FURUNO

OPERATOR'S MANUAL

MODEL: **WEATHER RADAR**

TYPE: **WR2120**

FURUNO ELECTRIC CO., LTD.

www.furuno.com

IMPORTANT NOTICES

General

- This manual has been authored with simplified grammar, to meet the needs of international users.
- The operator of this equipment must read and follow the descriptions in this manual. Wrong operation or maintenance can cancel the warranty or cause injury.
- Do not copy any part of this manual without written permission from FURUNO.
- If this manual is lost or worn, contact your dealer about replacement.
- The contents of this manual and equipment specifications can change without notice.
- The example screens (or illustrations) shown in this manual can be different from the screens you see on your display. The screens you see depend on your system configuration and equipment settings.
- Save this manual for future reference.
- Any modification of the equipment (including software) by persons not authorized by FURUNO will cancel the warranty.
- All brand and product names are trademarks, registered trademarks or service marks of their respective holders.

How to discard this product

Discard this product according to local regulations for the disposal of industrial waste. For disposal in the USA, see the homepage of the Electronics Industries Alliance (http://www.eiae.org/) for the correct method of disposal.

Importer in Europe

The following contact acts as our importer in Europe, as defined in Directive 2014/53/EU.
- Name: FURUNO EUROPE B.V.
- Address: Ridderhaven 19B, 2984 BT Ridderkerk, The Netherlands.

Software version: 8450002-06.07
**denotes minor modifications.

CE declarations

With regards to CE declarations, please refer to our website (www.furuno.com), for further information about RoHS conformity declarations.

SAFETY INSTRUCTIONS

The operator and installer must read the appropriate safety instructions before attempting to install or operate the equipment.

DANGER	Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION	Indicates a potentially hazardous situation which, if not avoided, can result in minor or moderate injury.

Warning, Caution Prohibitive Action Mandatory Action

DANGER

Radio Frequency Radiation Hazard

The radar antenna emits the electromagnetic radio frequency (RF) energy which can be harmful, particularly to your eyes. Do not look at the Antenna Unit from a close distance while the radar is in operation, or expose yourself to the transmitting antenna at a close distance.
The distances at which RF radiation levels of 10 W/m ^{2} exist are shown in the table below.
DO NOT approach closer than 9.1m (Safety standard is 10 W/m^2) when radar is transmitting.

NOTE: This value is applied when radar is installed in a public space. Value is defined as on human body surface over a 6-minute period with the flux density averaged from the measurement. Moreover, this measured value is measured by pointing the center of the antenna towards a human. However this is the worst value, definition required by actual regulation is written here as on safe side.

Distance from Antenna	9.1m
Power flux density	10 W/m ^{2}

WARNING

Do not open the radome.
Electrical shock can occur. Only qualified personnel should work inside the equipment.
Turn off the circuit breaker in the JCU if opening the radome is required.

Wear a hard hat and safety belt when mounting the Antenna Unit.
Serious injury or death can result from falls or dropped items while installing or servicing the radar components.

Do not use any other power except 100 to 240 VAC.
Connection of an incorrect power supply can cause fire or damage the equipment.

Turn off the power immediately if water leaks into the equipment or smoke or fire is coming from the equipment.
Failure to turn off the equipment can cause fire or electrical shock.

Do not operate the equipment with wet hands.
Electrical shock can occur.

Do not disassemble or modify the equipment.
Fire or electrical shock can occur.

Use only the specified power cable.
Fire or damage to the equipment can result if a different cable is used.

Use the power supply grounded certainly.
Electrical shock or defect of operation can occur.

When a thunderbolt is expected, do not approach a system or do not touch a hand.
There is a possibility of receiving an electric shock.
A worker's safety is guaranteed however the radar's internal protection devices only protect against indirect lightning and surges to the radar components. In case of a direct lightning strike these protection devices may not protect radar or surrounding personnel.

Attach securely protective earth to the unit.
The protective earth (grounding) is required to the AC power supply to prevent electrical shock.

⚠ CAUTION

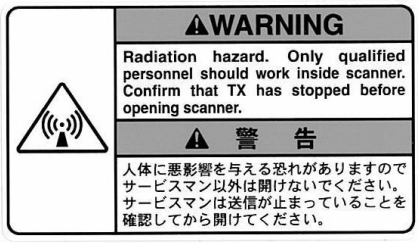
Do not put liquid-filled containers on the top of the equipment.
Fire or electrical shock can occur if a liquid spills into the equipment.

Establish best possible surrounding space for apparatus.
This helps eliminate performance degradation and failure.

Do impact the LCD glass.
Serious injury may occur due to broken glass.

WARNING LABEL

Warning labels are attached to the equipment. Do not remove any label.
If a label is missing or damaged, contact us for the replacement.



Name: Radiation Warning Label
Type: 03-142-3201-0
Code No.: 100-266-890-10

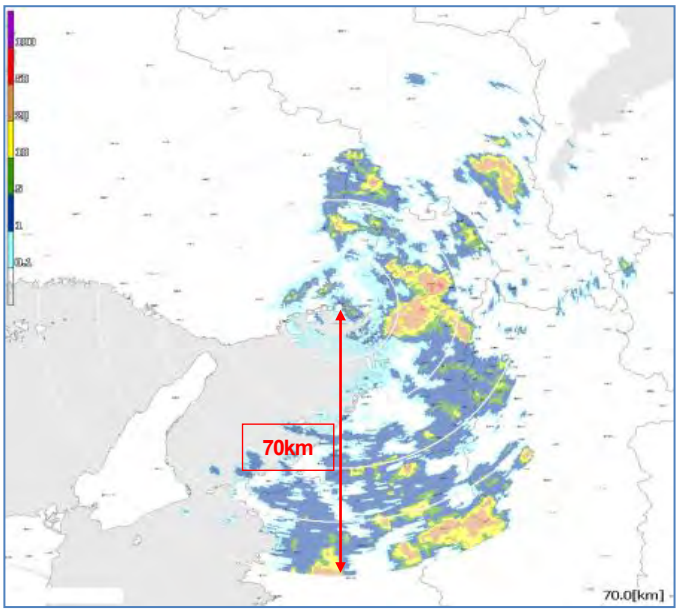
WR2120 restrictions

There are restrictions frequency band as follows to use at Switzerland, Lithuania and Slovakia.
Operate the WR2120 using one of the following four channels:
CH1: 9422.5MHz, CH2: 9427.5MHz, CH3: 9432.5MHz, CH4: 9437.5MHz

TABLE OF CONTENTS

OUTLINE OF SYSTEM

This system observes the strength of precipitation, the speed of rain clouds (Doppler speed), and observes phenomena of rainfall.



Notice:

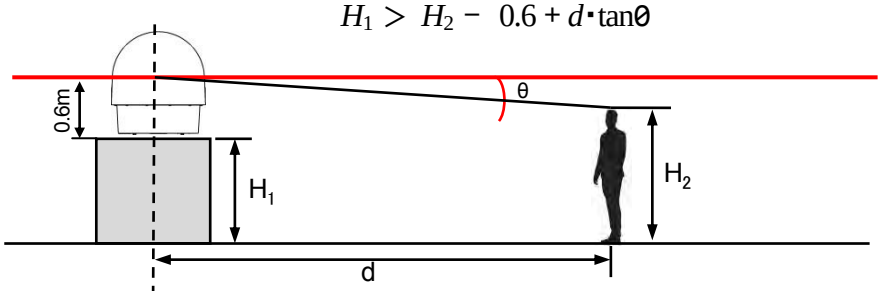
1. Do not go around the antenna area.
2. While installing antenna on a rooftop of building in urban area, it must be installed in the safety area and protected by a lightning rod(s) based on IEC 62305.
3. No obstacles should be around the antenna.

Safe distance:

- If H1 is taller than 1.9 meters, it is safe unless directly touching the antenna.
- If H1 is shorter than 1.9 meters, do not enter within a radius of 7.6 meters from the antenna.
  Note: It based on the standard human height of 2 meters.
- Refer the Radio Frequency Radiation Hazard on page i.

  Note: It is safe to follow this calculated value because it still has some extra safer margin.

$$H_1 > H_2 - 0.6 + d \cdot \tan\theta$$



e.g.: H_2 (Height) = 2m,

d (Distance between center of the antenna and human) =6m, θ=2° (Minimum azimuth is -2°)

H_2-0.6+d·tanθ = 2-0.6+6·tan2°=1.6095m<H_1

Therefore, H_1 (Height of radar stand) = **1.6**m,

SYSTEM CONFIGURATION

The observation system consists of an Antenna Unit (radome), a Junction Unit, and a Data Processing Unit (indoor unit) is shown below.

(1) Antenna Unit (radome)

Radome is to provide protection for enclosed physical environment. Inside the radome, there is the antenna that rotates and radiates the radio waves. The radiated waves are backscattered by particles on the propagation path, return to the antenna, and are processed by RF converter to transfer the signals to the Signal Processing Unit.

(2) Signal Processing Unit (storage box)

Signal Processing Unit is stored in the storage box, and processes received signals digitally. The digital processed signals are transferred to the Data Processing Unit via 1000Base-TX (LAN). This unit is a relay point of LAN cable (1000Base-TX Cat5e or better, it is recommend to use STP (Shielded Twisted Pair) instead of UTP (Unshielded Twisted Pair) and switches on the power of the ATU. Do not exclude them because of CE and FCC registration reason.

(3) Data Processing Unit (indoor unit)

Data Processing Unit is displaying radar data and operates the weather radar.
User needs to prepare the external storage device for recording the weather observation data if necessary.
DPU has 3 ports for the dedicated LAN connections; ATU/SPU (LAN1), Internet (LAN2), and MONI-CON (USB-LAN adaptor).

Note: Do not install any software into DPU because it will cause an out of system resource problem.

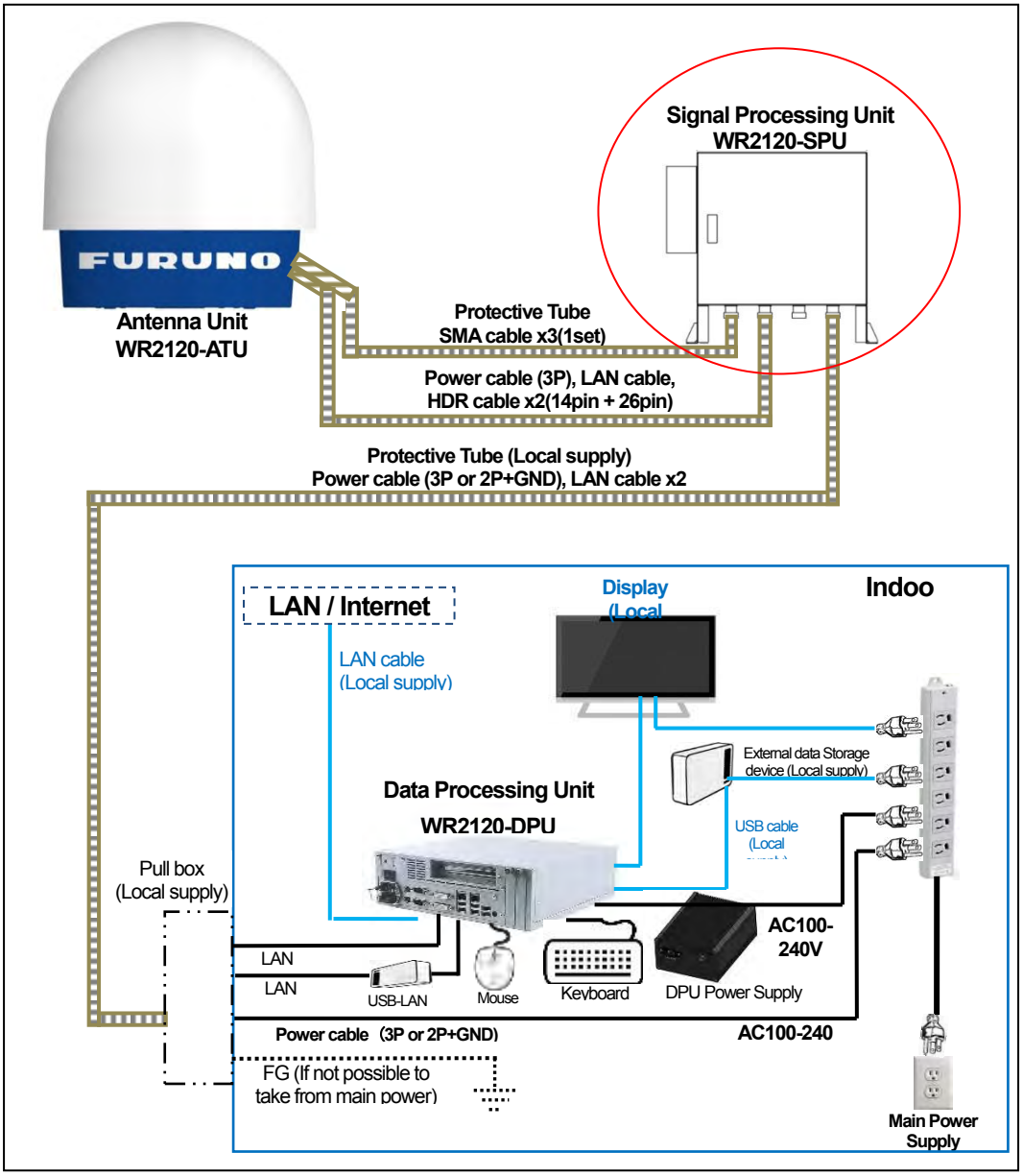


Image 1: System drawing

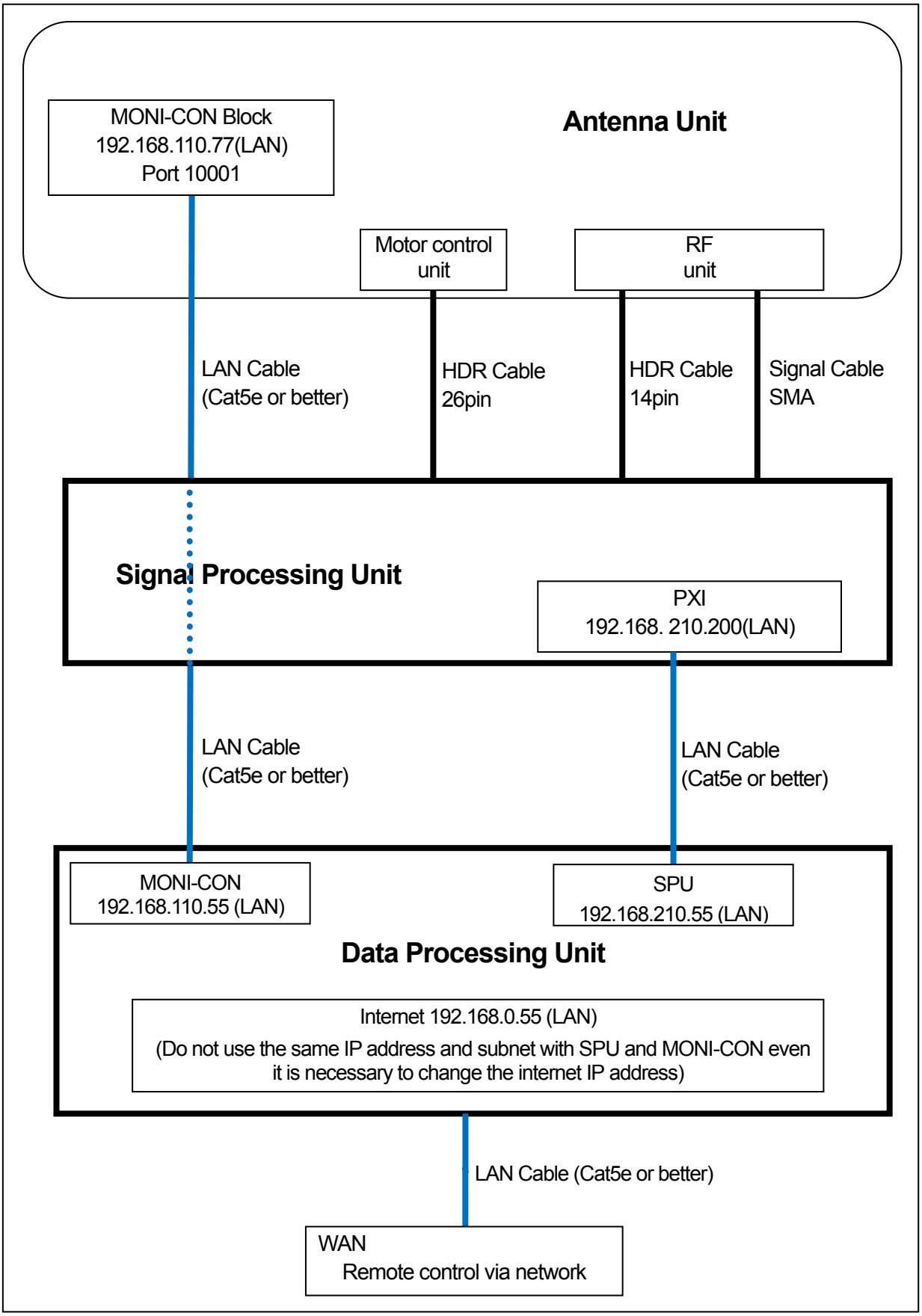


Image 2: Configuration diagram

Data Processing Unit

Software name	Display software	RainMap.exe
Specification	**Function**	
OS	**Windows® 10 IoT Enterprise 64bit**	
Data display		
Observational date and time:	Local time display corresponding to the time zone of Windows®	
Maximum distance displayed	70 km	
Display scale	0.5-70 km	
Polar coordinate display (rθ) Coloration	Maximum 15 colors in table (maximum 16 values including no color)	
Map display		
Local map display:	bmp, png	
Display status (Display the setting button and current setting values)		
Data types	R [mm/h], Zh [dBZ], Zh _corr [dBZ], Zv [dBZ],V [m/s], Zdr [dBZ], Zdr _corr [dBZ], Kdp[deg/km], φdp[deg], ρhv, W [m/s] (see page 9 for more information)	
ATU	Displays current activation and setting values of azimuth & observed elevation	
Radar operational settings (Selects ATU settings section from the menu and confirmations)		
Scan mode	PPI, Volume Scan, Sector PPI/RHI,	
Interference Rejection	Selects echo data interference rejection	
Ground clutter (topographical) Interference rejection	Selects ground clutter echo data rejection	
Transmission mask function	Selects sector blanking area in ATU.	
Elevation angle (-2 to 90 degrees)	Selects a specified elevation angle for ATU echo data.	
Setting of radar constant (Transmission pulse width, rainfall intensity conversion constant B, and β)	Selects required setting for echo data and confirm to ATU.	
Data manipulation		
Saving displayed data	Saved in a chronological order unit (Time based file name)	
Playing displayed data	Play from a specific file name.	
Software		
This product includes software licensed under the Tera Term Project and others.	Directory of Tera Term: C:¥Program Files (x86)¥teraterm¥ttermpro.exe	
Data output		
Output of data file	Output rate 1 to 60 minutes intervals	

1. OPERATING PROCEDURE OF SYSTEM

1.1. Startup the Radar System

(1) Turn on the circuit breaker of the Antenna Unit and the Signal Processing Unit (storage box)

⇩

The Antenna Unit and the Signal Processing Unit are in the waiting status.

