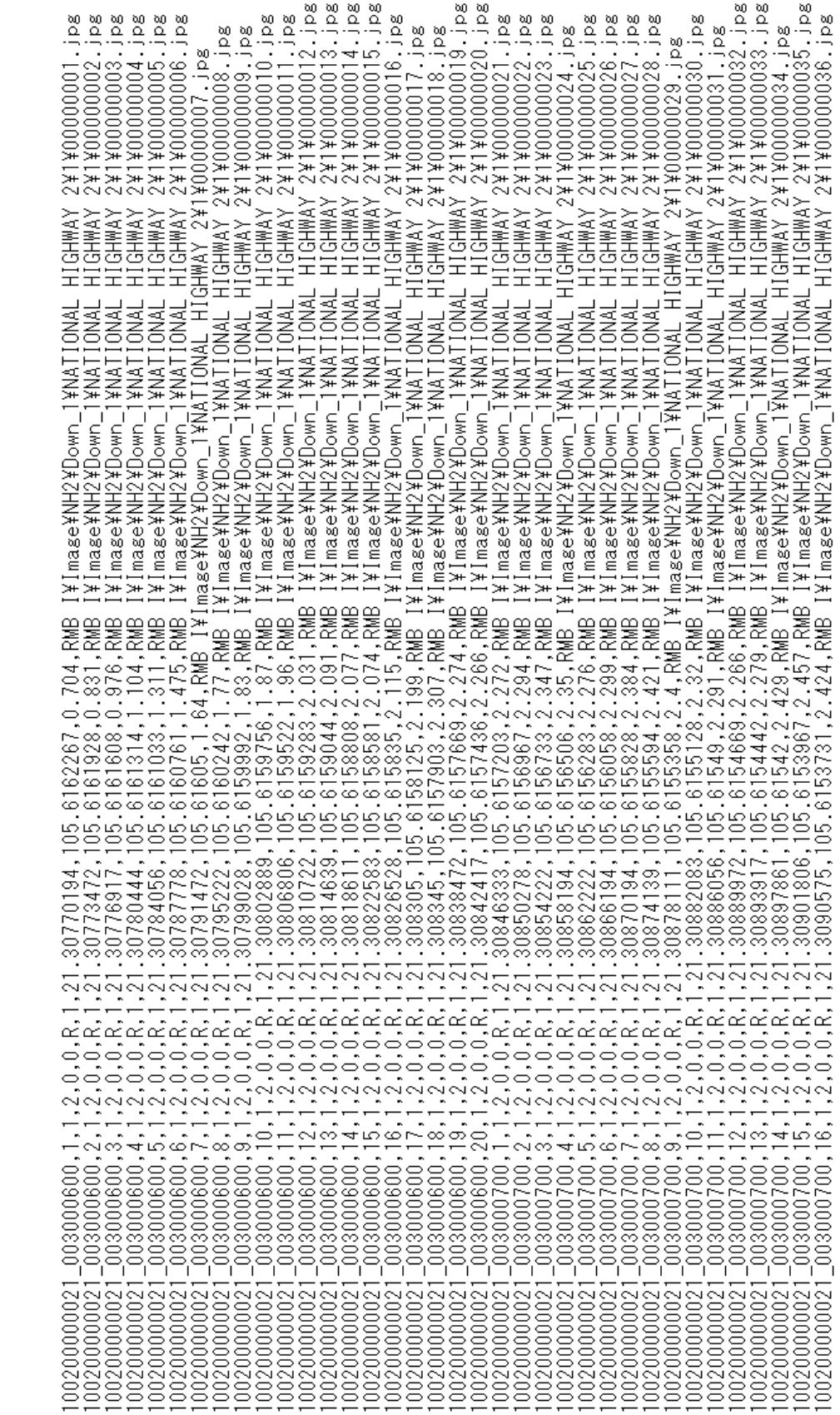
Image Data Sample



JAPAN INTERNATIONAL COOPERATION AGENCY

DIRECTORATE FOR ROADS OF VIETNAM

MINISTRY OF TRANSPORT (MOT)

THE SOCIALIST REPUBLIC OF VIETNAM

THE PROJECT FOR CAPACITY ENHANCEMENT IN ROAD MAINTENANCE PHASE II

PAVEMENT CONDITION SURVEY MANUAL

Volume 2.1.6: Data Validation

MARCH 2018

JICA PROJECT TEAM

Record of updates

Rev.	Date	Contents change
1.00	2017.12.19	First edition

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Glossary

Administration Database	Database of PMS data storing administrative information.
Analyzed section Table (Table-3)	The final section table prepared by PC data.
Calibration	Adjustment of devices for true value
Camera for front image	The device for measuring the front image
Camera for road image	The device for measuring the road image
Crack	Damage index based on the pavement surface crack.
End point	The end position of the target route.
Excluded section	The out of scope section for survey. For example, the section that is under construction or being transferred to the management of another agency.
IRI (International Roughness Index)	Damage index based on the longitudinal shape on the pavement surface.
KP (Kilometer post)	Positon of route. It is consist of Kilo-post station number and distance from the Kilo-post station.
Kilo-post station	A road sign on the side of the road to indicate distances from major cities.
Kilo-post station number	The number indicated on the kilo-post stations in the side of the road.
Laser displacement sensor	The device for measuring of longitudinal profile
Laser scanner	The device for measuring of transverse profile
Main control unit	The unit to control the measurement device
Marking	Marking of the start point and end point for easier recognition.
Overlapping section	A section in which two routes overlap in terms of management.
Patching	The repaired part of partially damage area (Pothole, crack, and so on).
Pavement condition	The condition of pavement surface. The pavement condition is evaluated for cracks, ruts and IRI.

Pavement condition survey vehicle	Vehicle assembled with measurement devices.
PDCA cycle	Management cycle acronym for PLAN, DO, CHECK and ACT.
PMS	Pavement Management System.
PMS Database	Database stored for PMS dataset.
Power control unit	The Unit for supply and control the electric power to the measurement device
REAL Mini	Name of the pavement condition survey vehicle made by PASCO CORPORATION.
Rut	Damage index based on the transverse shape on the pavement surface.
Start point	The start position of the target route.
Survey Consultant	Contractor of pavement condition survey
Survey plan section Table (Table-1)	Table of planned survey length
Surveyed section Table (Table-2)	Table-1 with extensions added
Top Manager	The investor of pavement condition survey, who approve report, decision maker, accept pavement condition work, is as Directorate for Road of Vietnam
Work Manager	Agency which belongs to Top Manager, which supports, supervises, manages and check pavement condition data

Acronyms

AC	Asphalt Concrete
BOT	Build-Operate-Transfer
BST	Bituminous surface treatment
CC	Cement Concrete
DPI	Department of Planning and Investment
DRVN	Directorate for Roads of Vietnam
HDD	Hard Disk Drive
IWP	In wheel path
KP	Kilometer post
MMD	Management and Maintenance Department
OWP	Out wheel path
PC data	Pavement condition data
PCS	Pavement Condition Survey
PCSV	Pavement Condition Survey Vehicle
PDOT	Provincial Department of Transport
PPC	Provincial People's Committee
QC	Quarter-Car
RMBs	Road Management Bureaus
SB	Sub Bureaus
STEICD	Science, Technology, Environment, International Cooperation Department
TOR	Terms of Reference

1. Introduction

1.1. About This Manual

Data Validation (PCS-Vol.6) is one of six manuals comprising the suite of the documentation for pavement condition survey. Figure 1.1 shows the component of pavement condition survey manual. Pavement condition survey manual is divided into three parts, Overview, Operation manual and Technical manual. Documents to be referenced depend on the responsibility and work steps of stakeholders involved in pavement condition survey. Overview describes the basic items of survey that all stakeholders should refer to. Operation manual shows important matters to be referred to mainly when survey work managing. Technical manual indicates technical matters such as system and device operation methods, data definition and data preparation. Figure 1.2 shows the description of contents of each document.

This manual explains the data validation procedure when creating the PC data. It is to be used by person whose task is to carry out the data validation in pavement condition survey. If there is any lack of information, addition and updates by DRVN staff would be recommended.

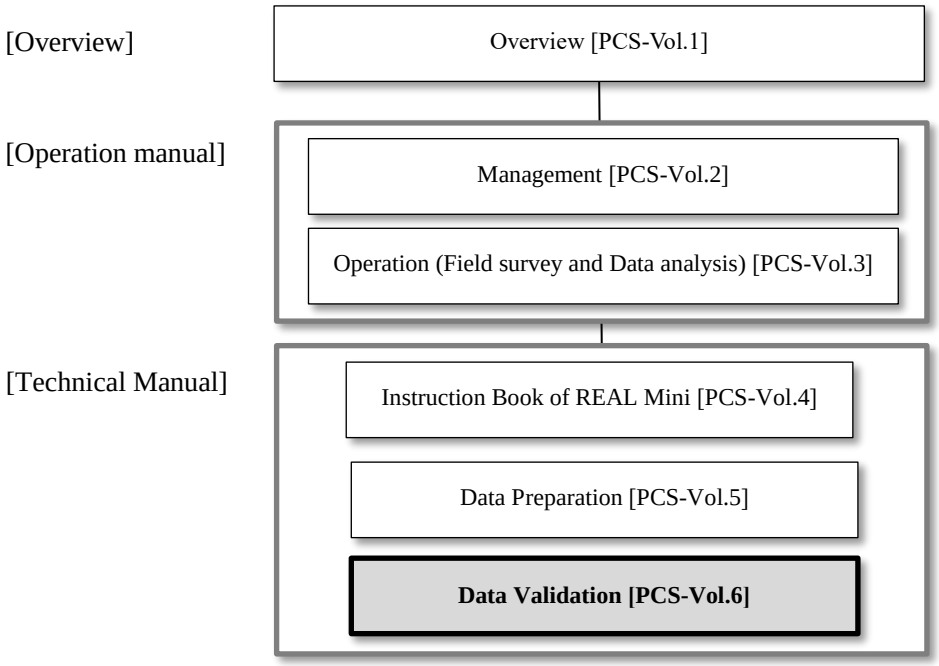


Figure 1.1 Pavement condition survey manual

[Overview]

Overview (PCS-Vol.1]

➔ Describe the overview and measuring methods of pavement condition survey. It is a general purpose document which provides in an understanding of pavement condition survey.

[Operation manual]

Management [PCS-Vol.2]

➔ Describe the management work of road administrator on pavement condition survey. It contains all management works such as the planning, supervising, and data checking on pavement condition survey describing. It is to be used by administrator who to carry out the management of pavement condition survey.

Operation (Field survey and Data analysis) [PCS-Vol.3]

➔ Describe the survey and analysis work of survey consultant on pavement condition survey. It contains the survey and analysis rule. It is to be used by surveyor and analysis operator who to carry out the pavement condition survey.

[Technical manual]

Instruction Book of REAL Mini [PCS-Vol.4]

➔ Describe the operation procedure of REAL Mini system. It contains the operation procedure of inspection vehicle and analysis system, calibration and maintenance of the inspection vehicle and so on. It is to be used by surveyor and analysis operator whose task is to carry out the deep study for operation procedure of REAL Mini system.

Data Preparation [PCS-Vol.5]

➔ Describe the contents of pavement condition data (PC data). It contains the code definition, explanation of each item of PC data and so on.

Data Validation [PCS-Vol.6]

➔ Describe the data validation procedure when creating the PC data. It is to be used by person whose task is to carry out the data validation in pavement condition survey.

Figure 1.2 Contents of Pavement condition survey manual

1.2. Summary of Pavement Condition Survey and Sharing Responsibility

1) Pavement Condition Survey

Pavement condition survey (PCS) measures pavement damages such as cracks, ruts and IRI using the pavement condition survey vehicle (hereafter PCSV) on moving and make the pavement condition data files. The pavement damage expresses surface (crack), transverse (rut) and longitude (IRI). The PCSV assembled some devices such as laser scanner and cameras for the pavement damages measurement (Figure **1.3**).

Pavement condition survey measures not only pavement condition but also road inventory information, forward view image and position information at the same time.

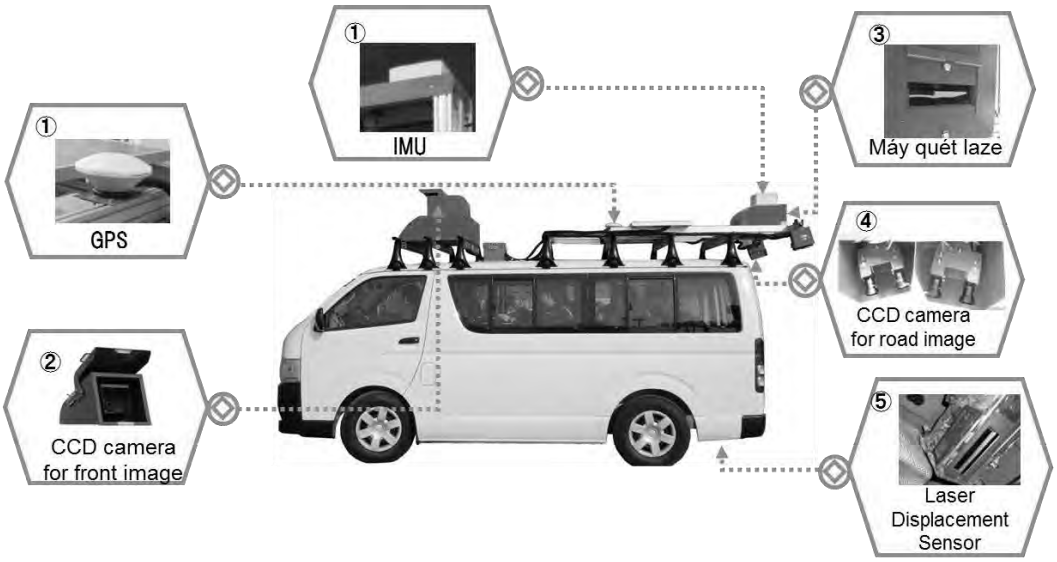


Figure 1.3 PCSV (REAL Mini)

2) Sharing Responsibility of Manager on Pavement Condition Survey

Pavement condition survey can be divided into four steps, 1) Survey Plan, 2) Measurement, 3) Data Analysis and Data Processing, and 4) Data Check and Data Install. List of work item and assignment on Pavement Condition Survey is shown in table 1.1. Responsible division of DRVN in pavement condition survey is shown in Figure 1.4.

- DRVN (DPI, MMD, STECID, IT Center)

DRVN has a responsibility of Top manager of pavement condition survey (hereinafter, this is called "Top manager"). In the future, RMBs or PDOT can become top manager of the pavement condition survey. Role of top manager are as follows;

- Approve the survey plan
- Check the progress of the pavement condition survey based on RMBs report
- Manage the PCSV
- Approve the completion of the pavement condition survey

- Install the PC data to PMS server (IT Center)

- RMB (DPI, MM, SB)

RMBs manages all work in pavement condition survey (hereinafter, this is called "Work manager").

Role of work manager are as follows;

- Prepare the survey plan
- Supervise the work of the survey consultant
- Submit the plan, progress report and complete PC data to top manager

- Survey consultant

Survey consultant conducts the below contents.

- Preparation of implementation plan
- Measurement
- Data analysis
- Data processing

Table 1.1 Work item and Assignment on Pavement Condition Survey

No.	Work Item	DRVN (Top manager)	RMBs (Work manager)	Survey Consultant
1	Survey plan	・Approve the survey plan	・Preparation of survey plan ・Submit the survey plan to DRVN ・Assign Survey consultant	・Preparation of Implementation plan
2	Field survey	・Management of PCSV ・Check the progress report form RMBs	・Supervise field work (Progress, Problem) ・Report the progress to DRVN	・Field survey
3	Data analysis Data Processing	・Check the progress report form RMBs	・Supervise data work (Progress, Problem)	・Data analysis ・Data processing
4	Data check Data install	・Approve the completion of the pavement condition survey ・Install PC data (IT center)	・Data check ・Submit PC data to DRVN	・Correct data

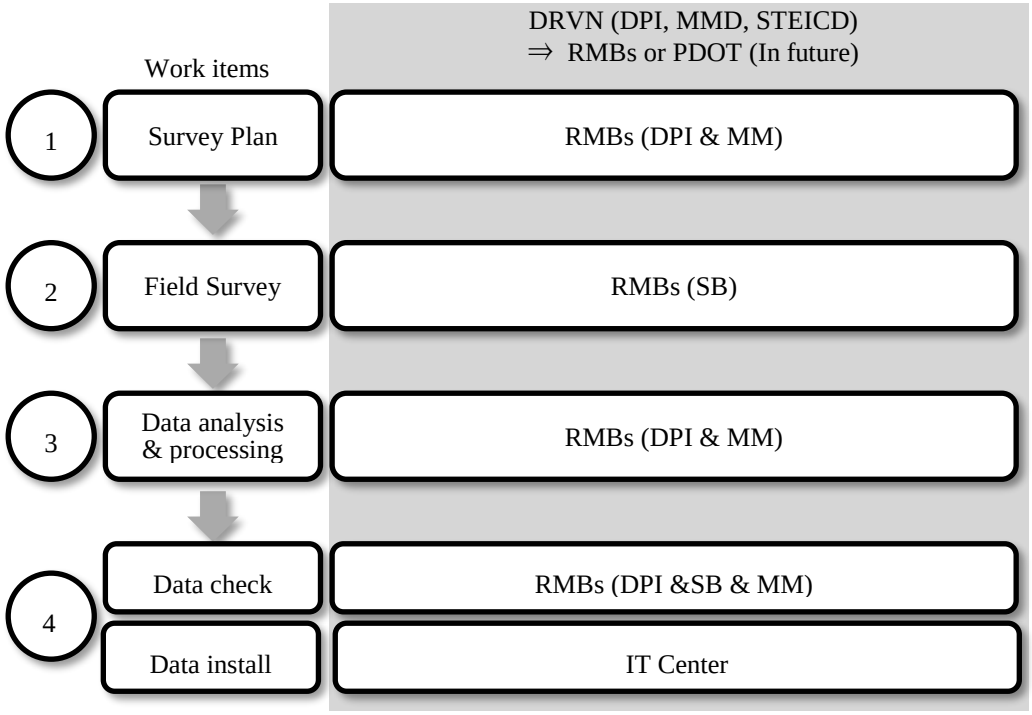


Figure 1.4 Responsible division of Pavement Condition Survey

1.3. Summary of Pavement Condition Data check

1) The Importance to Pavement condition data check

PC data is one of the most important information to make the maintenance plan of the pavement. Pavement condition data check is the most important works in the Pavement Condition Survey. If the pavement condition data would be installed to PMS Database having some errors, such data cannot be used for a Road Maintenance Plan. It is necessary to make a reliable pavement condition data or success of maintenance plan using PMS system. Therefore, pavement condition data check is necessary to keep the reliability and accuracy.

Furthemore, in order to acceptant mission of Survey Consultant, Work Manager has to check quantity of data and report to Top Manager.

If Work Manager finds errors in the data, Work manager instructs Survey Consultant to modify the data with such errors.

2) Sharing responsibility on Pavement Condition Data Check

Before submit data to Work Manager, Analysis Team of Survey Consultant has to check data by themselves. Check items are below:

- Quality of images
- Quality of damages analysis
- Position of peculiar
- Position of structure
- Position of intersection

- Abnormal value check
- Consistency of chainage and section length
- Lacking or inconsistency of KP

Analysis Team of Survey Consultant submits the Pavement Condition data to Work manager after complete the data analysis and data processing. Work manager check the quality of the data. If the quality of the data has no problem, Work manager accept the data. If the quality of the data has problem, Analysis Team modify the problem part. Work manager and Analysis Team should do the perfect data which have no problem.

Finally, Work manager submit the PC data to Top manager. Top manager receives the PC data and approve the completion of the pavement condition survey. Top manager (IT center) installs the PC data to PMS database.

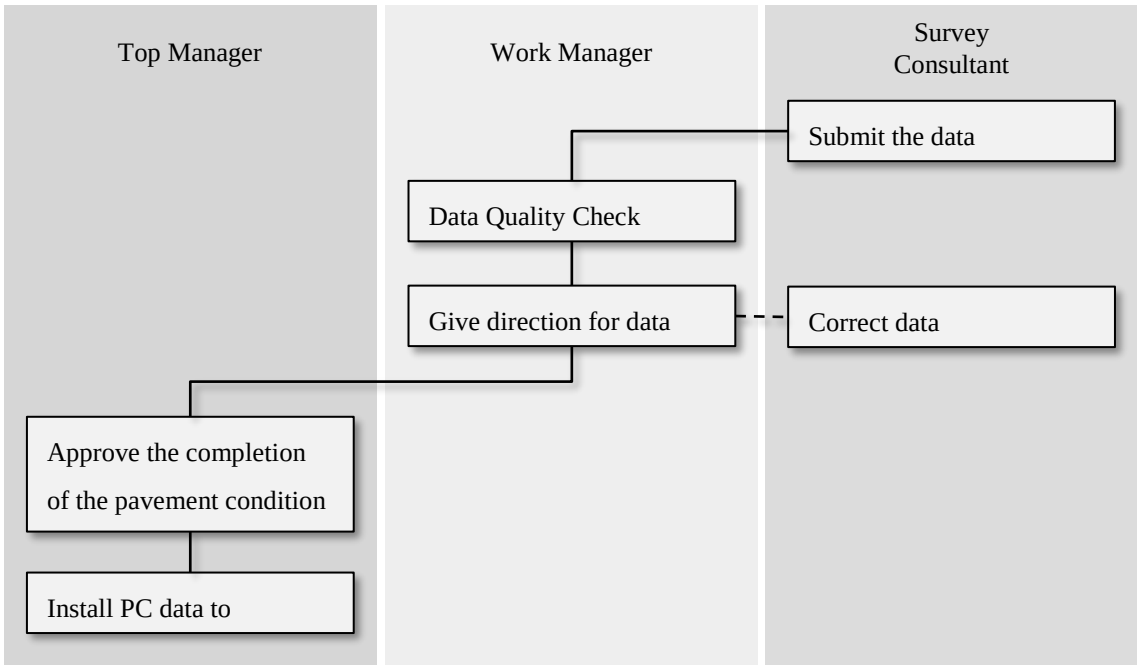


Figure 1.5 Responsibility sharing on Pavement Condition Data Check

3) Data check items

Pavement condition data check includes 5 check items as: “Check road inventory data”, “Confirm output data of pavement condition data”, “Confirm folder structure of pavememt condition data”, “Check quantity of Forward images”, “Check abnormal value”. Survey Consultant has to check data quality and data quantity before submit data to Work Manager.

In scope of this manual, it mentions about data check items which will be implemented by Work Manager.

4) Pavement condition data check procedure

Pavement condition data check procedure is shown in Figure 1.6

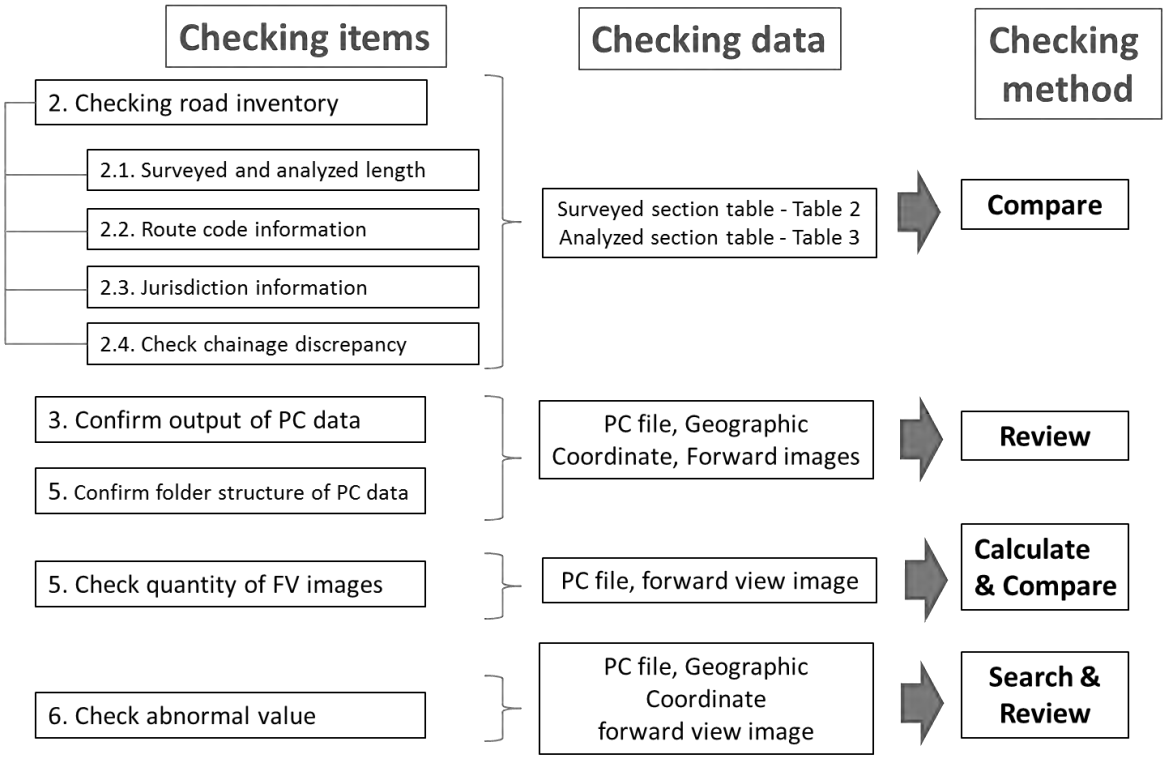


Figure 1.6 Pavement condition data check procedure

2. Check road inventory data

2.1. Source data and preparation steps for check road inventory data

2.1.1. Source data for check road inventory data

Work manager formulates the survey plan for impelementing the pavement condition survey of Survey Consultant. Work manager makes the "Survey Plan Section Table (Table-1)" after the selection of target routes and sections.

Survey Consultant aggregates the Table-1 and makes the "Surveyed Section Table (Table-2)" using the measurement length of survey work. After complete to prepare Table-2, Survey consultant submits Table-2 to Work manager.

Analysis Team makes the "Analyzed Section Table (Table-3)" based on the completed data of data analysis and data processing. Table-3 is created by PC data. Analyzed length in Table-3 is actual length in PC data. After complete to prepare Table-3, Survey consultant submits Table-3 to Work manager.

Surveyed Section table (Table-2) and Analyzed Section table (Table-3) are source data for check road inventory data.

Table 2.1 Surveyed Section table (Table-2)

Mã loại đường	Mã chính	Mã Phụ	Mã nhánh	Tên đường	Cục QLĐB	Chi Cục QLĐB	Chiều	Thứ tự làn	Từ _Km	Từ_m	Đến_Km	Đến_m	Giảm trừ	Trùng lặp	Chiều dài khảo	Ghi chú
1	1	0	0	NH1	RMB II	SB II.1	Right	1	321	800	330	0			8540	
1	1	0	0	NH1	RMB II	SB II.2	Right	1	423	600	425	875			2095	
1	1	0	0	NH1	RMB II	SB II.2	Right	1	449	300	451	0			1665	
1	1	0	0	NH1	RMB II	SB II.2	Right	1	458	0	467	0			9600	
1	1	0	0	NH1	RMB II	SB II.3	Right	1	468	0	484	0			16000	
1	1	0	0	NH1	RMB II	SB II.3	Right	1	504	400	517	1080			13630	
1	1	0	0	NH1	RMB II	SB II.3	Right	1	561	0	587	0			26000	
1	1	0	0	NH1	RMB II	SB II.3	Right	1	591	600	595	5			3405	
1	1	0	0	NH1	RMB II	SB II.4	Right	1	595	5	597	590			2585	
1	1	0	0	NH1	RMB II	SB II.4	Right	1	625	125	625	880			755	
1	1	0	0	NH1	RMB II	SB II.4	Right	1	657	25	663	815			6645	
1	1	0	0	NH1	RMB II	SB II.4	Right	1	671	230	672	305			1075	

Content of Surveyed Section table (Table-2) as below:

- Road category code
- Road number
- Road Supplement number
- Branch number
- Road name
- RMB
- SB
- Direction
- Path lane
- Chainage (From_Km; from_m; To_Km; To_m)
- Excluded sections

- Overlapping sections
- Survey length
- Note

Information in Surveyed Section table (Table-2) was collected from field survey.

Table 2.2 Analyzed Section table (Table-3)

Mã loại đường	Mã chính	Mã Phụ	Mã nhánh	Tên đường	Cục QLĐB	Chi Cục QLĐB	Chiều	Thứ tự làn	Từ _Km	Từ_m	Đến_Km	Đến_m	Chiều dài phân tích	Ghi chú
1	1	0	0	NATION	RMB II	SB II.2	R	1	321	800	330	0	8535	
1	1	0	0	NATION	RMB II	SB II.2	R	1	423	600	425	875	2095	
1	1	0	0	NATION	RMB II	SB II.2	R	1	449	300	451	0	1665	
1	1	0	0	NATION	RMB II	SB II.3	R	1	458	0	467	0	9590	
1	1	0	0	NATION	RMB II	SB II.3	R	1	468	0	484	0	15710	
1	1	0	0	NATION	RMB II	SB II.3	R	1	504	400	517	1075	13630	
1	1	0	0	NATION	RMB II	SB II.3	R	1	561	0	587	0	26095	
1	1	0	0	NATION	RMB II	SB II.3	R	1	591	600	595	5	3595	
1	1	0	0	NATION	RMB II	SB II.4	R	1	595	5	597	590	2330	
1	1	0	0	NATION	RMB II	SB II.4	R	1	625	125	625	880	755	
1	1	0	0	NATION	RMB II	SB II.4	R	1	657	25	663	815	6645	
1	1	0	0	NATION	RMB II	SB II.4	R	1	671	230	672	305	1075	

Content of Analyzed Section table (Table-3) as below:

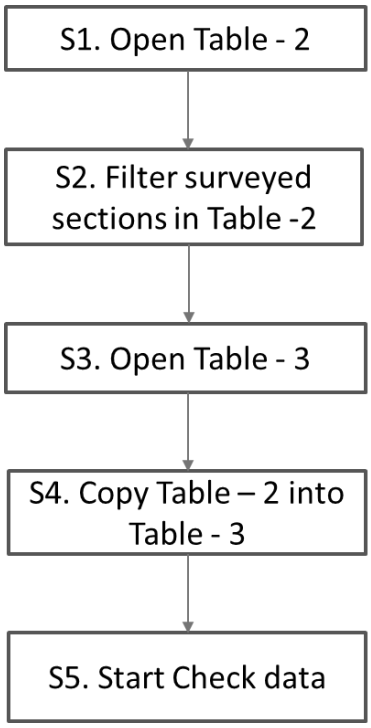
- Road category code
- Road number
- Road supplement number
- Branch number
- Route name
- RMB
- SB
- Direction
- Path lane
- Chainage (From_Km; from_m; To_Km; To_m)
- Analyzed length
- Note

Information in Analyzed Section table (Table-3) was extracted from PC file.

2.1.2. Preparation step for check road inventory data

In order to check road inventory data simply, it's necessary to prepare data before checking. Table 2.3 shows procedure to preparation work.

Table 2.3 Procedure to preparation work



2.2. Check surveyed length and analyzed length

Surveyed length and analyzed length have to be similar each other (the difference under 1% surveyed length is acceptable). If the difference is over 1% surveyed length, it's necessary to check in detail and find the reason.

Reason of difference is one of below reasons:

- Surveyed section is over target survey scope
- Surveyed section is missing
- Setting start point and end point are wrong during analysis work.

Checking steps are following:

Step 1: Compare column "Surveyed length" of Table – 2" and "Analyzed length" of Table – 3 by total length and each section.

Step 2: Take note all sections which the difference is over 1% surveyed length between 2 Tables, Work Manager requests Survey Consultant's explanation about differences.

Step 3: Calculate total Surveyed Length and Analyzed length. Compare 2 total length which will be used for acceptancing Pavement Condition Survey work.

If Survey Consultant doesn't give reasonable explanation, Work Manager will request to correct data by re-survey again or re-analysis.

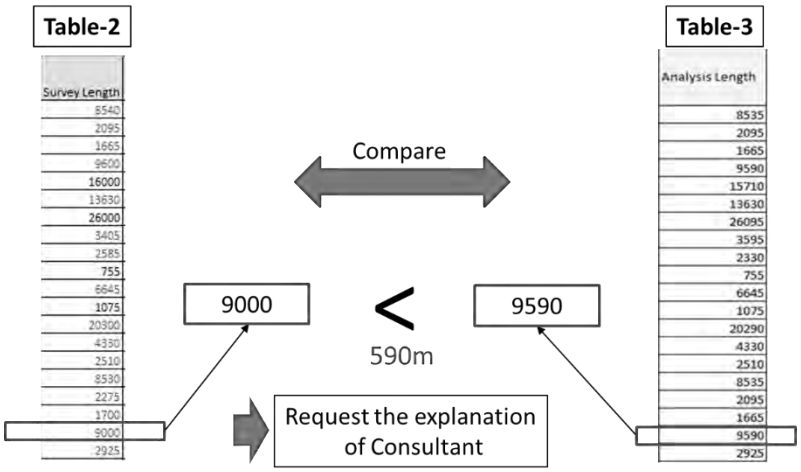


Figure 2.1 Example of checking surveyed length and analysis length

2.3. Check route code information

Route code of each route was defined by DRVN on the whole road network. Detail about definition, coding method of route code are presented on "Data Preparation Manual on Pavement Condition Survey".

Checking steps are following:

- Step 1: Work Manager has to compare "Road category" column, "Road Number" column, "Road Supplement Number", "Branch Number" between 2 Tables section by section.
- Step 2: Work Manager will list up all differences between 2 tables and request Survey Consultant to revise.

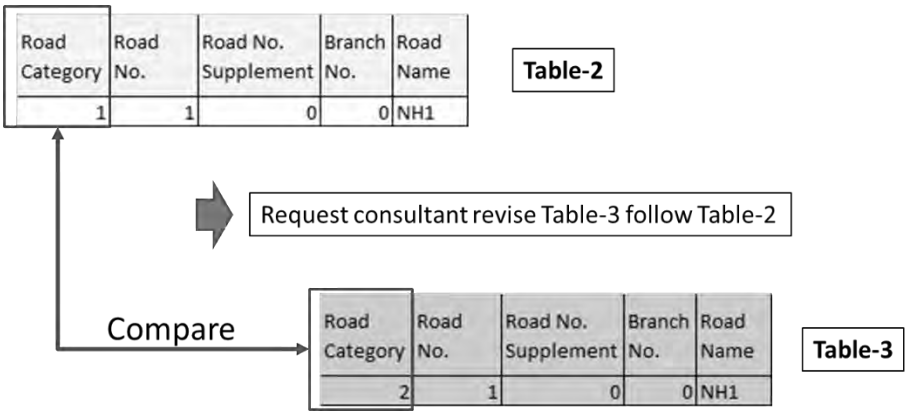


Figure 2.2 Example of check route code information

Reason of difference is the error of analyst who inputed mistake route code during analysis work. If theses diffrences aren't revised, PMS system will indentify to be the other route.

2.4. Check jurisdiction information

Jurisdiction information was downloaded Road Inventory by Work Manager from Database on Survey Plan step, these informations are shown on "Survey Plan Table (Table – 1). During measurement on field work, Survey Team of Survey Consultant collects jurisdiction information from notification board or confirm with staff of Work Manager and input these informations into Surveyed Section table (Table – 2). After Table – 2 had been approved by Work Manager, Analysis Team staff of Survey Consultant has to input jurisdiction information from Table-2 into analysis and processing data application. Therefore, jurisdiction information between Table – 2 and Table – 3 has to be same.

Checking step are following:

Step 1: Compare "RMB" column and "SB" column between Table – 2 and Table – 3 section by section.

Step 2: If there are any difference about jurisdiction information between 2 tables, Work Manager will request Survey Consultant to update Table – 3.

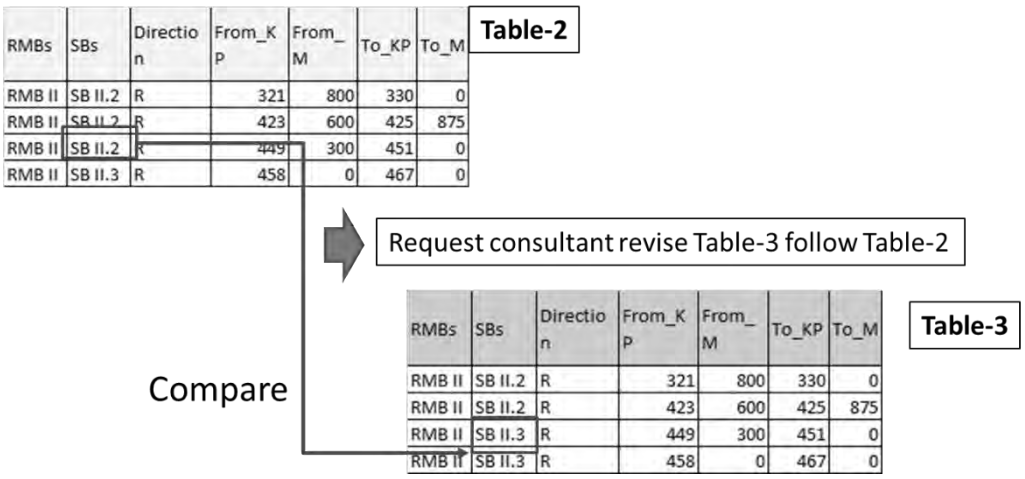


Figure 2.3 Example of check jurisdiction information

2.5. Check Chainage Discrepancy

Chainage of survey section was downloaded Road Inventory by Work Manager from Database on Survey Plan step, these informations are shown on "Survey Plan Table (Table – 1). During measurement on field work, Survey Team of Survey Consultant collects chainage information from notification board or confirm with staff of Work Manager and input these informations into Surveyed Section table (Table-2). During analysis work, analyst inperpreted data pavement condition data using actual length which was collected by pavement condition survey vehicle and inputed chainage information into Analyzed Section Table (Table – 3). Therefore, Discrepancy is available between Table – 2 and Table – 3. Top Manager and Work Manager will utilize these chainage discrepancies for management work and consider to update chainage of Road Inventory Data from Table – 3.