⇩

(2) Turn on the power of the Display Unit, and place the main outlet to supply a power for the Antenna Unit and the Signal Processing Unit

⇩

(3) Start the observation from the menu of the Display Unit

⇩

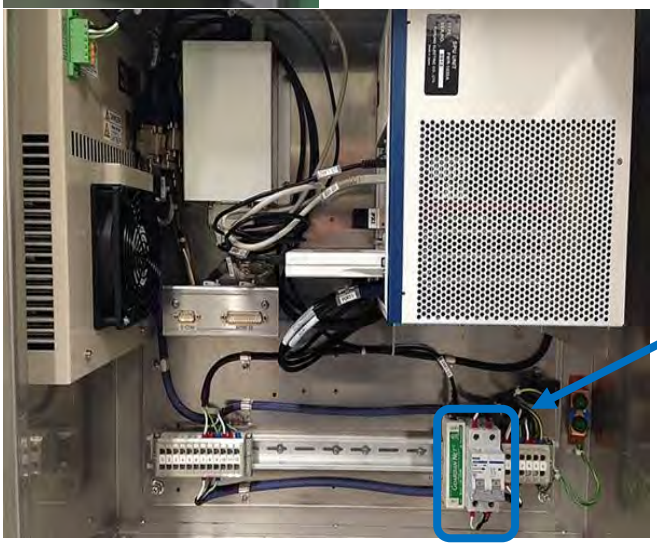
Output the data periodically with displaying images, and display the data image.

⇩

In process

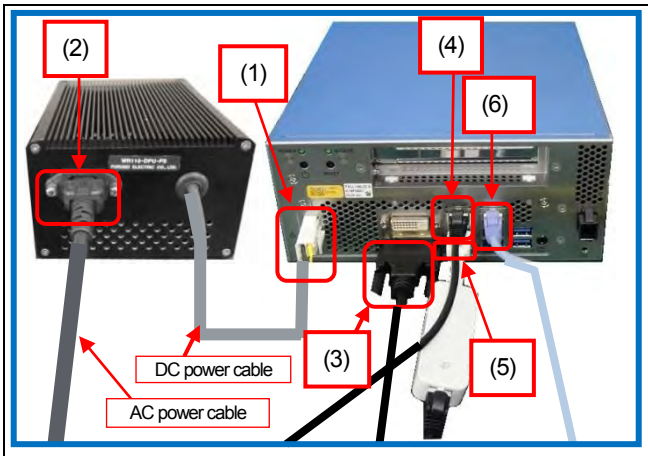
Signal processing unit (storage box).

1. The circuit breaker is in the Signal Processing Unit (storage box).

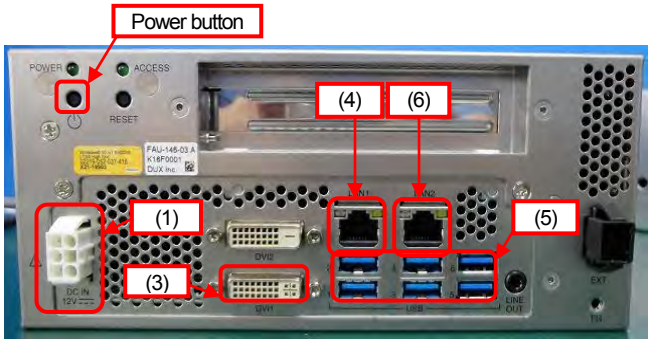


2. To turn on the circuit breaker.

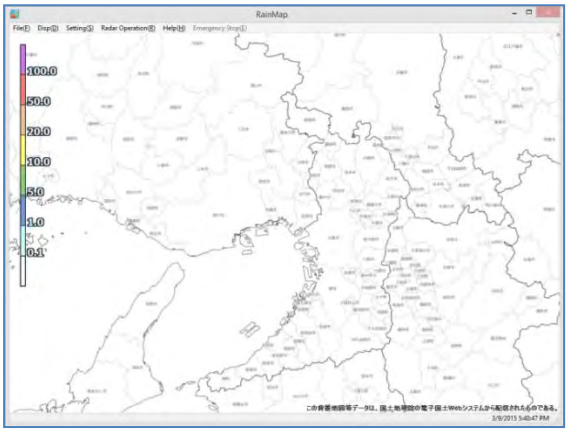
1.2. Startup the Data Processing Unit



1. Setup the Data Processing Unit
   (1) Connect DC power cable of DPU-PS to DPU.
   (2) Connect AC power cable to DPU-PS and electrical outlet.
   Note: Turn "ON" the power of ATU first and then DPU.
   Note: DPU will boot up automatically when DC power supplied. (Default setting)
   (3) Connect display to DVI port, And connect keyboard and mouse to USB port.
   (4) Connect LAN cable from ATU (SPU module inside the ATU) to LAN1 port..
   (5) Connect LAN cable from MONI-CON (inside the ATU) to USB port via bundled USB-LAN adapter.
   (6) Connect LAN cable from router to LAN2 port for using Internet.



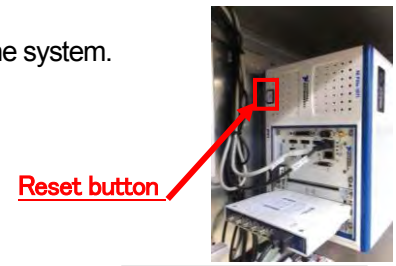
Notice:
1) Bundled cable is dedicated for Japan-US use. It can be used up to 125V. Appropriate power cable should be prepared at each site.
2) Do not use the same IP address on ATU.
3) Do not put heavy object on the DPU. It may deform the DPU chassis.



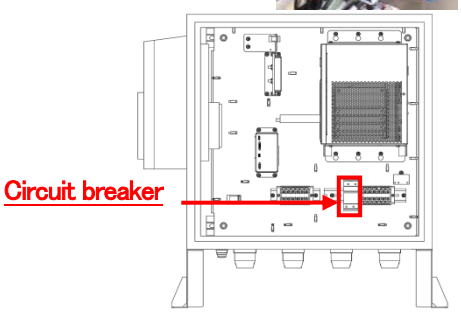
2. Turn on the power of the Data Processing Unit.
   Username: radar
   Password: radar
   Note: DPU will boot up automatically when DC power supplied (Default setting).
   1) The RainMap software starts automatically.
   2) Click [Radar Operation] on the menu bar, and select [Connect] to start radar operation.
   3) Click [Radar Operation] on the menu bar, and select [TX] to start observation and to display radar images.

1.3. Shut down / Reboot the Radar System

1. Press the switch button of Signal Processing Unit directly to turn off the system.
   Confirm a lamp inside the PXI (inside the Signal Processing Unit).
   If it turned to red, it means the PXI is down.
   * If just want to reboot SPU, wait about 1 minute and then press the switch button again to turn it on.



2. Shut down the circuit breaker in the storage box.



2. DPU OPERATION

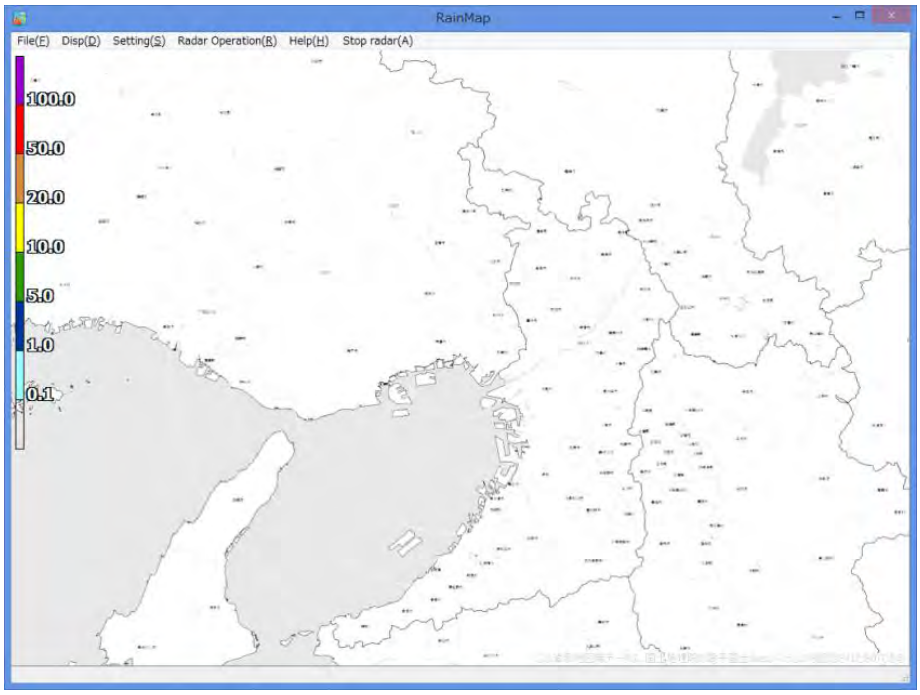
2.1. Startup

Turn on the power of DPU to start Windows®.

User name: radar

Password: radar

The following screen will display during startup.



2.2. Shutdown

1) Shut down the Windows®.

There are 3 ways to shut down the windows:

Method 1: Right click [Start button] -> [Shutdown or Sign out] -> [Shutdown]
This operation is only possible to the local computer.

Method 2: Press [Windows] + [X] key -> [Shutdown or Sign out] -> [Shutdown]

Method 3: Press [ALT] + [F4] key -> [Shutdown]

Note: Be aware to operate method 2 and 3 for trying to use from the remote desktop and TeamViewer. It may shut down your own local computer.

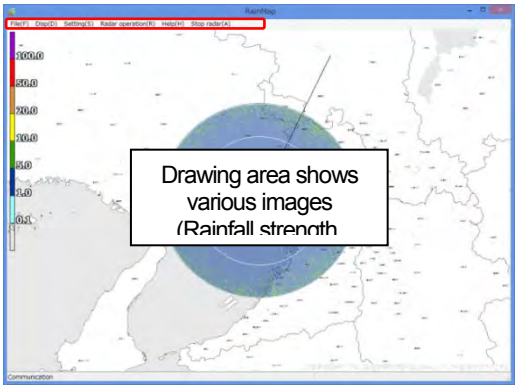
2) The power of DPU is off.

2.3. RainMap Operation

File Menu bar

Click the menu name to display each selected menu item.

- File(F)
- Disp(D)
- Setting(S)
- Radar operation(R)
- Help(H)
- Stop radar(A)



Caution:
Do not change the setting during the radar is observing.
It may cause malfunction. (There are some exceptions)

1) File

Replay files…:

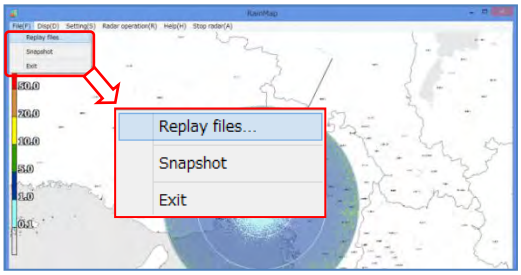
RainPlay opens and can play the log data files (scn, scnx etc.). Refer to section 2.9 for RainPlay instructions.

Snapshot:

Capture the screen in jpg file format.

Exit:

Close the RainMap software

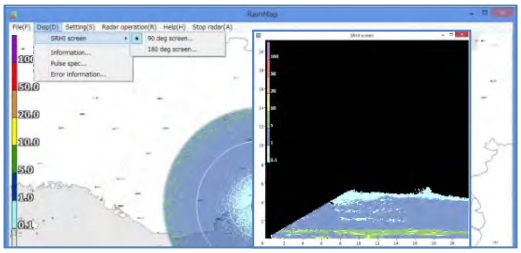


2) Disp

SRHI screen:

- 90 degrees screen (Displays SRHI echo at 90 degrees on sub screen)
- 180 degrees screen (Displays SRHI echo at 180 degrees on sub screen)

Note: It can only display while scanning by SRHI.

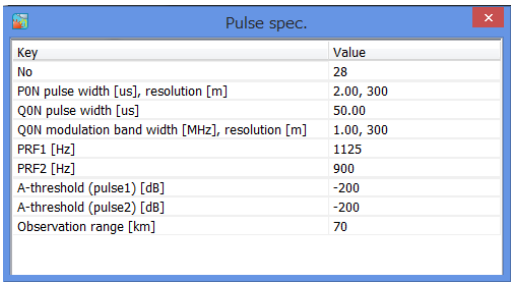


Radar const. info. :

Signal proc. Info. :

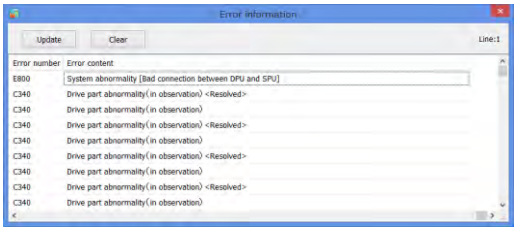
Pulse spec. info. :

Indicate current pulse settings.

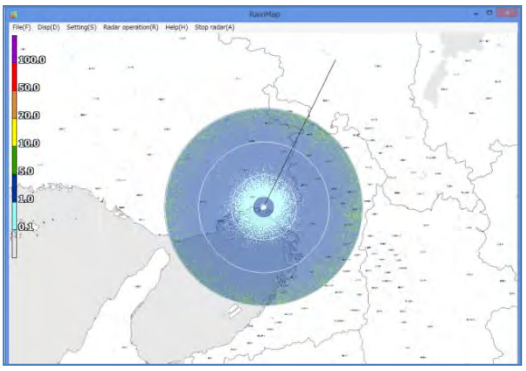


Error info. :

Displays last 50 (maximum) log error occurrences with date and time. Click [Update] button to indicate the latest error information. Click [Clear] button to clear error information.



3) Setting



Display:
Select and confirm display settings.

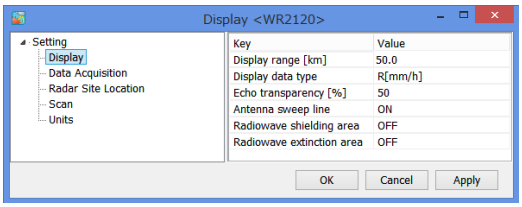
Data acquisition:
Select and confirm log settings.

Radar site location:
Select and confirm antenna location settings.

Scan:
Setup scan mode pattern and details.

Units:
Setup radar indicator rotation speed.

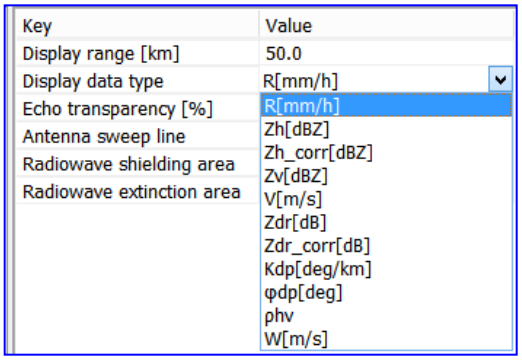
1. Display



Note: This item is possible to change the setting even when the radar is observing.

Display range [km]:
Setup radar range display.

Display data type:
Setup radar data output parameter.
Notice: WR2120 outputs the following data types.



- **R [mm/h]:** Intensity of rainfall
- **Zh [dBZ]:** Reflectivity factor of raindrop distribution and density
- **Zh_corr [dBZ]:** Attenuation corrected Zh of the horizontal polarity data
- **V [m/s]:** Speed factor of Doppler velocity data
- **Zdr [dB]:** Radar reflection factor difference
- **Zdr_corr [dB]:** Corrected differential reflectivity
- **Kdp [deg]:** Propagation phase difference rate of change
- **Φdp [deg]:** Differential propagation phase
- **ρhv:** Co-polar correlation coefficient
- **W [m/s]:** Doppler velocity spectrum width

Echo transparency [%]:
Set the echo returns transparency.

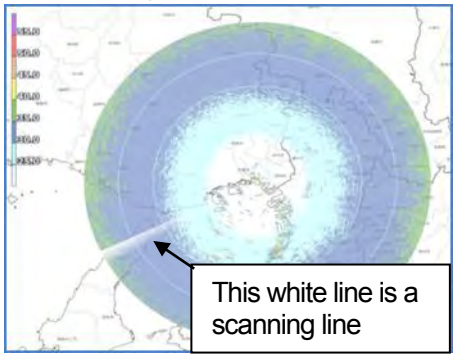
Antenna sweep line:
Turn ON or OFF sweep line indicator on screen.

Radiowave shielding area:
Select the radio wave shielding (sector blanking) area.
OFF: No sector blanking displayed.
1: Blank sector indicates with gray color
2: Blank sector indicates with transparent gray color (horizontal data only, it will not be transparent on SRHI).
Note: Setting file (clip_RainMap.csv in param folder) is necessary. (refer next page “About shielding area” for more information)

Radiowave extinction area:
Select the radio wave extinction (sector blanking) area.
OFF: No sector blanking displayed.
1: Blank sector indicates with gray color
2: Blank sector indicates with transparent gray color (horizontal data only, it will not be transparent on SRHI).

About antenna rotation:

Basically the antenna is rotating clockwise based on the azimuth origin during PPI and Volume scan as shown on Figure 2.1.



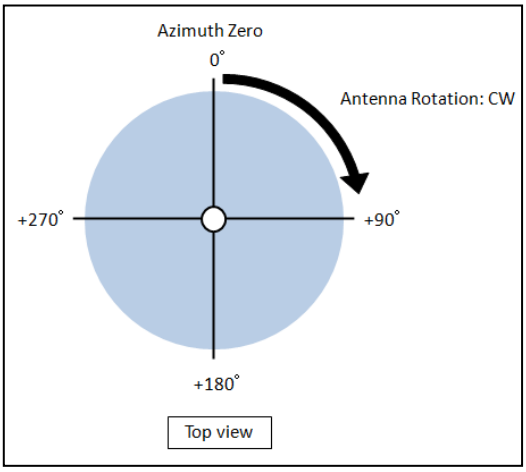


Figure 2.1: Antenna rotation

About shielding area:

There may be some areas where mountains or other obstructions are blocking the radio wave of radar. RainMap indicates those areas with a gray color.

First the "Clip_RainMap.csv" file that describes the grayed out area must be created.

Refer to quality information of observing data about scn format in section 3.2 for detail of shielding area.

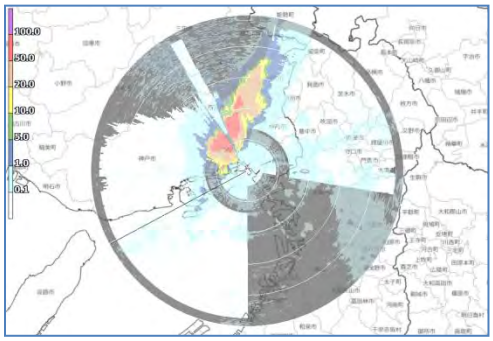


Figure 2.2:
Image of Radio wave shielding area

Shielding area data file format (see Figure 2.3):

The file format of shielding area uses a comma separated CSV file.
The first row is the header and below the first row will be the parameters.
Shielding area file name must be "Clip_RainMap.csv.

Header (reference and formula values)**:**

Each column of header (red frame of column 1 to 4, row 2 in Figure 2.3) indicates an individual parameter for the shielding area file.

Column 1: Distance value (m) used for shielding area range (distance) row cells calculation in "csv" file.

Column 2: Radar latitude in "clip_RainMap.csv" file must be entered as a decimal number, north latitude is positive and south latitude is negative.

Column 3: Radar Longitude in "clip_RainMap.csv" file must be entered as a decimal number, east longitude is positive and west longitude is negative.

Column 4: Radar altitude, entered in meter units for the "clip_RainMap.csv" file.

Note: Latitude, longitude, and altitude have to exactly match the values entered in "Radar Site Location" settings in RainMap.

Parameter (values used in shielding calculations)**:**

Let's consider the column direction of parameter (green frame of column 1 to 720, row 3 to 11 in Figure 2.3) as azimuth direction, shown as 720 columns of 0.5 [deg] units. Rows denote individual distances (range) direction and then the scan range of radar is divided by distance resolution and is the number of rows. It needs to consider beam width when generating shielding area from digital elevation map.

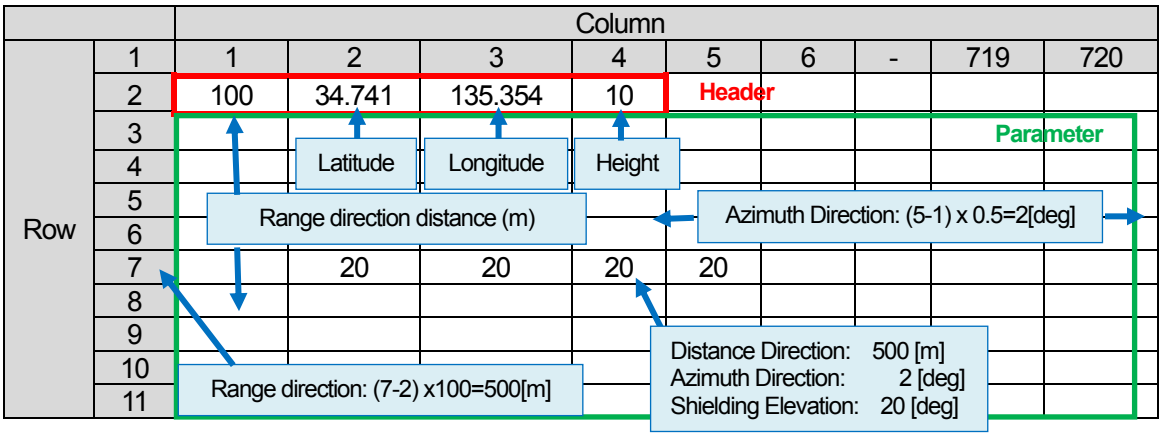


Figure 2.3: csv file

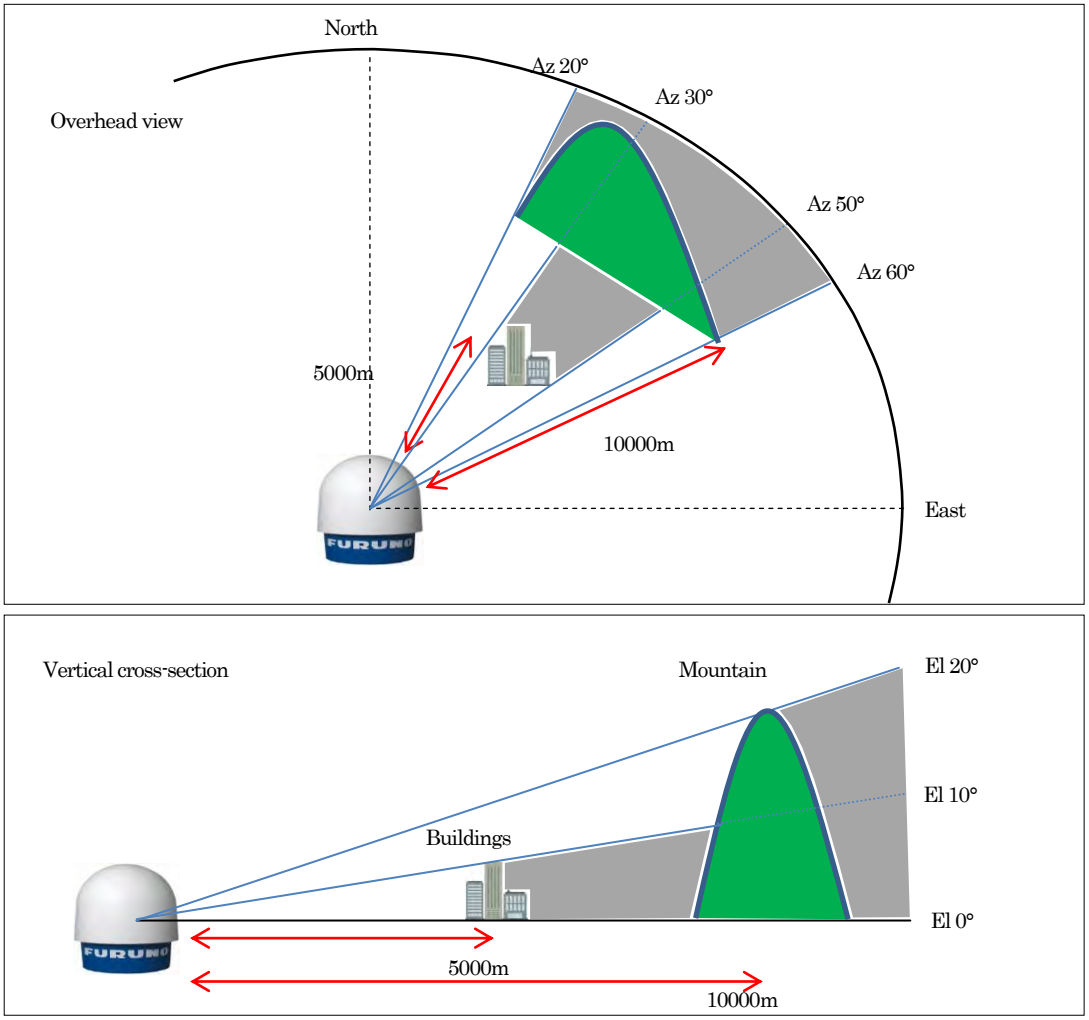


Figure 2.4: example of Radar view

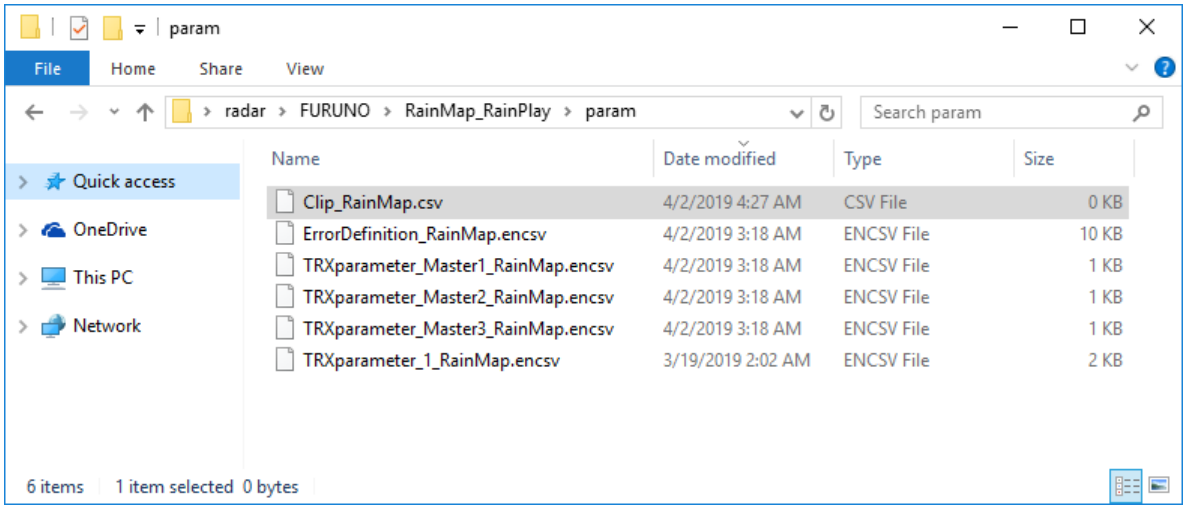
Creating parameters (green frame) below in Figure 2.5 for the shielding of Figure 2.4
(When it is around 100m in a distance direction)

		0deg	…	19.5deg	20deg	…	29.5deg	30deg	…	49.5deg	Az 50deg	…	59.5deg	60deg	…	359.5deg	Azimuth
		1	…	40	41	…	60	61	…	100	101	…	120	121	…	720	Column num.
0m	2																
…																	
4900m	51																
5000m	52							10	10	10							
…																	
9900m	101																
10000m	102				20	20	20	20	20	20	20	20	20				
…																	
50000m	502																
Range	Row num.																

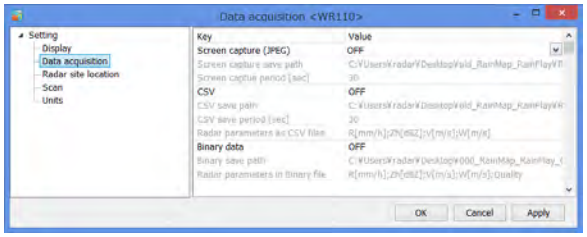
Figure 2.5: csv file for sample 2

In Figure 2.4, a building exists at a 5,000m distance from radar and in the azimuth area between 30 to 50 degrees. The building also shields the first 10 degrees of the radar's elevation. Therefore the file needs 10 degrees of elevation entered in each distance cell to 5,000m (100 x 52 rows) and each azimuth cell between 30 to 50 degrees (columns 61 to 100) in csv file.
Also a mountain exists at a 10,000m distance from radar and in the azimuth area between 20 to 60 degrees. The mountain also shields the first 20 degrees of the radar's elevation. Therefore the file needs 20 degrees of elevation entered in each distance cell to 10,000m (100 x 102 rows) and each azimuth cell between 20 to 60 degrees (columns 41 to 120) in csv file. Somehow it has to work on manually.

Save this "Clip_RainMap.csv" file into "Param" folder where locate in the "RainMap_RainPlay" folder.



2. Data acquisition



Screen capture (JPEG):
Select ON or OFF. Captures displayed screen data (jpeg).

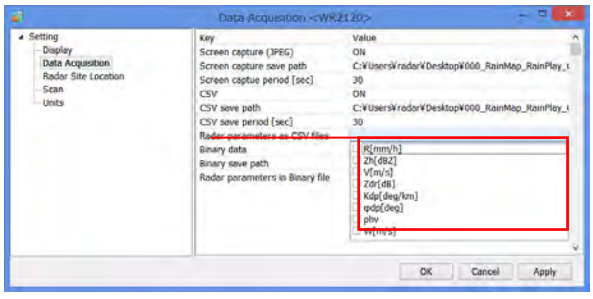
Screen capture save path:
Setup a folder location to save captured screen data.

Screen capture period:
Setup a time interval to save captured screen data.

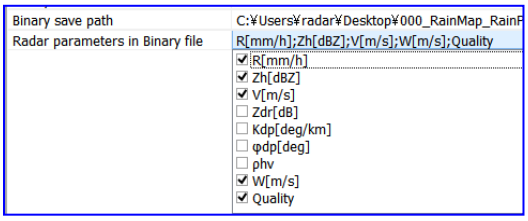
CSV:
Turn ON or OFF to save data in CSV file format. (Refer section 5.1. for detail of CSV file format)

CSV save path:
Setup a folder to save the CSV data.

CSV save period [sec]:
Setup an interval time to save the CSV data.



Radar parameters as CSV files:
Select type of parameter(s), R [mm/h], Zh [dBZ], V [m/s], Zdr[dB], Kdp[deg/km], φdp[deg], ρhv, W [m/s] to save in CSV file.



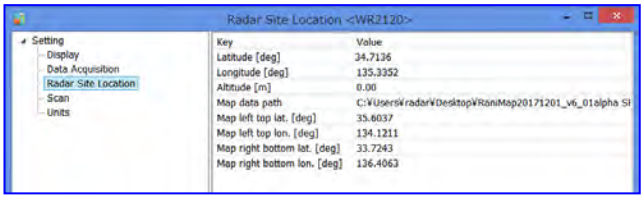
Binary data:
Turn ON or OFF to record in binary data format.
(Refer section 5.2 or 5.3. for detail of binary file format)

Binary save path:
Setup a folder to save the binary data.

Radar parameters in Binary file:
Select type of parameter(s),
R [mm/h], Zh [dBZ], V [m/s], Zdr[dB], Kdp[deg/km], φdp[deg], ρhv, W [m/s], Quality

Binary file version:
Select type of file format version,
v3 (legacy format),
v10,

3. Radar Site Location



Latitude [deg]:
Enter latitude of radar installed location.

Longitude [deg]:
Enter longitude of radar installed location.

Altitude [m]:
Enter the altitude of radar installed location.

Map data path:
Setup a background map for RainMap.
The RainMap program displays map as a cylindrical projection layer.

Map left top lat [deg]:
Setup the latitude of left top corner of Map Image.

Map left top lon [deg]:
Setup the longitude of left top corner of Map Image.

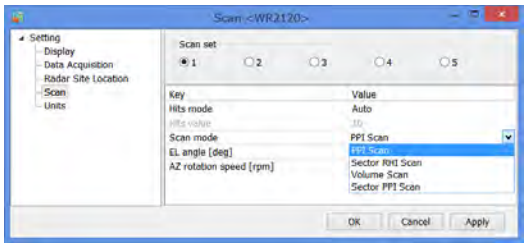
Map right bottom lat [deg]:
Setup the latitude of bottom right corner of "Map Image".

Map right bottom lon [deg]:
Setup the longitude of bottom right corner of "Map Image".

4. Scan

There are 5 scan patterns that can be customize and saved in settings.

Note:
This item is possible to change the setting even when the radar is observing.
However it is necessary to click [STBY] and [TX] again for reflecting the changes in the scan setting while observing.



Scan mode:
Select the scan mode of antenna. For PPI and Volume scan modes. It is recommended that an azimuth direction rotation speed of less than 7.0 [rpm] to maintain observation accuracy.

Table 2.1

Scan mode	Extension
PPI scan	scn or ppix
Sector RHI scan	rhi or rhix
Volume Scan	scn or scnx
Sector PPI scan	sppi or sppix

PPI scan [2D data]
[Plan Position Indicator scan]
Maintains a continuous equiangular 360 degree horizontal rotation at a single selectable elevation. It is used to observe one set elevation continuously in a 360 degree radius.
Example of Setting:
To observe a 3.5 [deg] elevation angle at a rotational speed of 7.0 [rpm] in a 360 degree azimuth radius set as shown in Table 2.2.

Table 2.2

Key	Value
EL angle [deg]	3.5
AZ rotation speed [rpm]	7.0

Sector RHI scan [3D data] (Refer to Figure 2.6)
[Sector Range Height Indicator scan]

Scans vertically (RHI) while moving horizontally, continuously within a preset azimuth and elevation range generating a 3 dimensional rectangular solid angle. Horizontal data is not saved.
It continuously moves between the preset clockwise and counter clockwise azimuth and horizontal limits.

Example of Settings:
The RainMap setting should be entered as shown in table 3 to observe the parameters shown below:

Elevation angle: 3.5 to 22.0 deg.
Range of azimuth angle: 30.0 to 60.0 deg.
Azimuth direction: 2.0 deg. (6.0 rpm interval)

Table 2.3

Key	Value
EL rotation speed [rpm]	6.0
AZ start angle [deg]	30.0
AZ end angle [deg]	60.0
AZ step angle [deg]	2.0
EL start angle [deg]	3.5
EL end angle [deg]	22.0

Volume scan [3D data] (Refer to Figure 2.7)
This mode activates PPI scan to change the elevation angle up to 32 steps. It references the Volume Scan Period and RainMap time indication.
Volume Scan is an observation of the azimuth rotation speed and multiple elevation angles as one complete pattern. Observation starts at the specified minute (0 second) of every set interval. Whatever set operation interval is used, all selected steps must be completed within the specified interval time. These volume scan periods include, 1 (60 / [h]) 1 minute, 2 minutes, 3 minutes, ..., 2 (30 / [h]) 2 minutes, 4 minutes, 6 minutes, etc. Therefore, it is necessary to consider the elevation angle value, observation rotation speed (rpm), moving speed to elevation direction (rpm), time to stabilize after elevation change (fixed at 10 deg.), and observation interval for setting.

Key	Value
Volume scan period [min]	1 (60 / [h])
Sync. Scan mode	AUTO
EL transition speed [rpm]	4.0
AZ rotation speed [rpm]	7.0
EL angel 0	3.5
EL angel 1	5.5
EL angel 2	9.0
EL angel 3	12.0
EL angel 4	16.2
EL angel 5	22.0

Table 2.4

For example setting will fail with following settings. 6.0 rpm azimuth rotation speed for 6 rotations in one minute would seem to be a correct setting when observing 6 elevation angles with 1 minute intervals (setting the operation interval to 1 (60 / [h]). However in Volume Scan, movement occurs in the elevation direction and does not display while moving from one elevation to the next elevation Because of the additional time required for these elevation movements the above observation scenario of 6.0 [rpm] AZ rotation speed cannot be completed within the 1 (60 / [h]) volume scan period.