Checking step are following:

Step 1: Compare “From_Km”; “From_m”; “To_Km”; “To_m” between 2 tables section by section “Từ _Km”, “từ_m”, “Đến_Km”, “Đến_m”.

Step 2: Take note all discrepancy section

Step 3: Top Manager and Work Manager will consider these discrepancy sections and update Road Inventory Data or accept discrepencies.

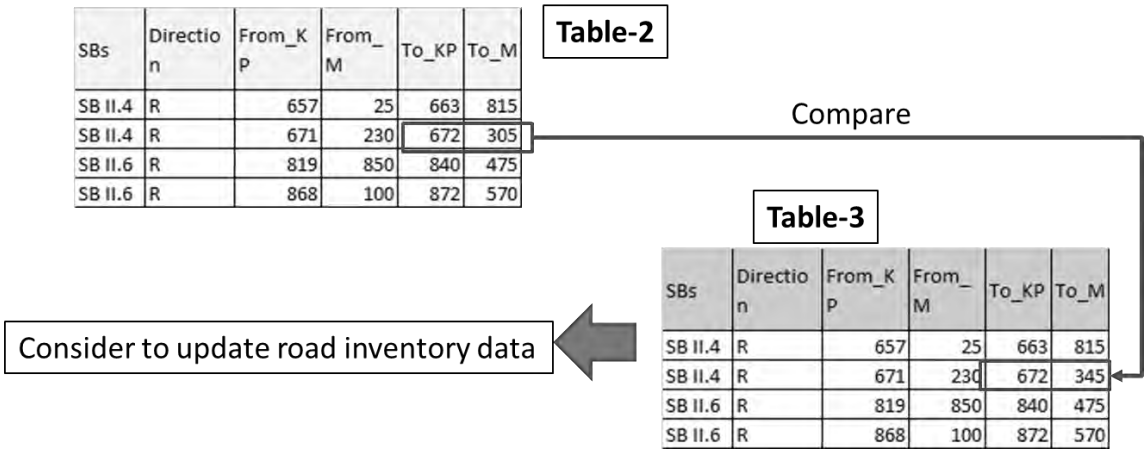


Figure 2.4 Example of Check Discrepancy

3. Confirm output of pavement condition data

Data items and format of PC data was requested in detail into TOR of Pavement Condition Survey. After finishing data analysis and processing work, PC data and report will be sent to Work Manager for checking. After checking, Work Manager will request Survey consultant to revise and update if data not reach the requirement about format/quantity/file name which were requested into TOR.

List of output data which need to be confirmed, shown in Table 3.1:

Table 3.1 List output of Pavement Condition Data

Data items	Function	Quantity	Unit	Format	File name	Note
Pavement Condition File	Store administration data and pavement condition information	1	File	MS Excel, CSV	PCfile_RMBx_YYYY.csv	
Geographic Coordinate File	Store GPS coordinate of each record data and refer link with Forward view Image Folder	1	File	MS Excel, CSV	Imagefile_RMBx_YYYY.csv	
Forward view image	Images which was captured by Front camera, use for refer pavement condition	1	Set	.JPG	ttttttt.JPG	All FV Images was stored in folder for each lane, each route

4. Confirm folder structure of Pavement Condition Data

After confirm output of pavement condition data, Work Manager has to confirm folder structure of pavement condition data. In order to install pavement condition data onto database server, folder structure of pavement condition data has to follow arrangement rule. Folder name has to follow naming common rule for installing conveniently. On the other hand, quantity of FV images is huge, therefore they should be arranged by direction and by lane for simplizing FV images reference and data installation.

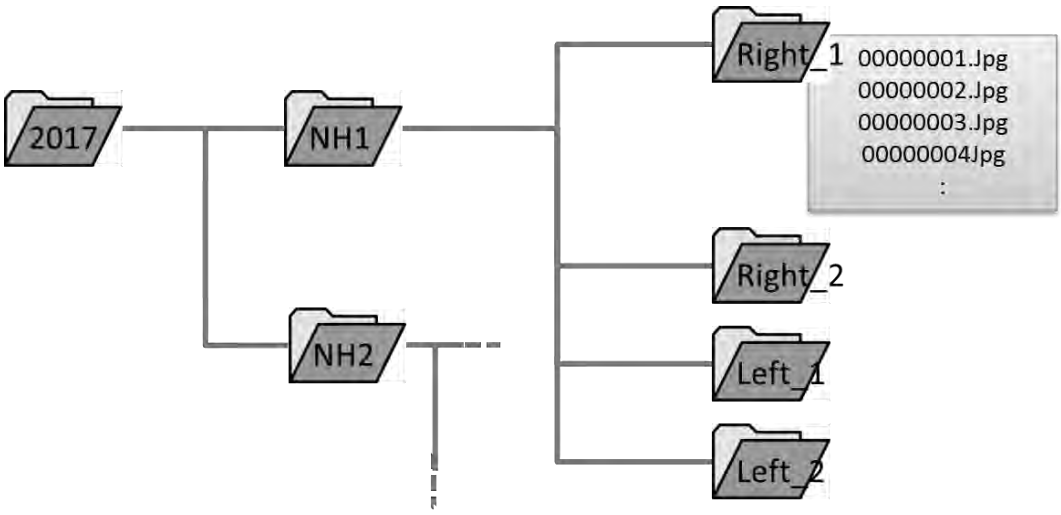


Figure 4.1 Folder structure of FV images

❖ Note: File and folder have to be named following common rules. If there are any different with common rule (including space or "_"), data installation process will be errored.

❖ Common rule for naming file and folder are as below:

- Pavement condition File : **PCfile_RMBx_YYYY.csv**
  With: x : Number of RMB
  YYYY : Surveyed year
- Geographic Coordinate File : **Imagefile_RMBx_YYYY.csv**
  With: x : Number of RMB
  YYYY : Surveyed year

- Folder structure of FV images: : Folder structure and naming of FV images are followed:

YYYY\RMBx\Road_Name\Direction_z\ttttttt.jpg

With: x : Number of RMB
YYYY : Surveyed year

Road_name	:	Name of Target route (Not using space)
Direction_z	:	Survey direction_Survey lane (Right; Left)
z	:	Survey lane (1; 2; 3; …)
tttttttt	:	name of FV image (output automatically by number)

5. Check quantity of FV images

FV images were captured 5m interval by Front view camera of Real-mini. Format and stroring folder of FV images was explained in Part 4. Real-mini collects pavement condition data lane by lane and direction by direction, therefore, FV images are stored into folder lane by lane too. However, surveyed length is different between right direction and left diection, so quantity FV images of each lane is different as well.

FV image's names are number from 00000001 to 99999999. 00000001.jpg file is FV image at start point of target route (no distinction between Right or Left). The last FV image name depends on length of each lane.

Figure 5.1 Forward images with 5 meters interval

Each 5 meters measurement on filed, Real-mini captures FV image to collect road information for data analysis and upload to Web Display System. Therefore, in order to appropriate case, quantity of FV images has to equal 1/5 survey length. Detail as below:

$$X = \frac{L}{5}$$

With:

X: Quantity of FV images by lane

L: Pavement condition survey length by lane

After checking, if quantity of FV images and pavement condition survey length are not appropriate. Work Manager will request Survey Consultant to ouptput data again and re-submit data for re-checking.

Checking steps are following:

- Step 1: Count quantity of FV Images
  - Open FV images folder lane by lane

    (Folder structure of FV images was presented in Part 4)
  - Count quantity of images **(X)** lane by lane
- Step 2: Calculate pavement condition data length
  - Open Pavement Condition File

    ("PCfile_RMBx_YYYY.csv" file which is presented in Part 3)
  - Filter lane for checking (The lane is same with Step 1)

    Colums need to be filtered following order: Road category, Road number, Road Supplement number, Brach number, Direction, Path lane
  - Calculate total length of the lane **(L)**
- Step 3: Confirm appropriate between FV images and pavement condition data length
  - Calculate: $X = \frac{L}{5}$
  - If $X \neq \frac{L}{5}$ **,** data isn't appropriate, request to output data again

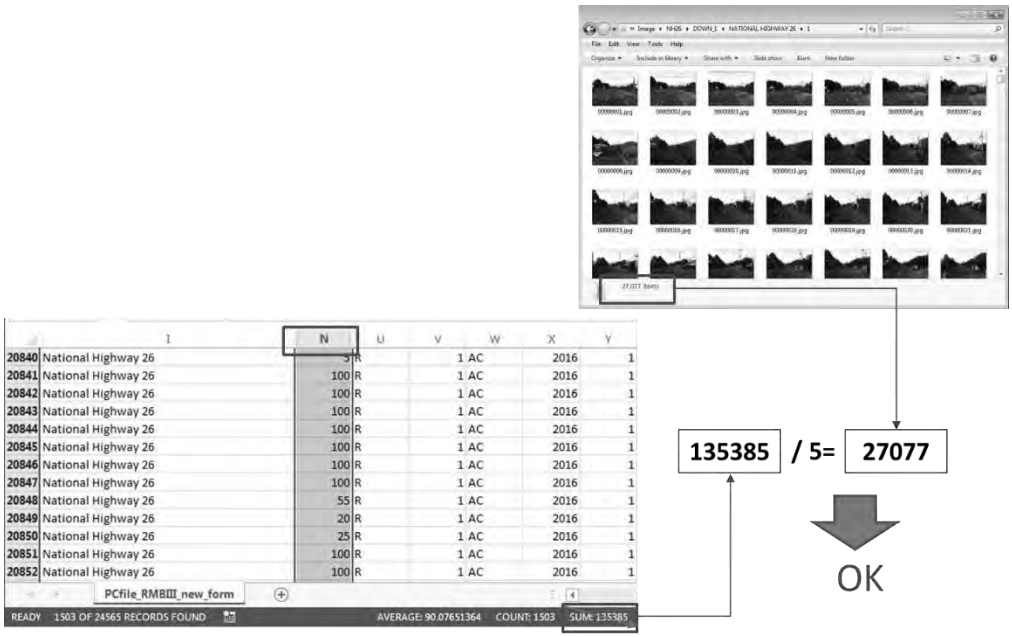


Figure 5.2 Example of Check quantity of FV images

6. Check abnormal value

6.1. Pavement Condition File

Pavement Condition File is outputted as 100m record data. Each record data include below information:

- Section ID
- Geographic Area
- Administration information group
  - Jurisdiction
  - Management Agency
- Road code information group
  - Road category
  - Road number
  - Road Supplement Number
  - Branch number
  - Road name
- Chainage, Length information group
  - From_Km
  - From_m
  - To_Km
  - To_m
  - Length of record data
  - Analysis area
- Structure and infracstructure information group
  - Road structure
  - Intersection
  - Overlapping section
- Survey direction, survey lane information group
  - Quantity of lane on Left-bound
  - Quantity of lane on Right-bound
  - Survey direction
  - Survey lane
- Pavement type
- Time information froup
  - Survey year
  - Survey month
- Pavement condition information group
  - Crack raito

- Patching ratio
- Pothole ratio
- Total crack ratio/crack index
- Rutting depth max
- Rutting depth average
- IRI
- MCI

❖ Perculiar condition

❖ Remarks

6.2. Abnormal value definition

❖ Abnormal value is value of "Pavement condition information group" which is over or less than normal value. Abnormal values may be correct. However, in some cases, analysts got mistake during analysis work due to pavement condition value be wrong. These mistakes make data un-reliable. Therefore, it's necessary to check and review these abnormal values, and request Survey Consultant to revise if abnormal value isn't un-resonable.

Data items which need to be check and review about abnormal value, include as below:

- Total crack ratio/crack index
- Rutting depth max
- Rutting depth average
- IRI

Criteria of abnormal values which were recommended bt JICA Project Team, shown in Table 6.1

Table 6.1 Abnormal values of pavement condition data

Data items	Abnormal value
Total crack raito/ crack index	Over 70%
Rutting depth max	Over 50mm
Rutting depth average	Over 30mm
IRI	Over 15mm/m
MCI	Equal 0

6.3. Method to check abnormal value

Abnormal values are separately into "Pavement Condition File", check person need to search the values using "Filter" function of Excel. Then, check person has to refer position of abnormal value to FV image. If FV image refects pavement condition data incorrectly, check person records position of abnormal value and request Survey Consultant to revise.

Work flow of check abnormal value is shown in Figure 6.1.

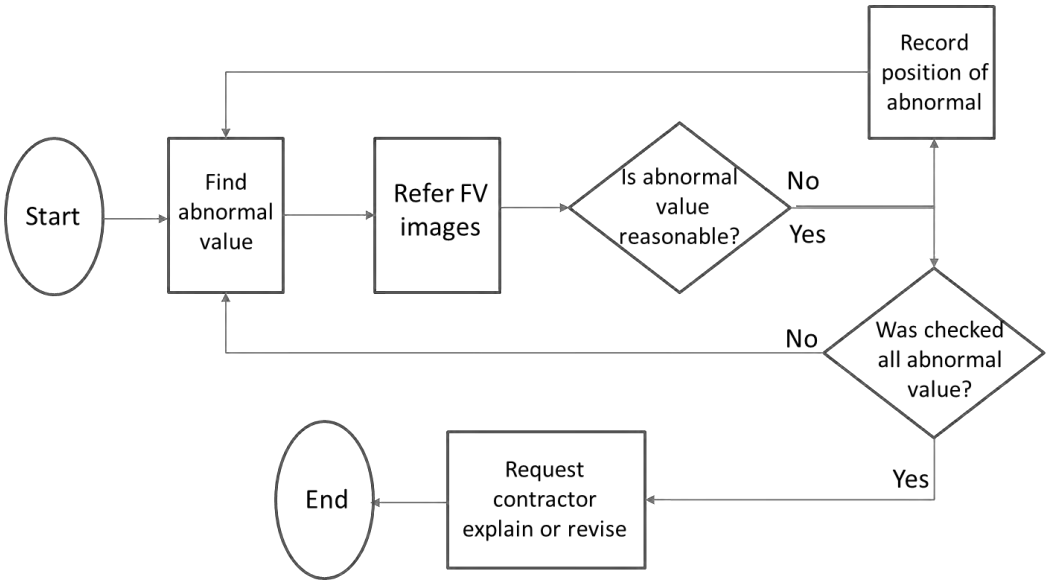


Figure 6.1 Work flow of check abnormal value

❖ Method to refer FV image

There is "Section_ID" for each record data, is explained in Part 6.1. Section_ID which is number and character "_", was integrated from "Road code information group", "Chainage, length information group", "survey direction, survey lane information group". Each record data has each "Section_ID" and this "Section_ID" isn't same with another record data.

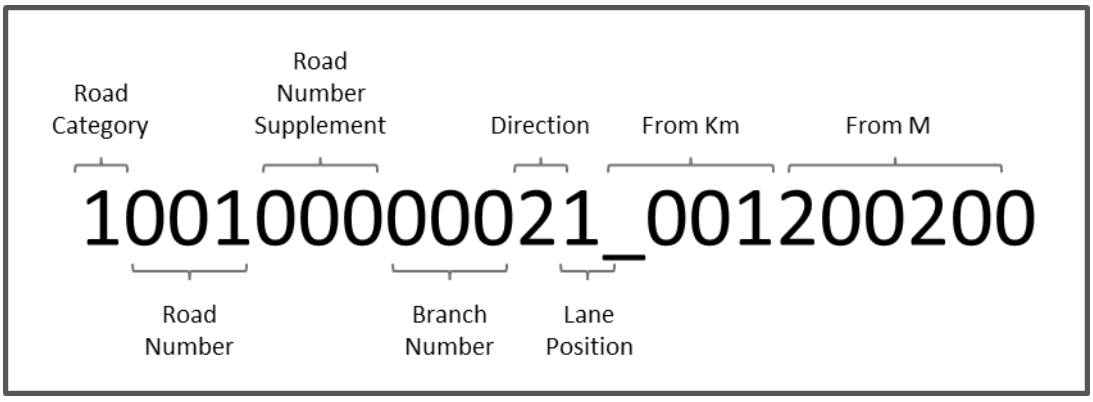


Figure 6.2 Section_ID definition

There is information of "Section_ID" in to "Geographic Coordinate File". Because each FV images was collected with 5 meters interval, therefore, each 100m record data in "Pavement Condition File" has 20 records data in "Geographic Coordinate File".

After find out storing link of FV image, check person opens the image and refer pavement condition at selected position.

Refer FV image step is summarized as below:

- Step 1: Select recoed data in "Pavement Condition File"
- Step 2: Record "Section_ID" of record data
- Step 3: Find "Section_ID" which was recorded in Step 2 in "Geographic Coordinate File"
- Step 4: Find stroring link of FV image in "Geographic Coordinate file"
- Step 5: Find FV image based on the storing link in Step 4.

❖ Example to refer FV image:

Find FV image of section from Km31+600 to Km31+700, Left-bound, lane 1

- Step 1: Select recoed data in "Pavement Condition File"

10020000011_003100100	NATIONAL HIGHWAY 2	31	100	31	200	L	1
10020000011_003100200	NATIONAL HIGHWAY 2	31	200	31	300	L	1
10020000011_003100300	NATIONAL HIGHWAY 2	31	300	31	400	L	1
10020000011_003100400	NATIONAL HIGHWAY 2	31	400	31	500	L	1
10020000011_003100500	NATIONAL HIGHWAY 2	31	500	31	600	L	1
10020000011_003100600	NATIONAL HIGHWAY 2	31	600	31	700	L	1

Figure 6.3 Example to refer FV Image, "Pavement Condition File"

- Step 2: Save "Section_ID" of record data

  Section_ID from Km31+600 to Km31+700 is 10020000011_003100600
- Step 3: Step 3: Find "Section_ID" which was saved in Step 2 in "Geographic Coordinate File"
- Step 4: Find stroring link of FV image in "Geographic Coordinate file"

10020000011_003100200	20	2017\RMB I\NH2\Left_lane1\00000125.jpg
10020000011_003100300	1	2017\RMB I\NH2\Left_lane1\00000126.jpg
10020000011_003100300	2	2017\RMB I\NH2\Left_lane1\00000127.jpg
10020000011_003100300	3	2017\RMB I\NH2\Left_lane1\00000128.jpg
10020000011_003100300	4	2017\RMB I\NH2\Left_lane1\00000129.jpg
10020000011_003100300	5	2017\RMB I\NH2\Left_lane1\00000130.jpg
10020000011_003100300	6	2017\RMB I\NH2\Left_lane1\00000131.jpg
10020000011_003100300	7	2017\RMB I\NH2\Left_lane1\00000132.jpg
10020000011_003100300	8	2017\RMB I\NH2\Left_lane1\00000133.jpg
10020000011_003100300	9	2017\RMB I\NH2\Left_lane1\00000134.jpg
10020000011_003100300	10	2017\RMB I\NH2\Left_lane1\00000135.jpg
10020000011_003100300	11	2017\RMB I\NH2\Left_lane1\00000136.jpg
10020000011_003100300	12	2017\RMB I\NH2\Left_lane1\00000137.jpg
10020000011_003100300	13	2017\RMB I\NH2\Left_lane1\00000138.jpg
10020000011_003100300	14	2017\RMB I\NH2\Left_lane1\00000139.jpg
10020000011_003100300	15	2017\RMB I\NH2\Left_lane1\00000140.jpg
10020000011_003100300	16	2017\RMB I\NH2\Left_lane1\00000141.jpg
10020000011_003100300	17	2017\RMB I\NH2\Left_lane1\00000142.jpg
10020000011_003100300	18	2017\RMB I\NH2\Left_lane1\00000143.jpg
10020000011_003100300	19	2017\RMB I\NH2\Left_lane1\00000144.jpg
10020000011_003100300	20	2017\RMB I\NH2\Left_lane1\00000145.jpg
10020000011_003100400	1	2017\RMB I\NH2\Left_lane1\00000146.jpg
10020000011_003100400	2	2017\RMB I\NH2\Left_lane1\00000147.jpg

Figure 6.4 Example to refer FV Image "Geographic Coordinate file"

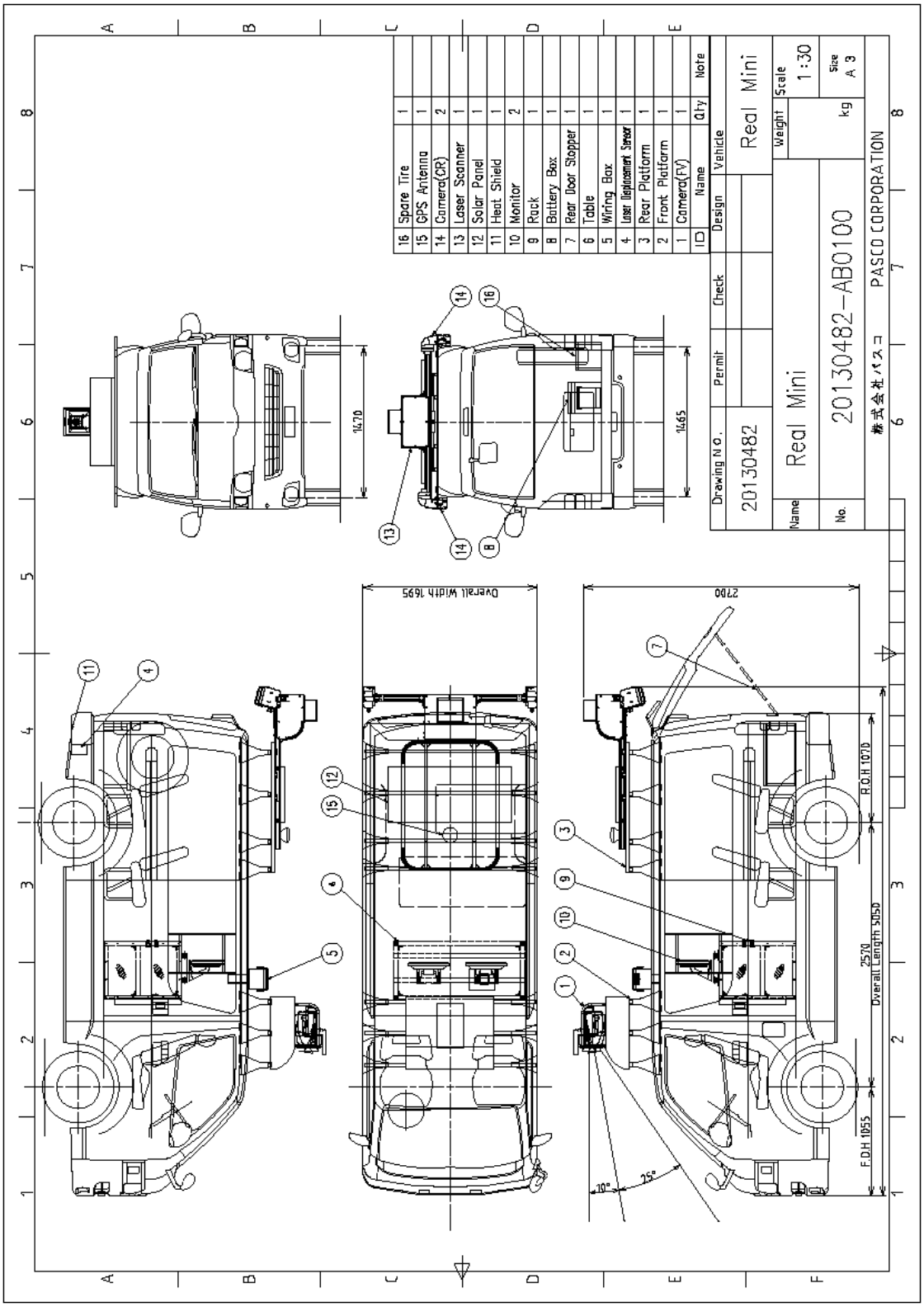
- Step 5: Find FV image based on the storing link in Step 4

  FV Images of section from Km31 to 600 ~ Km31+700, Lef-bound, Lane 1, from 00000126.jpg to 00000.147.jpg

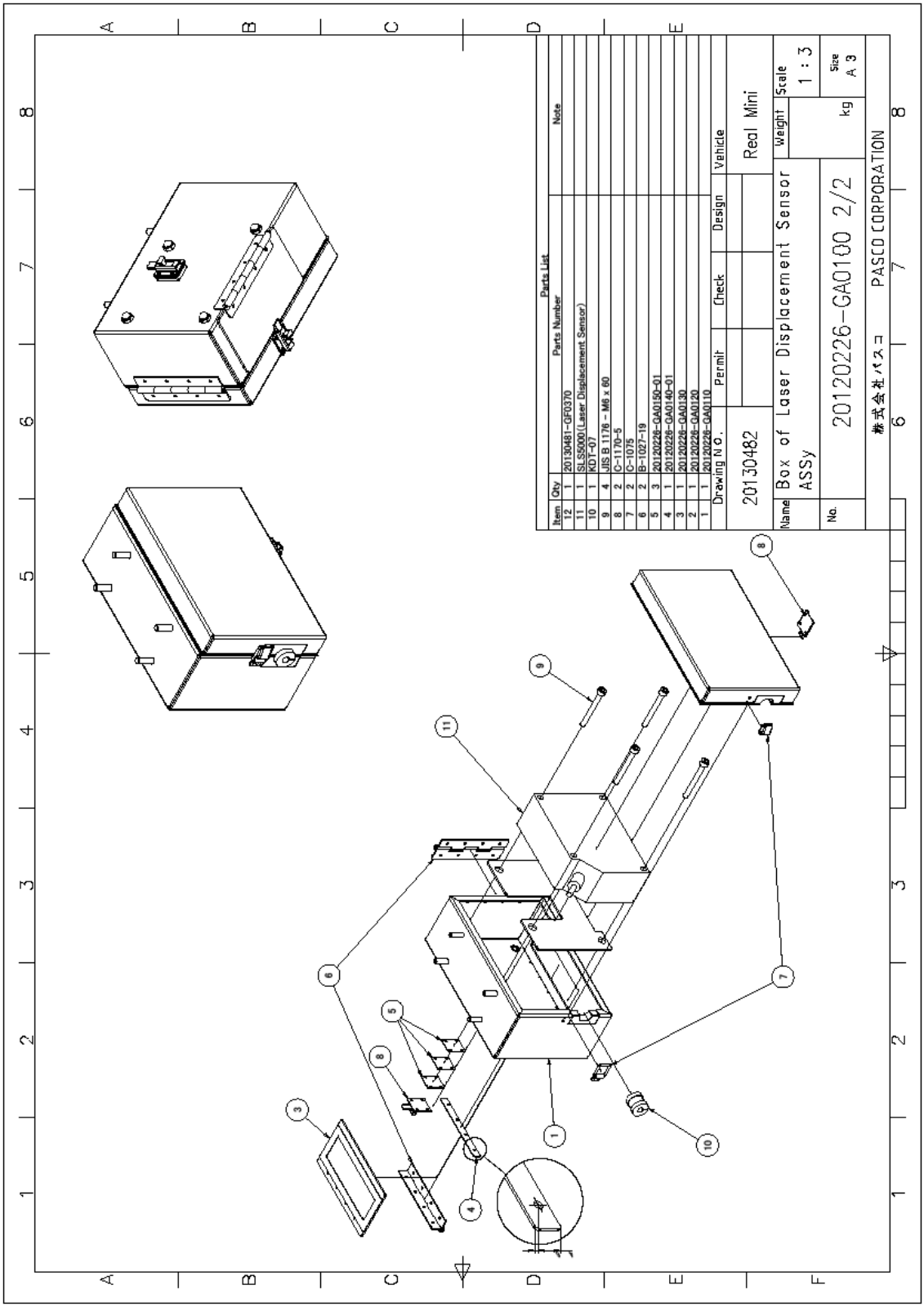
Appendix 1

Configuration Diagram

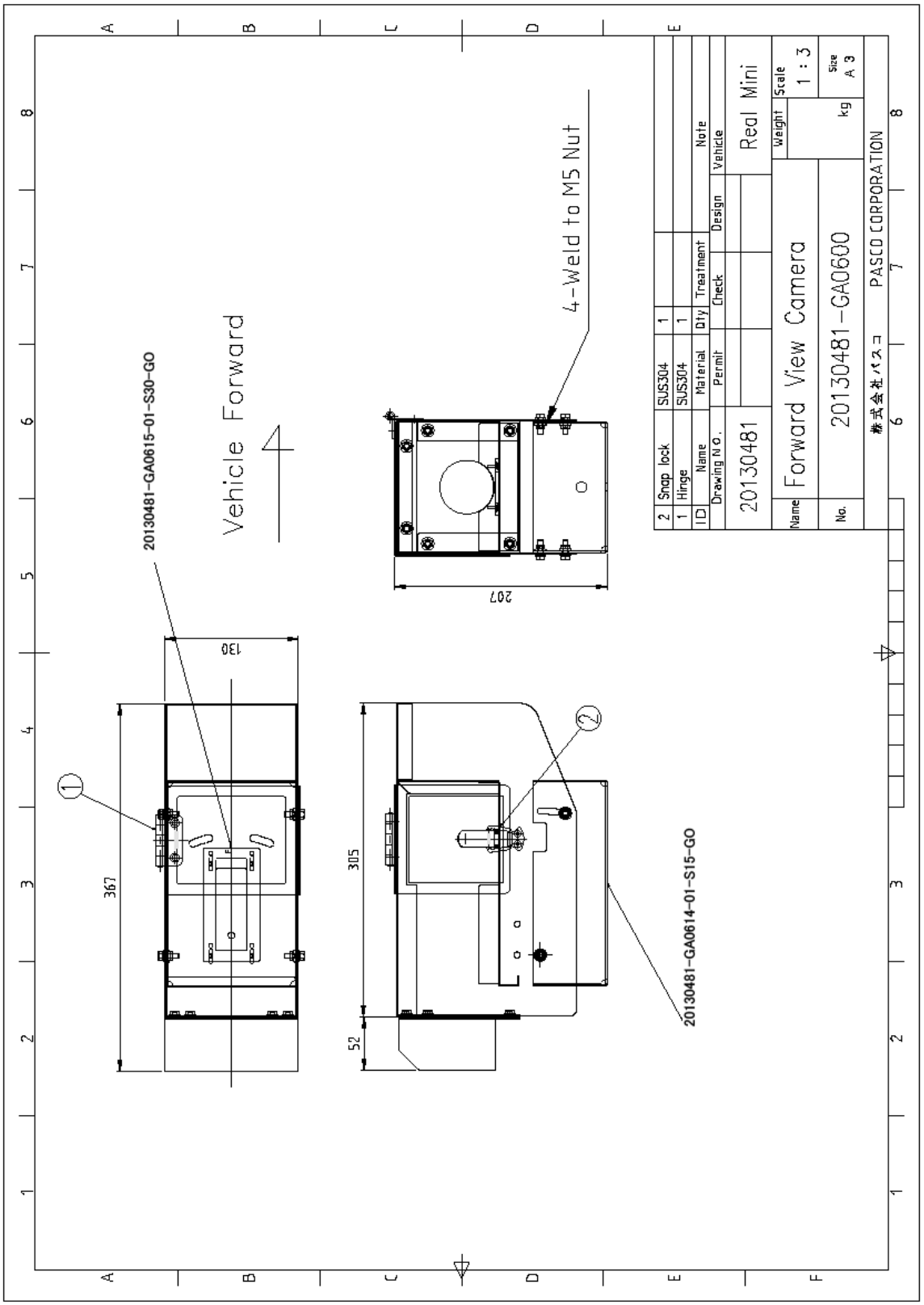
Configuration Diagram



Configuration Diagram



Configuration Diagram



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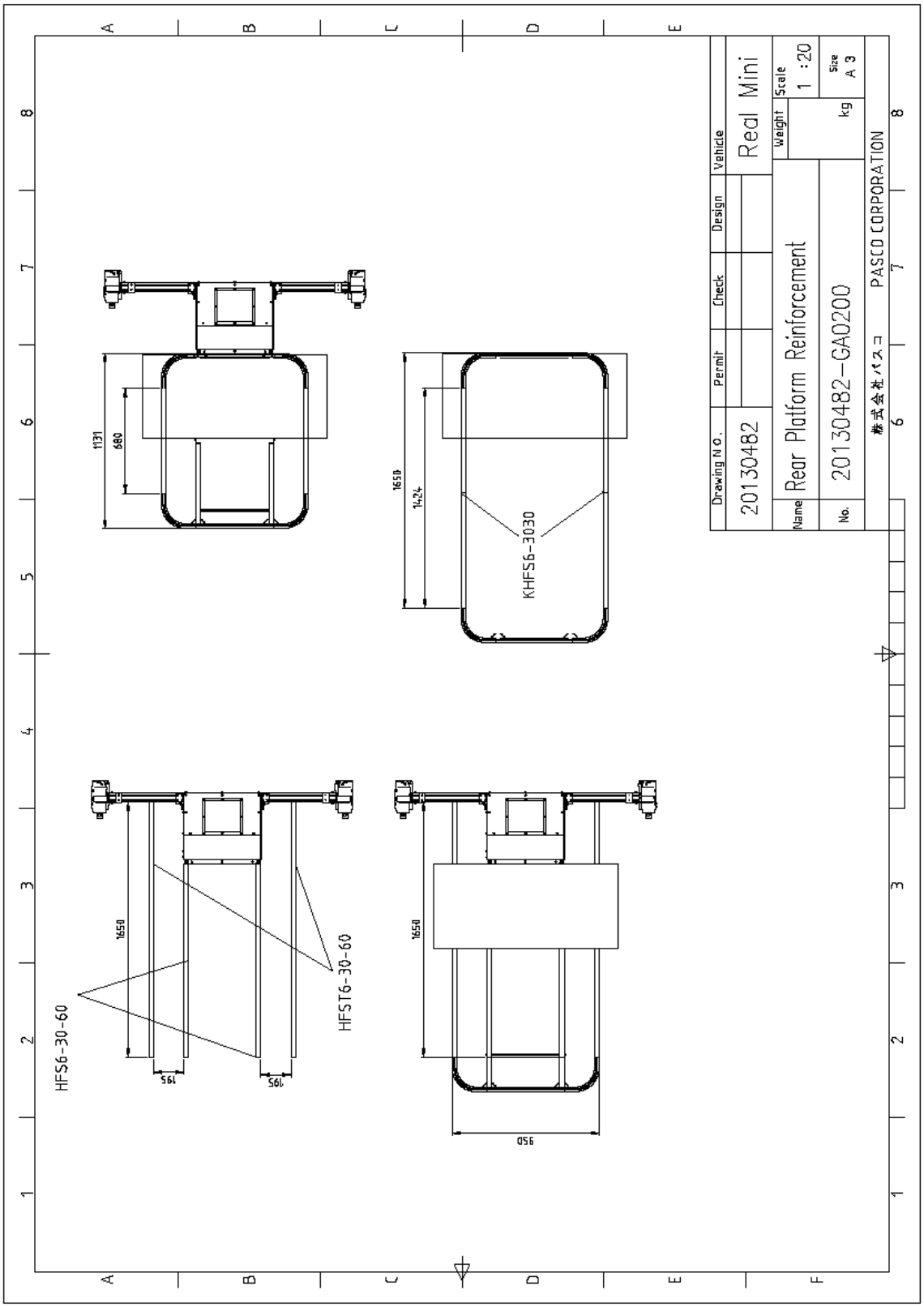
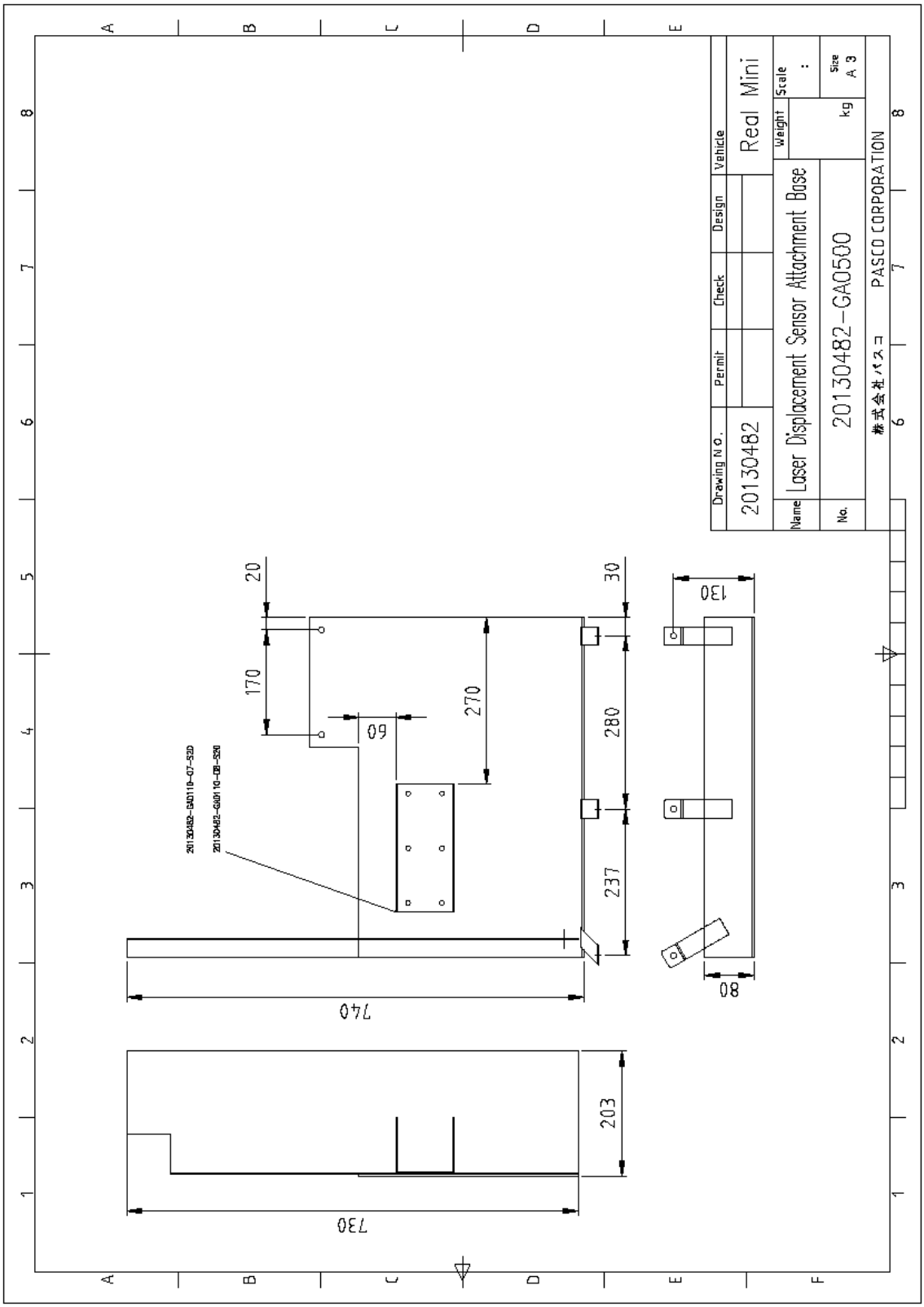
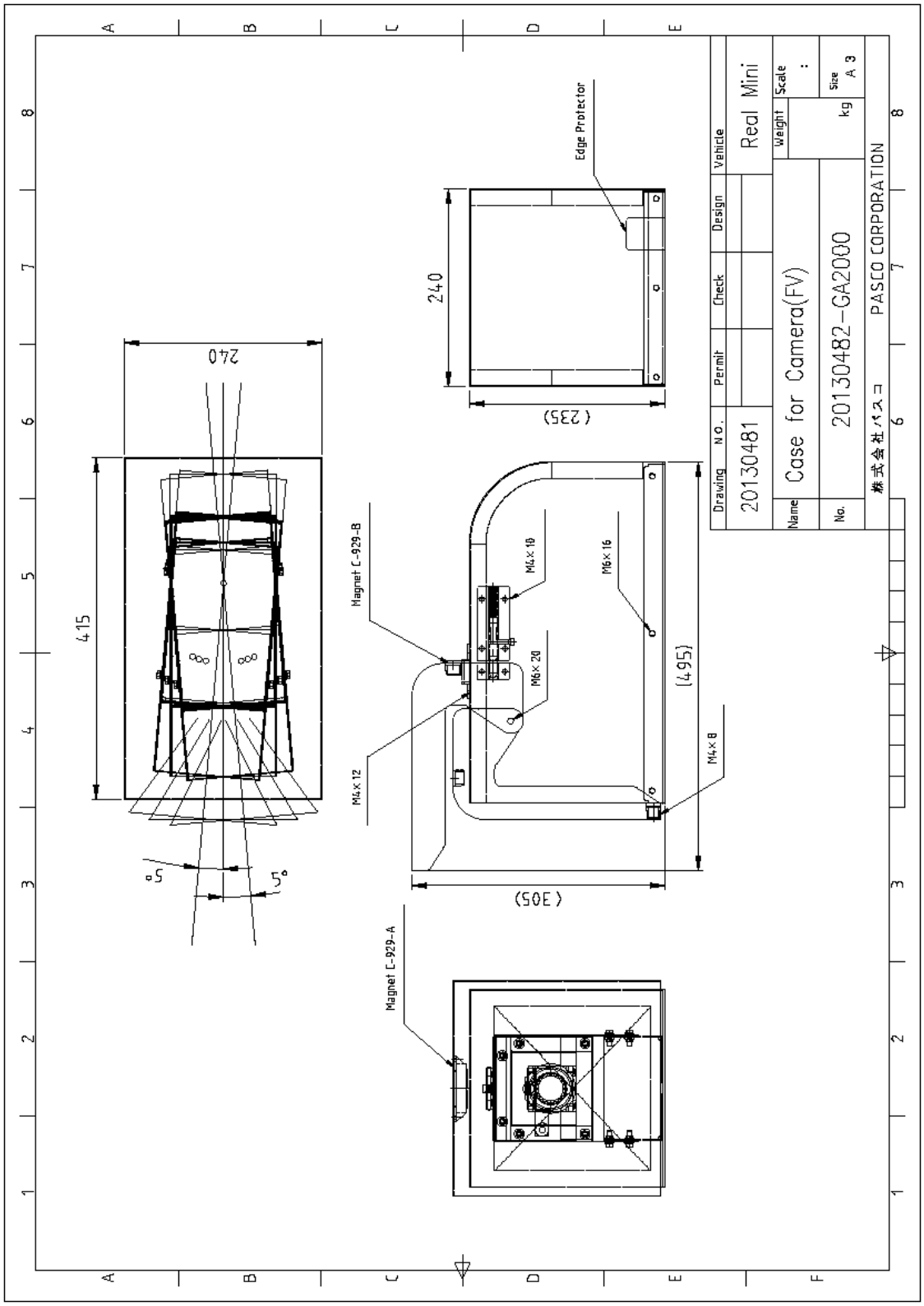


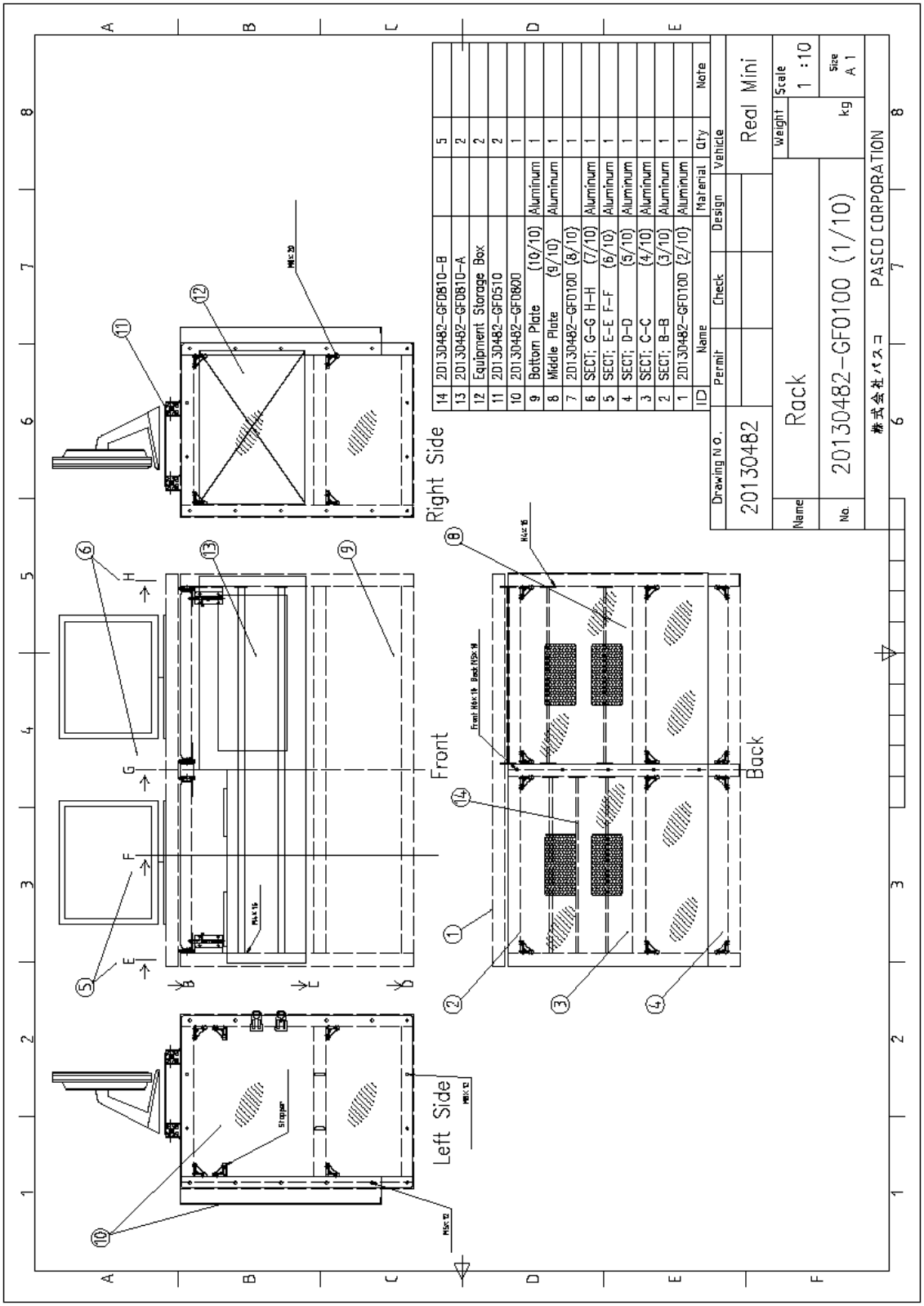
Configuration Diagram



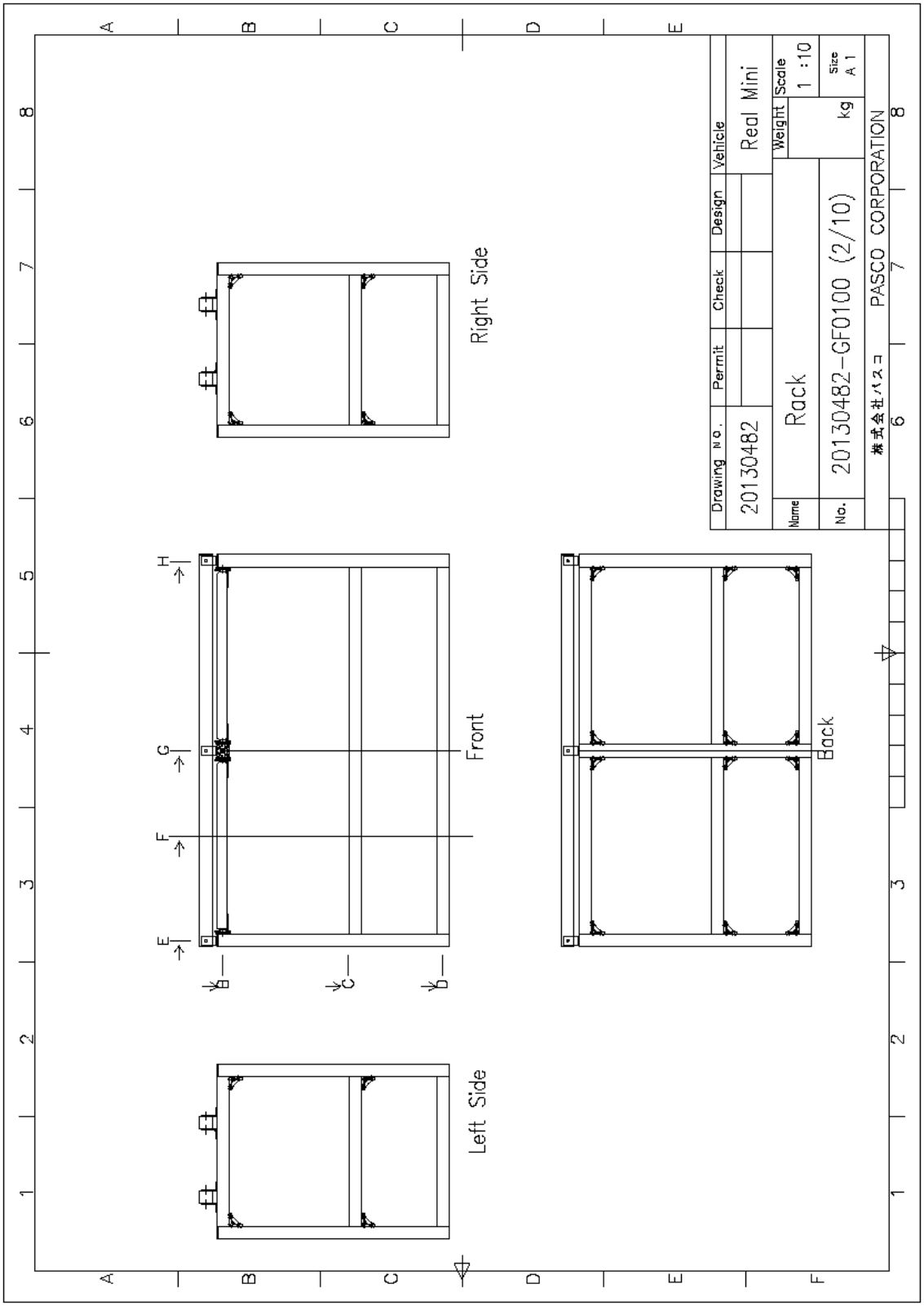
Configuration Diagram



Configuration Diagram



Configuration Diagram



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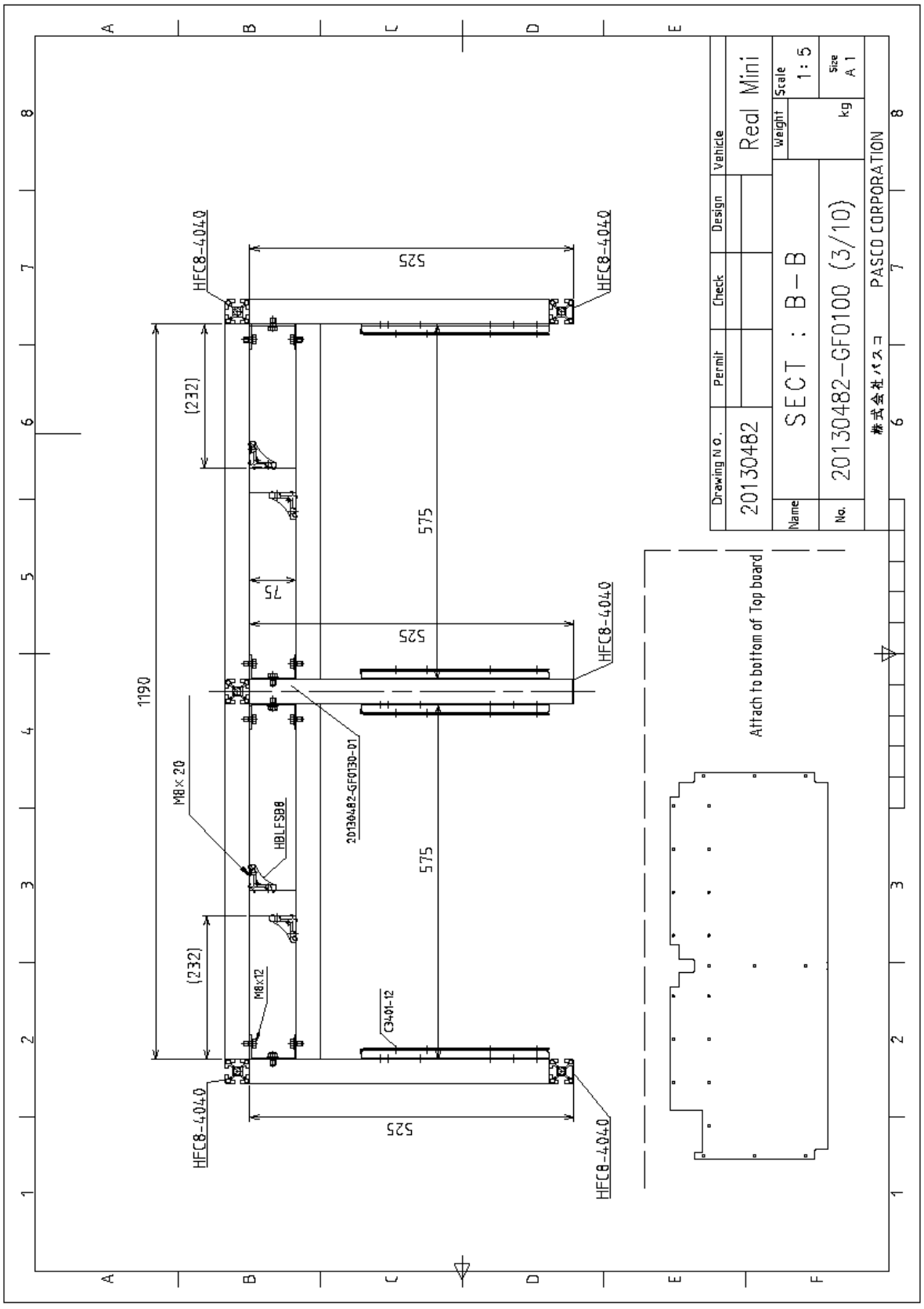
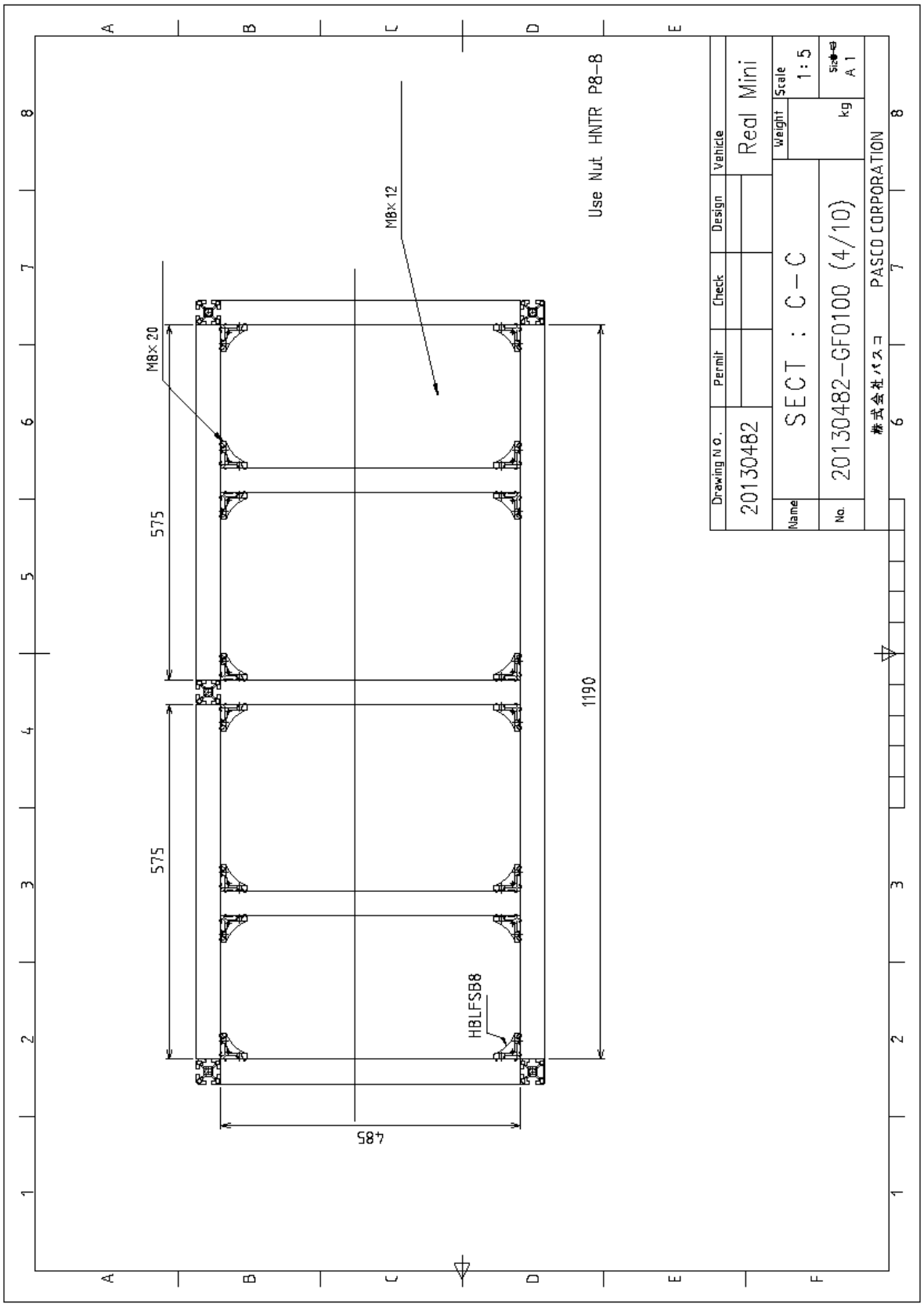


Configuration Diagram



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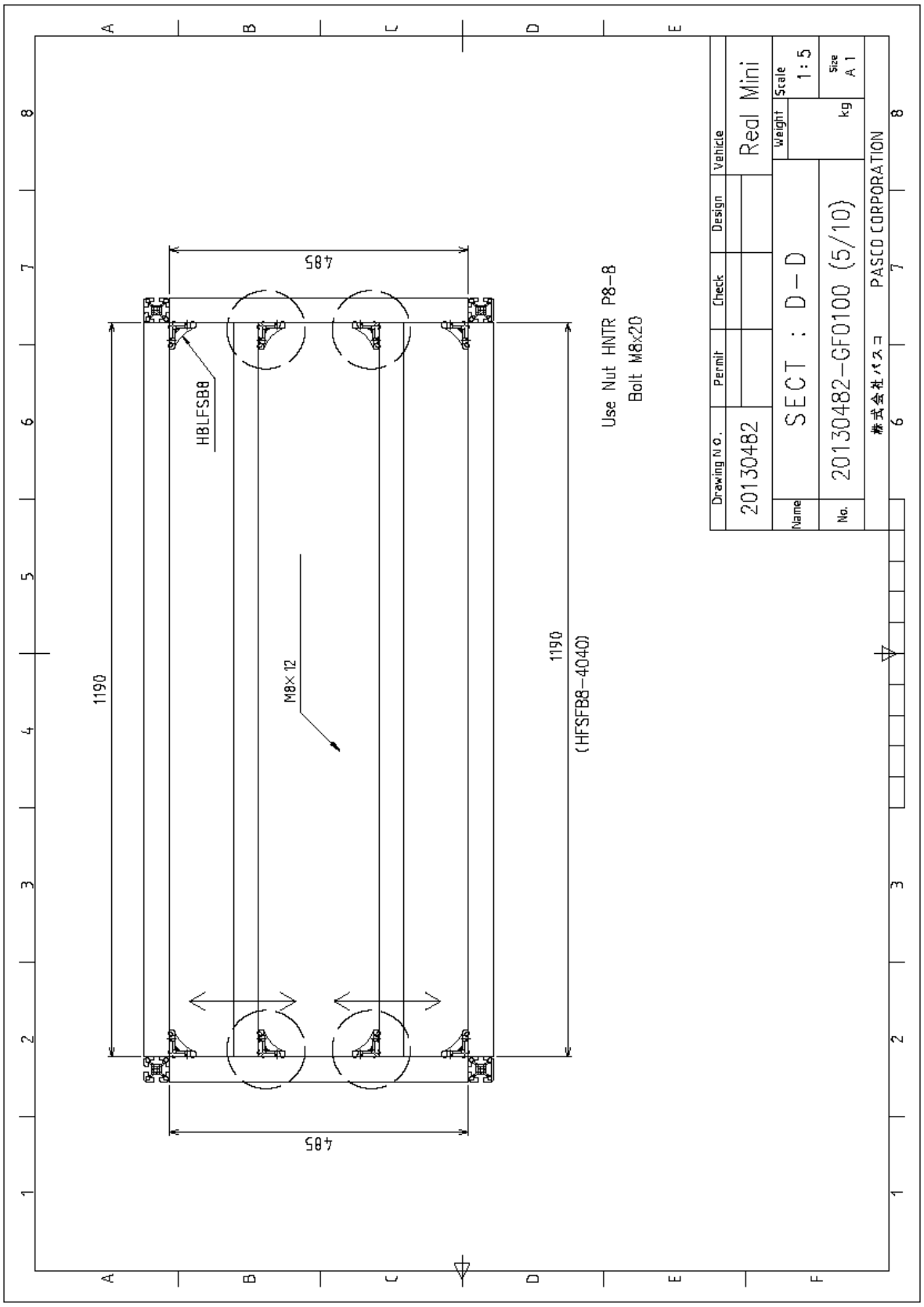

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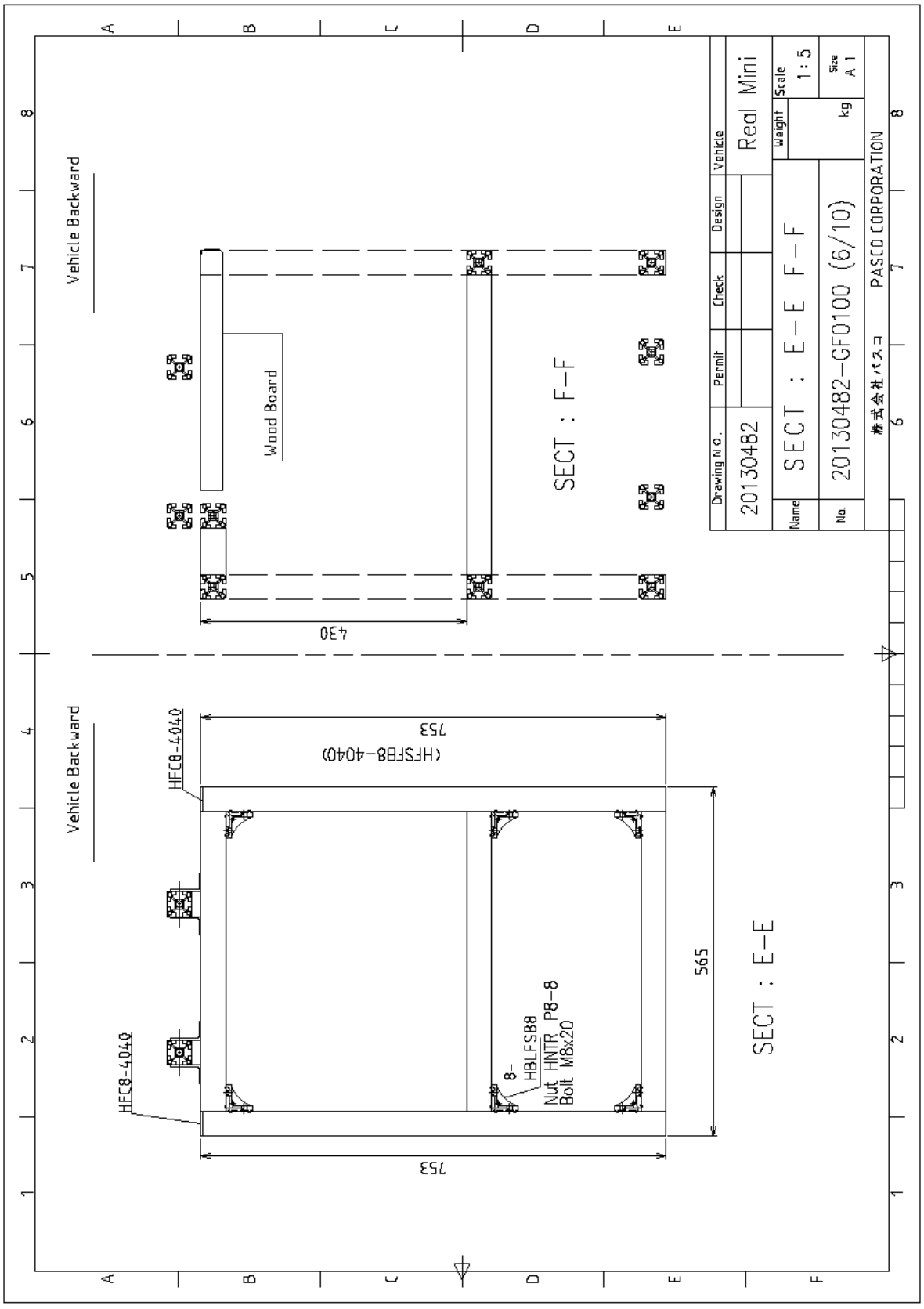

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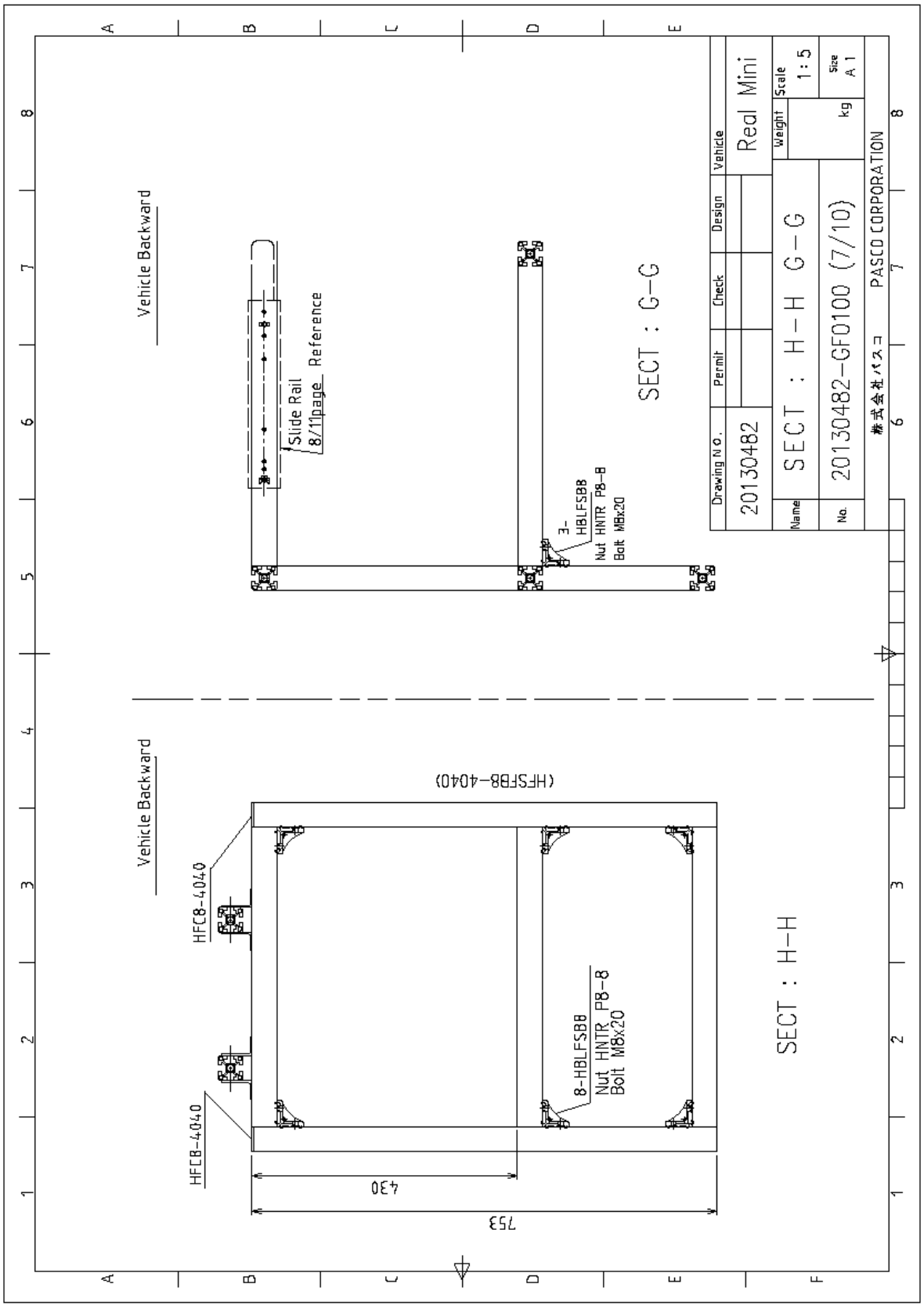

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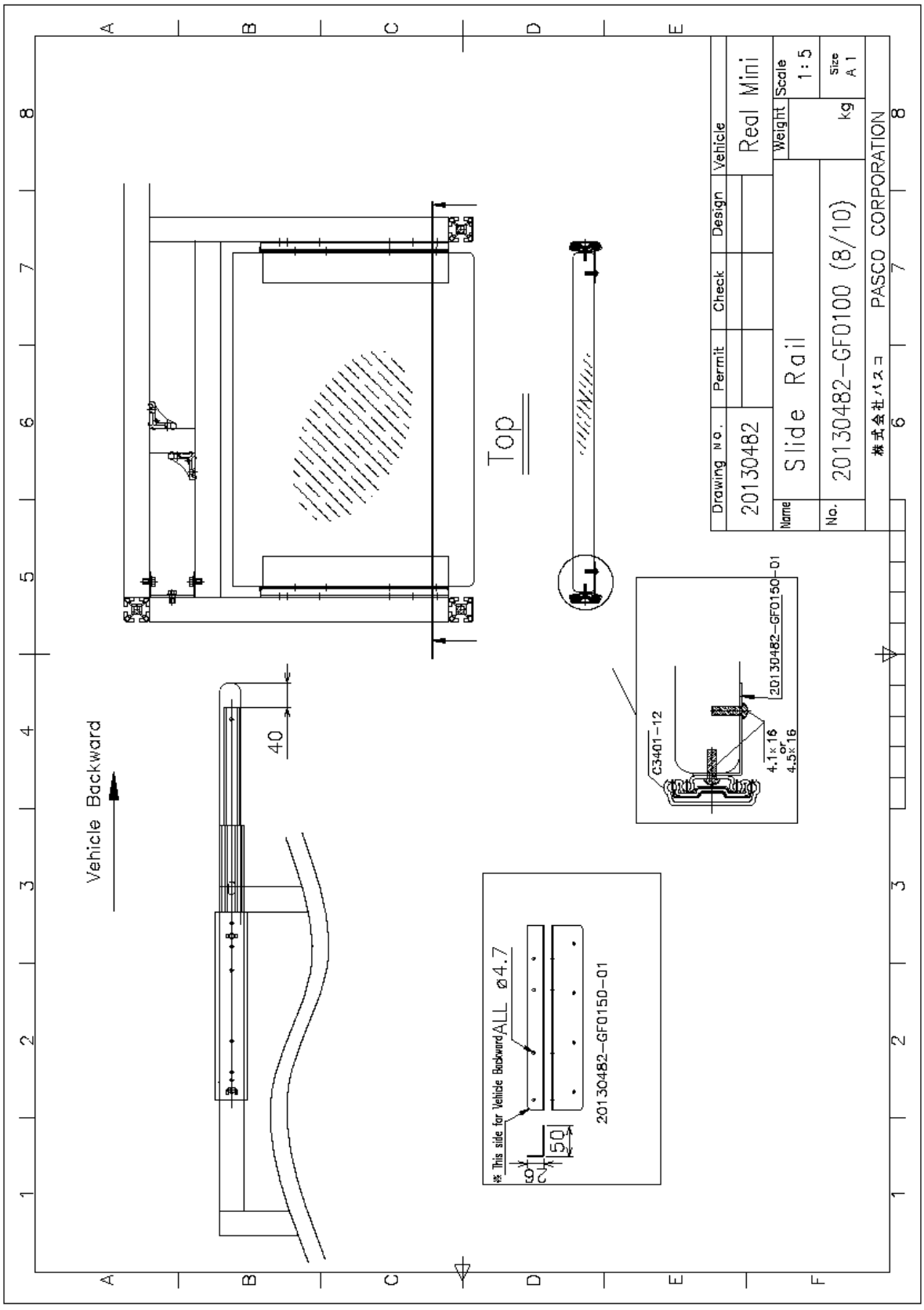
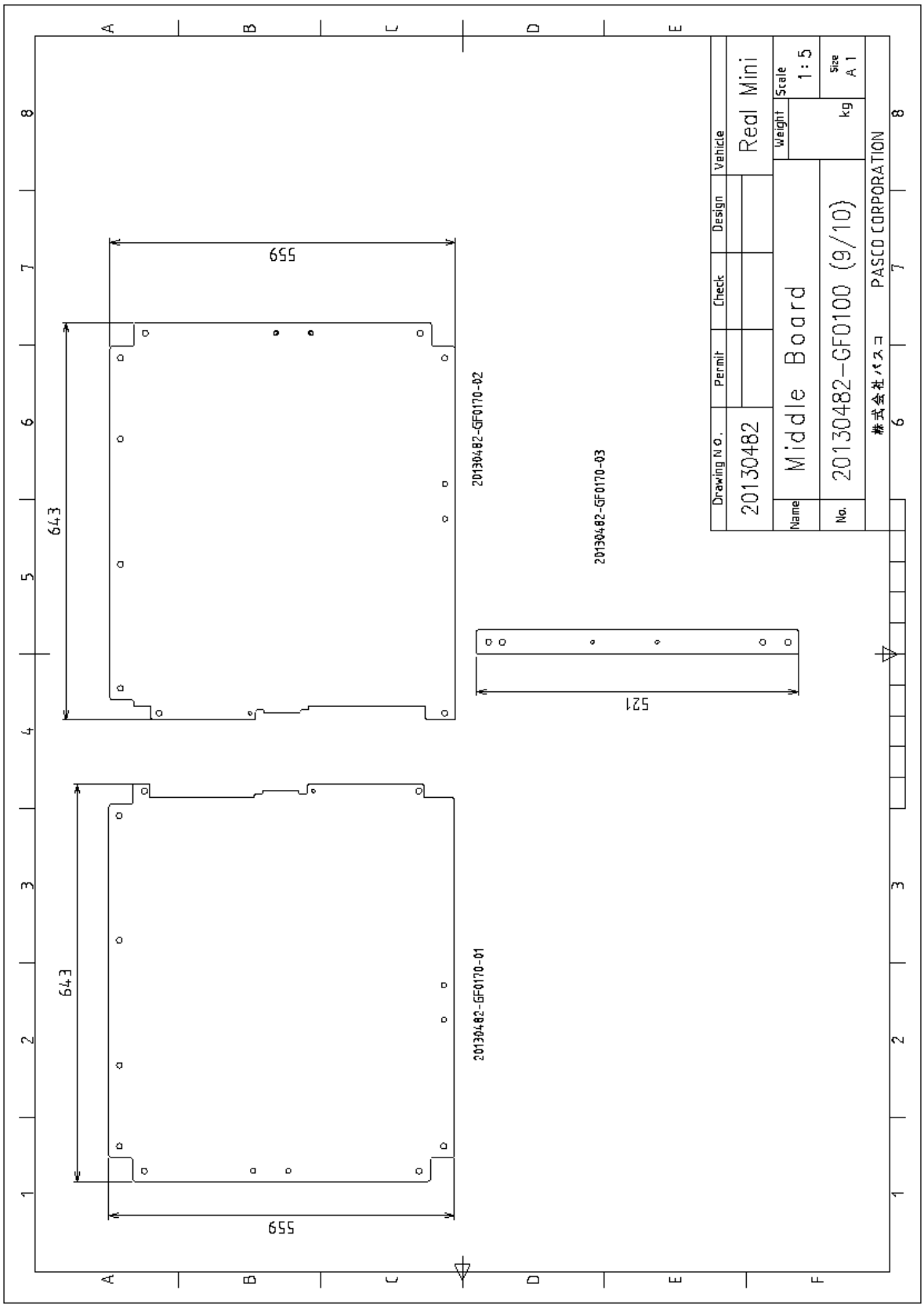
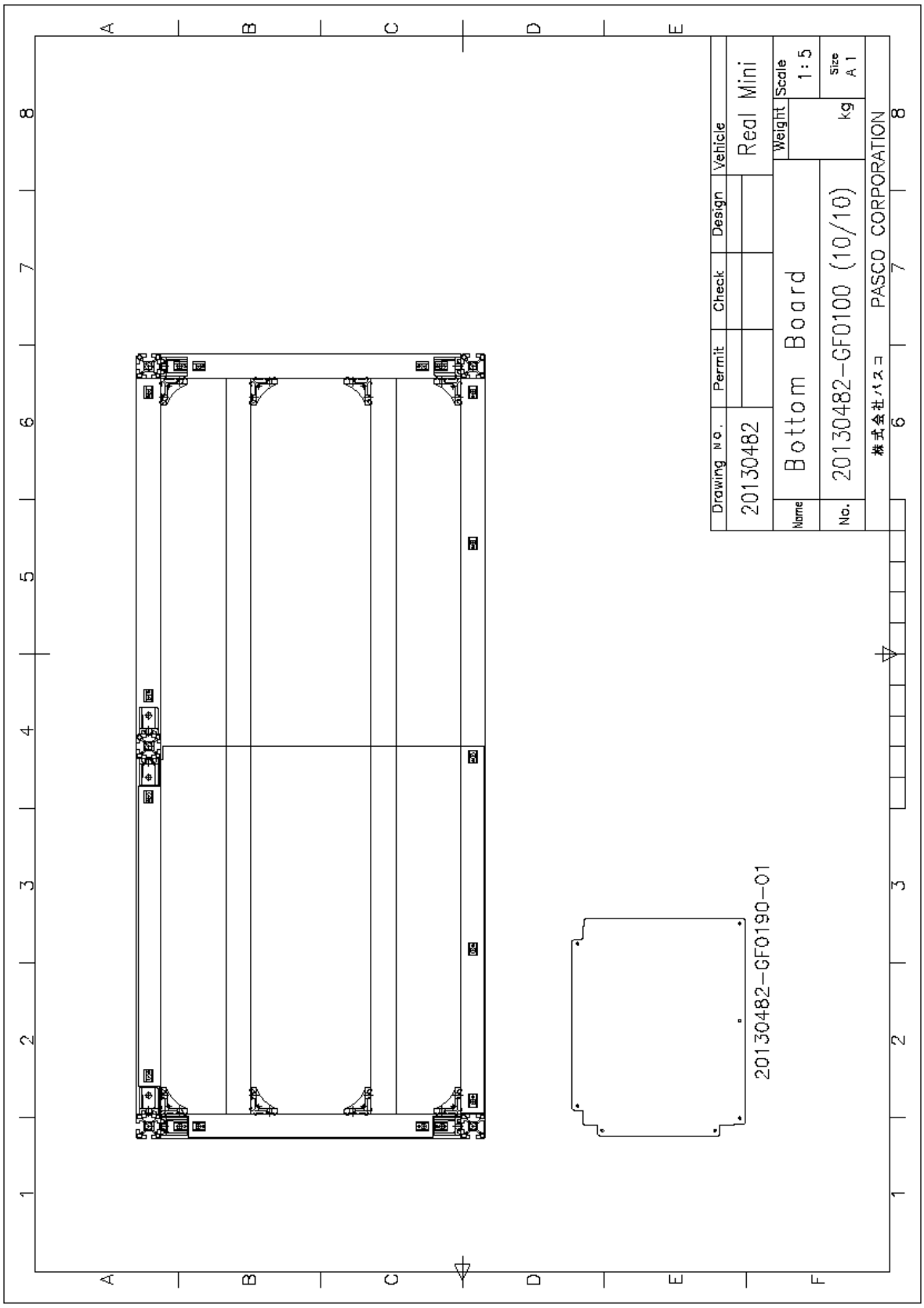