Key	Value
AZ rotation speed [rpm]	7.0
AZ start angle [deg]	30.0
AZ end angle [deg]	60.0
EL angle 0 [deg]	3.5
EL angle 1 [deg]	5.5
EL angle 2 [deg]	9.0
EL angle 3 [deg]	12.0
EL angle 4 [deg]	16.2
EL angle 5 [deg]	22.0

Table 2.5

Example setting:
When observing these 6 elevation angles (3.5 / 5.5 / 9.0 / 12.0 / 16.2 / 22.0 [deg]) every one minute, they can observed within a 58 second period by using settings in Table 2.4.
(Rotation set to 7.0 [rpm] in azimuth direction)

Note 1: The ending time of scenario will be different if elevation angle [deg] is different even when using the same (0 to 5) elevation numbers.
Note 2: Elevation movement azimuth rotation speed [deg] is fixed at 6.0 deg.

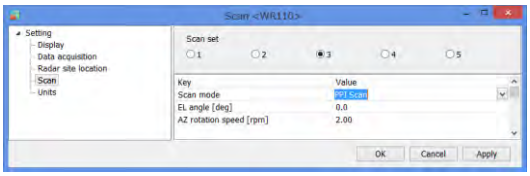
Note 3: When elevation movement mode is set to "AUTO" the upper limit value of elevation movement speed can be set to 6.0 [rpm]. After the observation of one elevation angle the movement to the next observed elevation can be completed faster. It is possible to select "MANUAL", but "AUTO" setting is recommended.

Sector PPI scan (Refer to Figure 2.8)
[Sector Plan Position Indicator scan]
Scan horizontally within a preset azimuth area while changing elevation based on up to 32 possible values generating a 3 dimensional rectangular solid angle.

Example of setting:
The RainMap settings are shown in Table 3 for the observation scenario below:
Azimuth: 30.0 to 60.0 deg.
Elevation: 3.5 / 5.5 / 9.0 /12.0 / 16.2 /22.0 deg. (6 elevation steps)
Azimuth rotation speed: 7.0 rpm.

Note: Elevation movement azimuth rotation speed [deg] is fixed at 6.0 deg.

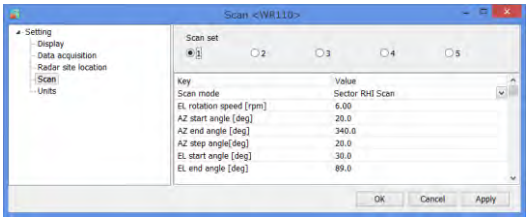
PPI scan



EL angle [deg]:
Set angle of antenna's elevation during PPI mode.

AZ rotation speed [rpm]:
Set azimuth rotation speed at fixed azimuth angle.

Sector RHI scan



EL rotation speed [rpm]:
Set elevation speed of SRHI.

AZ start angle [deg]:
Set angle of start azimuth range.

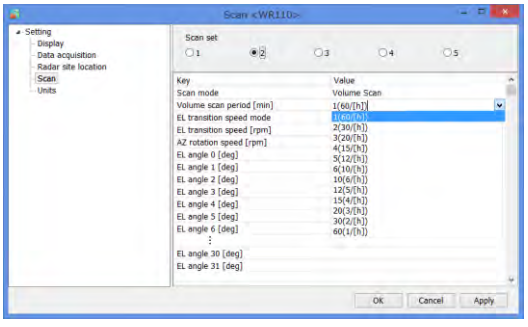
AZ end angle [deg]:
Set angle of end azimuth range.

EL end angle [deg]:
Set elevation end angle for observation area.

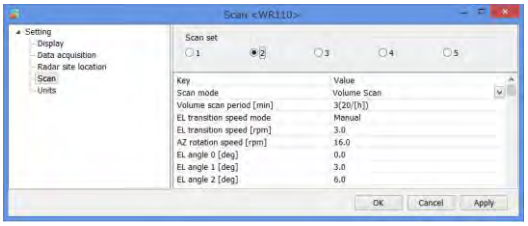
AZ step angle [deg]:
Set quantity of antenna rotation while changing azimuth angle.

EL start angle [deg]:
Set elevation start angle for observation area.

Volume scan



Volume scan period [min]:
Select a volume scan movement period from 1(60/[h]) / 2(30/[h]) / 3(20/[h]) / 4(15/[h]) / 5(12/[h]) / 6(10/[h]) / 10(6/[h]) / 12(5/[h]) / 15(4/[h]) / 20(3/[h]) / 30(2/[h]) / 60(1/[h])
e.g.: Volume scan will activate every 2 minutes if 2/30/(H) selected. (It activates 30 times per hour), the measurement start time will be; 00, 02, 04, ..., 58 seconds in Data Processing Unit.



EL transition speed mode:
Select speed mode of elevation "Auto" or "Manual".
Note: Basically select [Auto] mode.
- **Auto:** RainMap adjusts speed of radar elevation automatically in 4 rpm increment.
- **Manual:** Input speed value setting manually

except for 4 rpm.

EL transition speed [rpm] (Manual setting):

Set an elevation direction rotation speed during elevation change in volume scan (Horizontal Sequence) observation.

Elevation direction rotation speed = [Volume Scan elevation moving direction of rotation speed] + [Volume Scan elevation movement difference of rotation speed]

AZ rotation speed [rpm]:

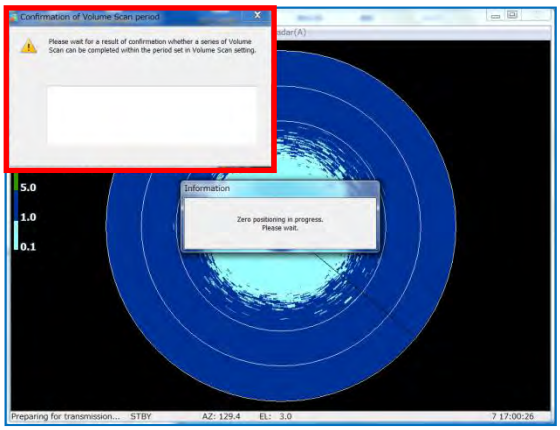
Set volume azimuth rotation speed for each elevation.

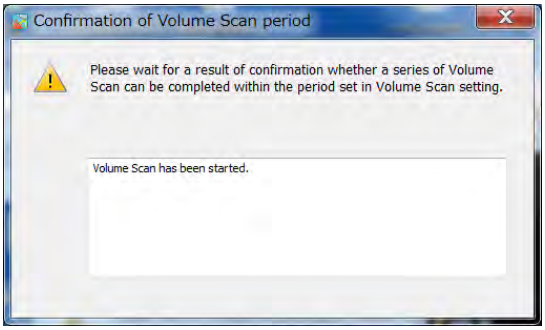
EL angle 0 – 31 [deg]

Set each elevation variation, up to 32 different values. It automatically sorted in ascending order of elevation setting value.

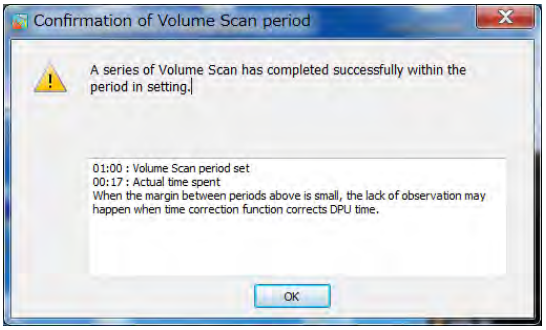
Status of volume scan screen:

Start observation after the volume scan setting, it will show an information of progressing and confirmation of volume scan period. It shows only when using the volume scan.

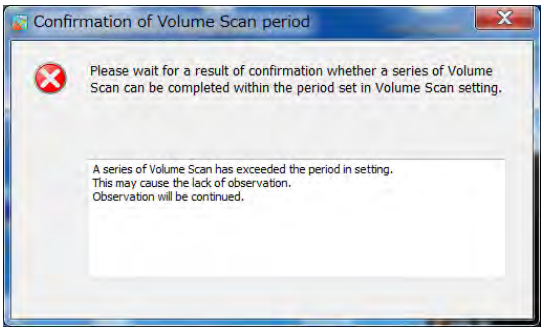




Correct setting message:



Wrong setting message:



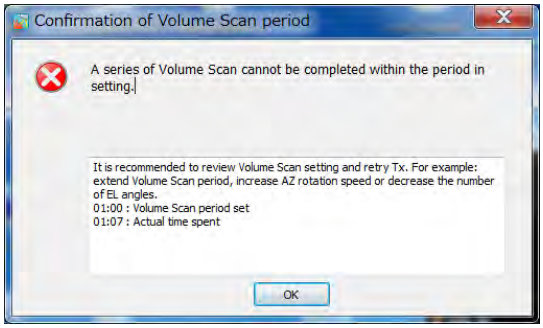
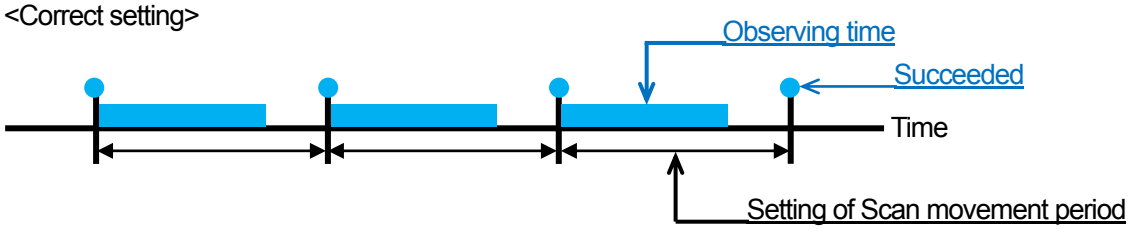
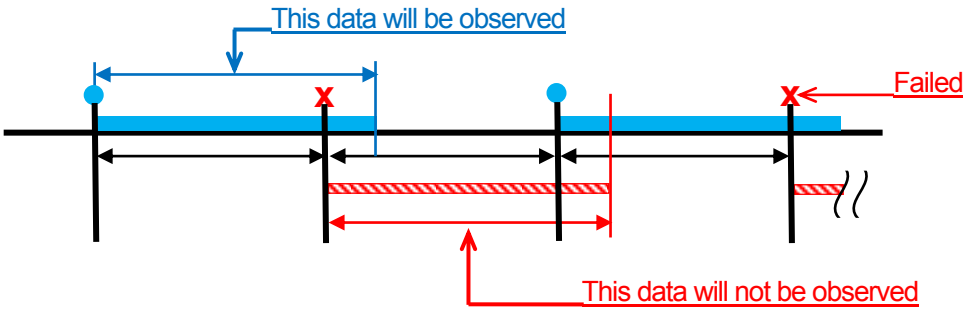


Image of observation timing:

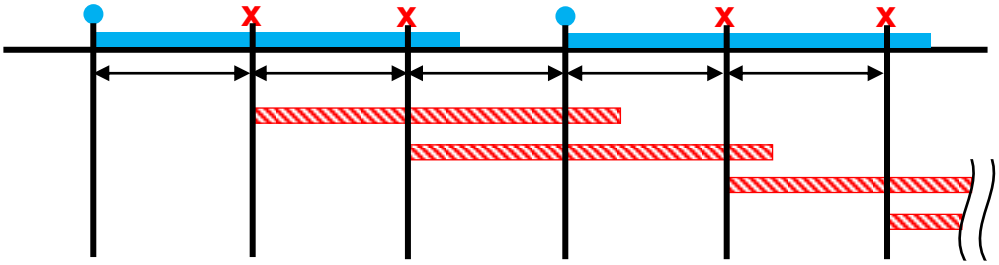
<Correct setting>



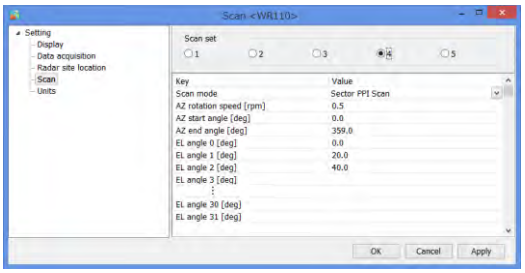
<Wrong setting pattern 1>



<Wrong setting pattern 2>



Sector PPI scan

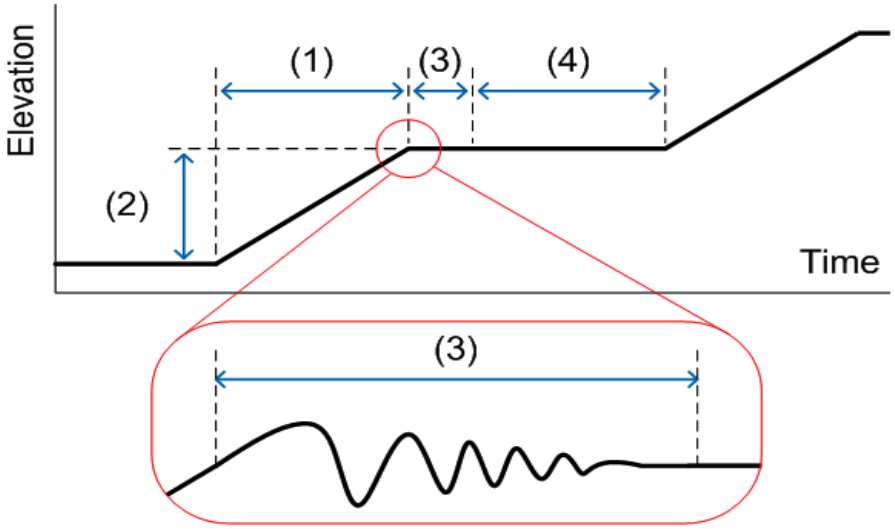


AZ rotation speed [rpm]:
Setup an azimuth rotation speed at fixed azimuth angle.

AZ start angle [deg]:
Setup the preset starting azimuth range.

AZ end angle [deg]:
Setup the preset ending azimuth range.

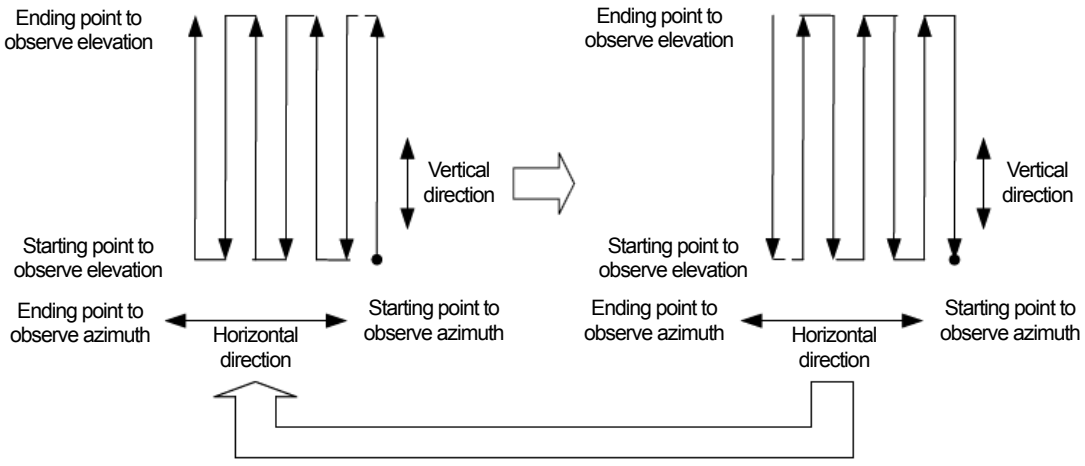
EL angle 0 – 31 [deg]:
Setup each elevation variation, up to 32 different values. It automatically sorted in ascending order of elevation setting value.



(1) Volume scan elevation movement azimuth rotation speed
(2) Volume scan elevation movement difference rotation speed
(3) Volume scan status delay azimuth revolution
*It needs time to wait for the antenna vibrations to disappear
(4) Volume scan measurement azimuth rotation speed

Table 2.6. Rotation speed range

Menu	Range
PPI azimuth rotation speed	0.5 to 16.0rpm
SRHI elevation	0.5 to 6.0rpm
Volume scan elevation movement azimuth rotation speed	0.5 to 16.0rpm
Volume scan elevation movement difference rotation speed	0.5 to 6.0rpm
Volume scan measurement azimuth rotation speed	0.5 to 16.0rpm
Antenna rotation speed	0.5 to 16.0rpm