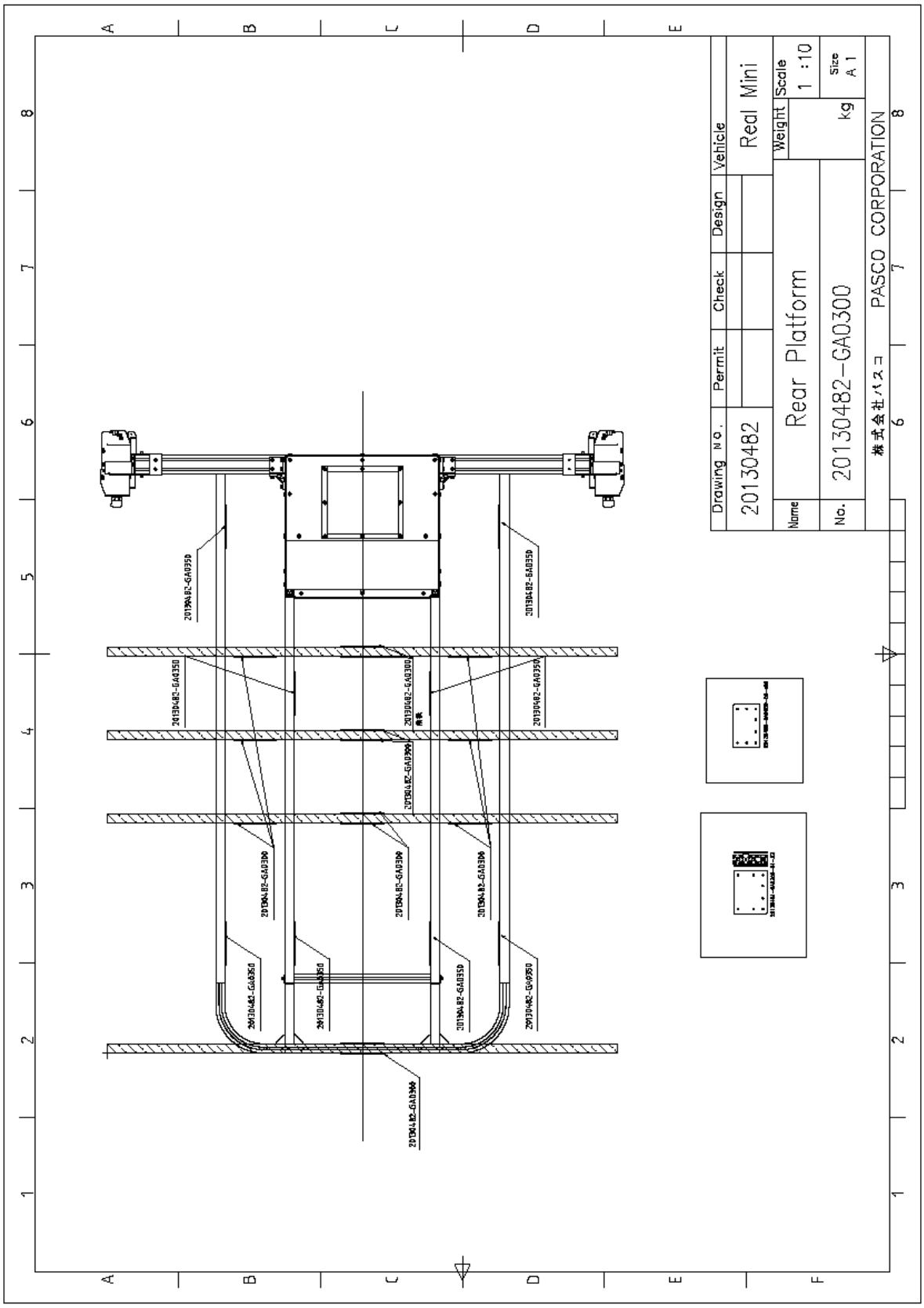
Configuration Diagram



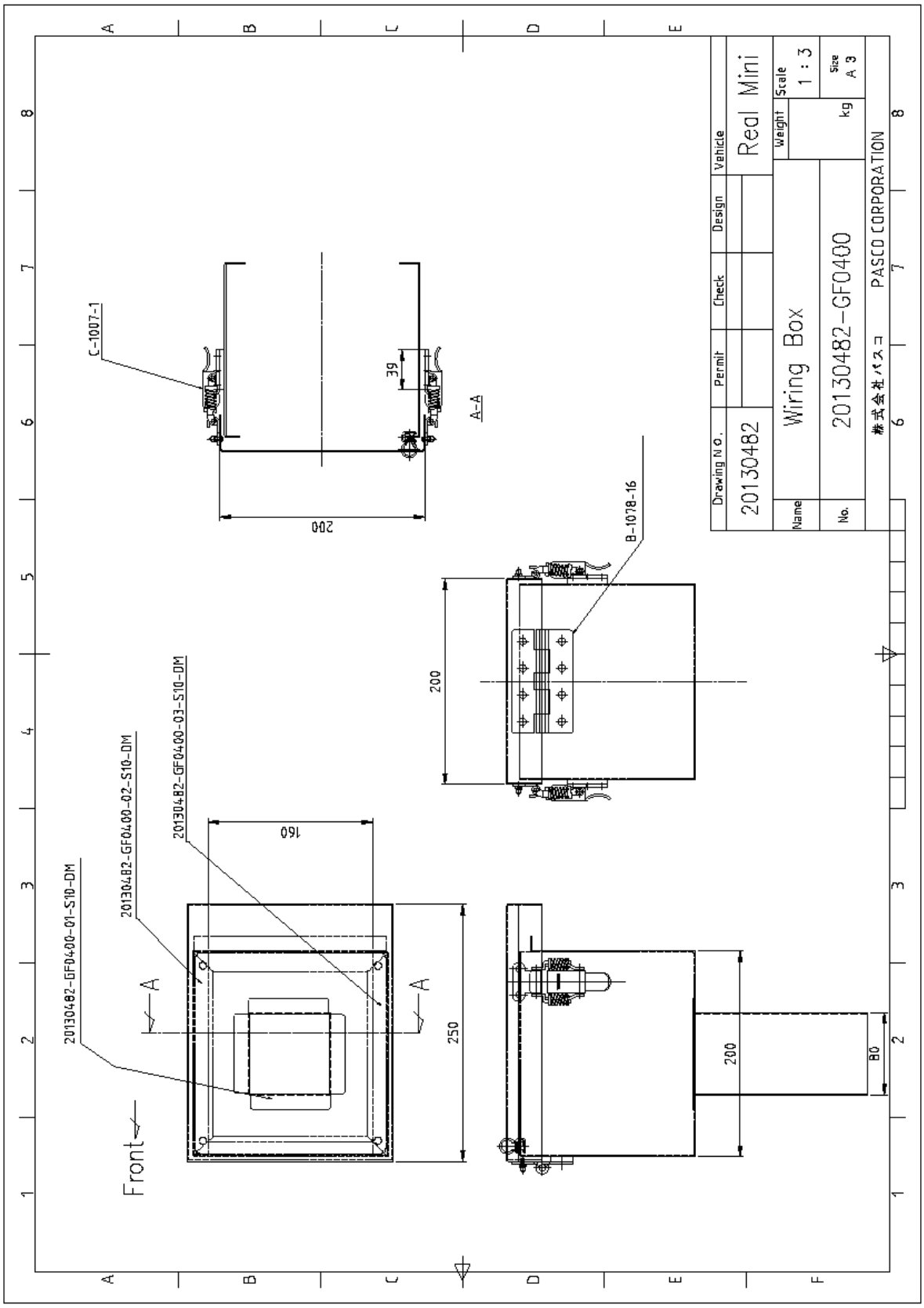
Configuration Diagram



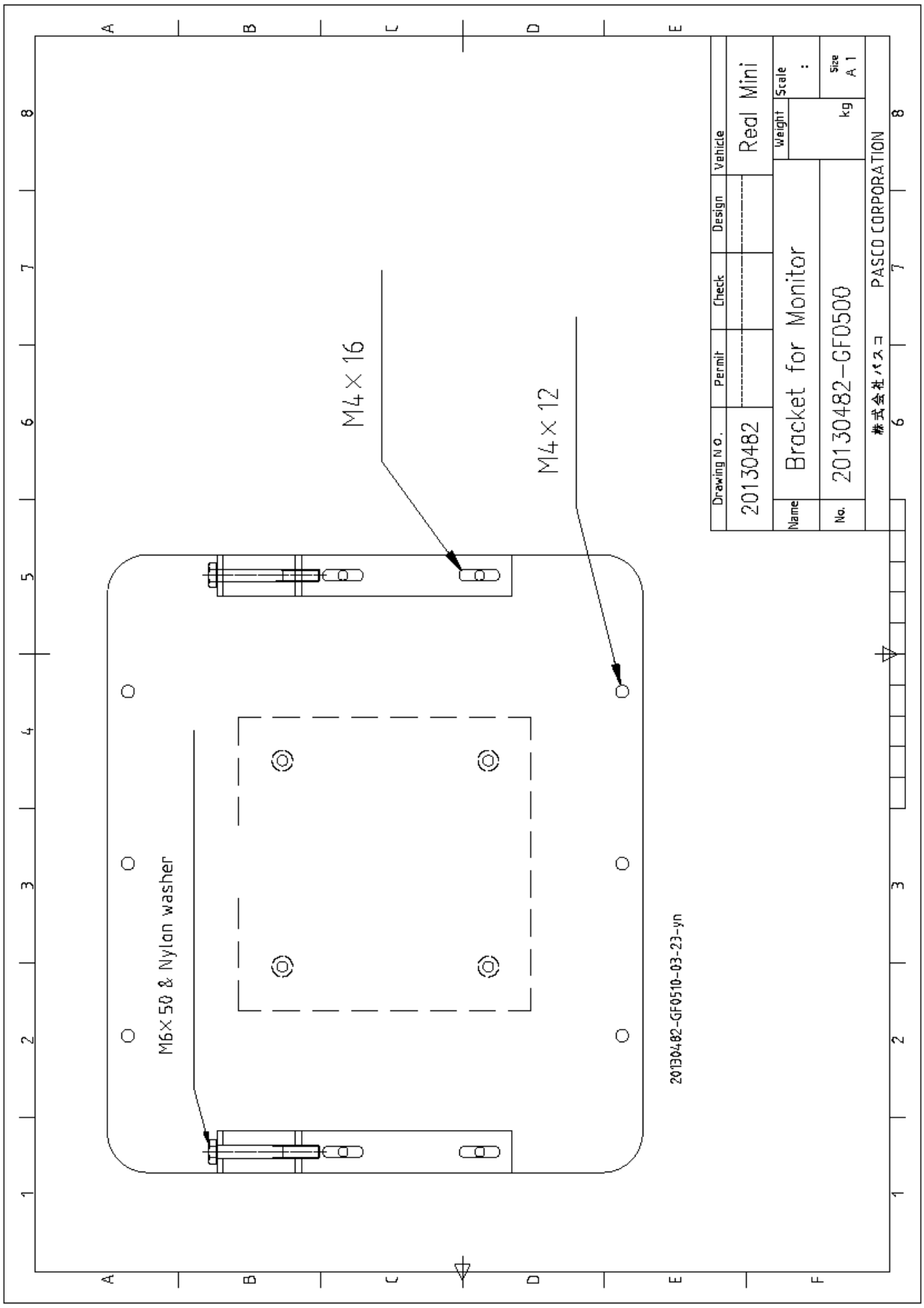
Configuration Diagram



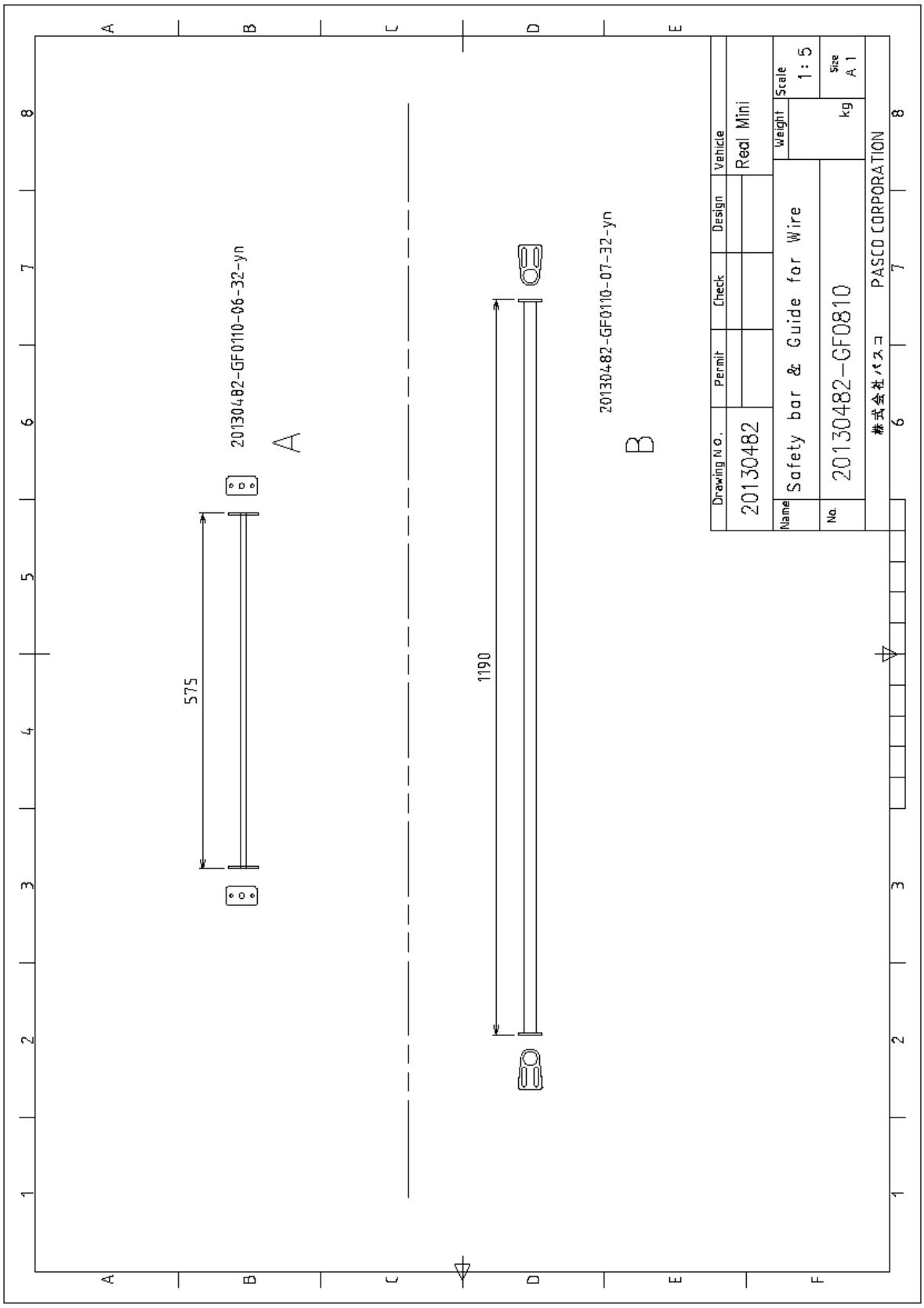
Configuration Diagram



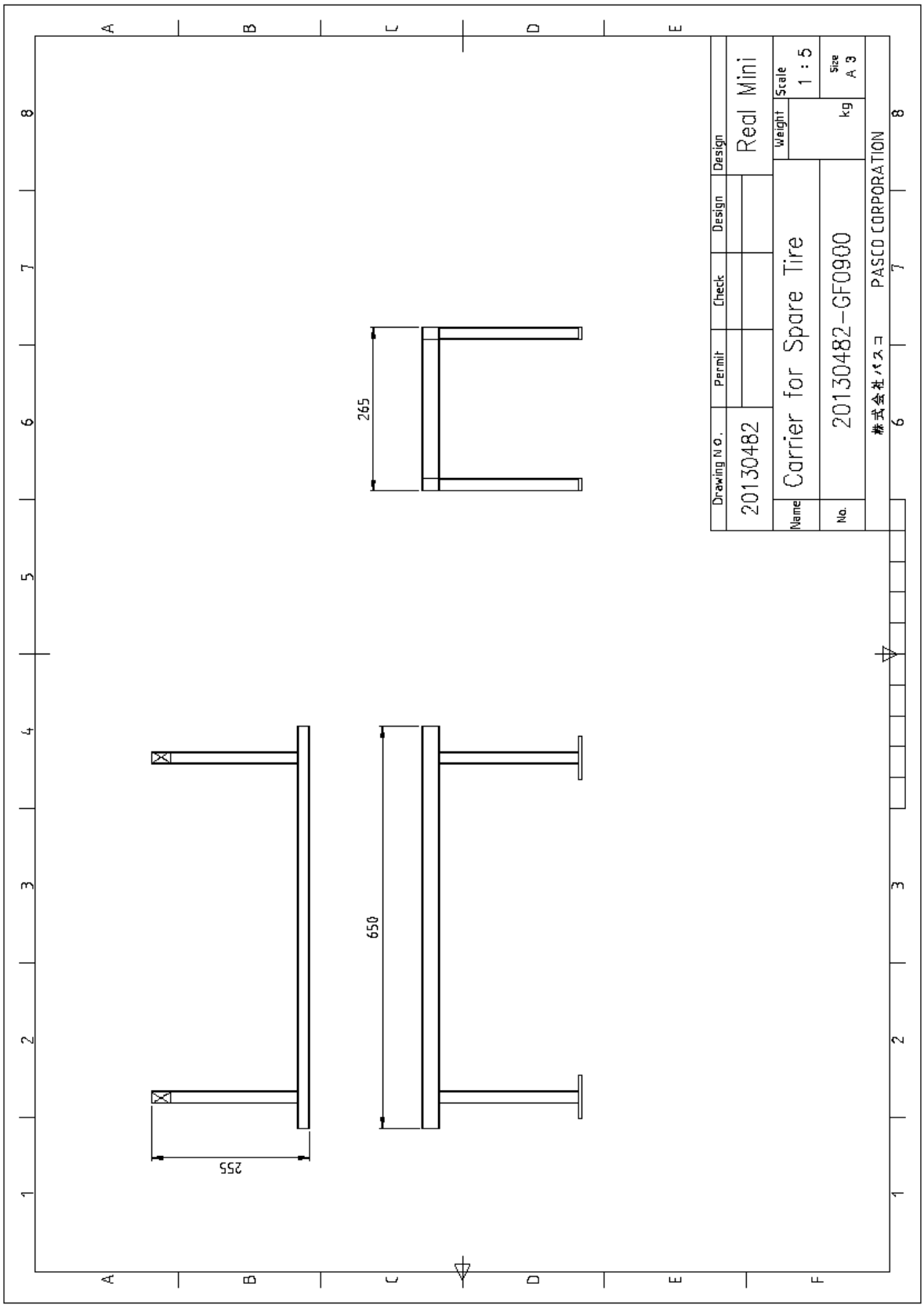
Configuration Diagram



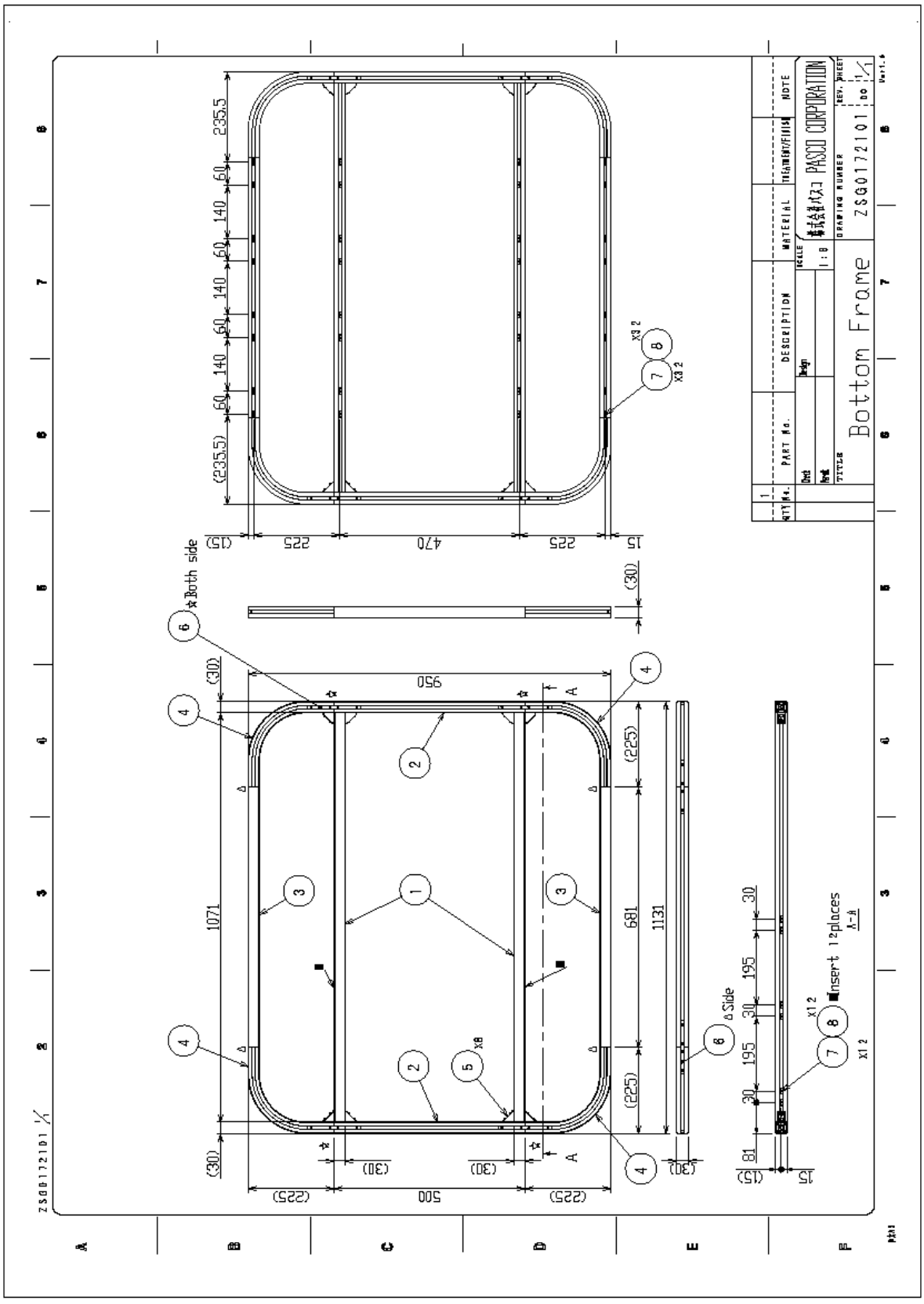
Configuration Diagram

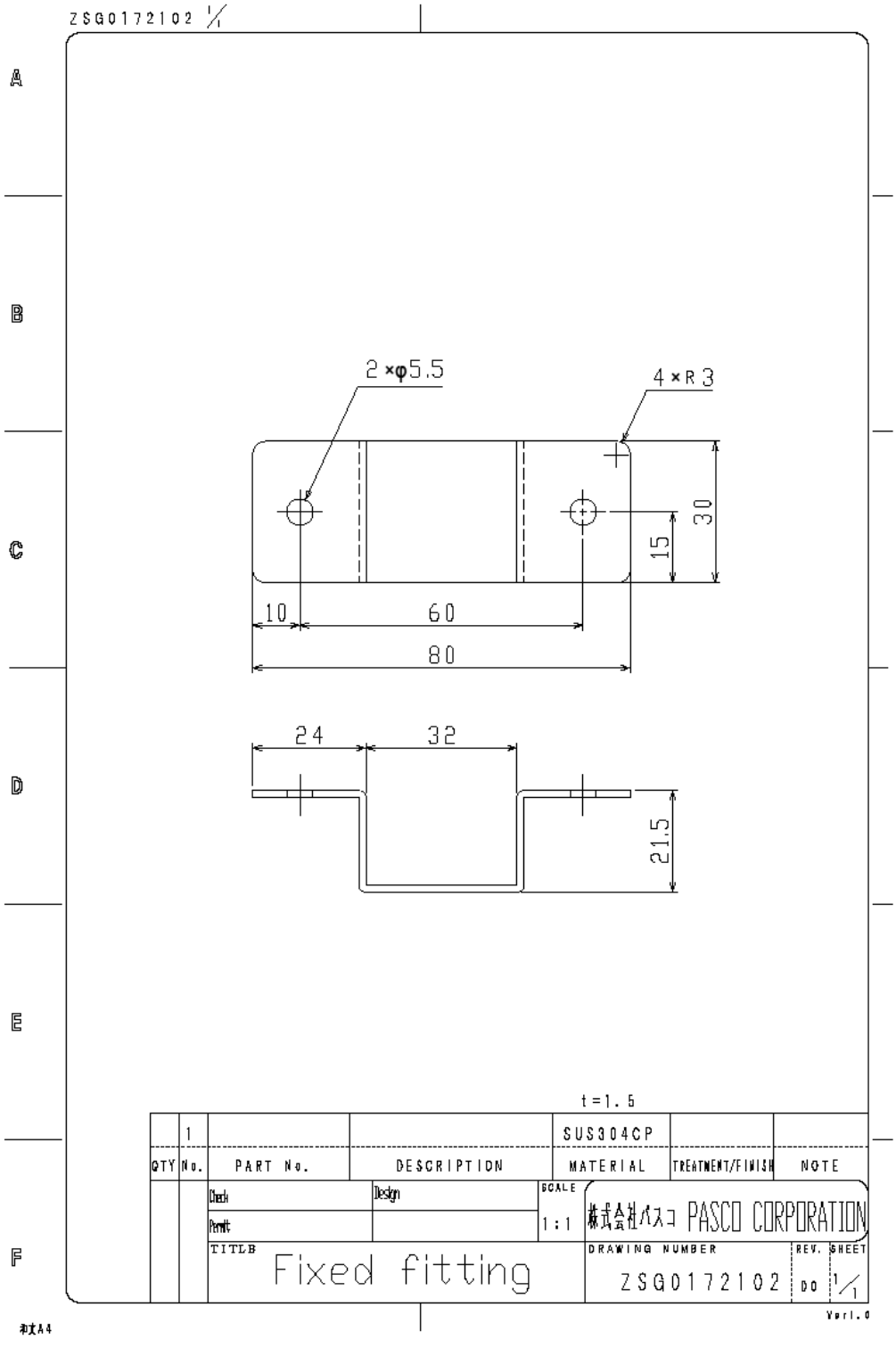


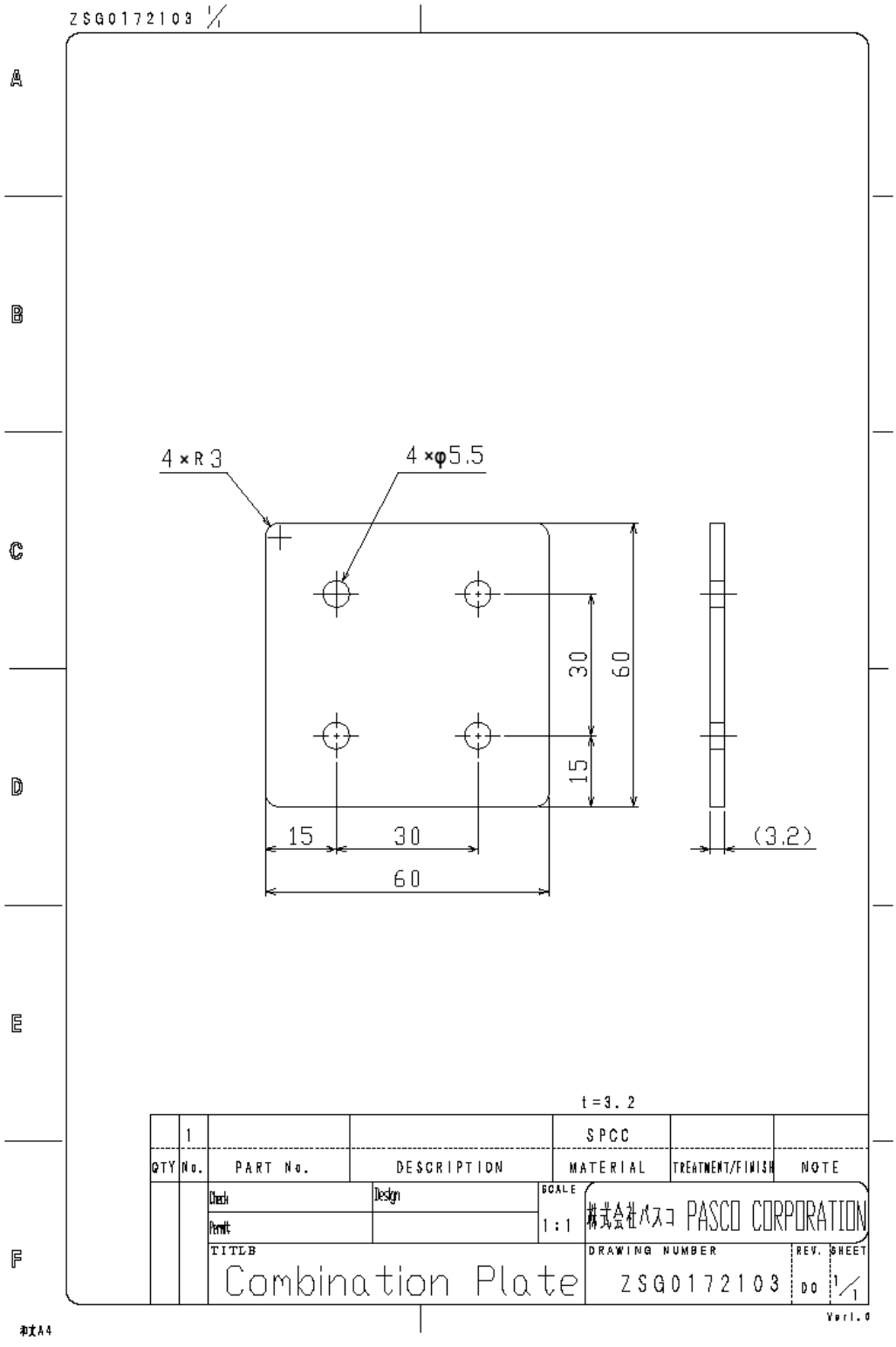
Configuration Diagram



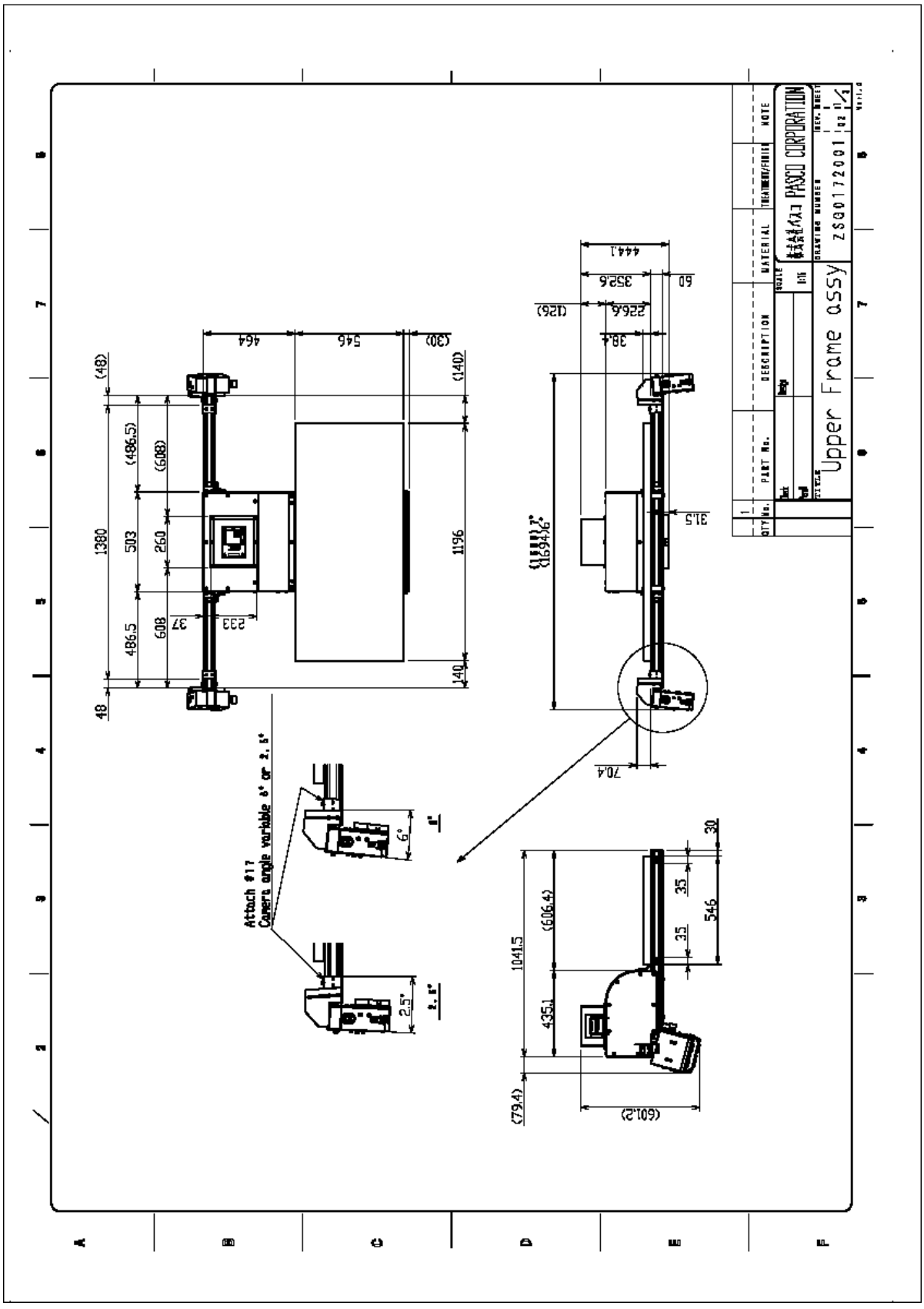
Configuration Diagram



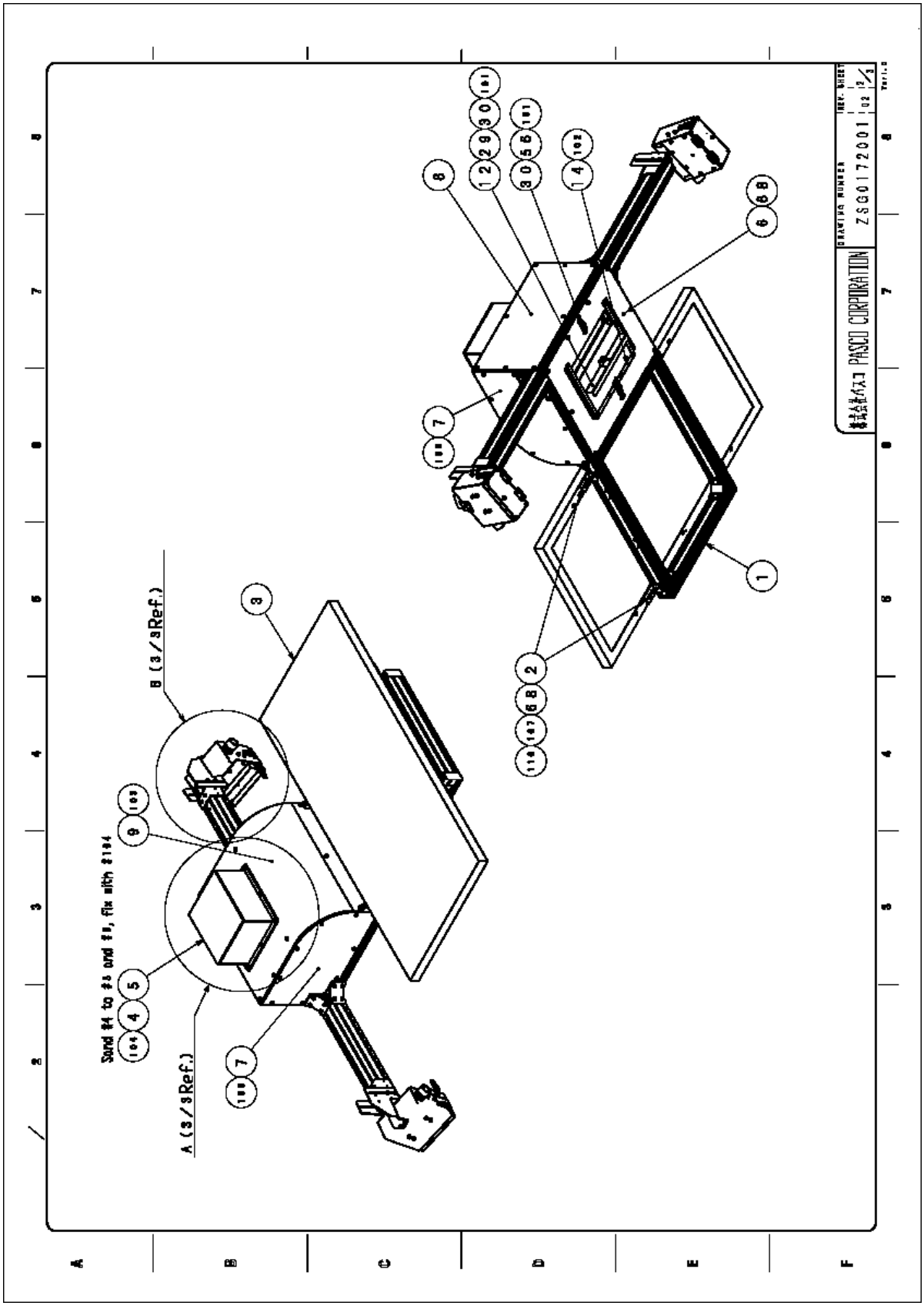

ZSG0172102 1/1
A
B
C
D
E
F
2×φ5.5
4×R3
30
15
10
60
80
24
32
21.5
t=1.5
1
SUS304CP
QTY No.
PART No.
DESCRIPTION
MATERIAL
TREATMENT/FINISH
NOTE
Check
Design
Permit
SCALE
1:1
株式会社パスコ PASCO CORPORATION
TITLE
Fixed fitting
DRAWING NUMBER
ZSG0172102
REV.
00
SHEET
1/1
Ver1.0
和文A4


ZSG0172103 1/1
A
B
C
D
E
F
4×R3
4×φ5.5
30
60
15
15
30
60
(3.2)
t=3.2
1
SPCC
QTY
No.
PART No.
DESCRIPTION
MATERIAL
TREATMENT/FINISH
NOTE
Check
Design
Permit
SCALE
1:1
株式会社パスコ PASCO CORPORATION
TITLE
Combination Plate
DRAWING NUMBER
ZSG0172103
REV.
00
SHEET
1/1
Ver1.0
A4

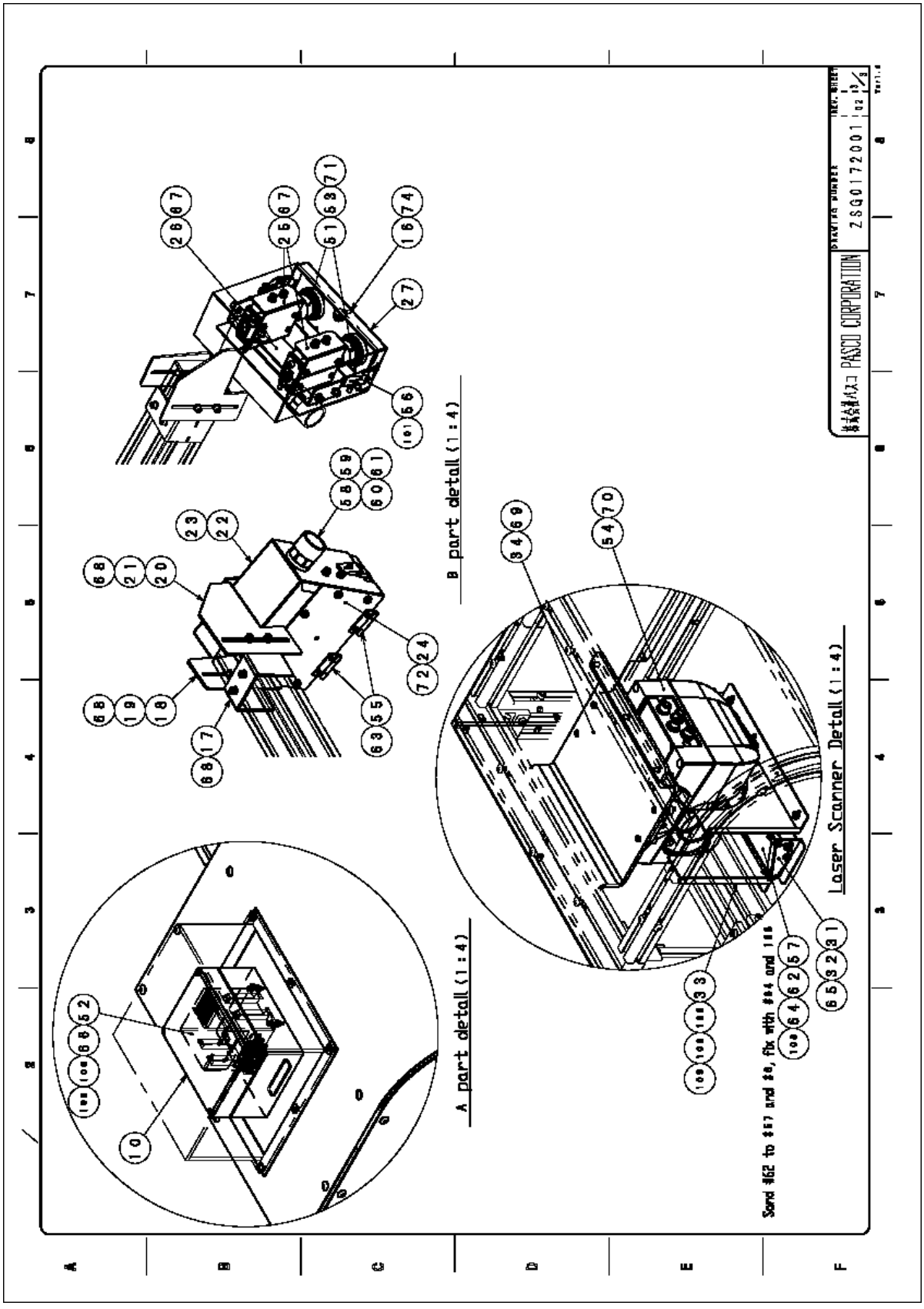
Configuration Diagram



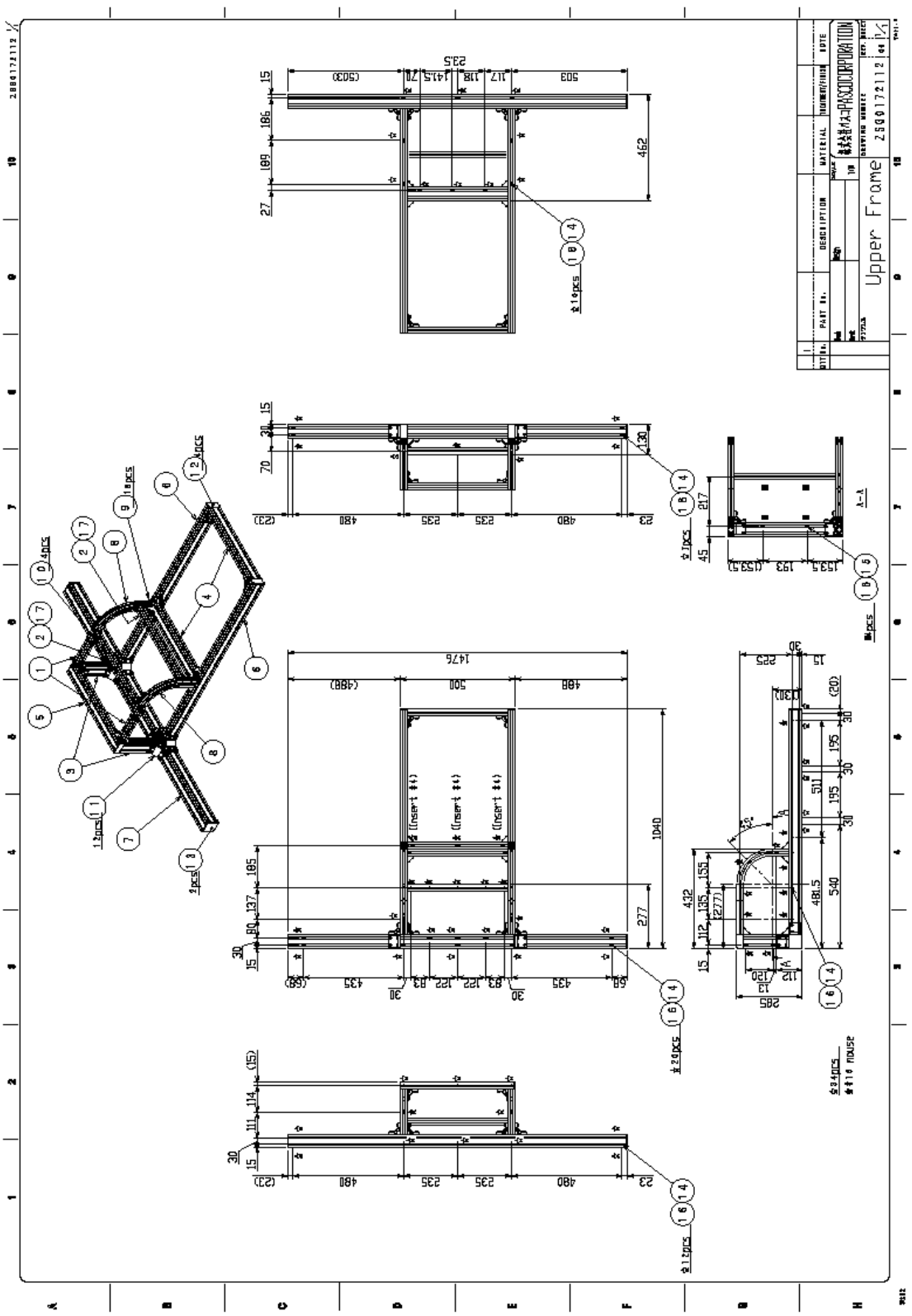
Configuration Diagram

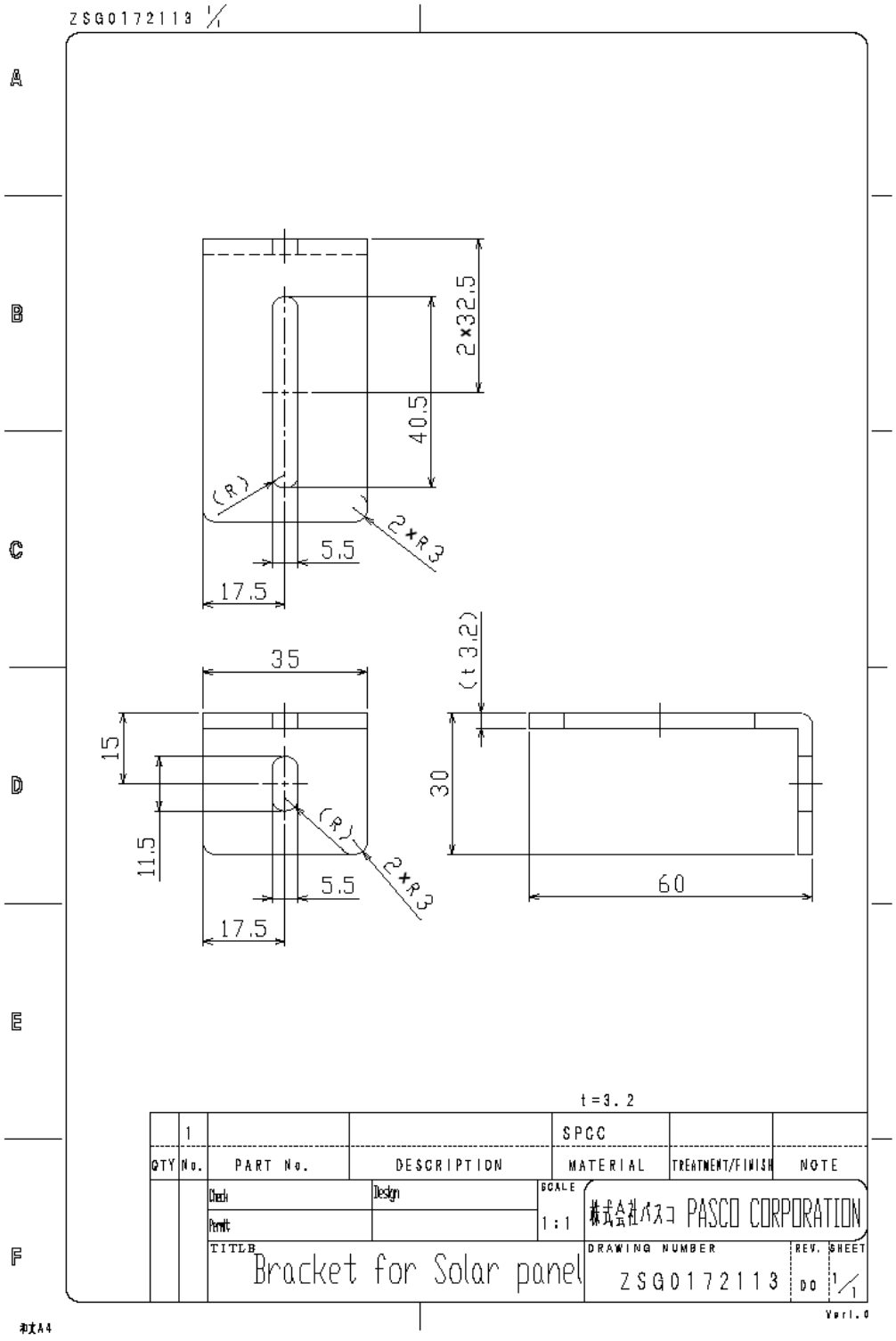


Configuration Diagram

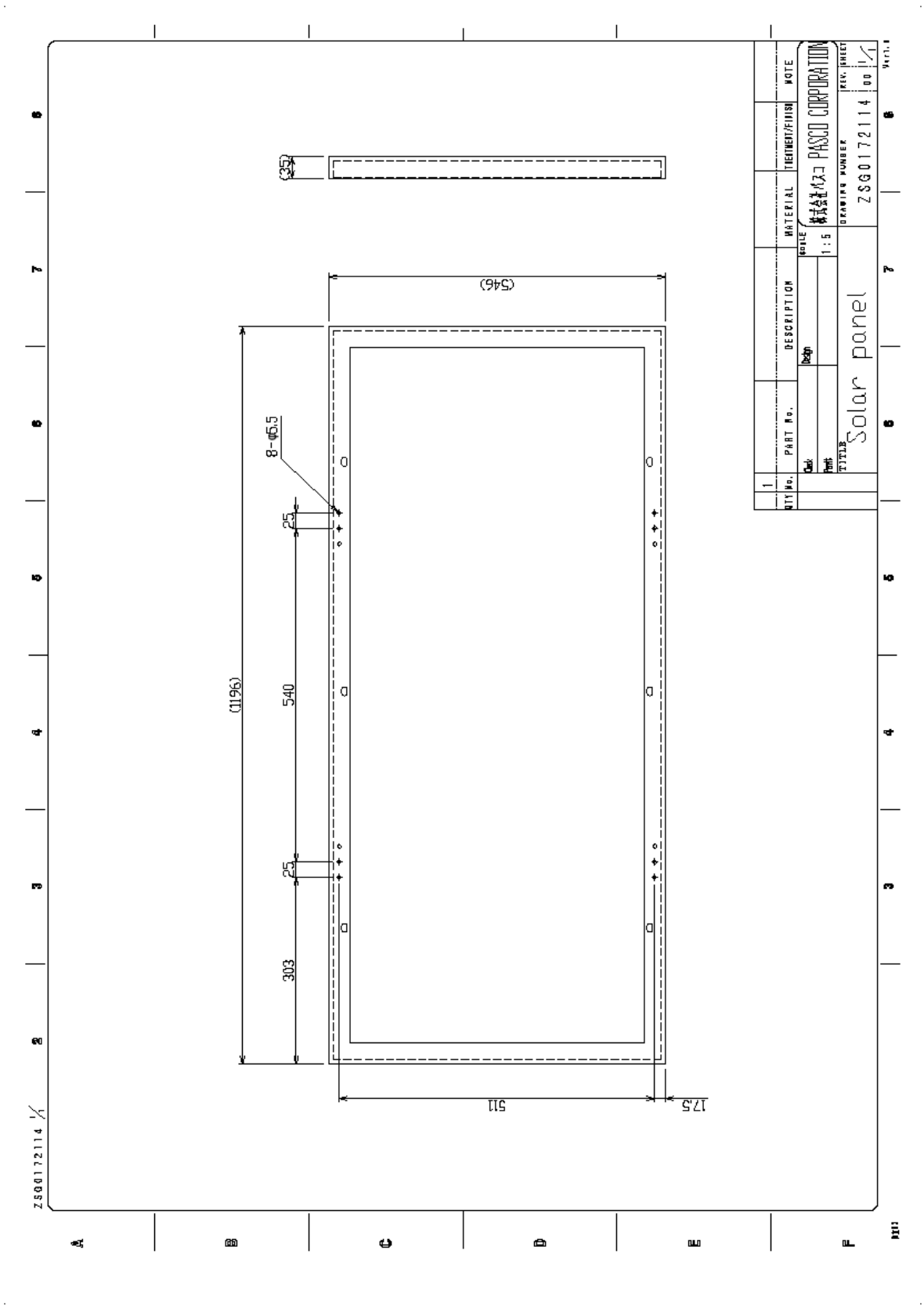


Configuration Diagram

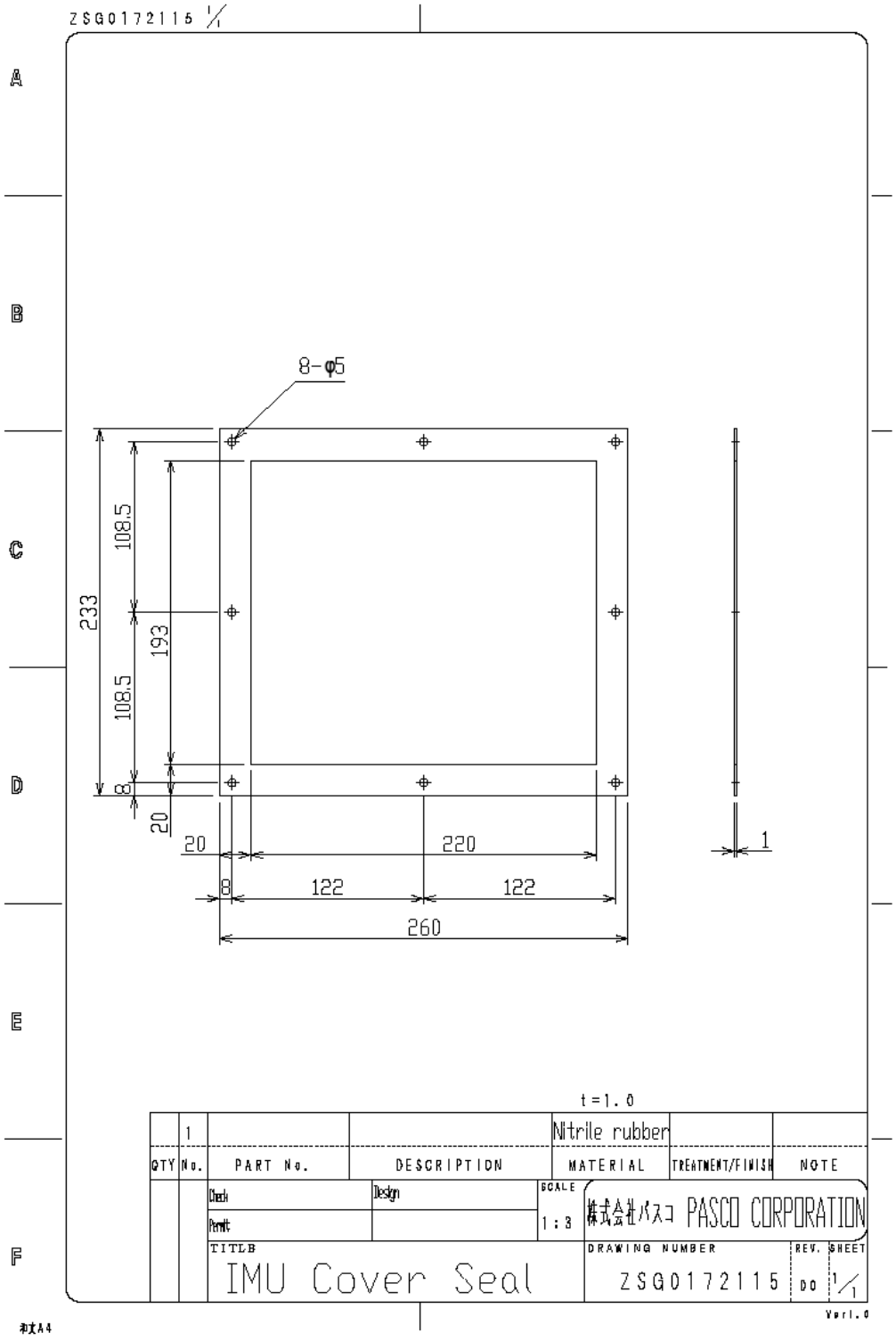



ZSG0172113 1/1
2×32.5
40.5
(R)
2×R3
5.5
17.5
35
15
11.5
(t3.2)
30
60
t=3.2
1
SPCC
QTY No.
PART No.
DESCRIPTION
MATERIAL
TREATMENT/FINISH
NOTE
Check
Design
Permit
SCALE
1:1
株式会社パスコ PASCO CORPORATION
TITLE
Bracket for Solar panel
DRAWING NUMBER
ZSG0172113
REV.
SHEET
D0
1/1
Ver1.0
和文A4