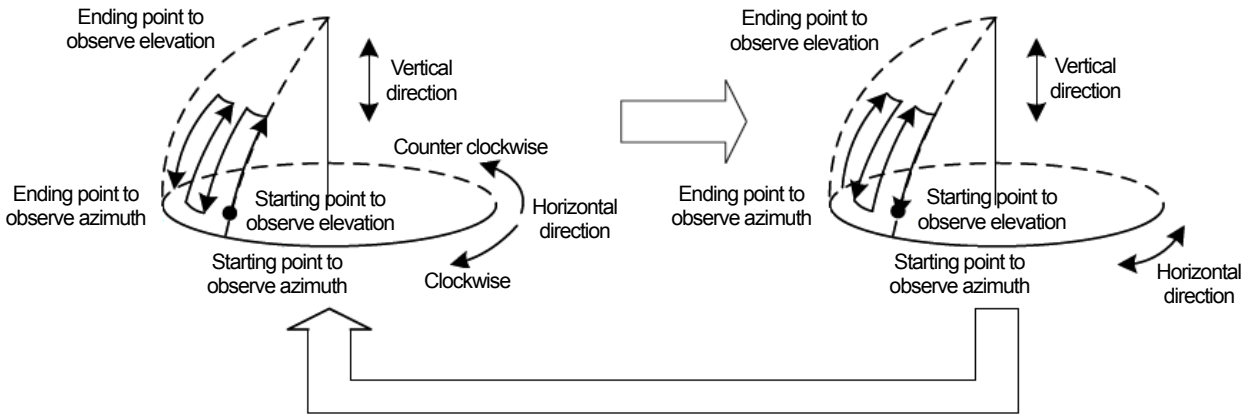


Figure 2.6: SRHI scan mode

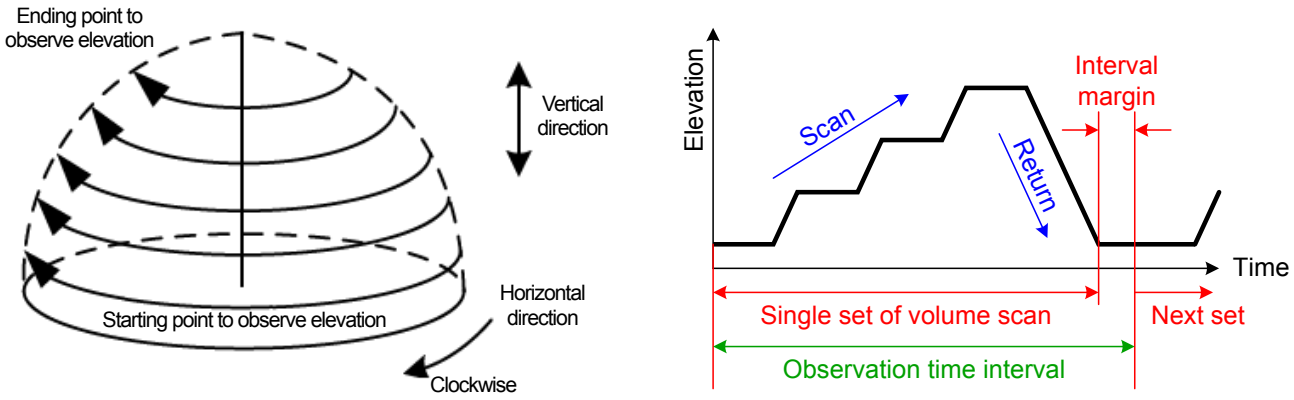


Figure 2.7: Volume scan mode

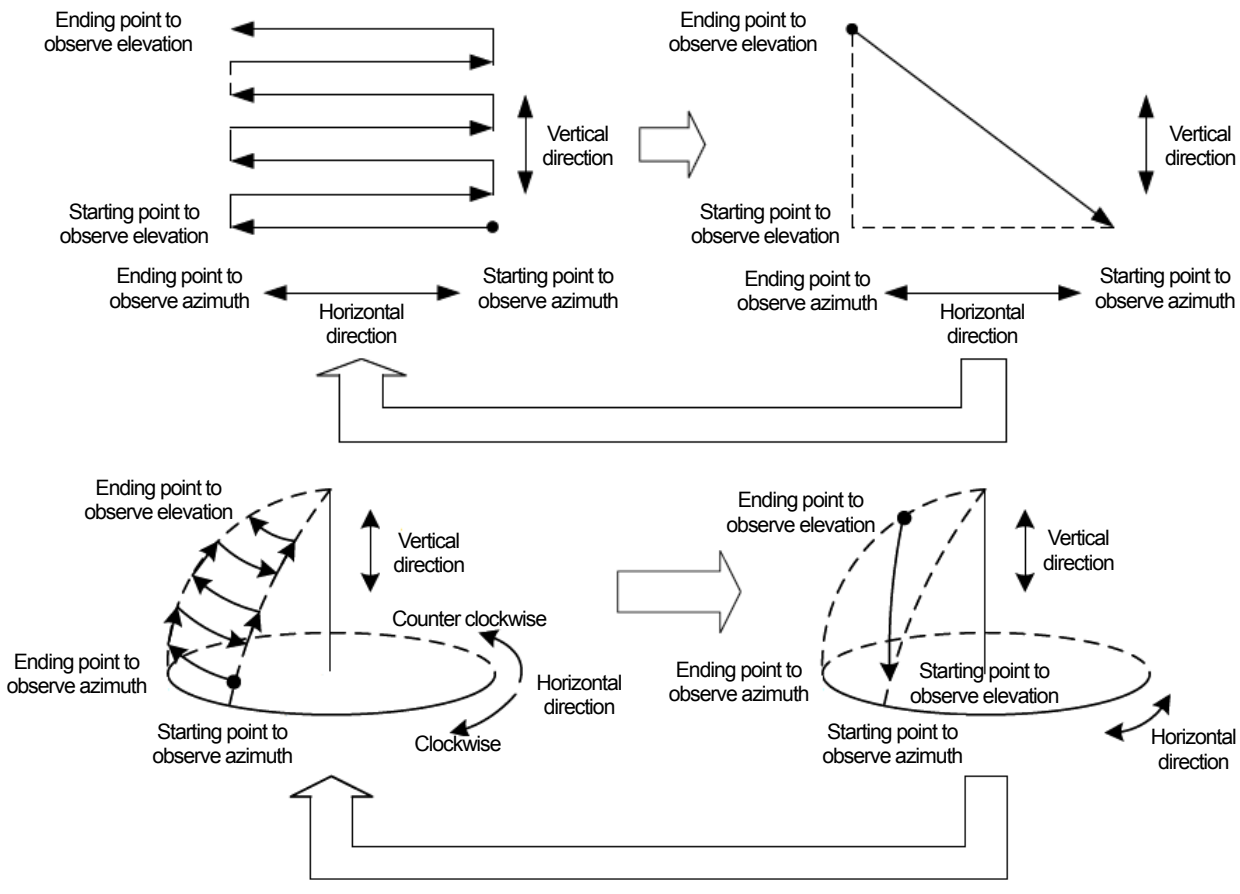


Figure 2.8: SPPI Scan mode

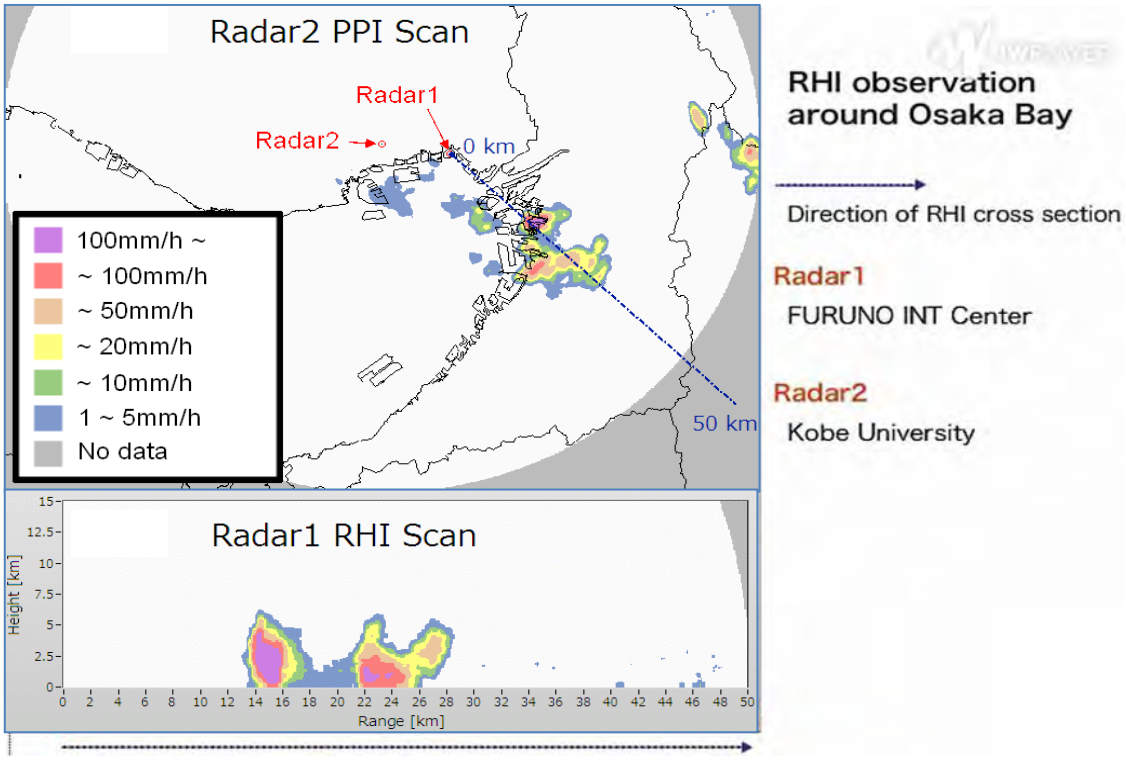


Figure 2.9: Range Height Indicator

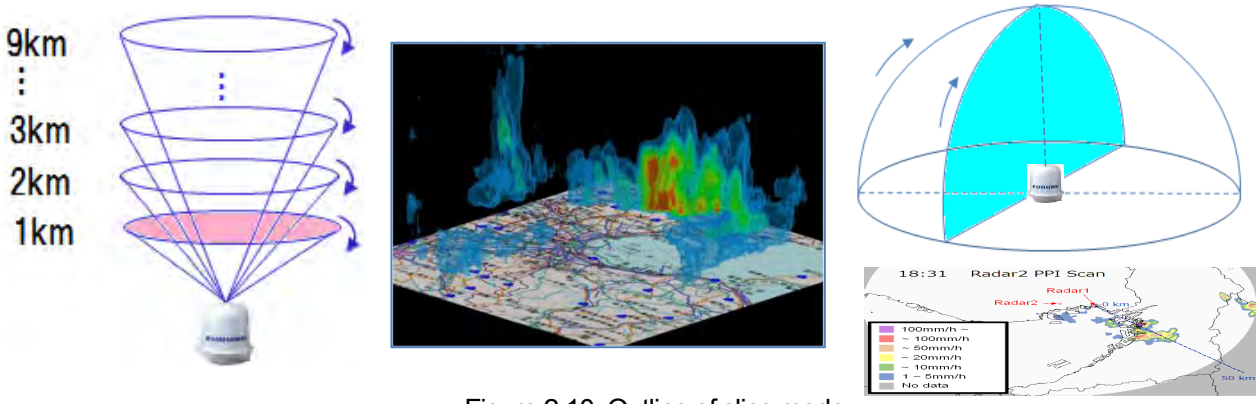


Figure 2.10: Outline of slice mode

About antenna rotation:

Basically the antenna is rotating clockwise based on the azimuth origin during PPI and Volume scan as shown on Figure 2.6.

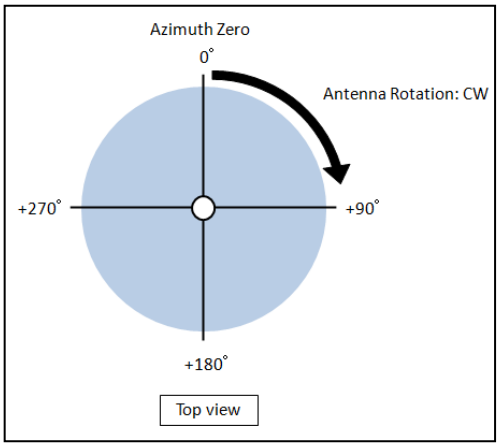


Figure 2.11: Antenna rotation

Recommend values for pulse setting:

In radar operations it is necessary to select the optimum setting for the location while considering all related trade-offs.

For example; there is no way to observe rain with high accuracy using a fast antenna rotation speed or having wide detection range, high PRF, high sensitivity, and high resolution.

The length of the detection range and the value of PRF are a trade-off relationship. High sensitivity and high resolution are also generally another trade-off relationship. It is also difficult to achieve both high antenna rotation speed and precise precipitation observation.

The general trade-offs of radar, operational precautions, etc. are described in the World Meteorological Organization's "WMO GUIDE TO METERROROLOGICAL INSTRUMENTS AND METHODS OF OBSERVATION (the CIMO Guide, WMO-No. 8) PART 2 OBSERVING SYSTEMS CHAPTER 7 Radar measurements" Since it is written in detail, please refer to when configuring the radar.

For some observational tradeoffs, please select the optimal setting which best fits the radar installed location using Table 2.7 or Table 2.8 below.

Table 2.7: Pulse setting

Pulse No.	RX	Non-modulation pulse width	Short pulse range	Modulation pulse width		PRF1	PRF2	Resolution	Sensitivity	PRF
	[km]	[μs]	[km]	[μs]	[MHz]	[Hz]	[Hz]	[m]		
1-1	30	0.5	3.3	20	4	2000	1600	75	Low	High
1-2	30	1	4.8	30	2	2000	1600	150	Mid	High
1-3	50	1	6.3	40	2	1700	1360	150	Low	Mid
1-4	70	1	7.8	50	2	1300	1040	150	Low	Low
1-5	50	2	7.8	50	2	1600	1280	75/150 Mix*	Mid	Mid
1-6	30	2	4.8	30	1	2000	1600	300	High	High
1-7	50	2	6.3	40	1	1700	1360	300	Mid	Mid
1-8	70	2	7.8	50	1	1300	1040	300	Mid	Low
2-1	30	0.5	3.3	20	4	1900	1520	75	Low	High
2-2	30	1	4.8	30	2	1850	1480	150	Mid	High
2-3	50	1	6.3	40	2	1575	1260	150	Low	Mid
2-4	70	1	7.8	50	2	1200	960	150	Low	Low
2-5	50	2	7.8	50	2	1450	1160	75/150 Mix*	Mid	Mid
2-6	30	2	4.8	30	1	1850	1480	300	High	High
2-7	50	2	6.3	40	1	1575	1260	300	Mid	Mid
2-8	70	2	7.8	50	1	1200	960	300	Mid	Low
3-1	30	0.5	3.3	20	4	1825	1460	75	Low	High
3-2	30	1	4.8	30	2	1750	1400	150	Mid	High
3-3	50	1	6.3	40	2	1475	1180	150	Low	Mid
3-4	70	1	7.8	50	2	1125	900	150	Low	Low
3-5	50	2	7.8	50	2	1350	1080	75/150 Mix*	Mid	Mid
3-6	30	2	4.8	30	1	1750	1400	300	High	High
3-7	50	2	6.3	40	1	1475	1180	300	Mid	Mid
3-8	70	2	7.8	50	1	1125	900	300	Mid	Low

Note:

1. Pulse No.3-2 means PRF pattern = 3 and Pulse set = 2 in RainMap TX setting.
2. The values of PRF are slightly different between No.1-1, No.2-1, and No.3-1. The same applies to No. 1-2, No.2-2, No.3-2, and subsequent values.
3. Method of using No.1-1, No.2-1, and No.3-1 properly: For example if changed from No.1-1 to No.2-1 or No.3-1, when No.1-1 scans it may have interference waves from other transmissions. However there are cases when this interference influence can be reduced.
4. Mix*: Short pulse is 150, and long pulse is 75. It does not affect to scn file.
5. Non-modulation pulse width is P0N, Modulation pulse width is Q0N.

High sensitivity: Approximately 1mm/h can be observed.
Middle sensitivity: Approximately 1.5mm/h can be observed.
Low sensitivity: Approximately 2.5mm/h can be observed.

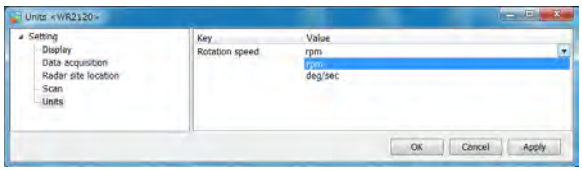
PRF1 High: 1700 to 2000Hz (Doppler range ±54.6 to ±64.2m/s)
PRF1 Middle: 1300 to 1700Hz (Doppler range ±41.7 to ±54.6m/s)
PRF1 Low: 1100 to 1300Hz (Doppler range ±35.2 to ±41.7m/s)

Table 2.8: Rain precision examples

		Antenna rotation speed [rpm]				
		1	2	4	6	10
PRF	High	Very Good	Very Good	Good	Good	Not Good
	Mid	Very Good	Good	Good	Not Good	Not Good
	Low	Very Good	Good	Good	Not Good	Not Good

5. Units

Rotation speed:
Select the type of rotation speed indicator.



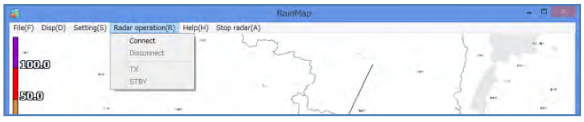
4) Radar operation

Connect:
Connect the network between DPU and ATU.

Disconnect:
Disonnect the network between DPU and ATU.

TX:
Transmit and receive signals for weather observation.

STBY:
Stop and standby transmit and receive signals.

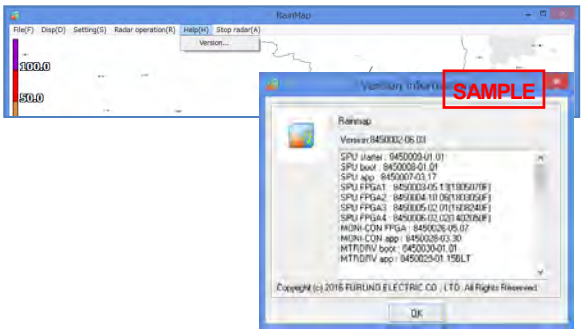


5) Help

Version:
Indicates version of software and connecting devices.

Note: It indicates only when radar operation is connected.

(RainMap, PXI app / Moni-Con FPGA / Moni-Con app / MTRDRV boot / MTRDRV app)



6) Stop radar

Stop radar:
Stops both radar motor and TX.

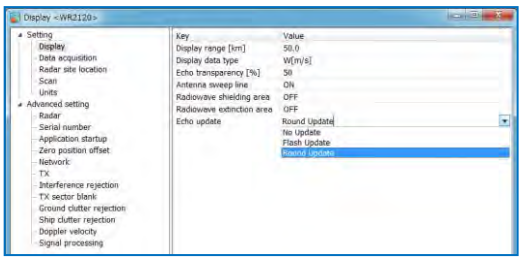
2.4. Advanced Setting

1) Setting

Press [Ctrl] + [Alt] and click [Setting] simultaneously to open advanced menu in the settings menu.

1. Display

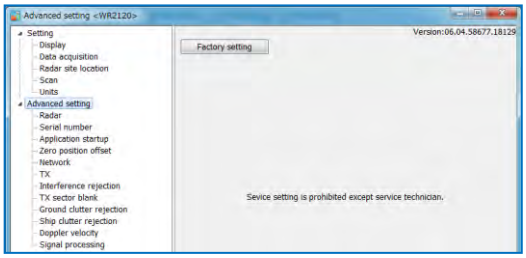
Echo update:



Select the echo display update type:

- No Update:
  Radar echo will not display on screen.
  This can substantially reduce the CPU load.
- Flash Update:
  Radar echo display will only update after one full rotation. This can help reduce the CPU load.
- Round Update (Default setting):
  Updates the Radar echo display in real-time. It keeps loading a standard CPU. (Default setting)

Note: [Factory setting] in the Advanced setting menu is for manufacturer use only.



2. Radar: Only for the manufacturer use.

3. Serial number (Only for the manufacturer use)

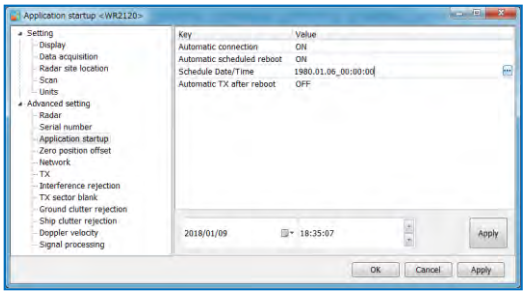
Serial number: Indicate the serial number of the radar.

Product number: Indicate the product number of the radar.

Product name: Indicate the product name of the radar.

4. Application Startup

Automatic connection:



ON: It will automatically connect and start TX operation after RainMap startup.

OFF: It will not connect and TX the RainMap after startup. Therefore it has to connect and start TX manually when set this off.

Automatic schedule reboot:

Select ON or OFF. It uses a preset schedule to reboot the radar automatically. (It will not connect to the radar)

Schedule Date/Time:

Setup the schedule for year/month/date/time (hh/mm/ss) to restart RainMap and PC automatically.