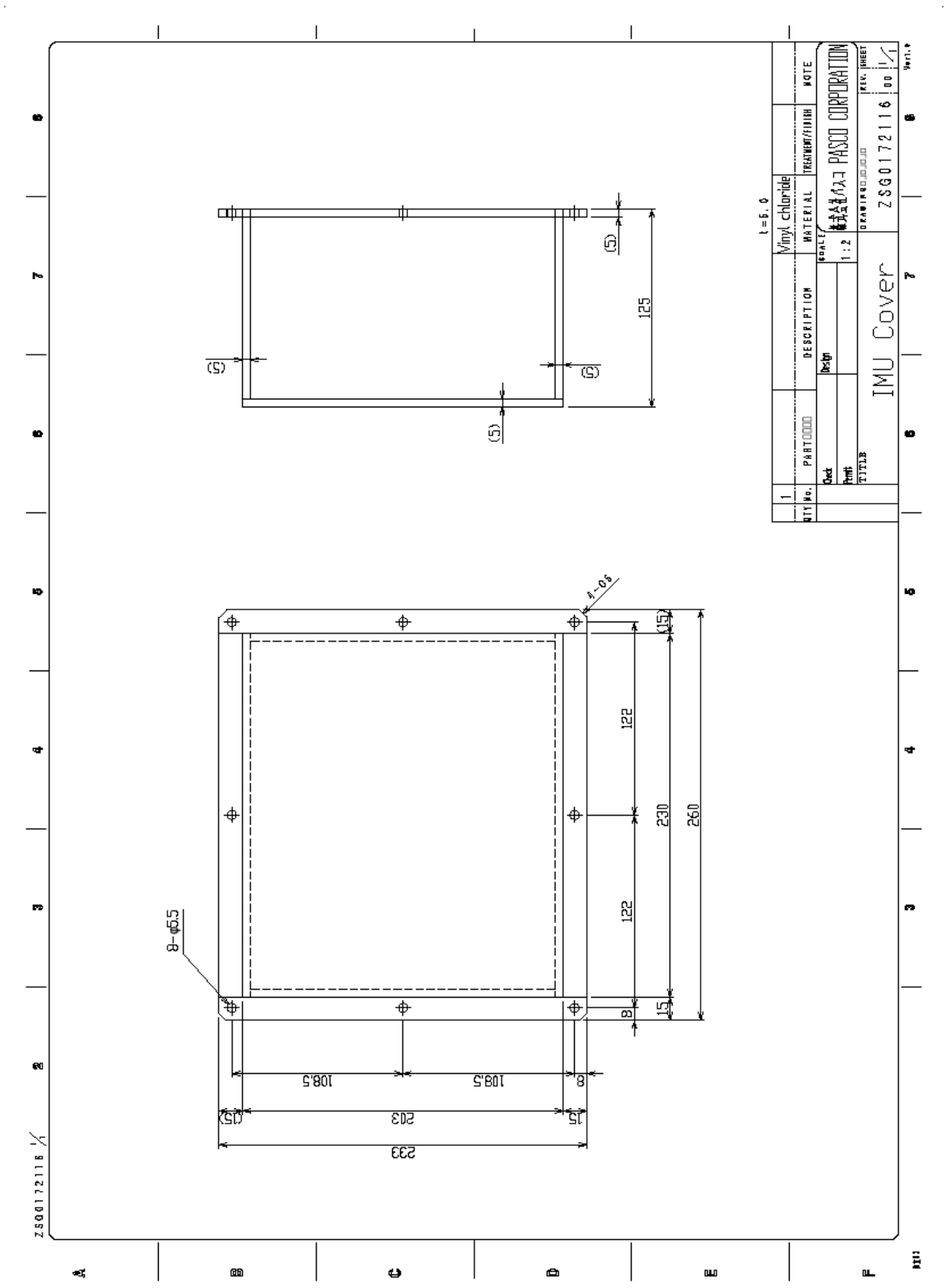
Configuration Diagram



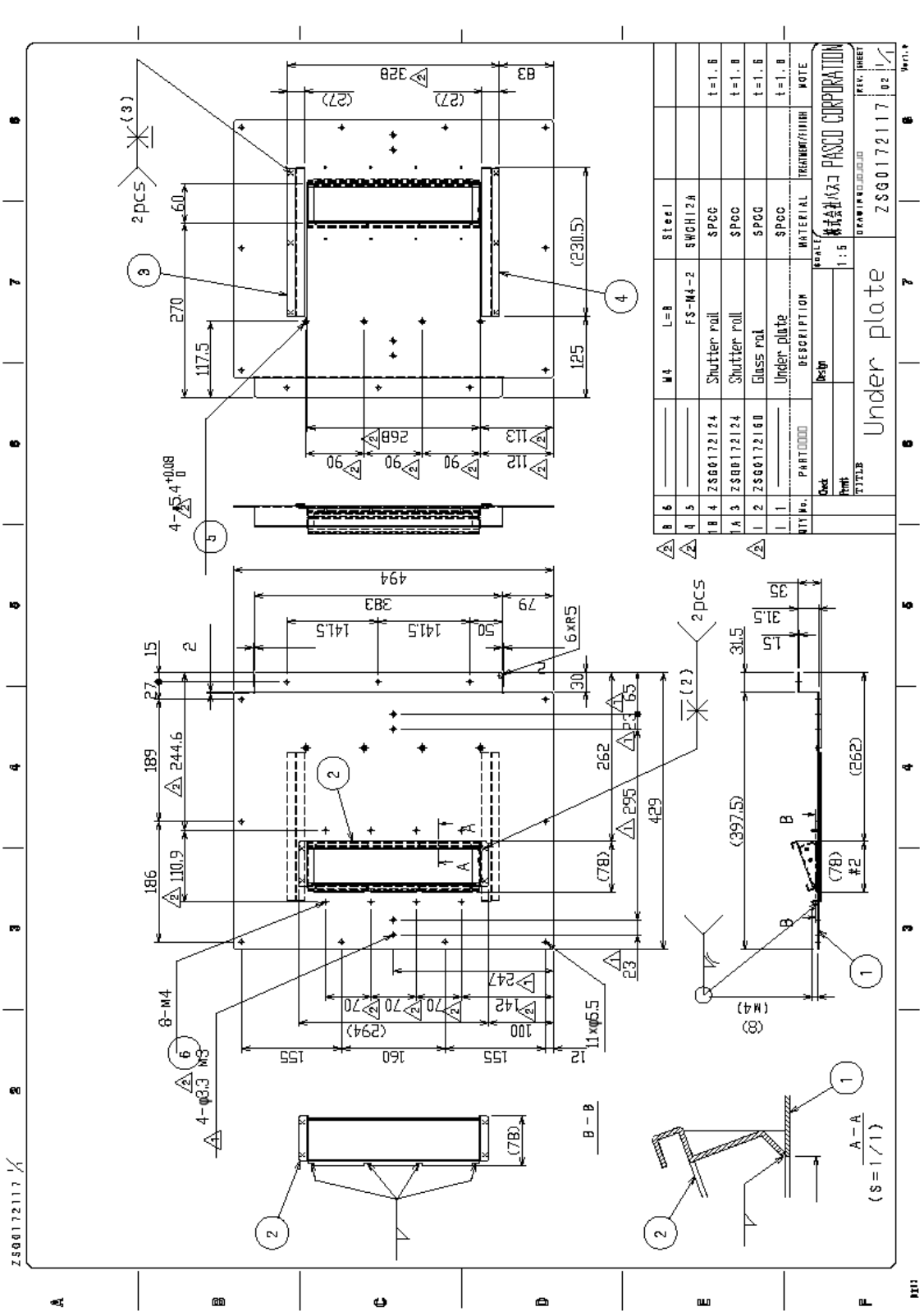
Configuration Diagram



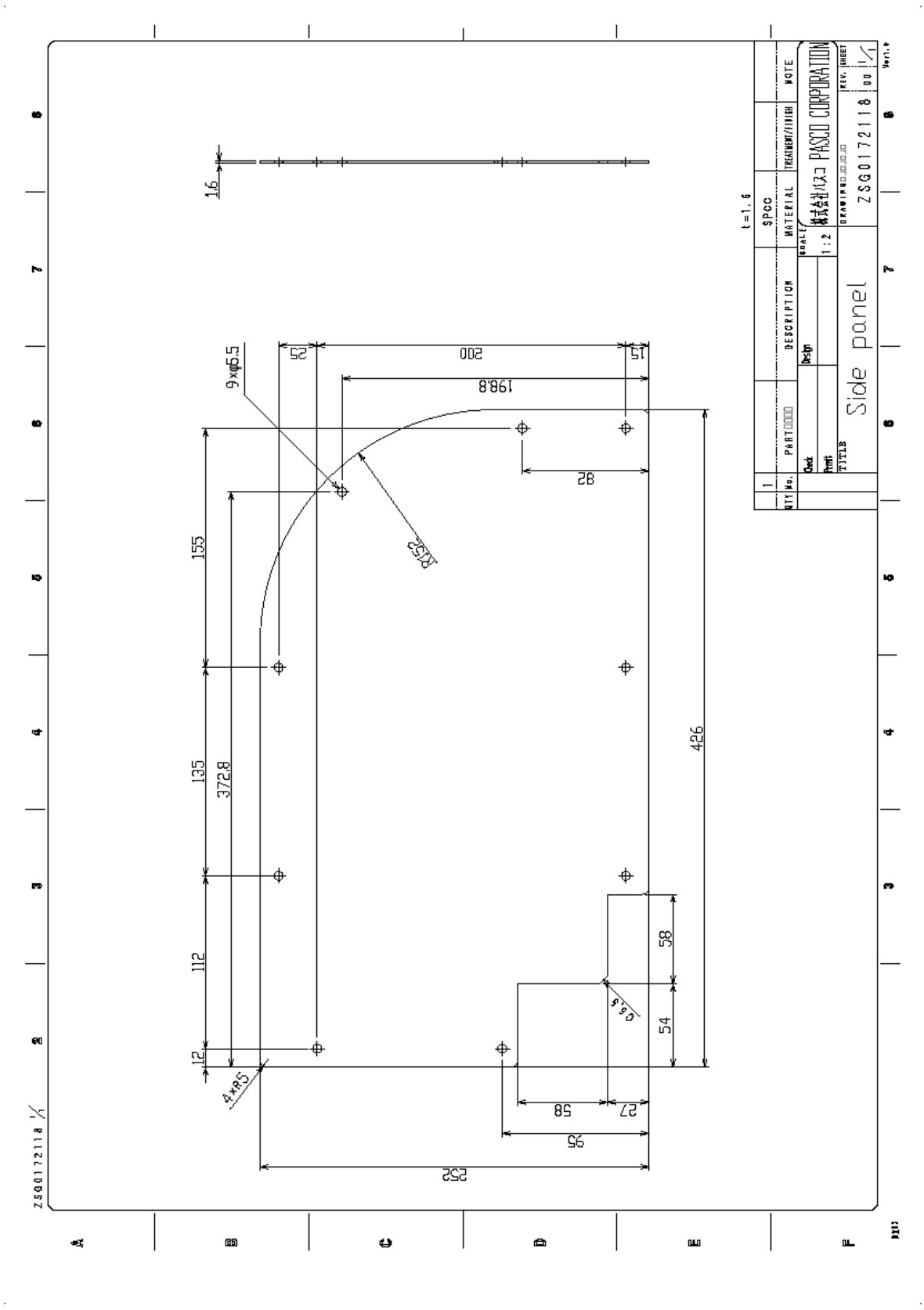
Configuration Diagram



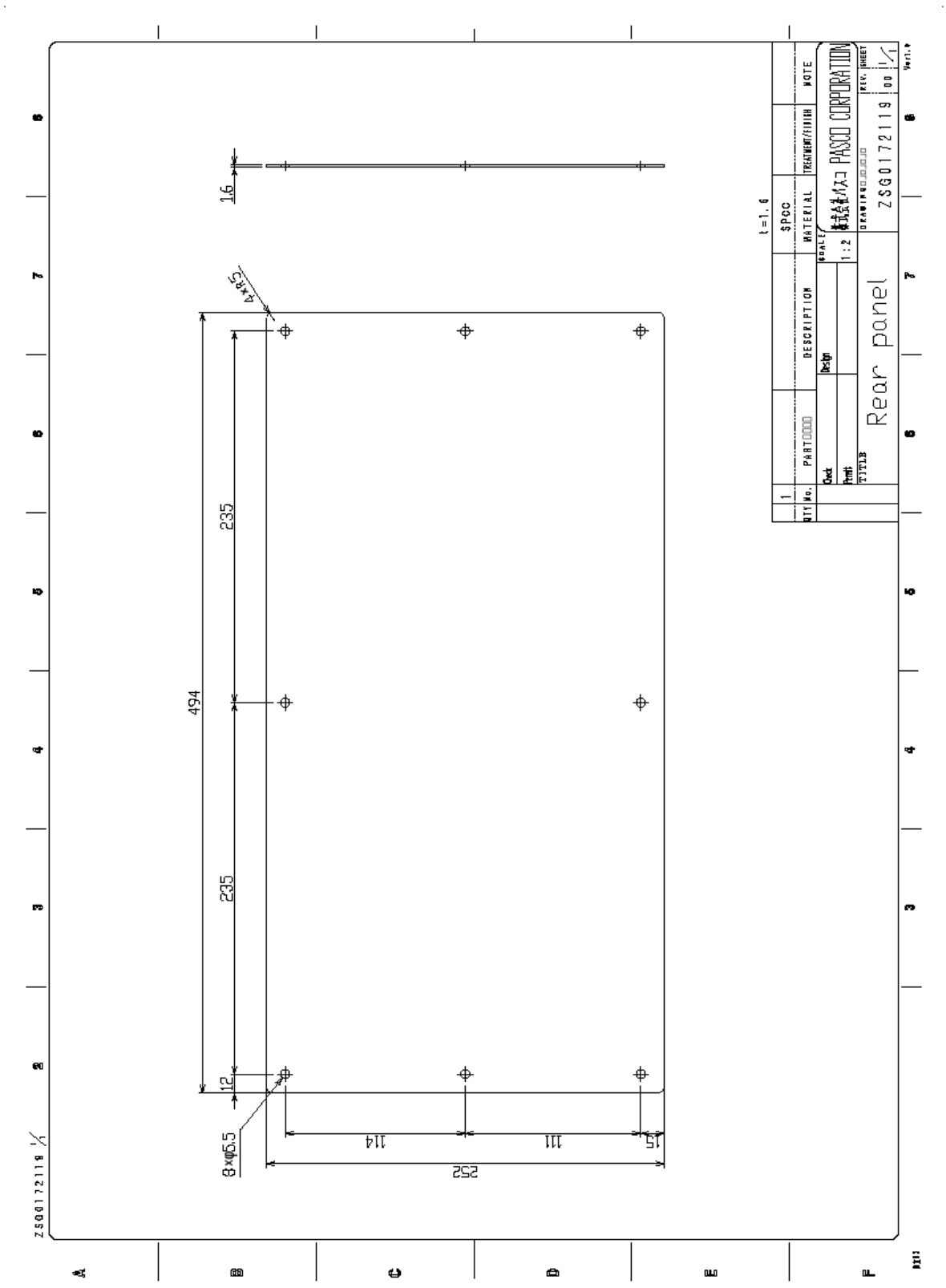
Configuration Diagram



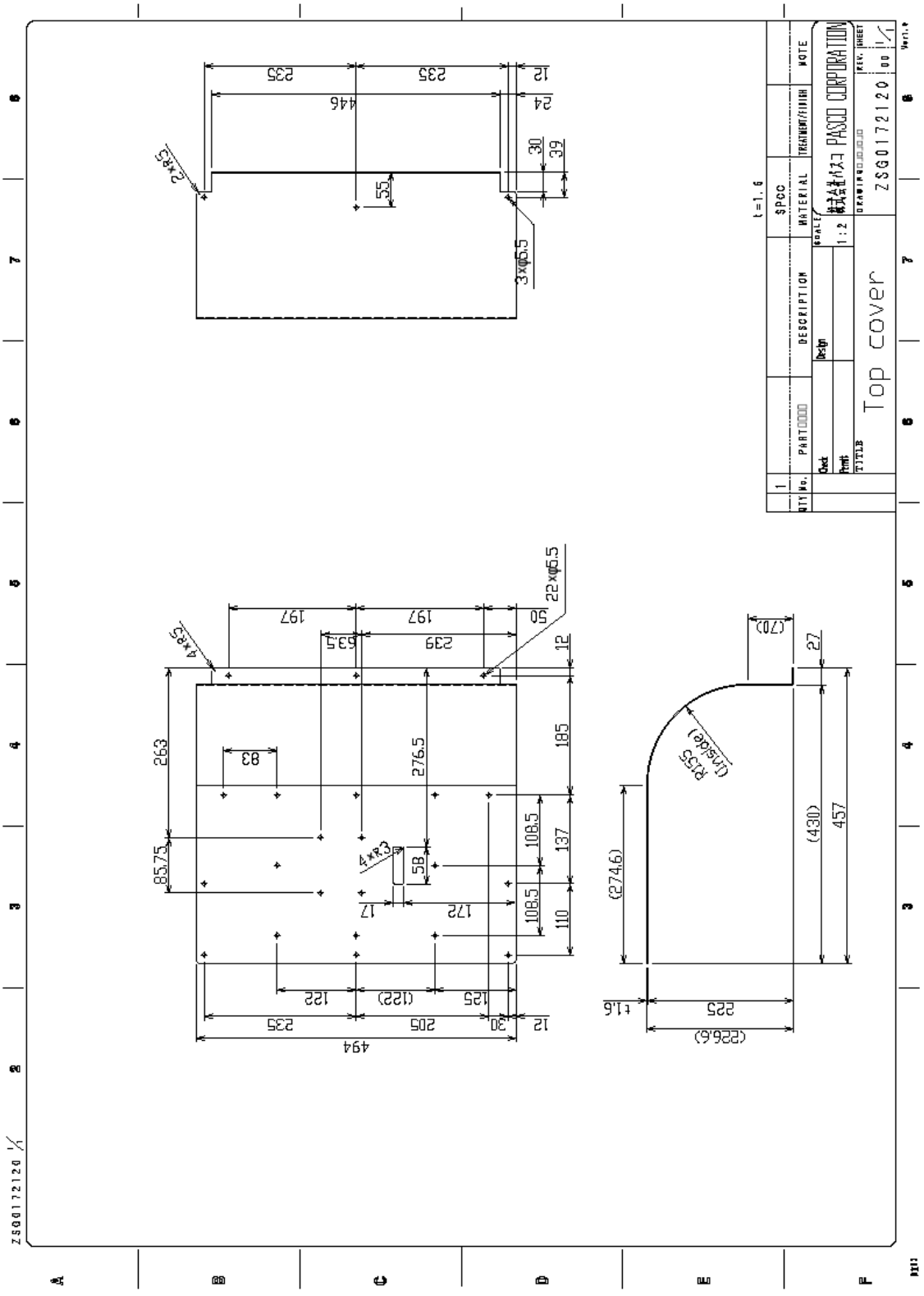
Configuration Diagram



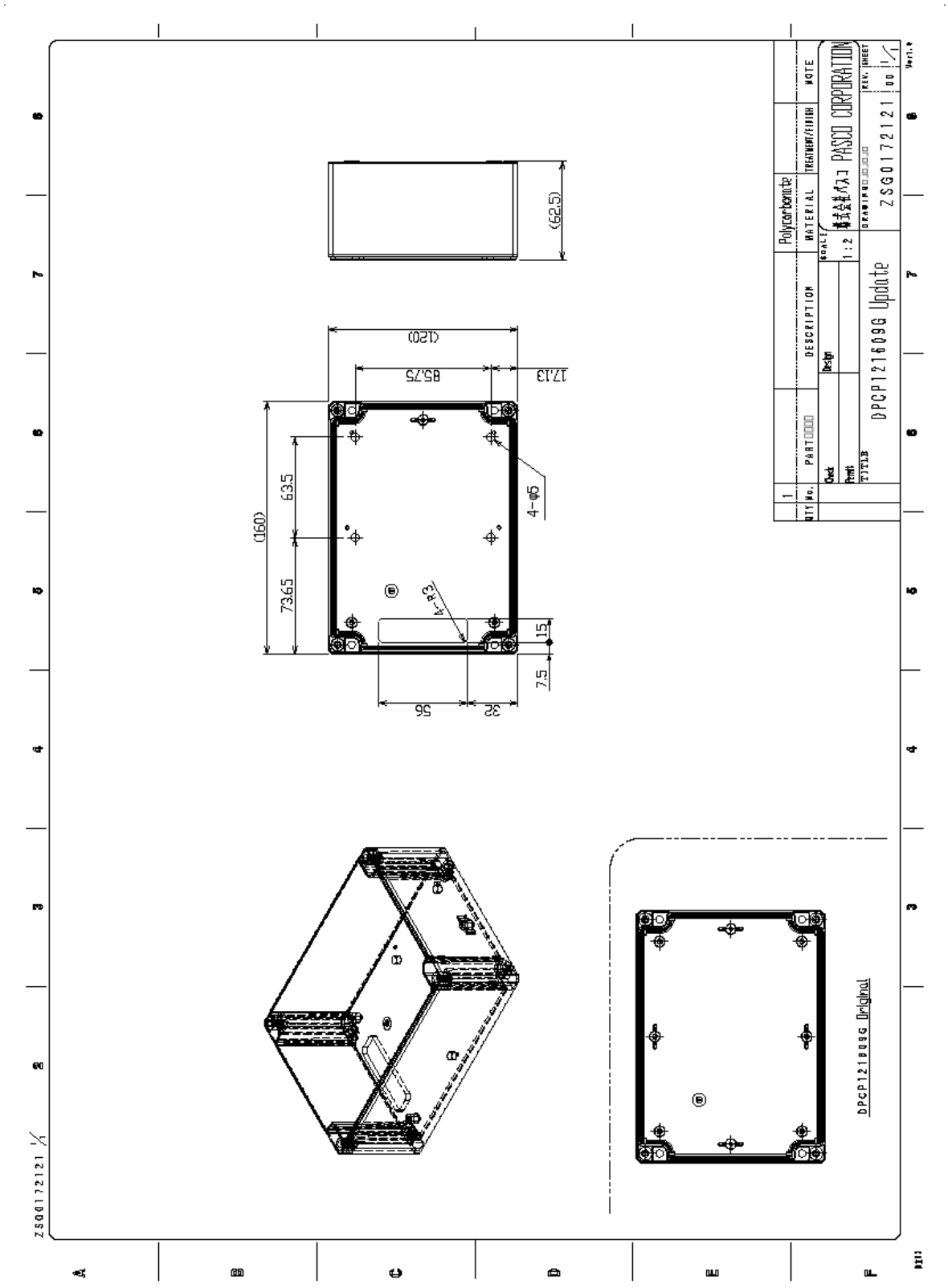
Configuration Diagram

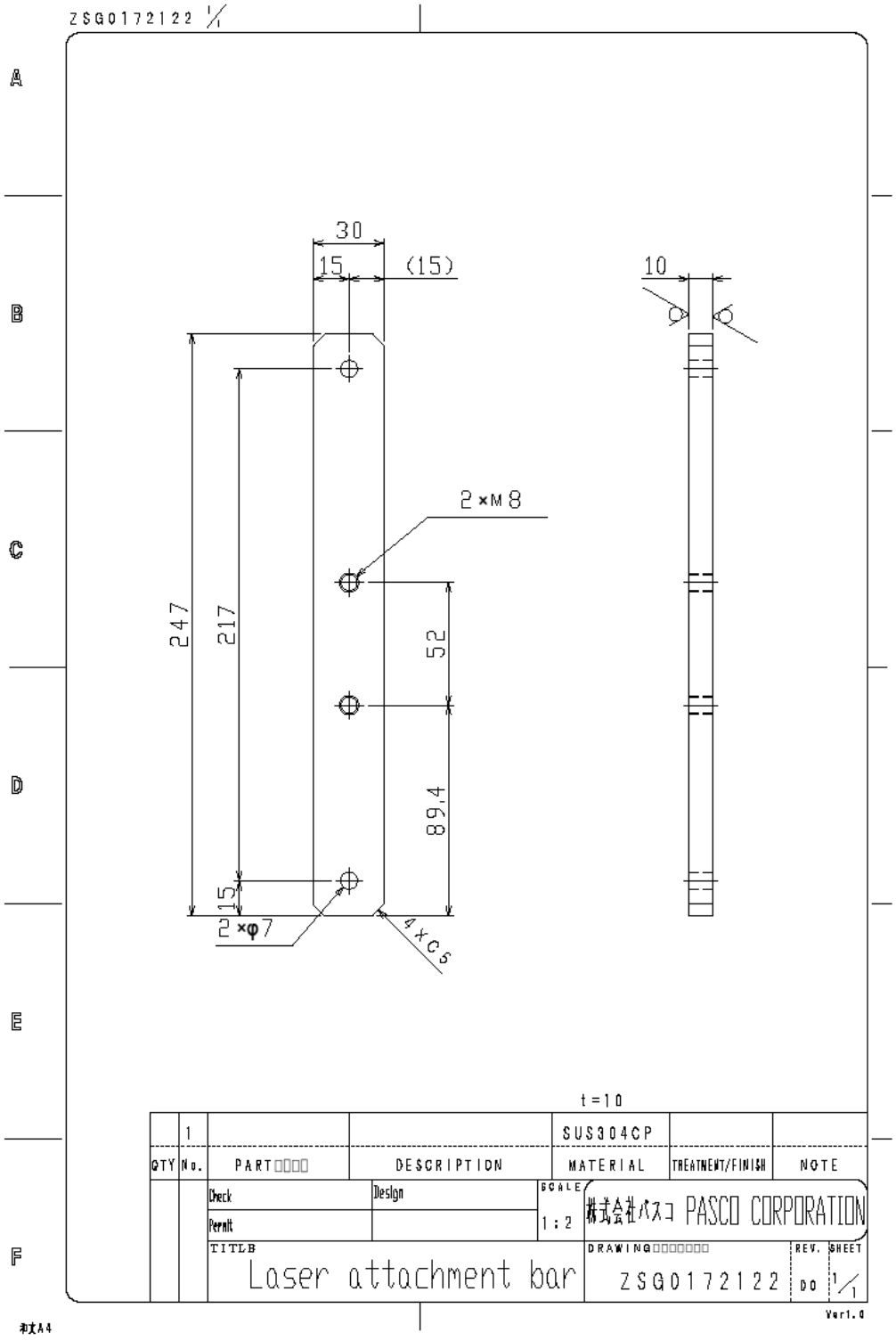


Configuration Diagram

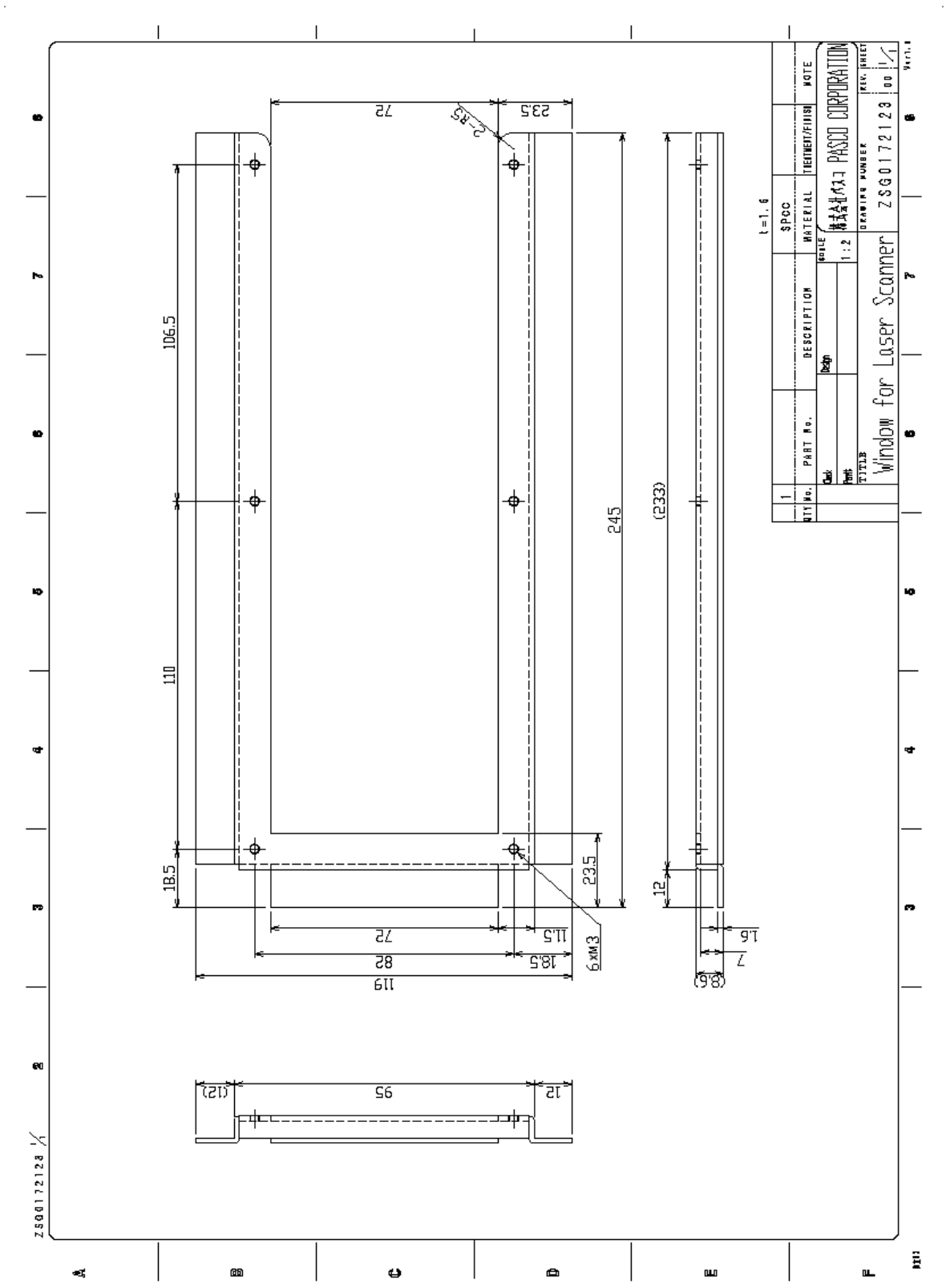


Configuration Diagram

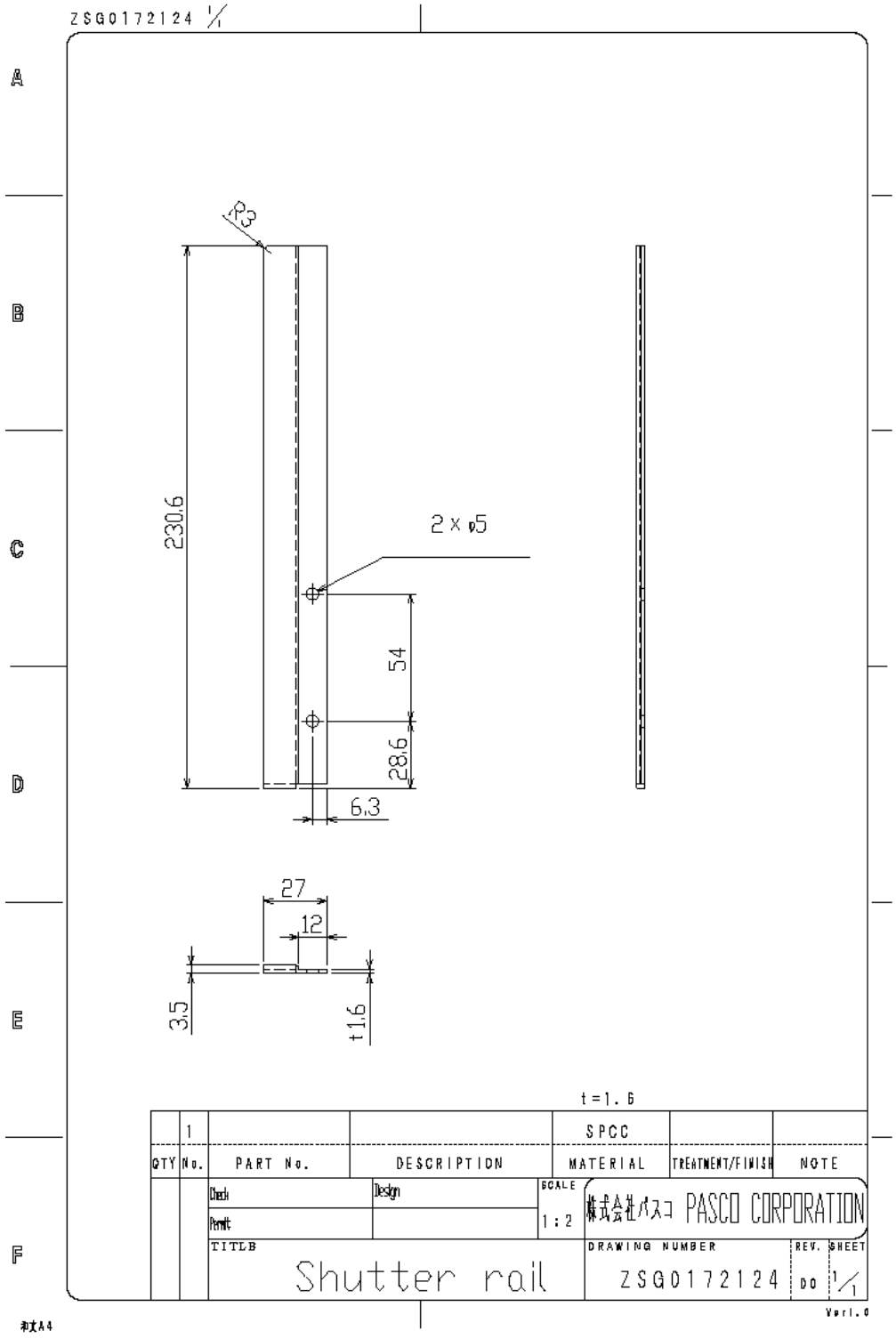



ZSG0172122 1/1
30
15
(15)
10
2×M8
247
217
52
89.4
15
2×φ7
4×C5
t=10
1
SUS304CP
QTY No. PART□□□□ DESCRIPTION MATERIAL TREATMENT/FINISH NOTE
Check
Design
Permit
SCALE 1:2
株式会社パスコ PASCO CORPORATION
TITLE Laser attachment bar
DRAWING□□□□□□□ ZSG0172122
REV. D0
SHEET 1/1
和文A4
Ver1.0

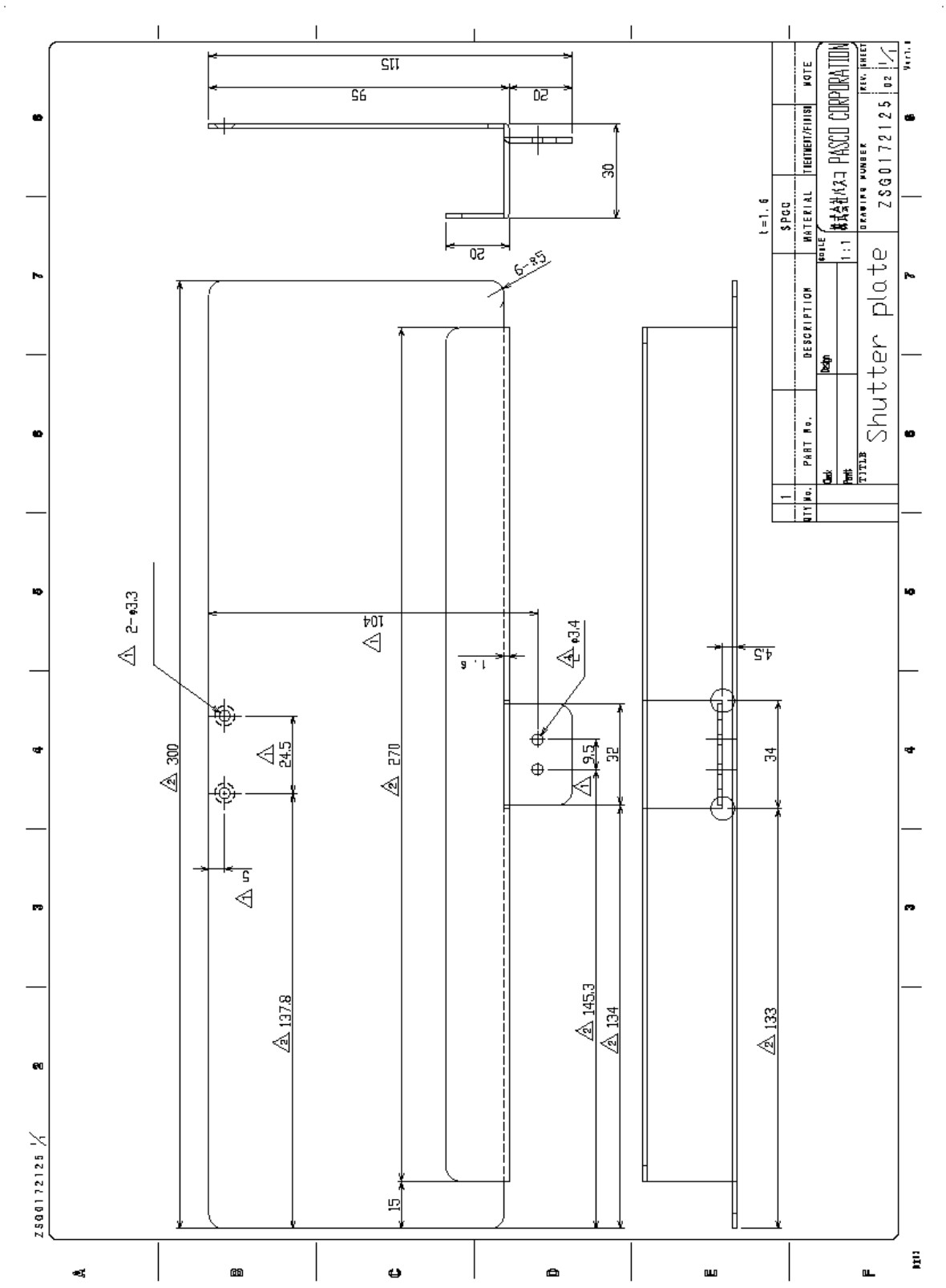
Configuration Diagram

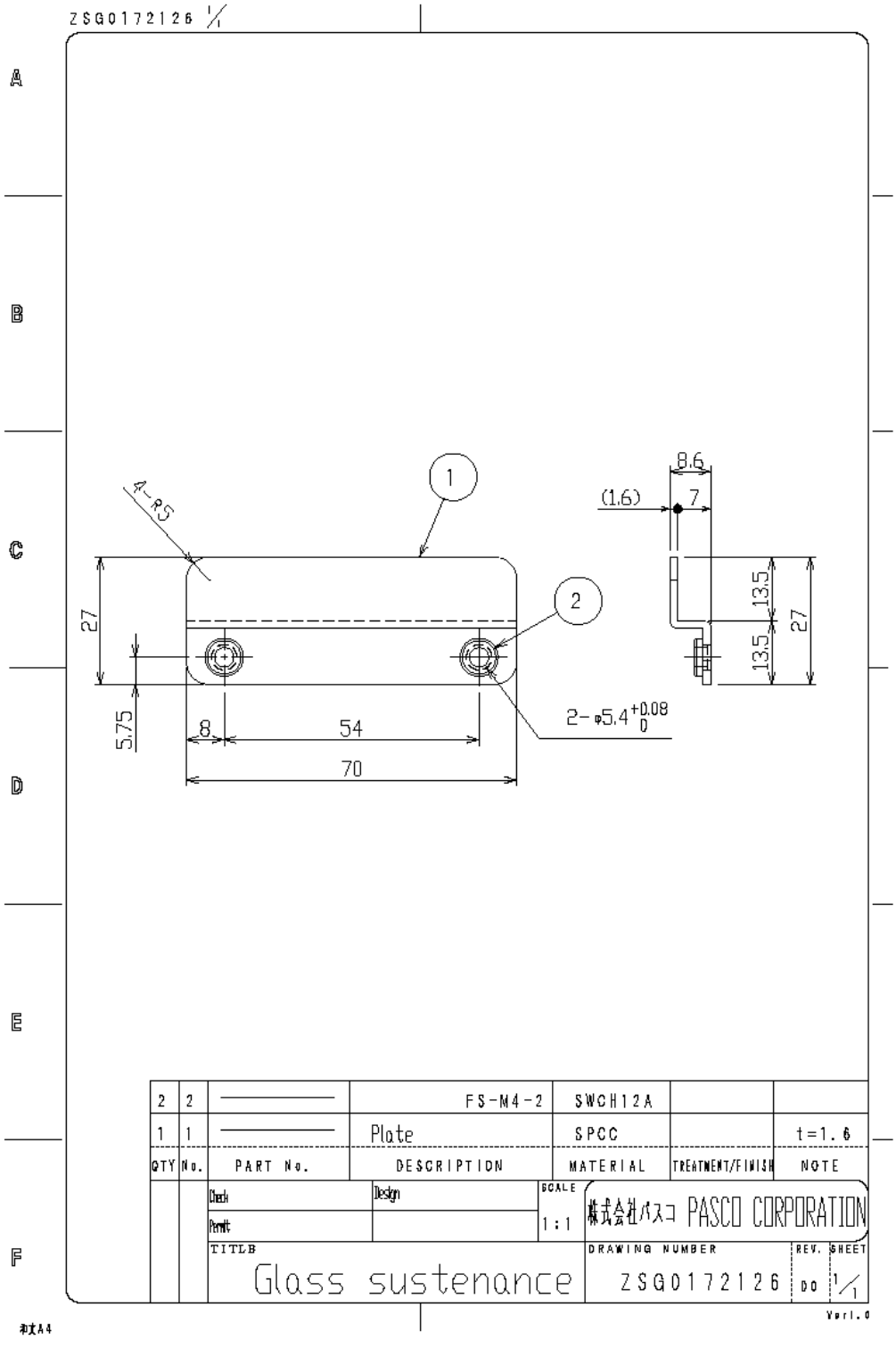


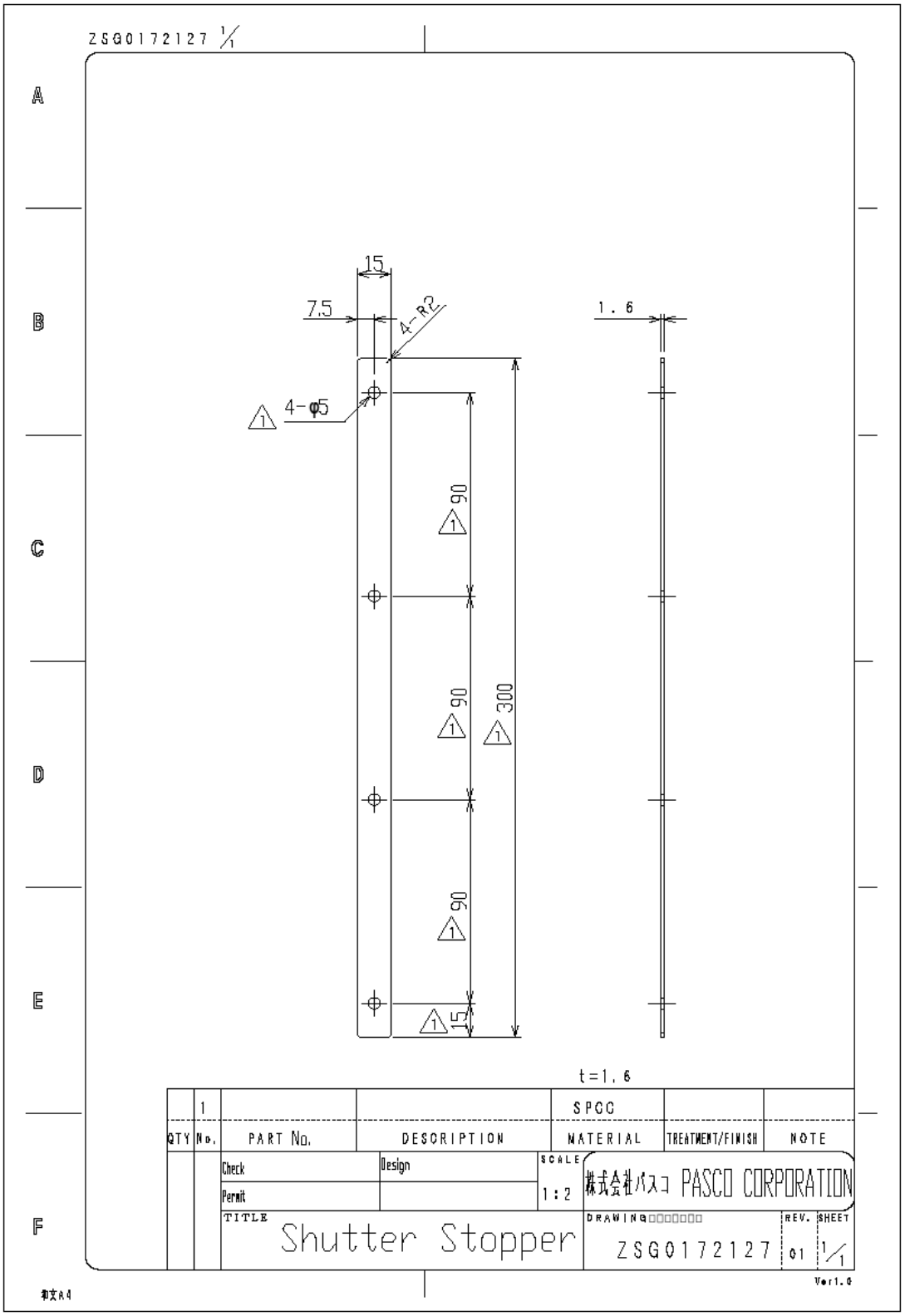
Configuration Diagram



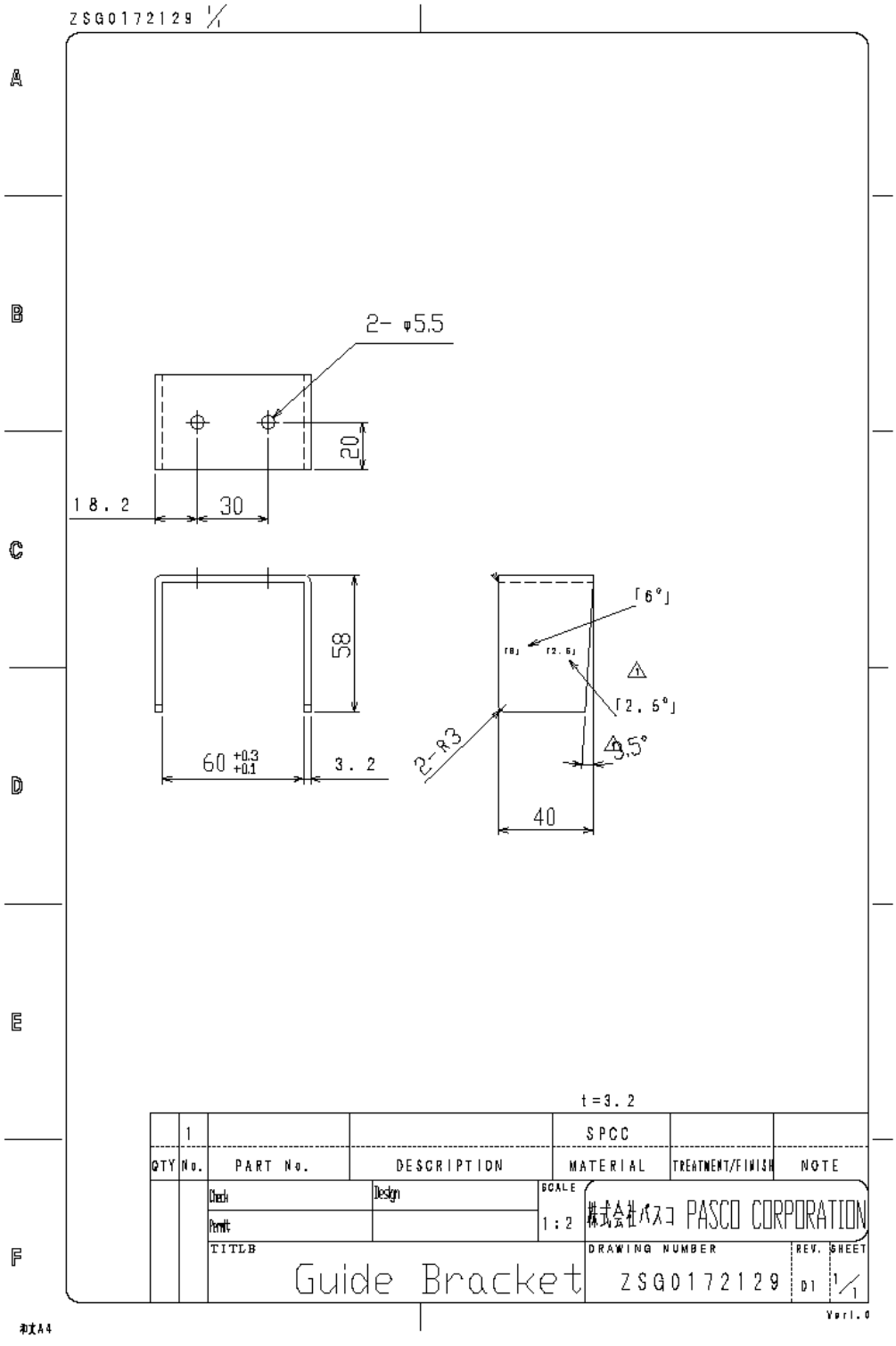
Configuration Diagram



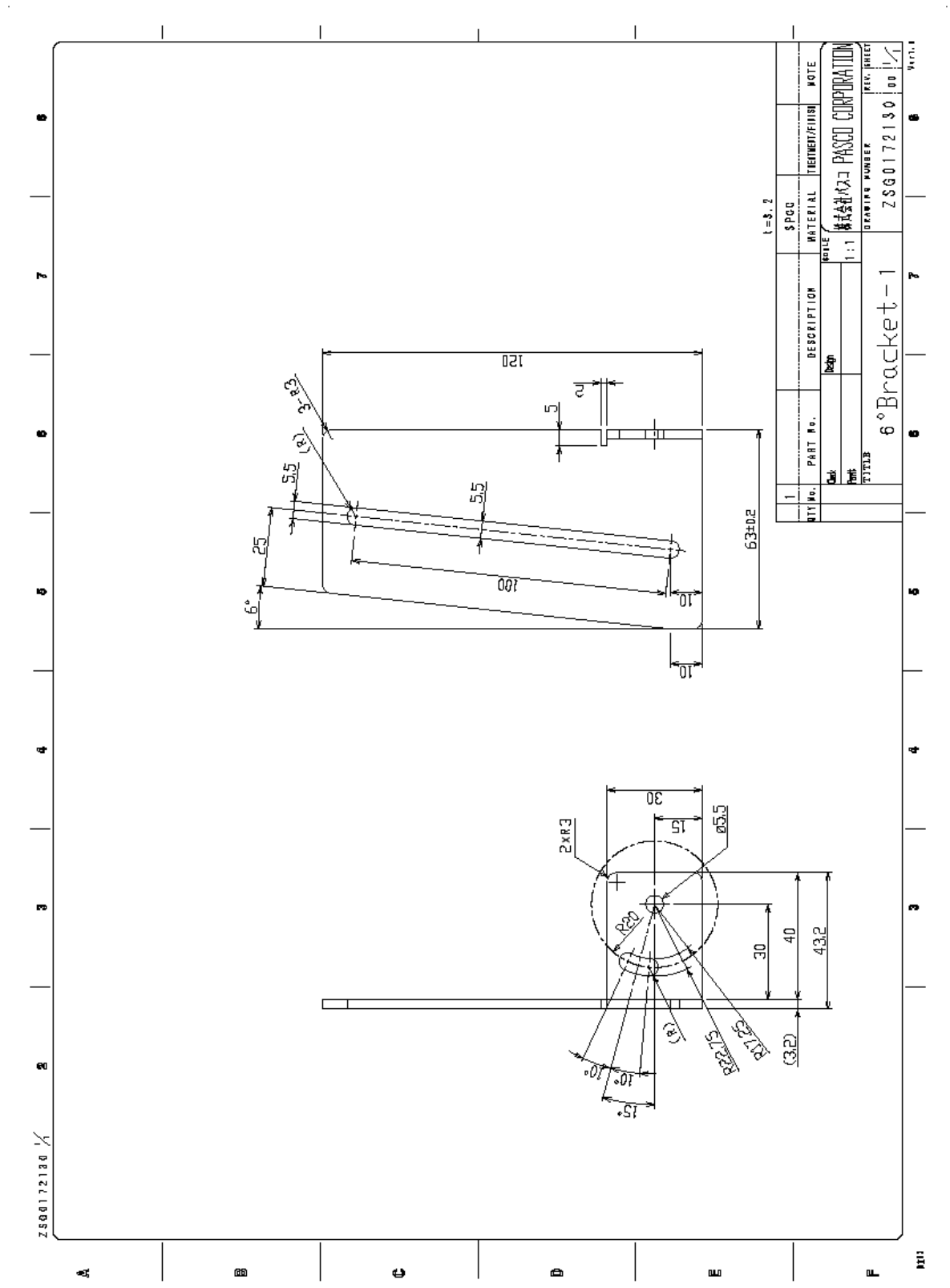

ZSG0172126 1/1
A
B
C
D
E
F
4-R5
1
2
27
5.75
8
54
70
2-φ5.4 +0.08 0
8.6
(1.6)
7
13.5
13.5
27
2 2 FS-M4-2 SWCH12A
1 1 Plate SPCC t=1.6
QTY No. PART No. DESCRIPTION MATERIAL TREATMENT/FINISH NOTE
Check Design
Permit
SCALE 1:1
株式会社パスコ PASCO CORPORATION
TITLE Glass sustenance
DRAWING NUMBER ZSG0172126
REV. D0
SHEET 1/1
和文A4
Ver1.0