Automatic TX after reboot:

ON: It will restore to the previous state before the RainMap was restarted.

OFF: This function is not implemented.

e.g.1: If set to [ON], RainMap will connect and automatically start TX operation again if RainMap was previously connected and radar was in TX mode before restarting the DPU.

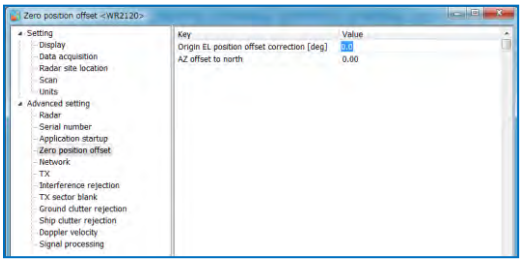
e.g.2: If set to [ON], RainMap will stay at startup only (it will not connect and start TX) if RainMap was previously not connecting to the radar before restarting the DPU. (Automatic connection setting must be OFF)

e.g.3: If set to [ON] and Automatic connection [ON] RainMap will connect and automatically start TX operation even if RainMap was not previously connecting to the radar before restarting the DPU.

5. Zero position offset

Origin EL position offset correction [deg]:

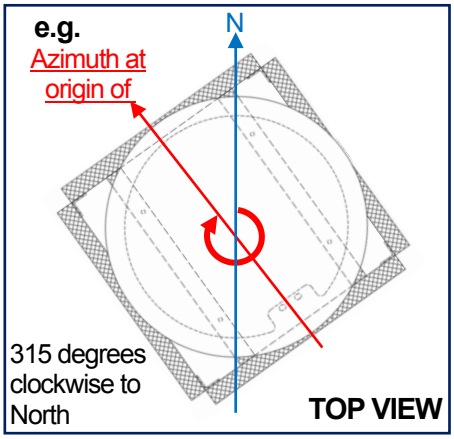
Setup an elevation offset from horizontal level.
Measure the elevation angle after antenna initialization and set the offset field.



AZ offset to north:

Setup an azimuth offset angle clockwise from origin of radar.

e.g.: The azimuth origin of the radar is 45 degrees (measured value) from north. This means 315 degrees difference from north to the azimuth origin.
The value to input into "Azimuth Offset" is 315 degrees.
To clarify it is set as a positive degree offset from north to the azimuth origin.



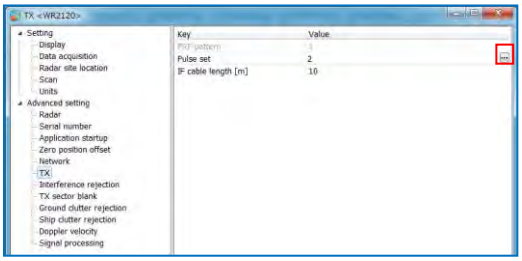
6. Network: Only for the manufacturer use.

7. TX

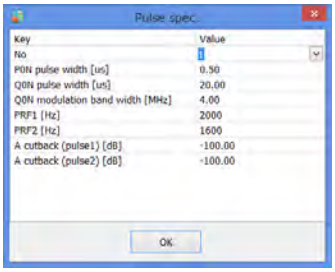
PRF pattern: Select PRF pattern from 1 to 3. Details are written in Table 2.7.

Pulse set:

Select pulse number pattern from 1 to 8 by clicking […] button.
Setting values will be adjusted automatically by using noise measurement. Also values of A-threshold could manually change.



- PRF 1 [Hz] is using a short cycle for dual cycle signal processing.
- PRF 2 [Hz] is using a long cycle for dual cycle signal processing.
- A-threshold (pulse 1) [dB] is P0N.
- A-threshold (pulse 2) [dB] is Q0N.

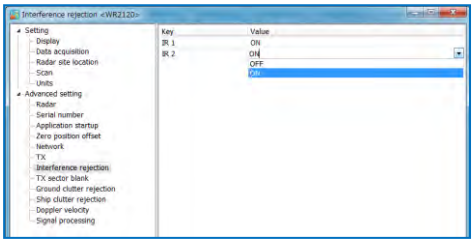


Note: A-threshold is to eliminate a background noise of received signal.
P0N: Sequence of pulses without modulation (CW) used for short range detection
Q0N: Sequence of frequency modulated pulses used for long range detection.
Note: Click [STBY] to select a pulse set, and it is necessary to click [OK] button after every changing a parameter to reflect.

IF cable length [m]:

Enter the length of signal cable between Antenna Unit and Signal Processing Unit.

8. Interference rejection



Many radar designs include an operator-selectable feature called interference rejection (IR). The purpose of IR is to reject or suppress interference into a radar receiver from co-channel transmissions from other radars. For reasons that will presently become clear, IR is not effective against non-radar (communication -type) signals. IR is especially useful in radar bands in which large numbers of radars are tuned to the same frequency.

IR 1, 2:

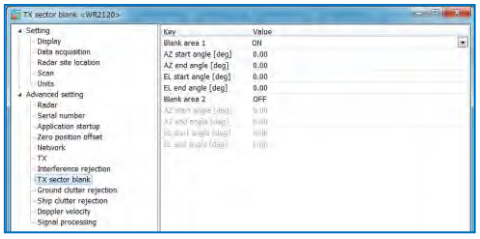
Select ON or OFF. Turn ON to reject interference.

IR1 will reject the part of before matched filter (pulse compression).

IR2 will reject the part of after matched filter (pulse compression).

Note: This does not use strength level to reject interference

9. TX sector blank



Blank area 1 and 2:

Turn ON or OFF sector blanking

AZ start angle [deg]:

Setup a starting angle of azimuth to create a sector blank.

AZ end angle [deg]:

Setup the ending angle of azimuth to create a sector blank.

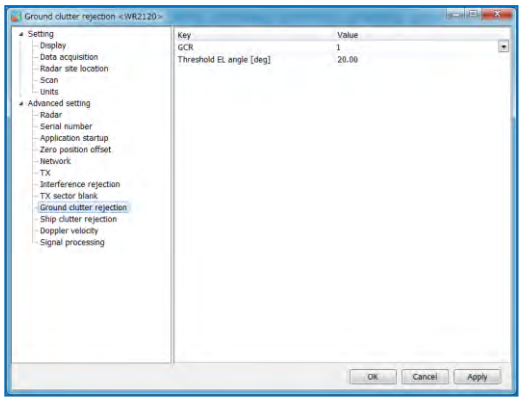
EL start angle [deg]:

Setup the starting angle of elevation to create a sector blank.

EL end angle [deg]:

Setup the ending angle of elevation to create a sector blank.

10. Ground clutter rejection



GCR:

Select OFF, 1, or 2 to whether remove ground clutter as a target if moving speed is lower than setting speed.

OFF: Ground clutter will not be rejected.

1: Reject the ground clutter by using observed data with MTI (Moving Target Indicator) process. (Instead of V and W)

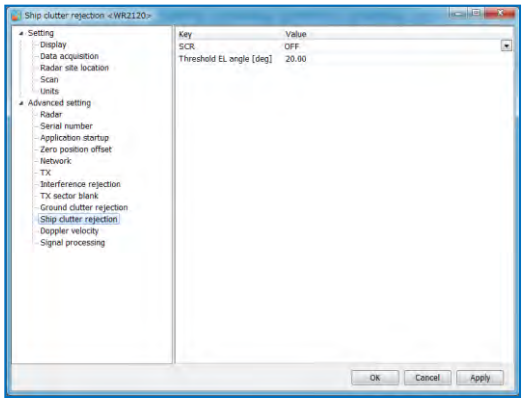
2: Reject the ground clutter of Rain data based on data of Reference folder (scr)

(Refer section 5.2. for detail of scr)

Threshold EL angle [deg]:

Setup the threshold elevation angle.

11. Ship clutter rejection



SCR:

Select OFF, 1, or 2 to whether remove ship clutter as a target if moving speed is lower than setting speed.

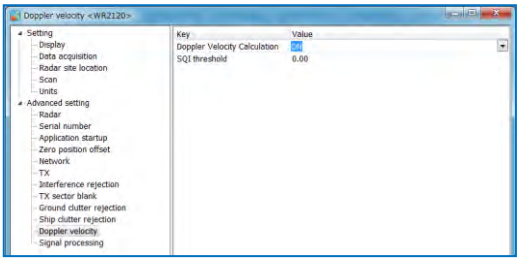
OFF: Ship clutter will not be rejected.

1: Reject the ship clutter by using observed data

Threshold EL angle [deg]:

Setup the threshold elevation angle.

12. Doppler velocity



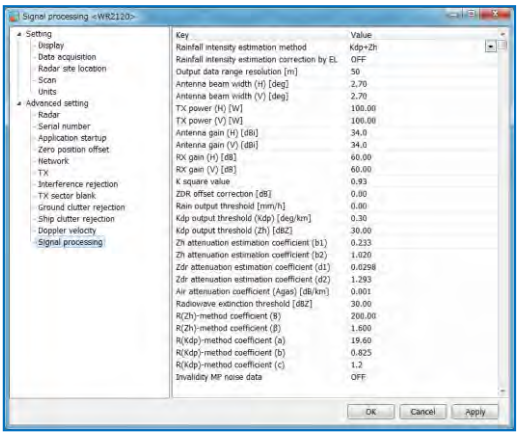
Doppler Velocity Calculation:

Select ON or OFF to calculate the Doppler velocity.

SQI threshold:

Setup SQI (Signal Quality Index) threshold (0.00 to 1.00)

13. Signal processing



Rainfall intensity estimation method:

Select a Rainfall intensity estimation type.

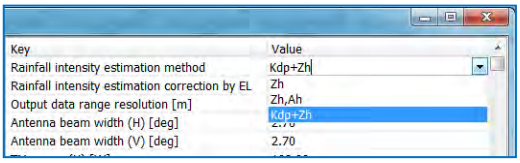
- **Zh:** Use horizontal amplitude information only.
- **Zh, Ah:** Zh is calculated from the value that corrected rain attenuation by the Ah method.
- **Kdp+Zh:** Use complex information, amplitude, and phase.

Rainfall intensity estimation correction by EL:

Select ON or OFF to correct rainfall intensity estimation by degree of elevation.

Output data range resolution [m]:

It is a data separation in range direction. If set this value to 75 m, data will output every 75 m.
It recommends using that which has set on the resolution of pulse setting in Table 2.7.



However, required data can not be acquired if the resolution of Output data range resolution is larger than the set pulse

Antenna beam width (H) [deg]:

It is a half power width of main lobe on horizontal plane. (Not affected to physical beam width)

Antenna beam width (V) [deg]:

It is a half power width of main lobe on vertical plane. (Not affected to physical beam width)

TX power (H) [W]:

It sets the power apply to antenna. (Not affected to physical TX power)

Antenna gain (H) [dBi]:

This gain is according to the basic definition of horizontal, in which the antenna is compared to an isotropic radiator. (Not affected to physical Antenna gain)

Antenna gain (V) [dBi]:

This gain is according to the basic definition of vertical, in which the antenna is compared to an isotropic radiator. (Not affected to physical Antenna gain)

RX gain (H) [dB]:

It is the gain of whole receiver chain to horizontal. (Not affected to physical RX gain)

RX gain (V) [dB]:

It is the gain of whole receiver chain to vertical. (Not affected to physical RX gain)

K square value:

It is a parameter proportional to raindrop's refractive index. The default value for rain is 0.93.

ZDR offset correction [dB]:

Setup a value of Zdr to revise amplitude deviation of horizontal and vertical.

Rain output threshold [mm/h]:

It is a data threshold in rainfall intensity. Default setting will be 0mm/h that may see a joint part between P0N and V0N. Change the setting to around 0.5 [mm/h] if it is annoying. If you want to observe even to the light rain, then set this threshold to below 0.5 [mm/h].

Kdp output threshold (Kdp) [deg/km]:

Setup Kdp value of Signal processing to calculate Propagation phase difference rate of change Kdp[deg/km]. The default value is 0.3 [deg/km]. Lower than default value is not recommended.

Kdp output threshold (Zh) [dBZ]:

Setup Zh value of Signal processing to calculate Propagation phase difference rate of change Kdp[deg/km]. The default value is 30 [dBZ]. Lower than default value is not recommended.

Zh attenuation estimation coefficient (b1) (b2):

Setup two types of the signal processing coefficients (b1, b2) to calculate the rainfall attenuation for Zh.

Zdr attenuation estimation coefficient (d1) (d2):

Setup two types of the signal processing coefficients (d1, d2) to calculate the rainfall attenuation for Zdr.

Air attenuation coefficient (AGAS) [dB/km]:

Setup the coefficient to attenuate the air.

Radiowave extinction threshold [dBZ]:

Setup a value for whether or not to determine signal extinction which compare with a signal extinction and a value comes with rainfall attenuation value (Ah) and propagation phase difference rate (Kdp).

R (Zh)-method coefficient (B):

These are parameter of Z-R relation: Z = BR^β

Here, Z [mm^6/m^3] is reflectivity factor and R [mm/h] is rainfall intensity. The default value for rain is 200 and 1.6, respectively.

Enter a value for Z-R relationship parameter of “B” coefficient.

R (Zh)-method coefficient (β):

Enter a value for Z-R relationship parameter of “**β (Beta)**” coefficient.

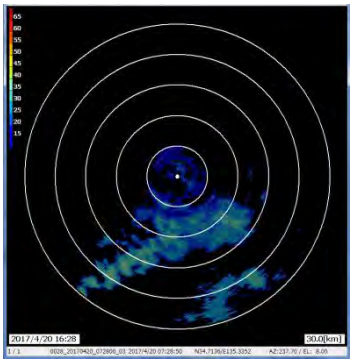
R (Kdp)-method coefficient (a), (b), (c):

a, b, c are setting for the coefficient to calculate Kdp[deg/km] to rainfall intensity R (Kdp)[mm/h].

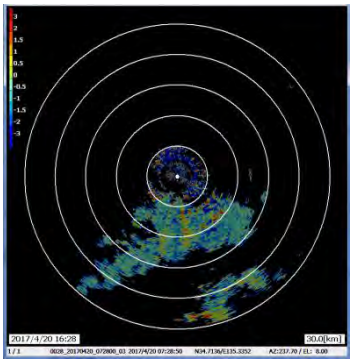
Calculation method: Rain (Kdp) = $c \times a \times Kdp^{b}$

Invalidity MP noise data:

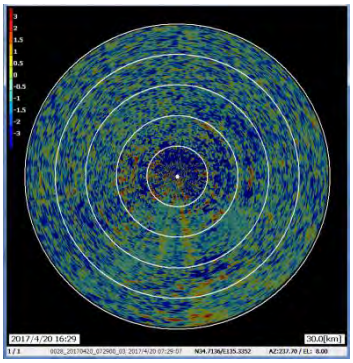
This is the function to invalid Zdr, ρhv, φdp, Kdp when Zh is under A cutback value. Invalid the noise of Multiple Parameter by ON/OFF switch.



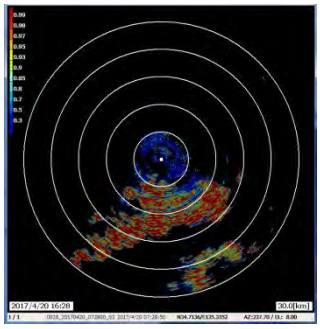
Zh



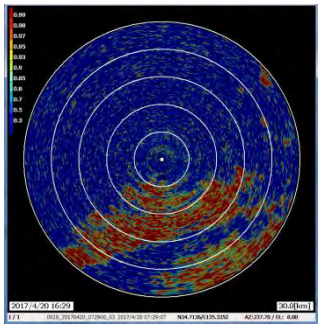
Zdr
Invalid MP Noise “ON”



Zdr
Invalid MP Noise “OFF”



φdp
Invalid MP Noise “ON”



φdp
Invalid MP Noise “OFF”

Note: Default value: Z = 200 R ^ 1.6 refers to Marshall-Palmer relation.
Please refer to the CIMO Guide to change the coefficient, please be aware of the possibility that rainfall error may increase.
(RM: Marshall, J. S., and W. McK. Palmer, 1948: The distribution of raindrops with size. J. Meteor., 5, 165–166.)

2.5. Precipitation Estimates Methods

It is possible to accommodate by adjusting the following parameter if rainfall is large or small.

Zh method

1. Use standard equation, $\mathrm{Rain(Zh)} = \left(\frac{1}{\mathrm{B}}\right)^{\frac{1}{\beta}} \times 10^{\frac{\mathrm{Zh}}{10\times\beta}}$
2. Parameters “B” and “β” are able to set by maintenance interface.
   Default value of “B” is 200. ”β” is 1.6. Zh unit is using $\mathrm{mm}^6/\mathrm{mm}$.

Zh, Ah decay correction method

1. Calculate Zh_{corr} from Zh and Ah

$$\mathrm{Ah(i)} = \mathrm{b1} \times \mathrm{Kdp(i)}^{\mathrm{b2}}$$

$$\mathrm{Zh_{corr}(i)} = \mathrm{Zh(i)} + 2 \times \sum_{\mathrm{i=0}}^{\mathrm{i}} \mathrm{Ah(i)} \times \frac{\Delta \mathrm{r}}{1000}$$

2. Where, the parameters b1, b2 and range bin data resolution $\Delta \mathrm{r}$ are able to set by maintenance interface. Default values are 0.233, 1.020 and 0.1 [km], respectively.
3. Calculate rainfall intensity R from Zh_{corr} using same method of “Zh method” previously described.

$$\mathrm{Rain}(Zh_{corr}) = \left(\frac{1}{\mathrm{B}}\right)^{\frac{1}{\beta}} \times 10^{\frac{Zh_{corr}}{10\times\beta}}$$

Kdp+Zh method

1. Calculate rainfall intensity R from Kdp. This calculation will be selected by the elevation correction setting of RainMap.
2. Calculate the rainfall intensity R from “Kdp” or from “Zh”. This will be selected by thresholds setting of RainMap.

$$\mathrm{Rain(Kdp)} = \mathrm{c} \times \mathrm{a} \times \mathrm{Kdp}^{\mathrm{b}} \qquad \text{(eq.5)}$$

$$\mathrm{Rain(Kdp)} = \mathrm{c} \times (\mathrm{a} + 2.64 \times 10^{-2} \times el + 1.73 \times 10^{-3} \times el^2 + 1.09 \times 10^{-4} \times el^3) \times \mathrm{Kdp}^{\mathrm{b}} \qquad \text{(eq.6)}$$

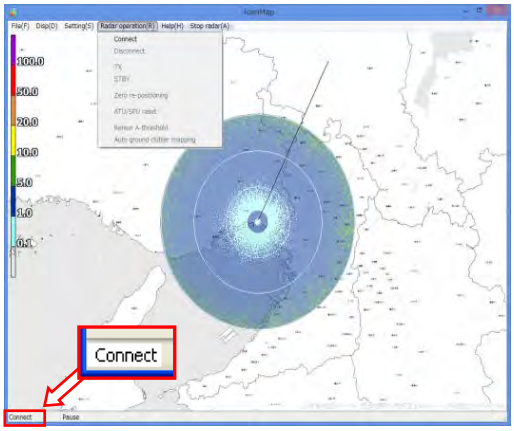
3. Where, the parameters a, b, and c are able to set by maintenance interface. Default values are 19.6, 0.825 and 1.2, respectively.

$$\text{Rainfall intensity R} = \begin{cases} \mathrm{Rain(Kdp)} & \mathrm{Kdp} > th(\mathrm{Kdp}) \\ \mathrm{Rain(Zh)} & \mathrm{Zh} > th(\mathrm{Zh}) \\ & \text{other} \end{cases}$$

4. Where, the parameters $\mathrm{th(Kdp)}$ and $\mathrm{th(Zh)}$ are able to set by maintenance interface. Default values are 0.3 [deg/km], and 30 [dBZ], respectively.