ZSG0172127 1/1
A
B
C
D
E
F
15
7.5
4-R2
1.6
4-φ5
90
90
90
300
15
t=1.6
QTY
No.
PART No.
DESCRIPTION
MATERIAL
TREATMENT/FINISH
NOTE
1
SPCC
Check
Design
Permit
SCALE
1:2
TITLE
Shutter Stopper
DRAWING
ZSG0172127
REV.
01
SHEET
1/1
株式会社パスコ PASCO CORPORATION
和文A4
Ver1.0

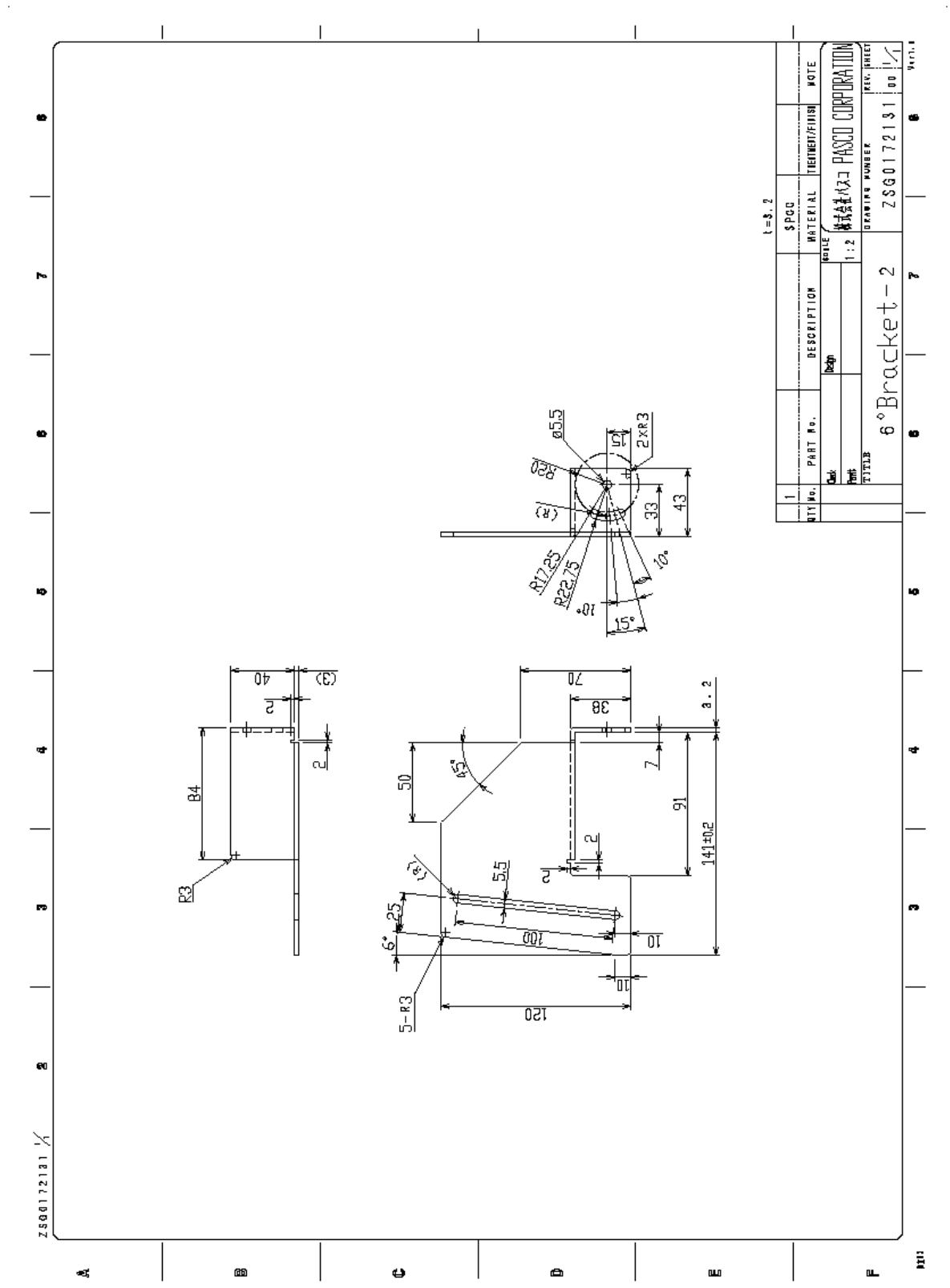
Configuration Diagram



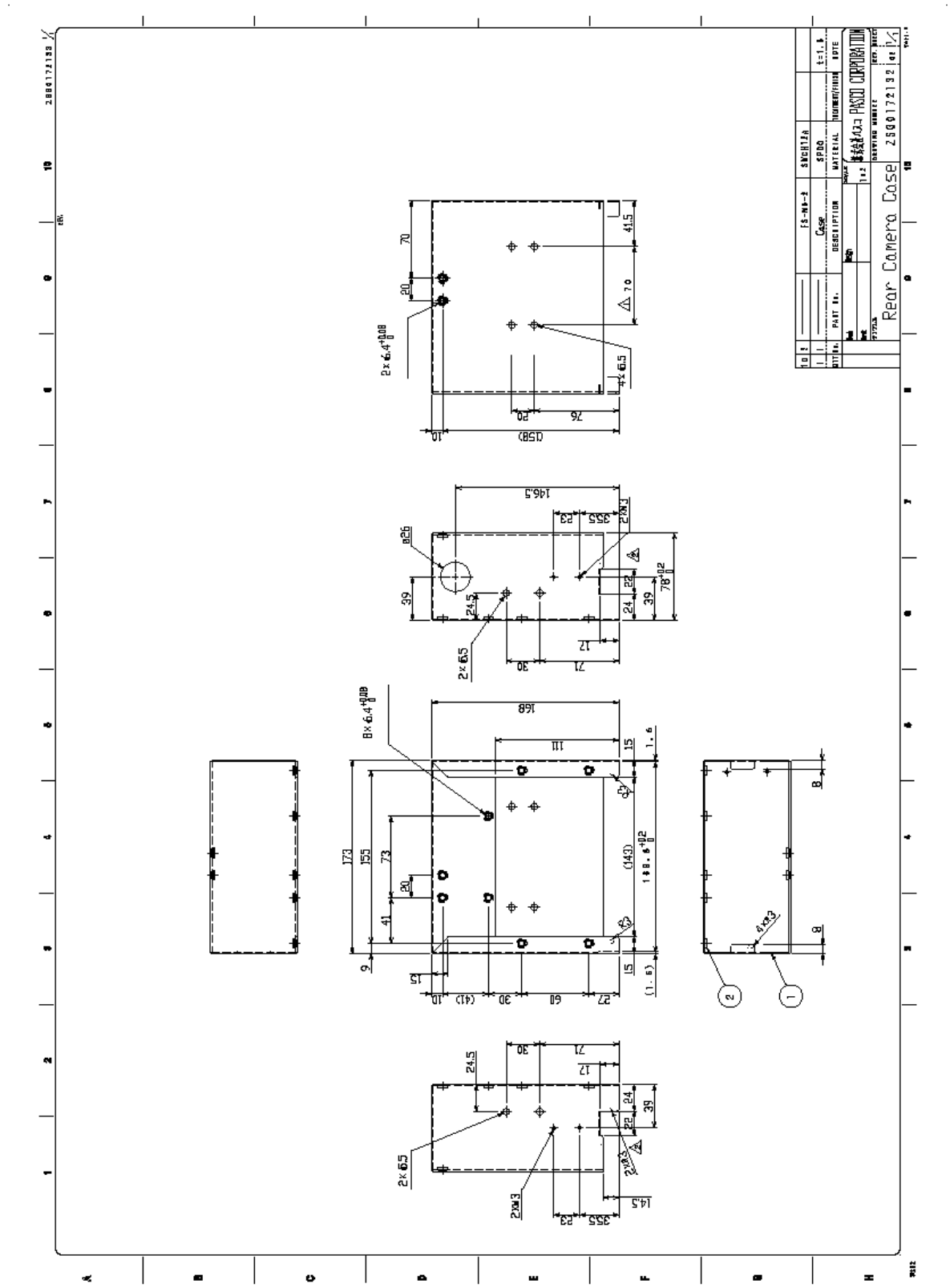
Configuration Diagram

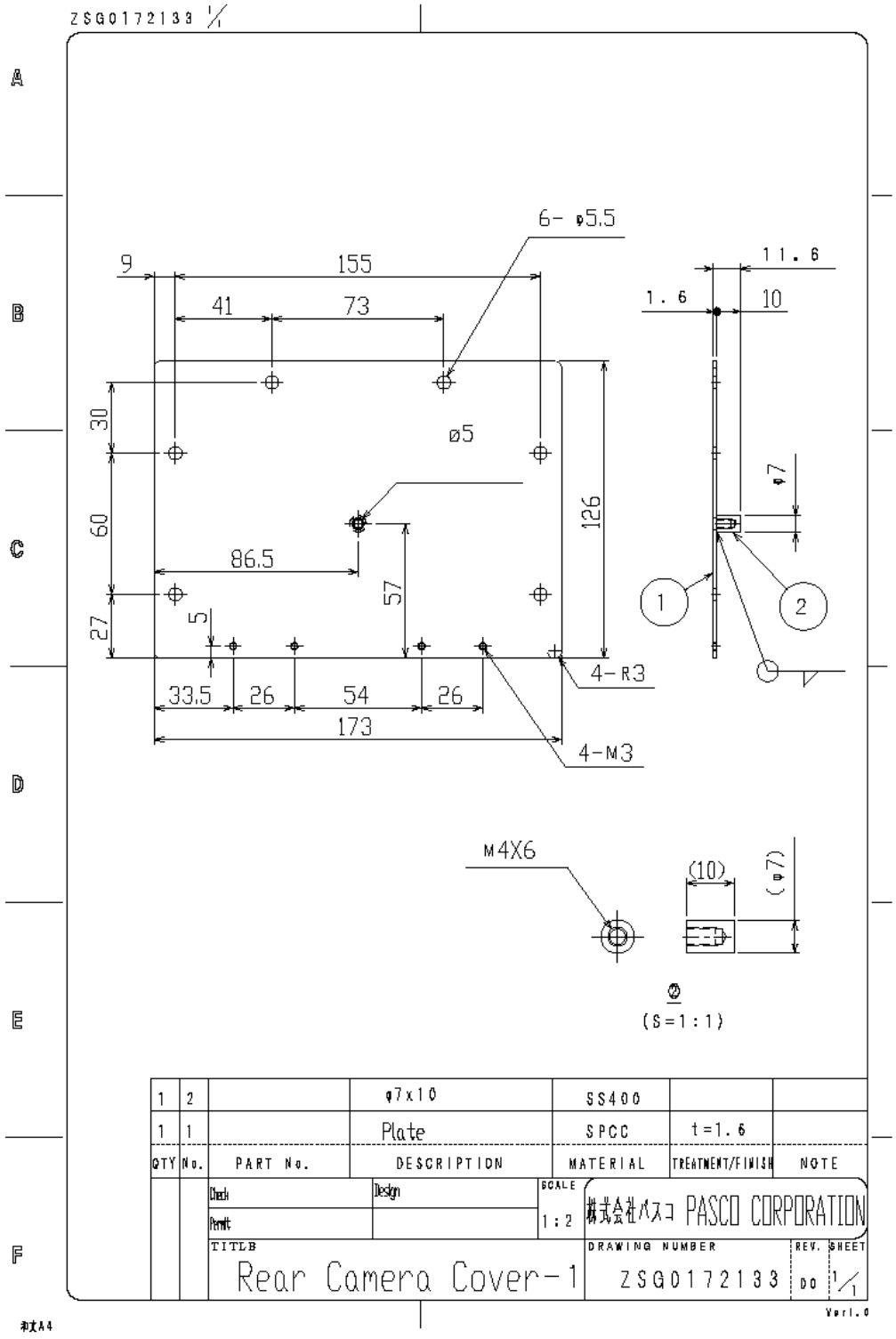


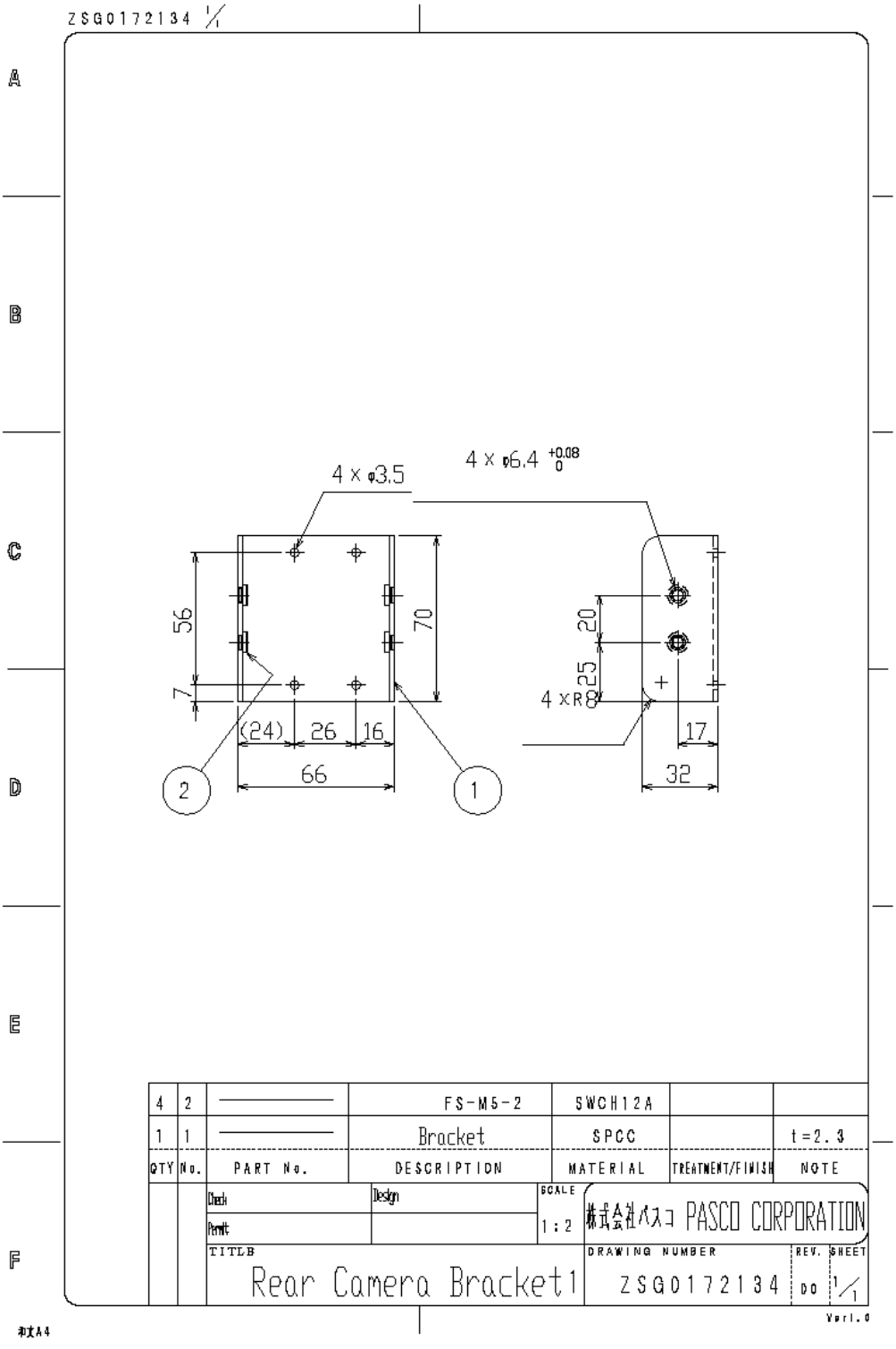
Configuration Diagram



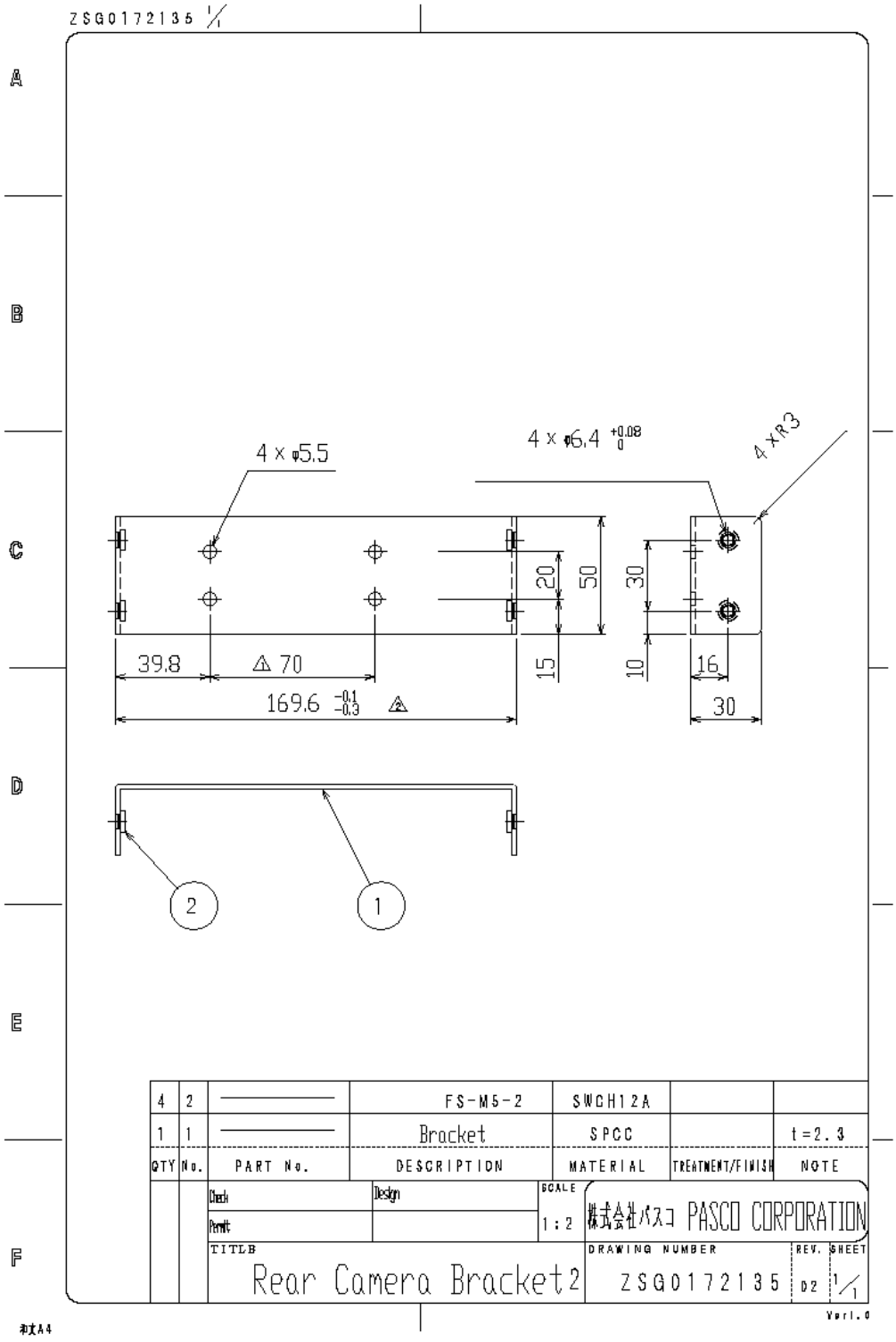
Configuration Diagram



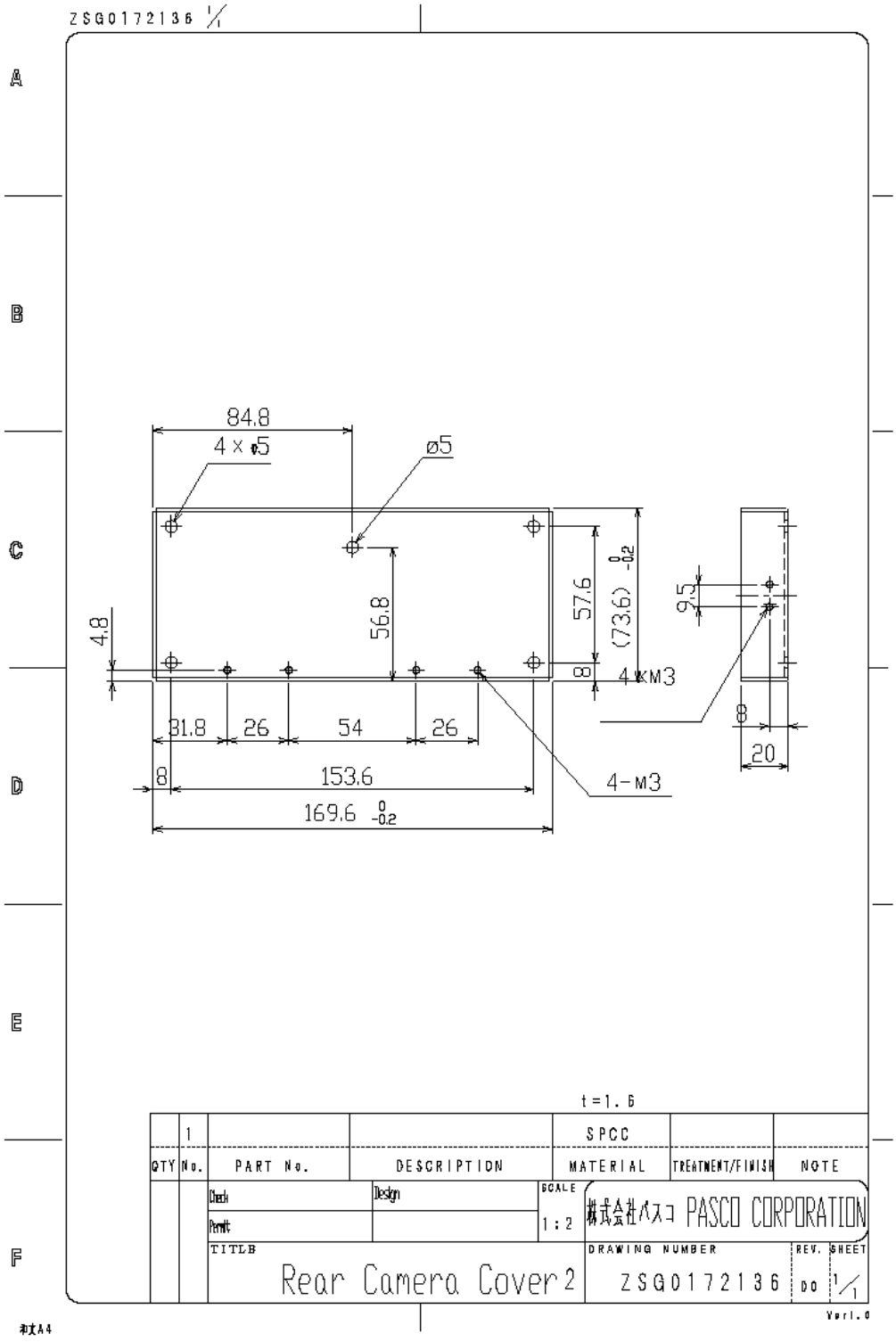

ZSG0172133 1/1
6- φ5.5
9
155
41
73
30
ø5
60
126
86.5
57
27
5
33.5
26
54
26
173
4-R3
4-M3
11.6
1.6
10
φ7
1
2
M4X6
(10)
(φ7)
(S=1:1)
1 2 φ7x10 SS400
1 1 Plate SPCC t=1.6
QTY No. PART No. DESCRIPTION MATERIAL TREATMENT/FINISH NOTE
Check Design
Permit
SCALE 1:2
PASCO CORPORATION
TITLE Rear Camera Cover-1
DRAWING NUMBER ZSG0172133
REV. D0
SHEET 1/1
Ver1.0


ZSG0172134 1/1
A
B
C
D
E
F
4 x φ3.5
4 x φ6.4 +0.08 0
56
70
7
20
25
4 xR8
(24)
26
16
66
17
32
2
1
4 2 FS-M5-2 SWCH12A
1 1 Bracket SPCC t=2.3
QTY No. PART No. DESCRIPTION MATERIAL TREATMENT/FINISH NOTE
Check Design
Permit
SCALE 1:2
株式会社パスコ PASCO CORPORATION
TITLE Rear Camera Bracket1
DRAWING NUMBER ZSG0172134
REV. D0
SHEET 1/1
Ver1.0
本文A4

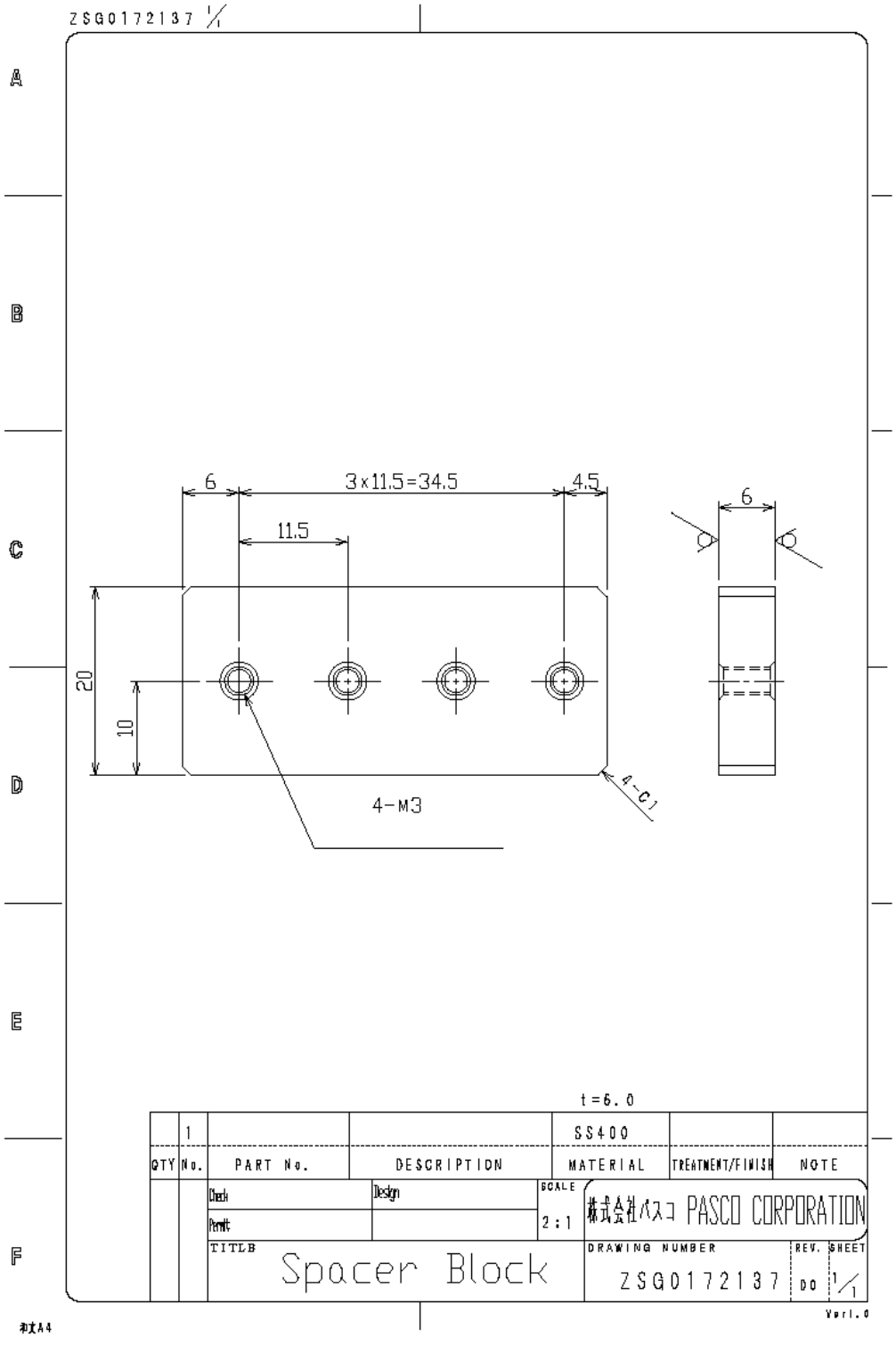
Configuration Diagram



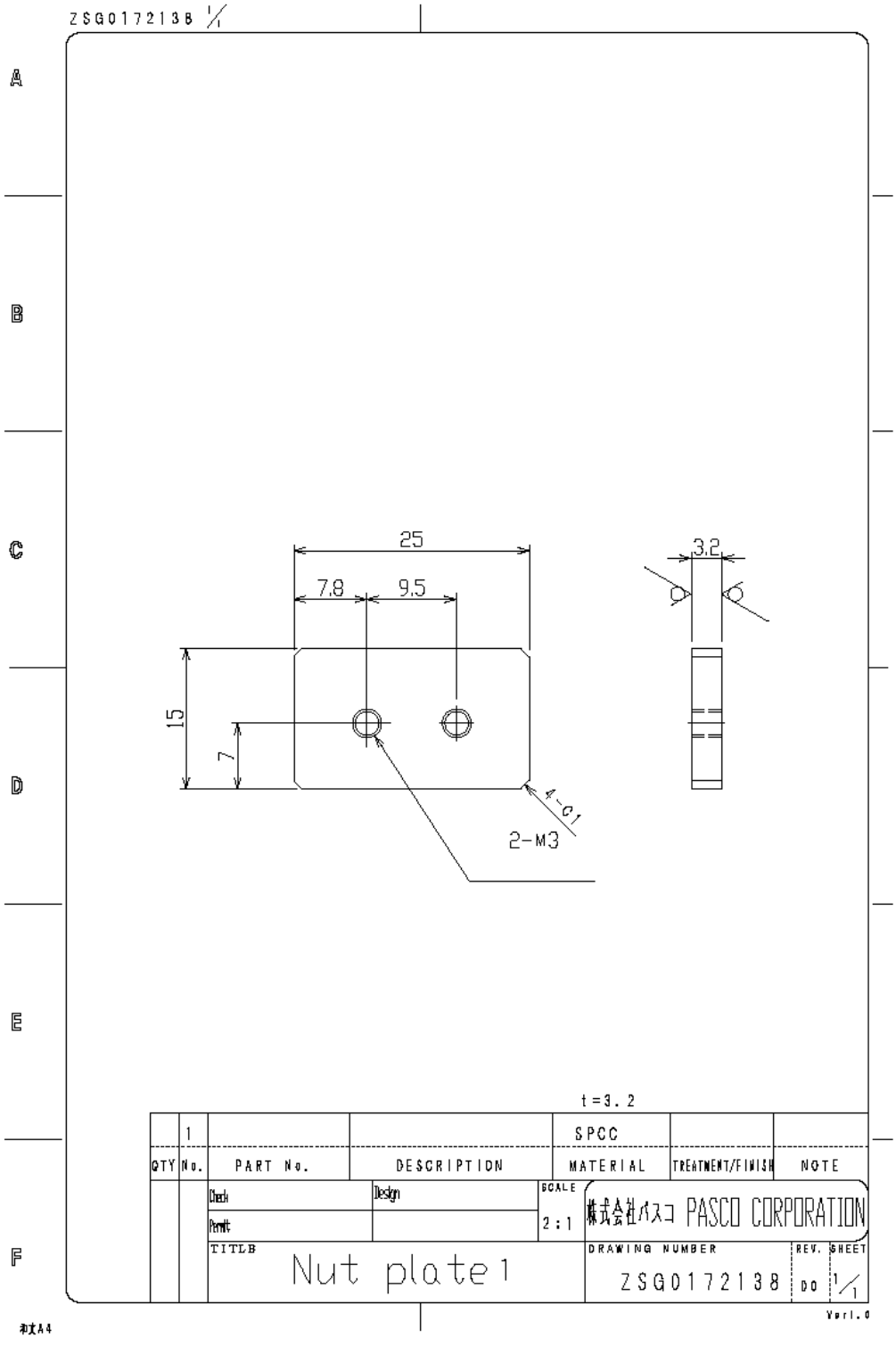
Configuration Diagram

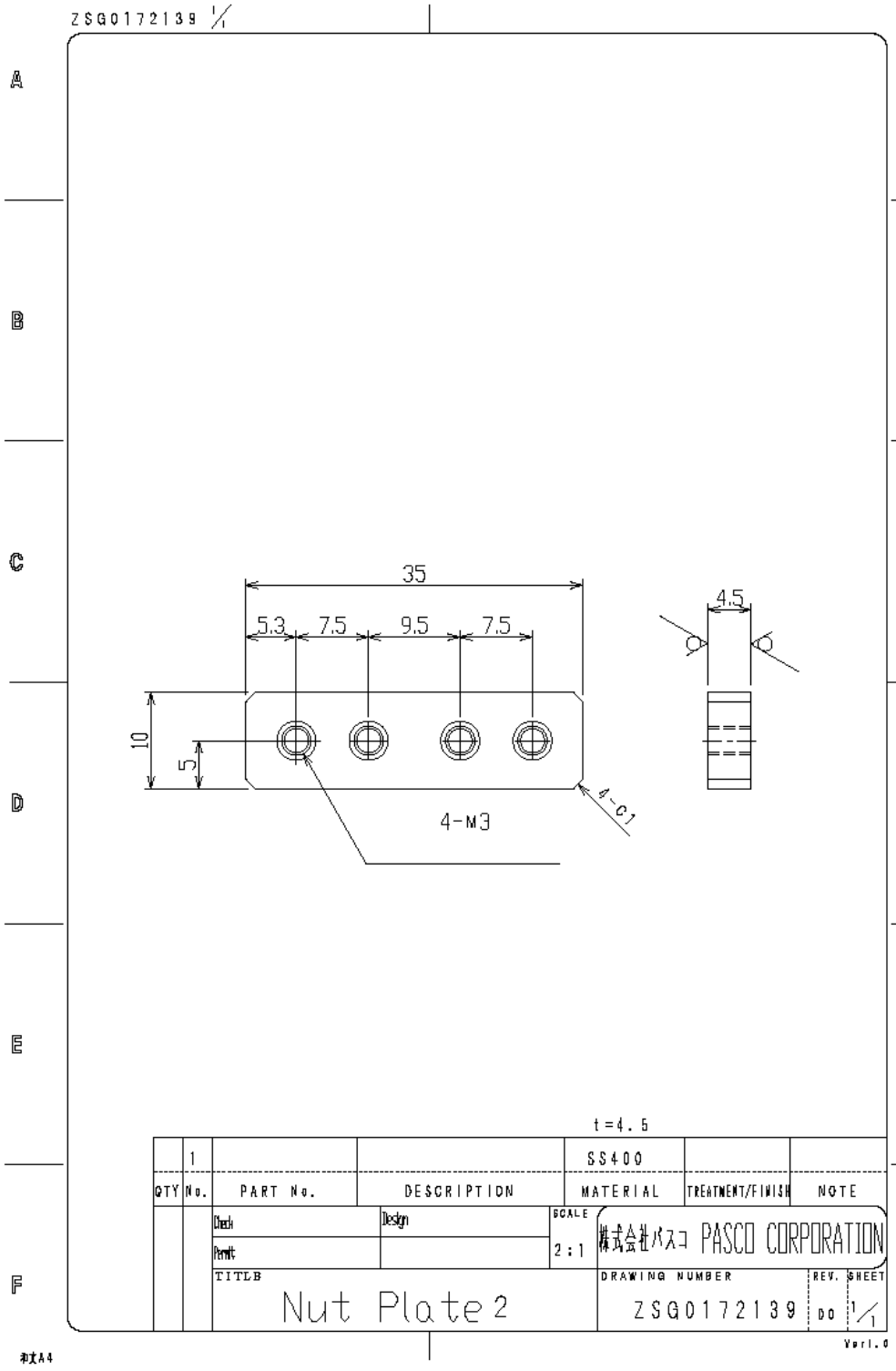


Configuration Diagram

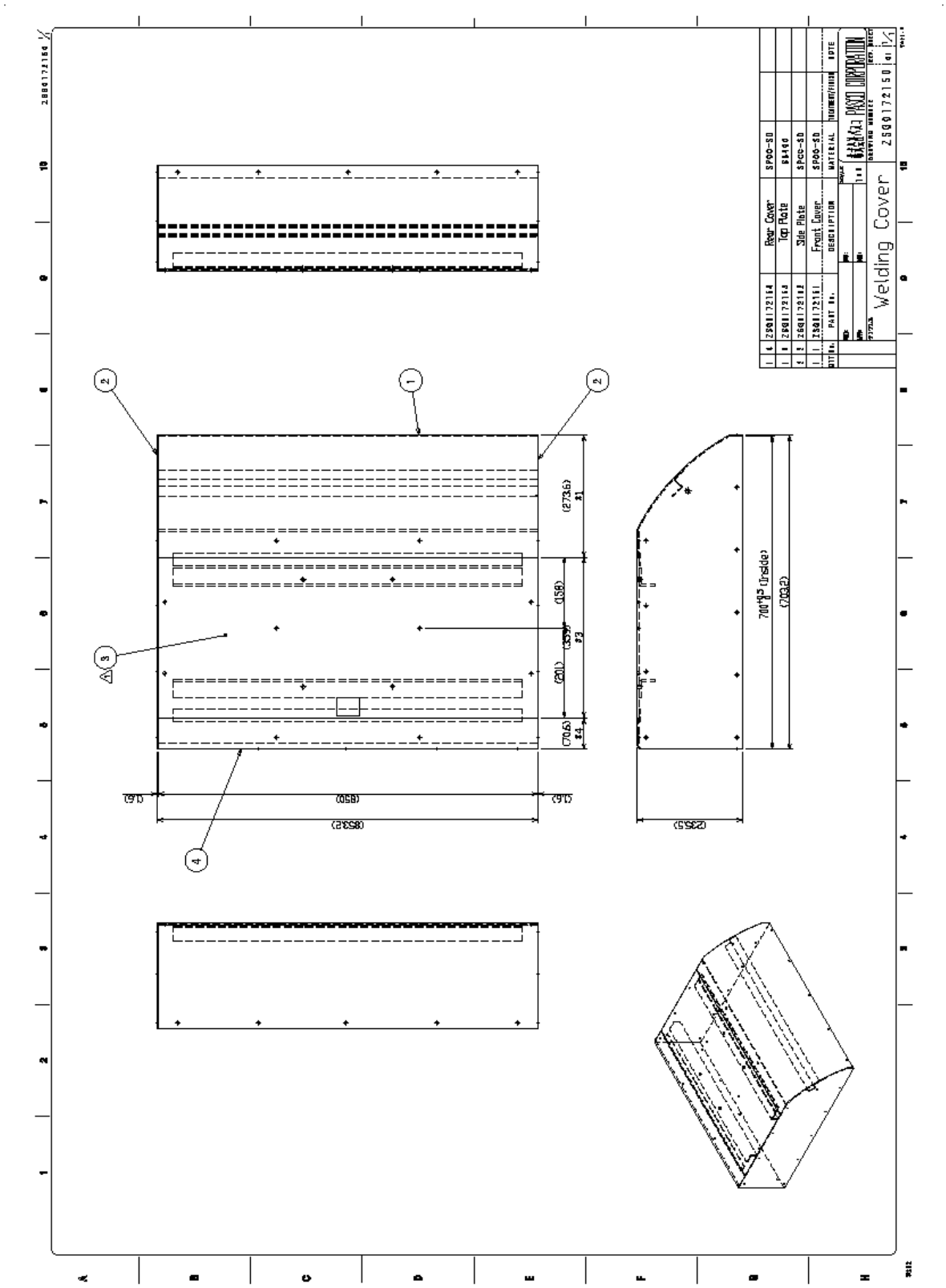


Configuration Diagram

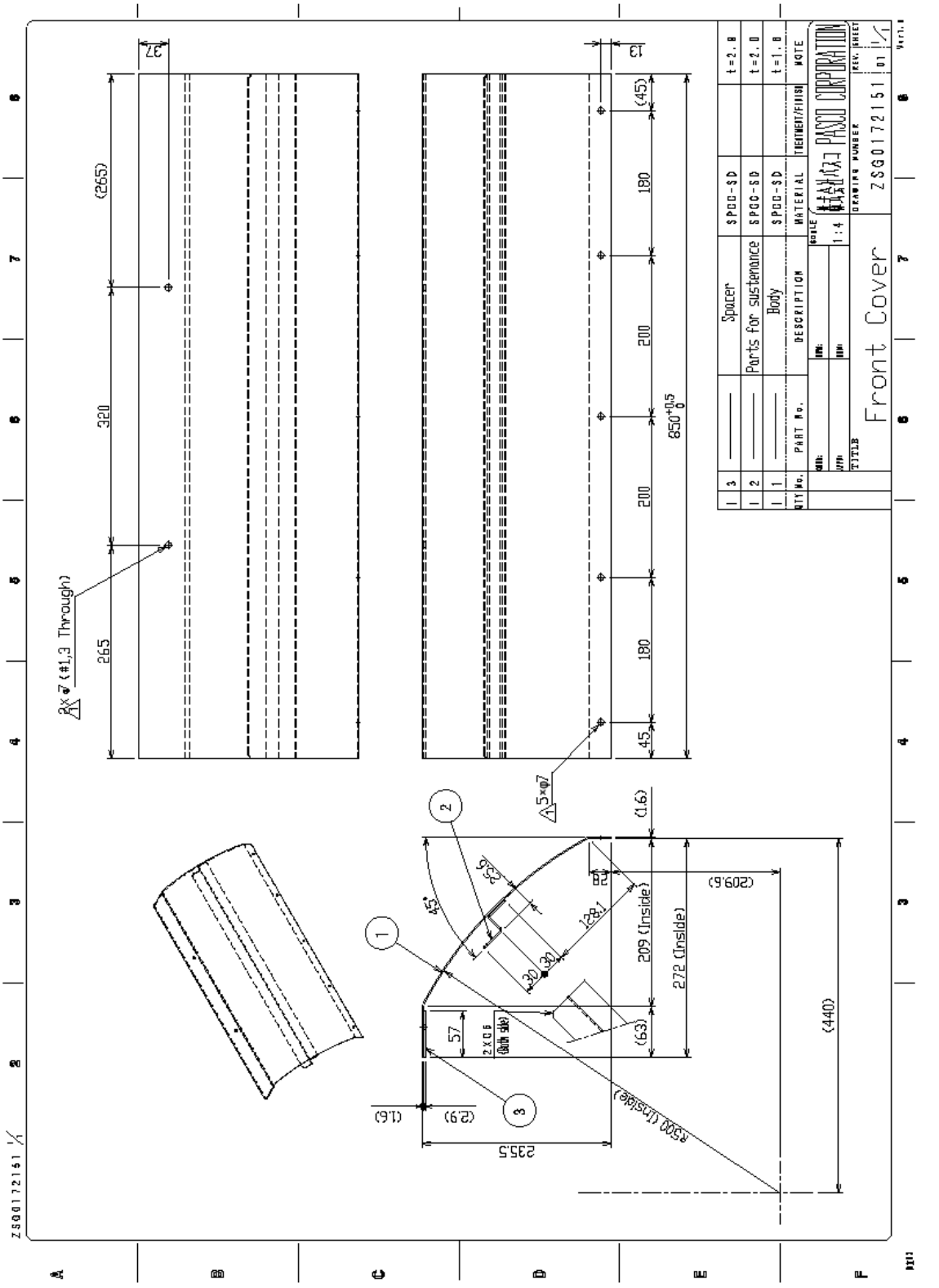



ZSG0172139 1/1
A
B
C
D
E
F
35
5.3
7.5
9.5
7.5
4.5
10
5
4-M3
4-C1
t=4.5
1
SS400
QTY
No.
PART No.
DESCRIPTION
MATERIAL
TREATMENT/FINISH
NOTE
Check
Design
Permit
SCALE
2:1
株式会社パスコ PASCO CORPORATION
TITLE
Nut Plate2
DRAWING NUMBER
ZSG0172139
REV.
D0
SHEET
1/1
和文A4
Ver1.0

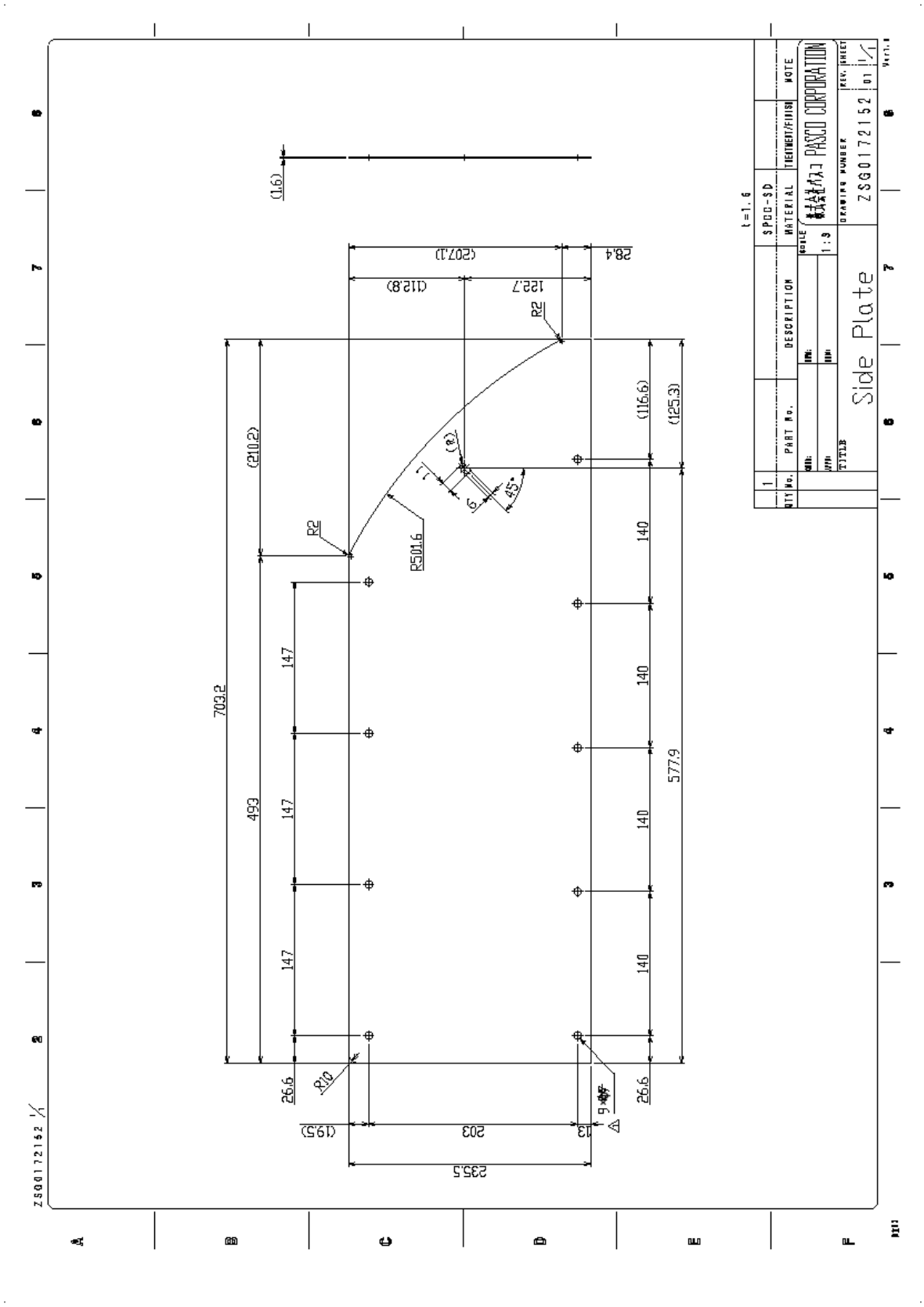
Configuration Diagram



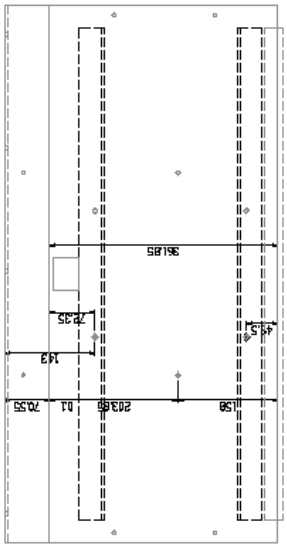
Configuration Diagram

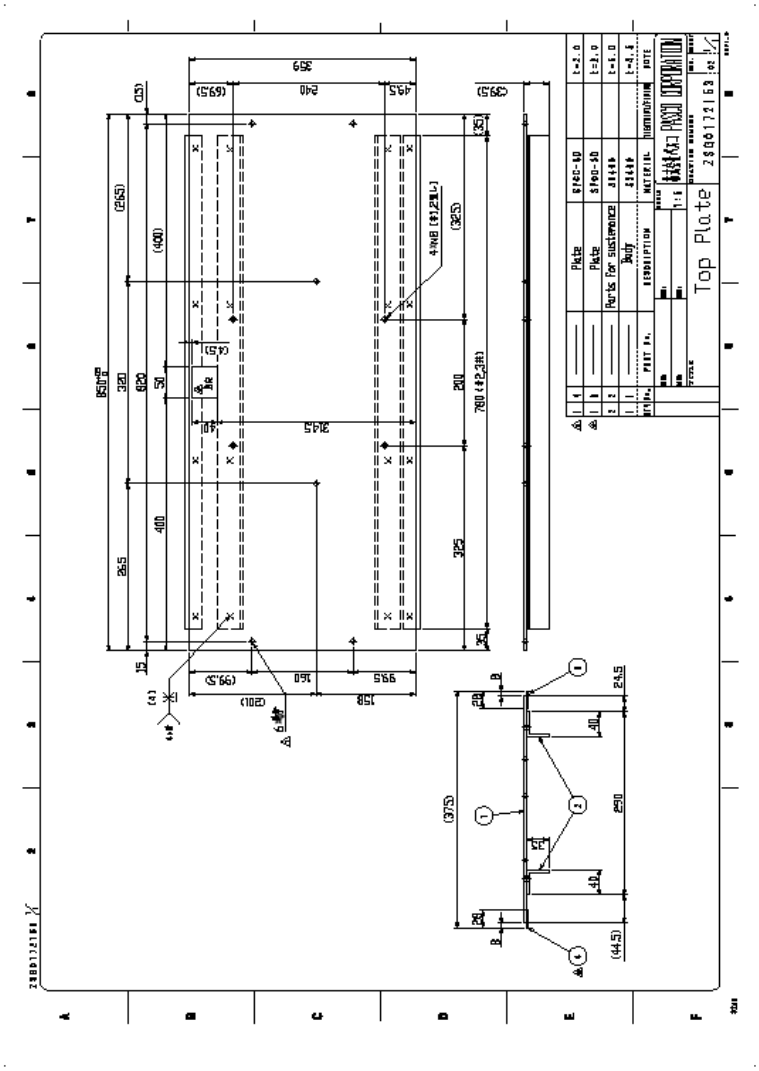


Configuration Diagram

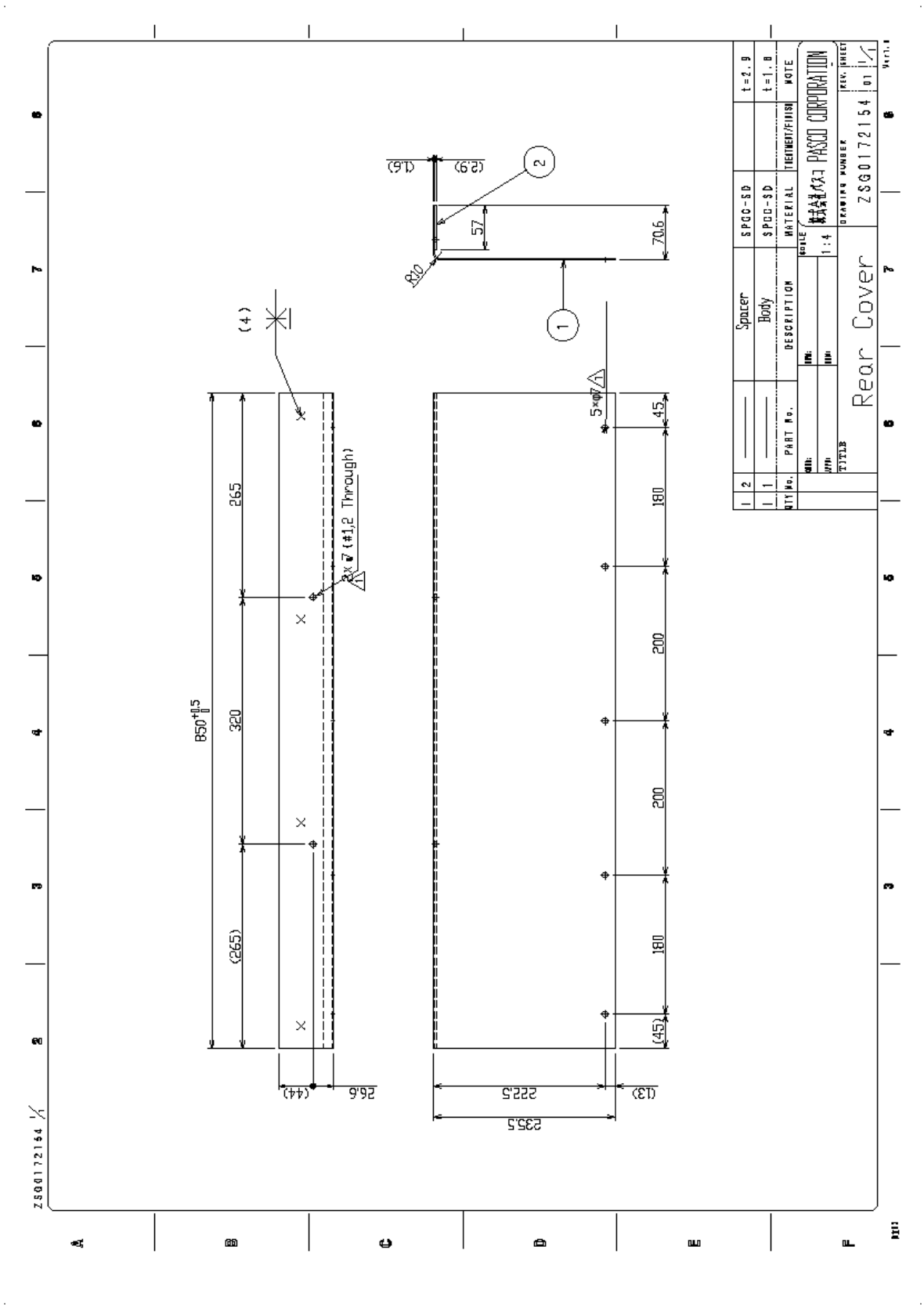


Configuration Diagram

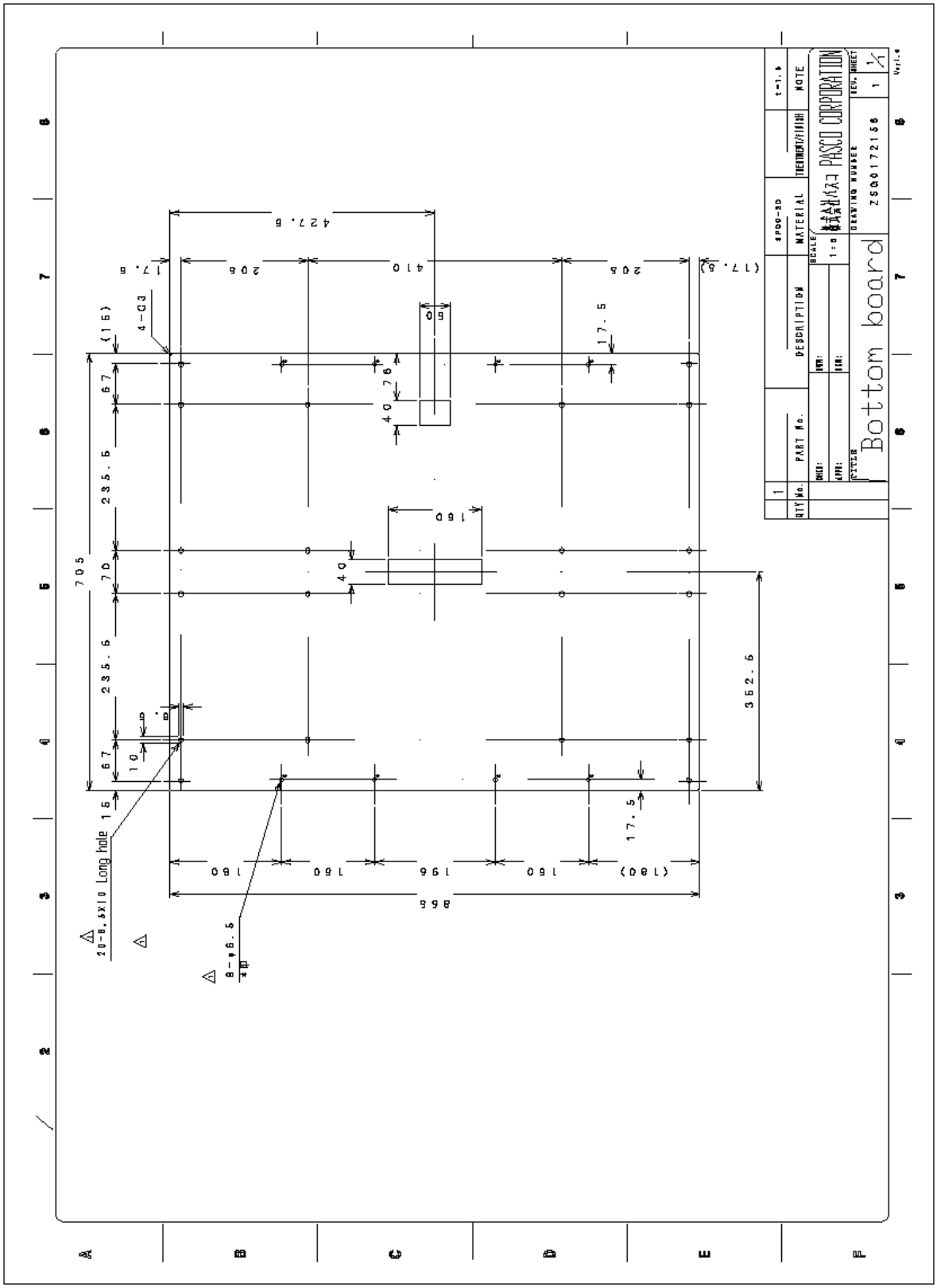




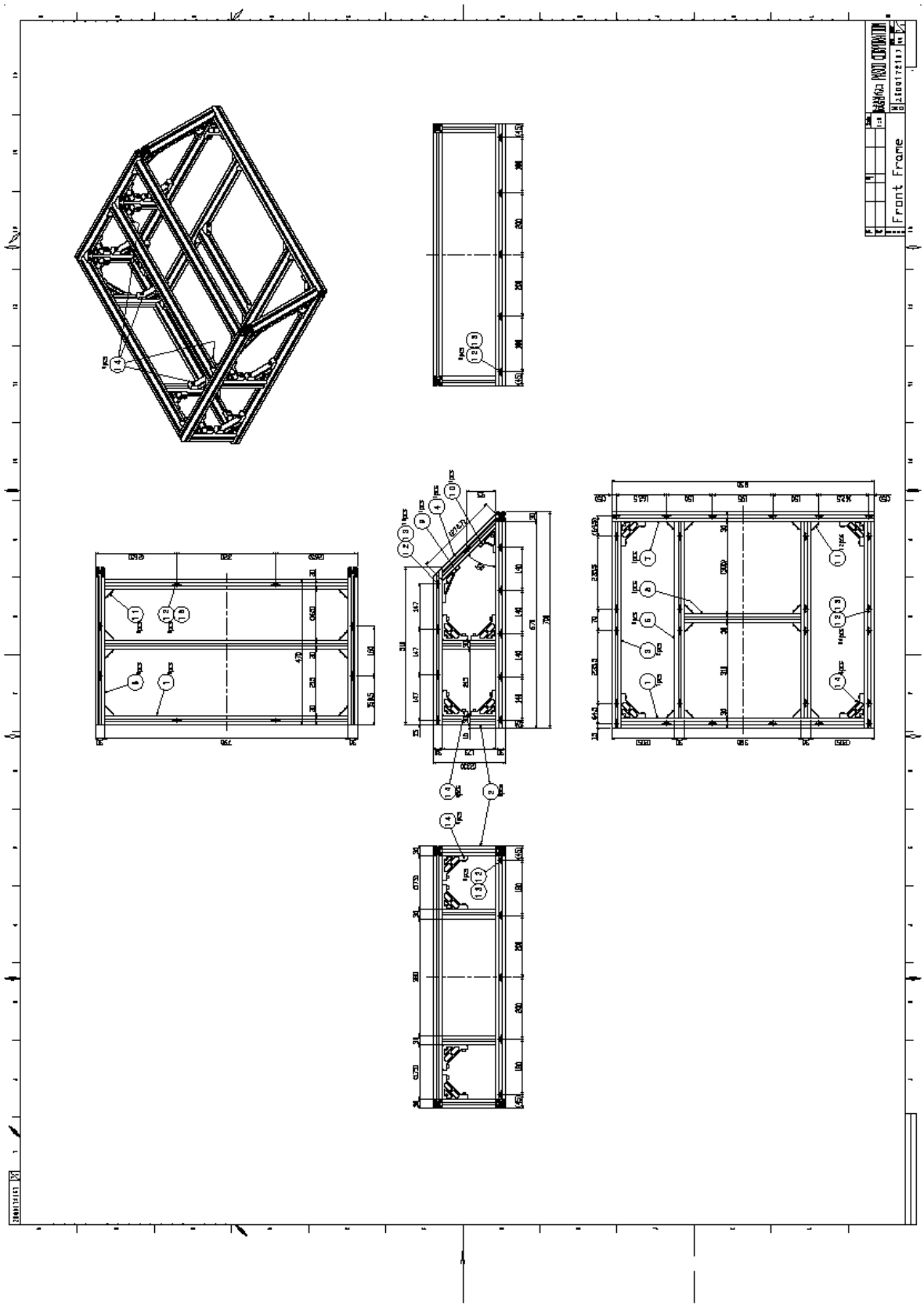
Configuration Diagram



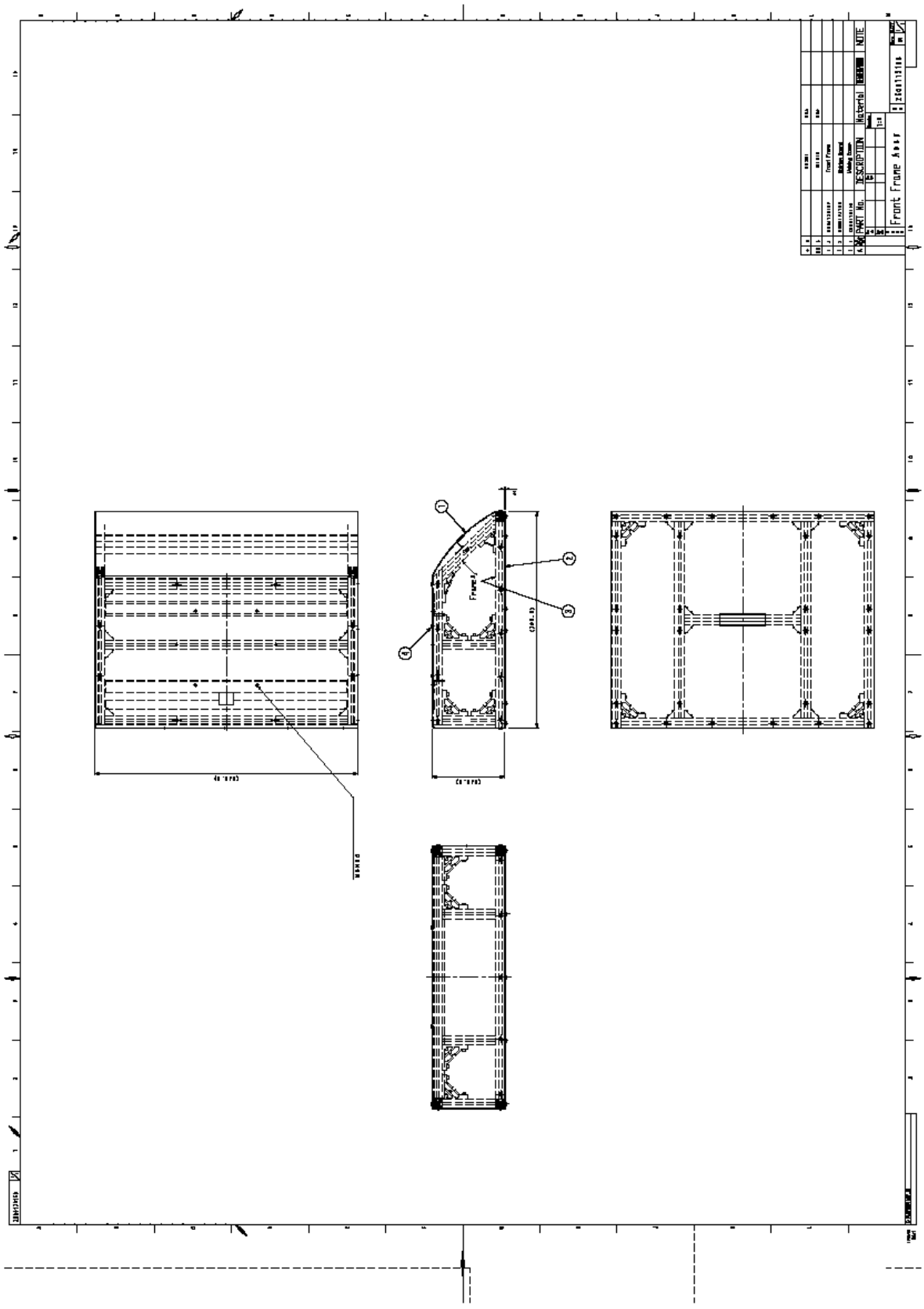
Configuration Diagram



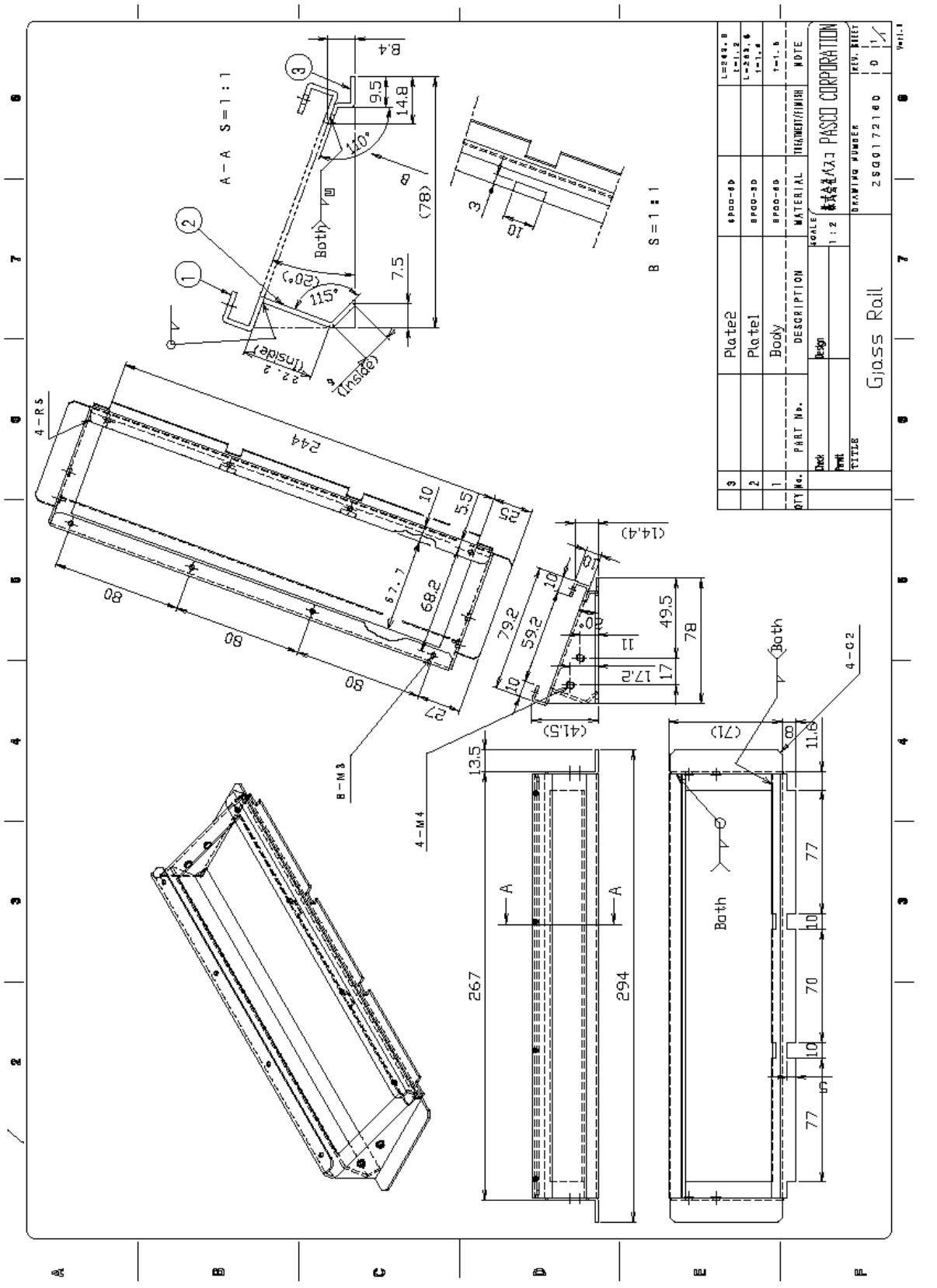
Configuration Diagram



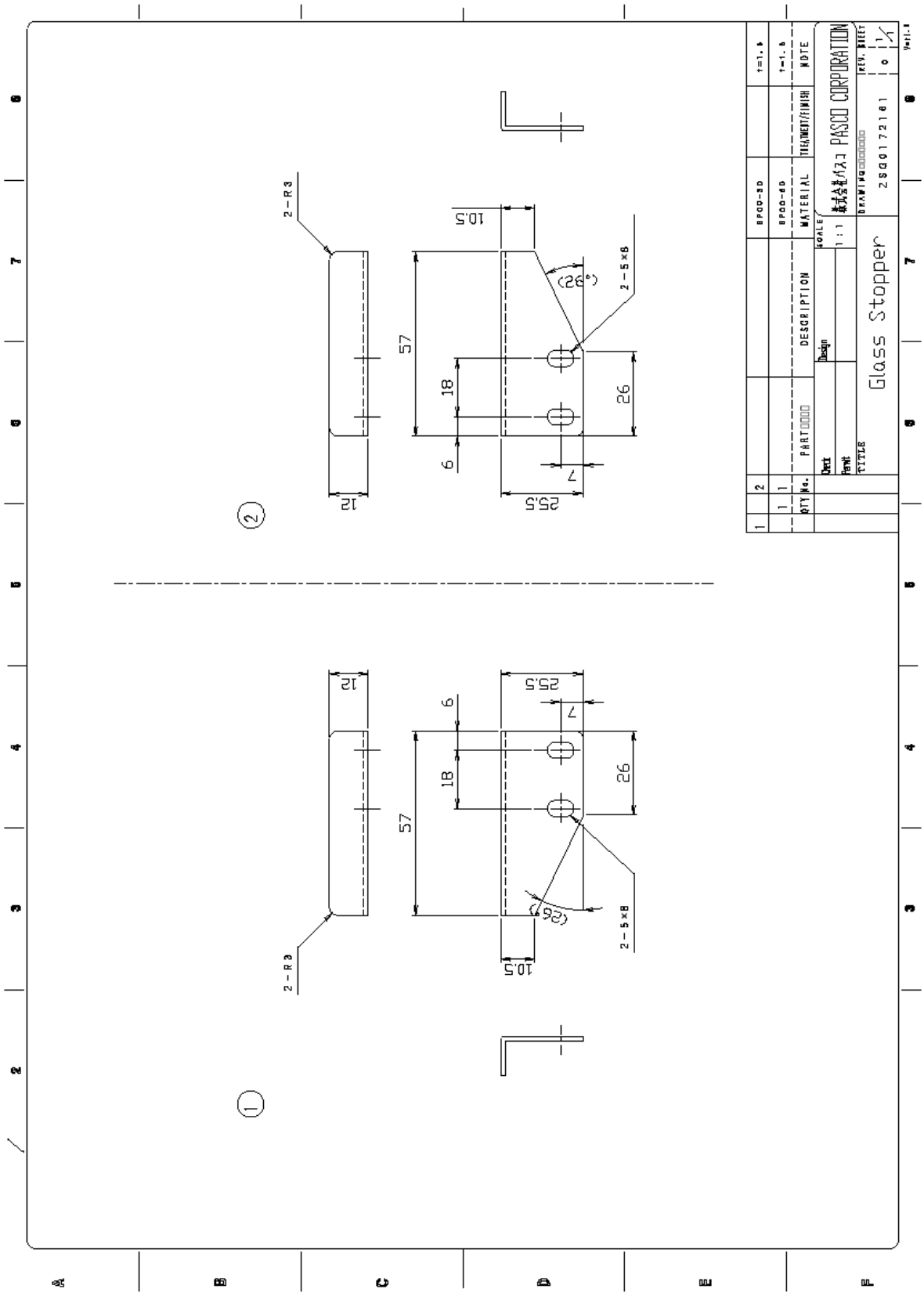
Configuration Diagram



Configuration Diagram



Configuration Diagram



Configuration Diagram