2.6. Radar Adjustment

Press [Ctrl] + [Alt] + [Radar Operation] simultaneously to display the adjustment menu in the menu bar.



1) Turn on the power of Data Processing Unit
2) Software will start automatically.
3) Click [Connect] button to start radar operation. [Connect] will be displayed in the left bottom.
4) Click [TX] button to start observation.
5) Radar echoes will display with rotate scanning line after on-screen message "[Initializing]".
6) Click [STBY] button to stop observation.
7) Click [Disconnect] button to disconnect from radar.

Notice:

The following commands will not operate without connecting radar:

- Radar operation (Connect/Disconnect, TX/STBY).
- Screen capture.

Starting radar in cold weather:

If initialization of transmit [TX] fails after turning on the ATU power in cold weather, wait for a period of time with the power on and then try [TX] again.

1. Zero re-positioning

It forces the radar antenna to re-acquire the origin (zero point) direction if an elevation failure occurs.

2. ATU/SPU reset

It forces ATU to reboot. Only use when error occurs during normal operations.

3. Renew A-threshold

Notice: A-threshold has been adjusted at factory, therefore it uses only when really necessary but it still have to adjust by [Pulse spec.] in [TX] setting menu (Refer to section 2.2.1) 7) after this operation.

Click [Renew A-threshold] to adjust the noise level after clicking [Connect]. It will start receiving radar and then stop automatically after adjustment. Also it will overwrite to A-threshold.

Caution: DO NOT engage function arbitrarily or current optimized data may be erased.

4. Auto ground clutter mapping

This ground clutter mapping is using the function of volume scan mode.
When possible it should only be measured during a sunny and cloudless day.

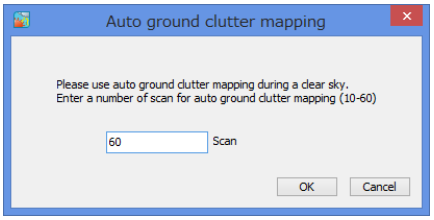
Please setup the following:

- Setting -> Advanced setting -> Ground clutter rejection -> GCR: 1

Pressing [Ctrl] + [Alt] + [Radar operation] simultaneously, and click [Auto ground clutter mapping] to start measurement after above setup is completed.
32 elevations are possible and can be setup by Volume scan mode to measure up to 32 elevations automatically.

(1) Setup the number of times to run scenario: Setup a number of times to scan from 10 to 60 (Large scan number can produce higher accuracy).

(2) Confirm start of measurement: Click [OK] to begin when ready. Click [Cancel] to quit measurement.

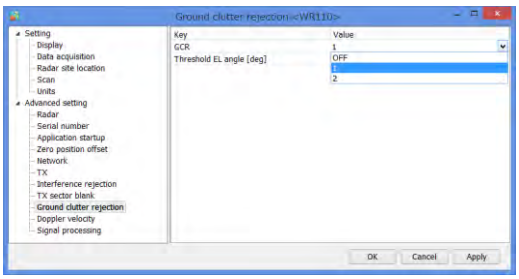


(3) The ground clutter measurement will be completed after reference map (scr) is created. Restart RainMap after measurement completed (Refer to the right sample screen).

Data format of measured “scr” file is same as “scn” file. It can see by the rainplay.

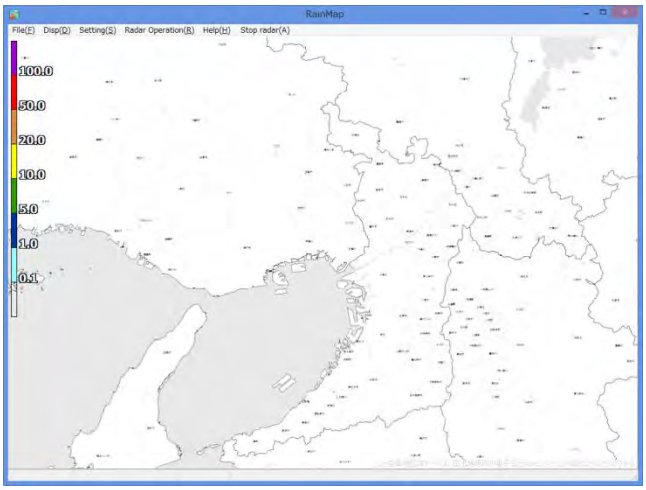
e.g.) Radar may take up to 6 hours to complete measurements and create reference map data.
- Setup the maximum volume scan period for 4(15/[h]) [min] in volume scan mode.
- Setup volume scan setting elevation from 0 to 5 [deg]
- Setup 10.00 [rpm] on Antenna rotation speed in RDR Parameter.
- Select “1” in ground clutter removal.
- Set 3.00 in Filter constant of ground clutter reference auto processing.
- Setup the maximum scan measurement to 60 when popup menu indicates before starting ground clutter measurement.

There may be a delay while RainMap saves the new measured data into RainMap.
Ground clutter reference file can be only be used when the ground clutter rejection is set to “2”.

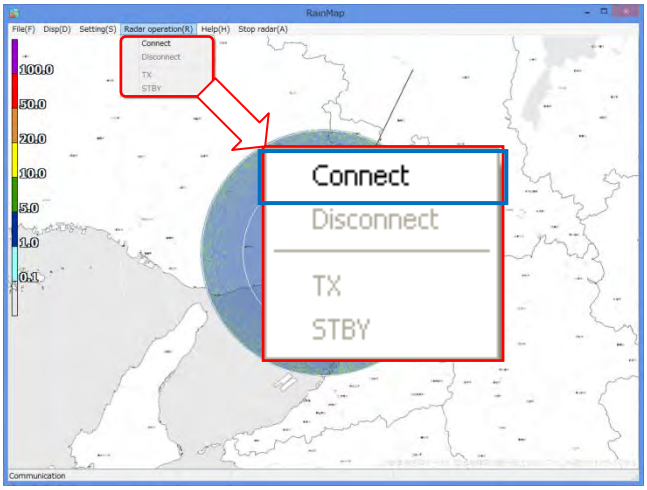


2.7. Operation Process

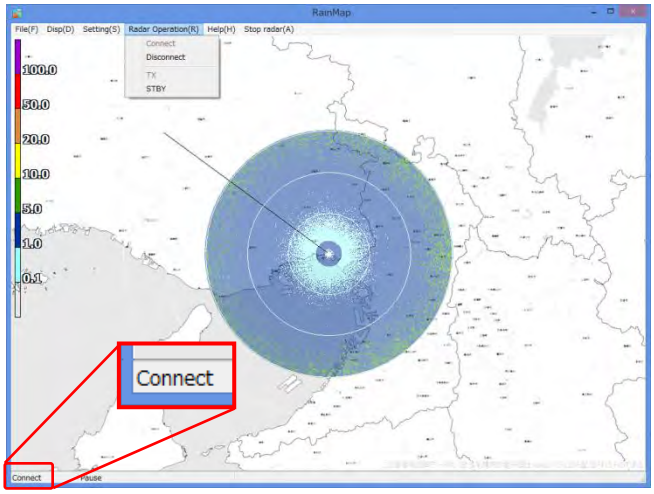
1) Start rainfall observation



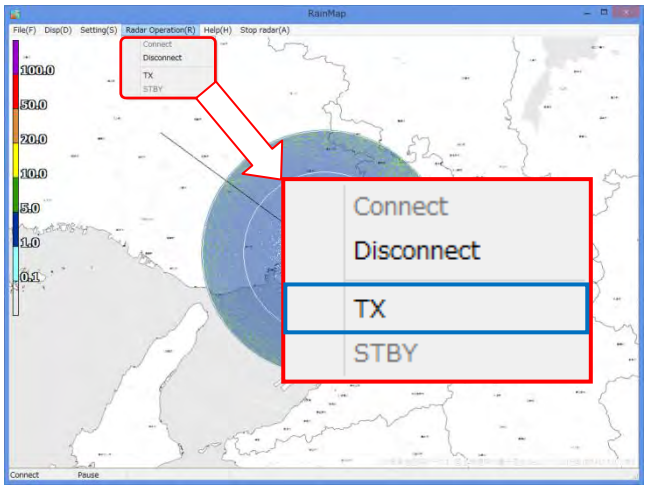
Enter the elevation angle of antenna, data recording and display data settings.



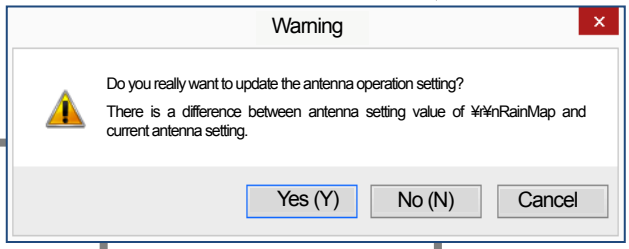
Click [Connect] from [Radar operation] pull-down menu.



RainMap will display [Connect] at the bottom-left of screen when the Antenna Unit (ATU) and Display Processing Unit (DPU) are connected and communicating.



Click [TX] from [Radar operation] pull-down menu.



Yes

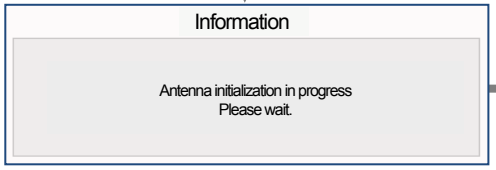
If [Yes] clicked, antenna will initialize and will indicate the message below. Radar will start TX operation after initialization completed.

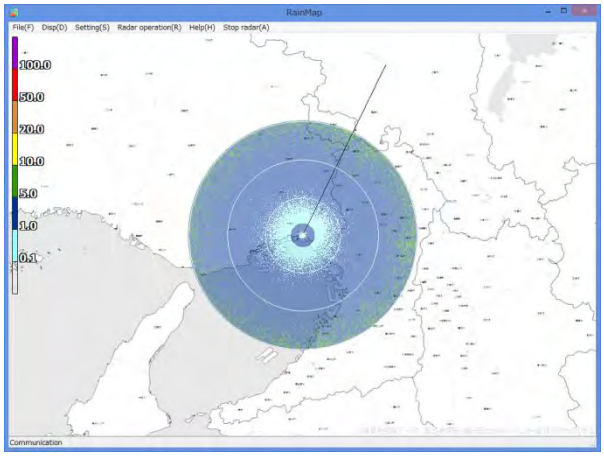
No

Cancel

If [Cancel] clicked, the operation will be cancelled.

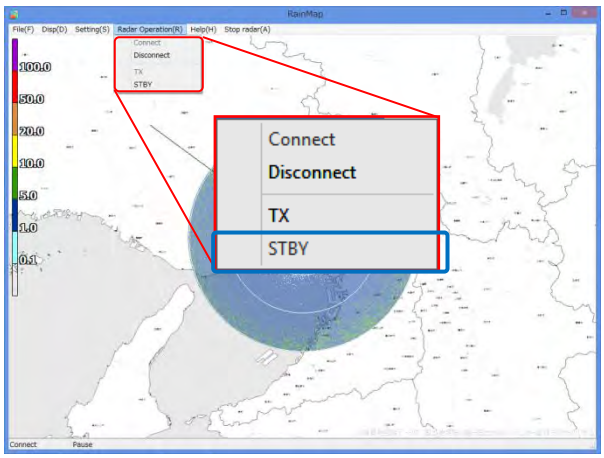
If [No] clicked, radar will start TX operation without making any change.



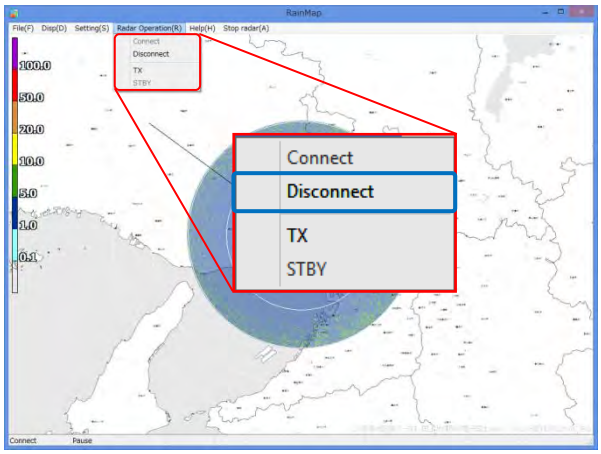


Start operation of radar and display observed information on the screen.
The recorded data is saved in the data storage device.

2) Stop rainfall observation



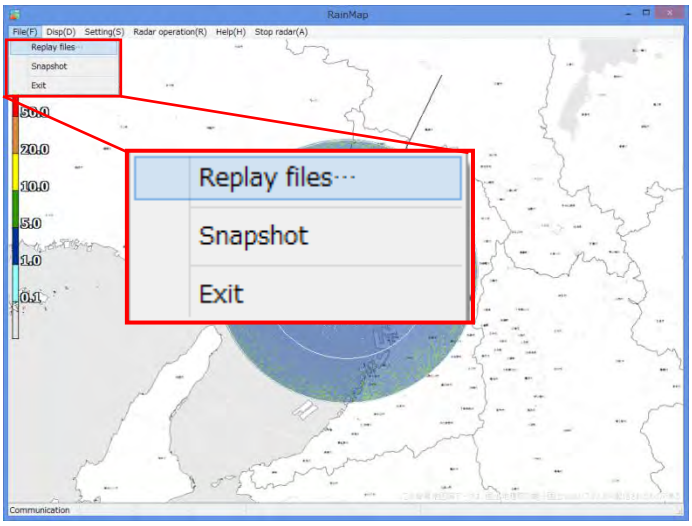
Click [STBY] to stop the radar operation.



Click [Disconnect] to close ATU.

2.8. Observation Data Operation

1) Start playing the Observation Data



Click [File] on File menu bar, and select [Replay files···.]

Go to [4.7. RainPlay function]

2) Scale label

It indicates the signal level of displayed image by color. The upper color means stronger signals and the lower color means weaker signals. These scale labels colors and values correspond to the observation data type. The size of label on the screen depends on available left side screen area.

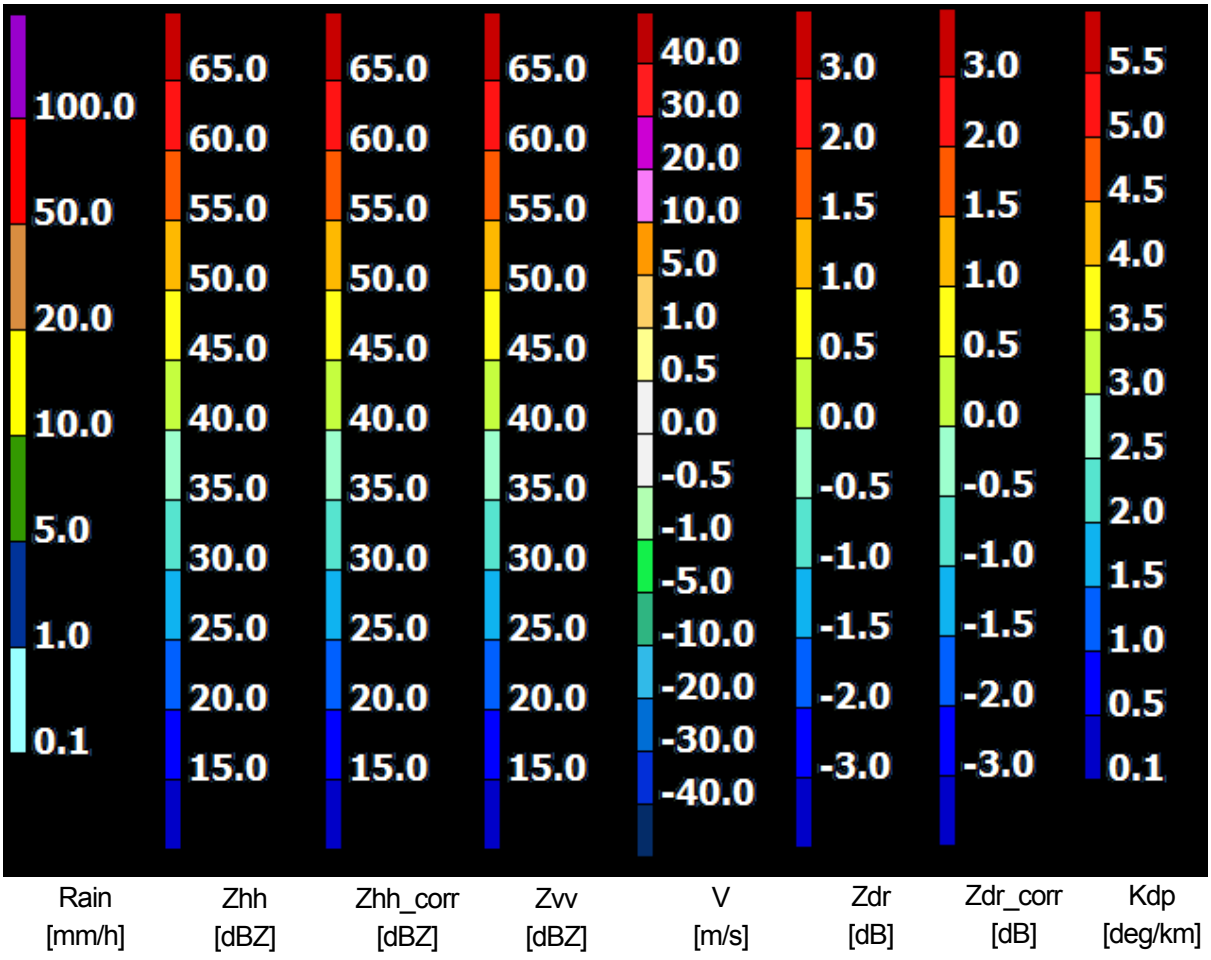
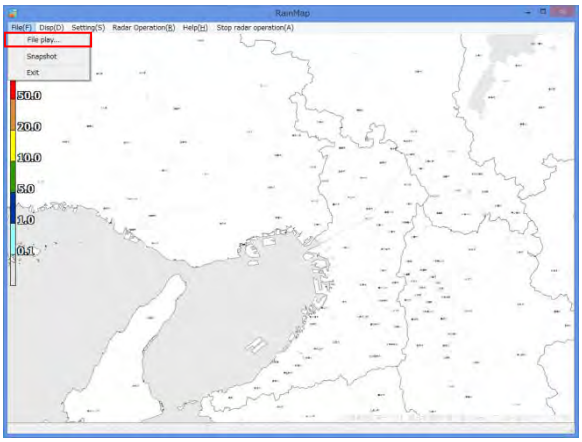
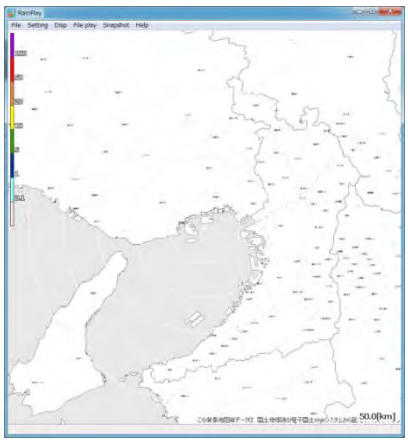


Figure 2.12: Scale label indication

2.9. RainPlay Function

RainPlay will display after selecting [File play] on RainMap.
It is also possible to use RainPlay.exe from “RainMap_RainPlay” folder on desktop even when RainMap is activated.





File

File play:

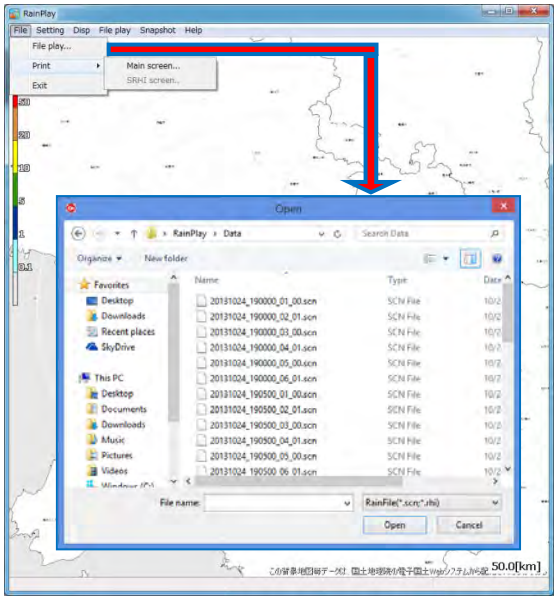
Select files of log data (*.scn; *rhi) to play (Slide show) on screen

Print:

・Main screen: Print the main screen
・SRHI screen: Print the SRHI screen

Exit:

Close the software



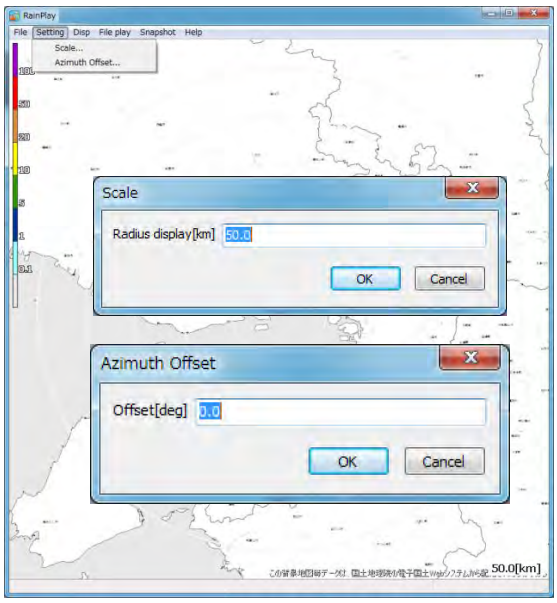
Setting

Scale:

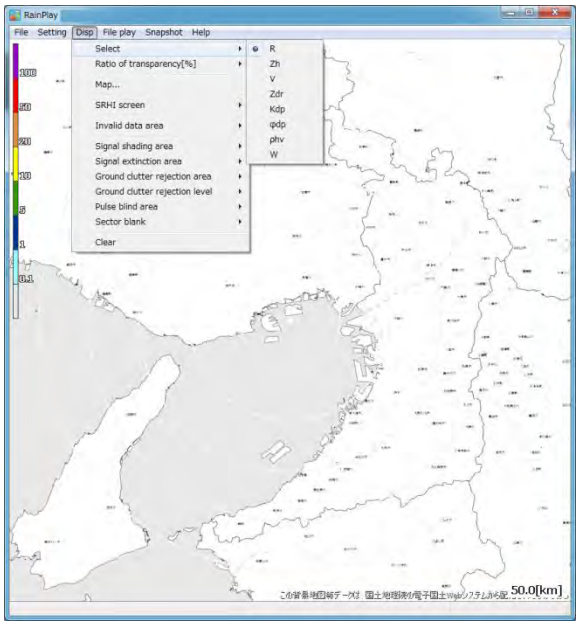
Setup a scale distance (radius display [km]) in [Scale] pop-up window.

Azimuth Offset:

Setup a degree of offset in [Azimuth Offset] pop-up window.



Disp



Select:
Select a data type to display.

- **R**: Intensity of rainfall
- **Zh**: Reflection intensity factor of horizontal polarimetric radar
- **V**: Doppler velocity
- **Zdr**: Radar reflection factor difference
- **Kdp**: Propagation phase difference rate of change
- **φdp:** Differential Phase Shift (cross polarization)
- **ρhv:** Co-polar correlation coefficient
- **W:** Doppler velocity spectral width

Ratio of transparency [%]:
Set the echo returns transparency.

Map:
Display a background map image from map file (*.bmp *.png).

SRHI screen:

- 90 degrees screen (Displays SRHI echo at 90 degrees on sub screen)
- 180 degrees screen (Displays SRHI echo at 180 degrees on sub screen)

Invalid data area:
Turn ON/OFF the invalid data area indication.

Signal shading area:
Select the signal shading area indication.
OFF: Hidden, 1: Grayed out, 2: Gray scale

Signal extinction area:
Select the signal extinction area indication beyond the strong rain area.
OFF: Hidden, 1: Grayed out, 2: Gray scale

Ground clutter rejection area:
Select the ground clutter rejection indication area.
OFF: Hidden, 1: Grayed out, 2: Gray scale

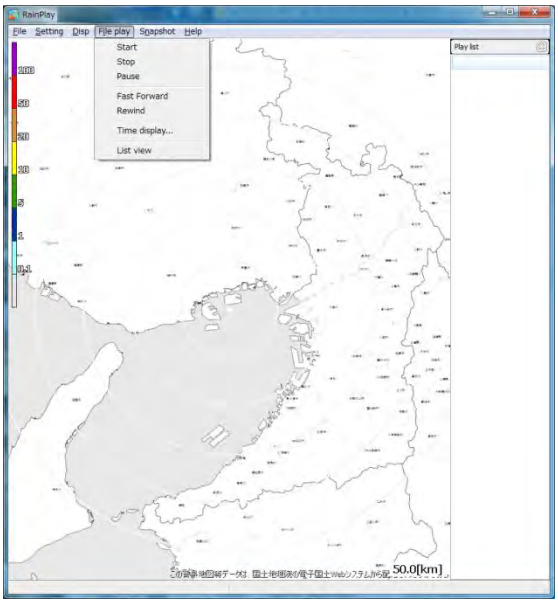
Ground clutter rejection level:
Select the level of ground clutter rejection, 0 to 7.

Pulse blind area:
Select the pulse blind area indication zone.
OFF: Hidden, 1: Grayed out, 2: Gray scale

Sector blank:
Select the sector blank indication.
OFF: Hidden, 1: Grayed out, 2: Gray scale

Clear:
Rain file data will be cleared from screen.

File play



Start:
Start plays the log data.

Stop:
Stops play.

Pause:
Pauses play.

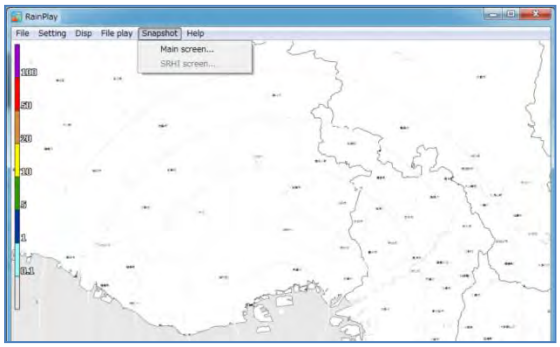
Fast Forward:
Fast forwards play.

Rewind:
Rewind play.

Time display:
Setup a time display in pop-up window between 1,000 - 10,000 [ms].

List view:
Show the play list on right side of screen.

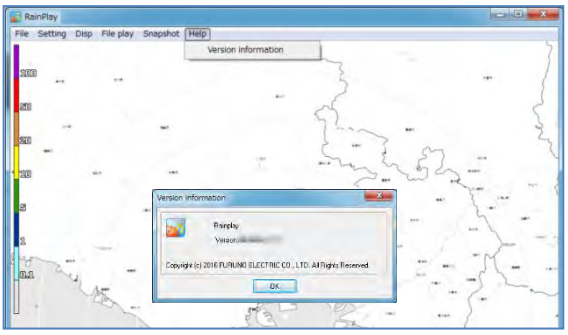
Snapshot



Main screen:
Copy the main screen and select place to save the screen file (*.jpg).

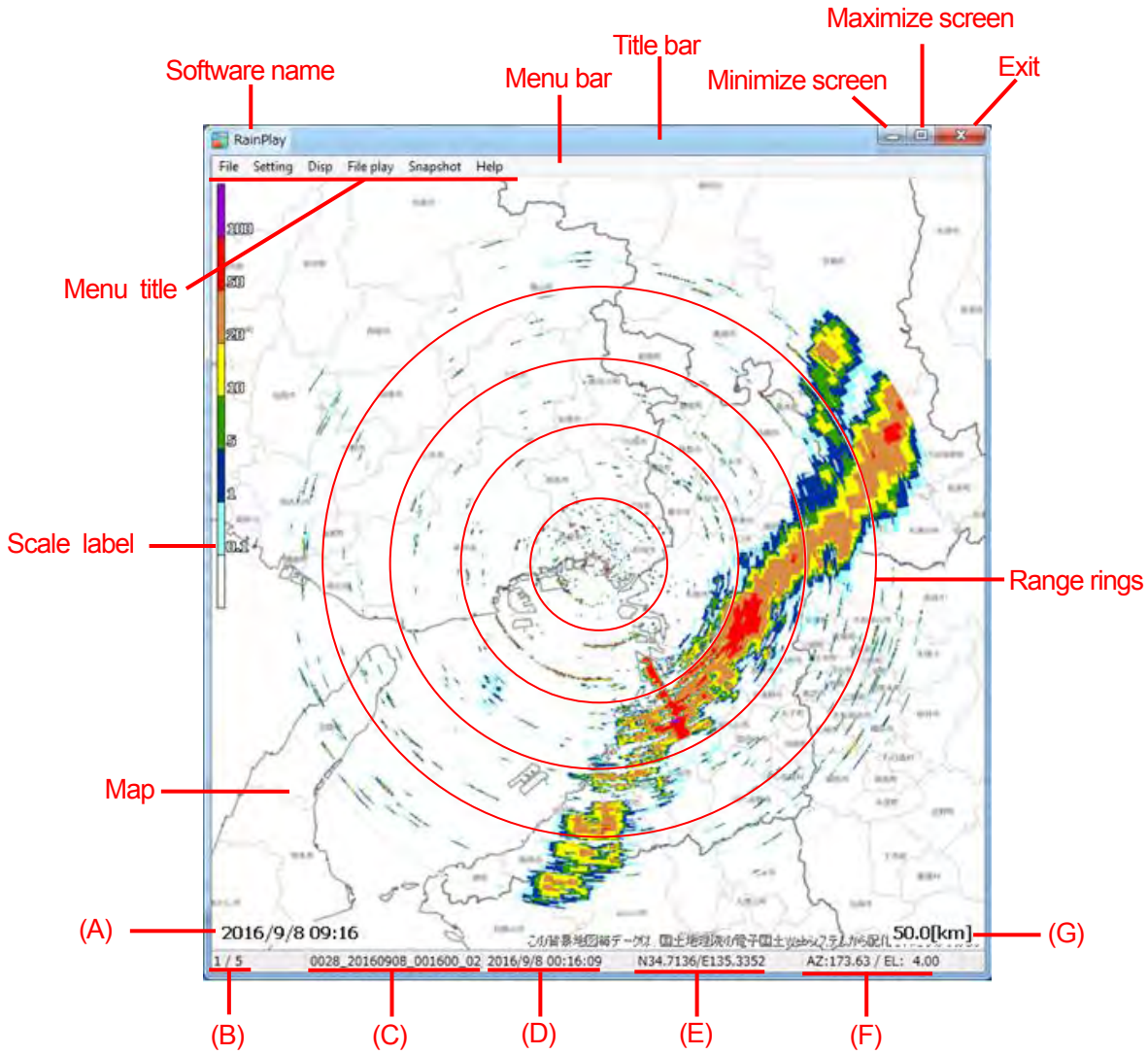
SRHI screen:
Copy a SRHI screen and select place to save the SRHI screen file (*.jpg) while displaying SRHI screen from [Disp].

Help



Version information
It shows the version information of this software.

2) RainPlay screen

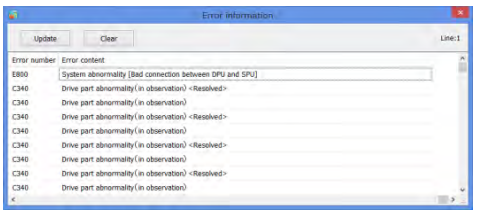


(A) Computer acquired date/time (Local time)
(B) Play file number / display number
(C) Play file name
(D) Acquired date/time (UTC)
(E) Radar location
(F) Start location of acquired Azimuth/Elevation
(G) Maximum set range distance

2.10. Log File Function

1) Error information

Displays any captured error information up to 50 lines on screen. Once entries exceed 50 lines, additional error information overwrites older line entries. These older line entries are saved into separate log files in the same "log" folder in RainMap the program folder.



2) Log record:

Log record folder is created automatically in the RainMap folder and saved log data [log].

・RainMap.log (Log file)

・YYYYMMDDhhmmss.dat File configuration is compressed (ZIP) and includes the transmission start date and time up to 1, 000 file maximum.

3) Limit of Log files (RainMap.log):

When transmission start date and time exceeds 1,000 files it will overwrite the oldest file.

4) Log file (RainMap.log) format:

Save in "text" format.

e.g.)

[2014/06/17 10:35:06] SendParam,20140617_103506.dat
[2014/06/18 20:08:45] TRxStart,20140618_200845.dat

Configurations file (YYYYMMDDhhmmss.ini).
This file is saved by section and key setting with RainMap software.
(This file saves the current setup information entered in the RainMap program)

RainMap_ErrorDisp.log: Saves display detail failure information compiled from GUI of RainMap.
RainMap_ErroHist.log: Saves all previous failure information.

Detail of Log record contents: (Rrecords both normal and error conditions)

Message	Detail	Situation	Remarks
AppStart	—	Start of Application	
AppEnd	—	End of Application	
Connect	—	Start Connection	
Connected	Command	Connect Command Port	
	Data	Connect Data Port	
Disconnect	—	Shutdown Connection	
	Command	Shutdown Command Port	
	Data	Shutdown Data Port	
SendParam	(Saved configuration file)	Send Parameter	ZIP configuration file
TRxStart	(Saved configuration file)	Start TRX	ZIP configuration file
EmrStop	—	Emergency stop	
ErrStat	(PXI status))	Failure status	

3. RAINMAP SETTING TABLE

This is a table of RainMap settings.

Data backup:

Because there is no guarantee of data integrity including observation data, output file, etc., make sure to back up the data to external hard disk drives.

Furuno has no responsibility for damages, data integrity, repair or any other damages resulting from data loss.

Software version:

Information of the software version is displayed on software screen panel.
This manual revision is for the following software version:

- RainMap v06.06
- RainPlay v02.10

1) Setting

Gray column in the table below indicates during advanced settings.

Major menu	Medium menu	Minor menu		Input value [unit]
Setting	Display	Display range [km]		0.5 - 70.0 [0.1]
		Display data type		R [mm/h] / Zh [dBZ] / Zh_corr [dBZ] / Zv[dBz] / V [m/s] / Zdr[dB] / Zdr_corr[dB] / Kdp[deg/km] / φ dp[deg] / phv / W [m/s]
		Echo transparency [%]		0 - 100 [1]
		Antenna sweep line		OFF / ON
		Radiowave shielding area		OFF / 1 / 2
		Radiowave extinction area		OFF / 1 / 2
		Echo update		No Update / Flash Update / Round Update
	Data Acquisition	Screen capture (JPEG)		OFF / ON
		Screen capture save path		C:\<exe pass>\RecData\capture
		Screen capture period [sec]		0 – 3600 [1]
		CSV		OFF / ON
		CSV save path		C:\<exe pass>\RecData\csv
		CSV save period [sec]		0 - 3600 [1]
		Radar parameters as CSV files		R[mm/h] / Zh[dBz] / V[m/s] / Zdr[dB] / Kdp[deg/km] / φ dp[deg] / phv / W[m/s]
		Binary data		OFF / ON
		Binary save path		C:\Documents and Settings\USER\Desktop/RecData\binary
		Radar parameters in Binary file		R[mm/h] / Zh[dBz] / V[m/s] / Zdr[dB] / Kdp[deg/km] / φdp[deg] / phv / W[m/s] / Quality
	Radar Site Location	Latitude [deg]		-90.00000 - 90.00000 [0.00001]
		Longitude [deg]		-90.00000 - 90.00000 [0.00001]
		Altitude [m]		0.00 – 100000.00 [0.01]
		Map data path		C:\<exe pass>\RainMap
		Map left top lat. [deg]		-90.00000 - 90.00000 [0.00001]
		Map left top lon. [deg]		-90.00000 - 90.00000 [0.00001]
		Map right bottom lat. [deg]		-90.00000 - 90.00000 [0.00001]
		Map right bottom lon. [deg]		-90.00000 - 90.00000 [0.00001]
	Scan	Hits mode		Auto / Manual
		Hits value		1 - 500 [1]
		Sweep decimation mode		Auto / Manual
		Sweep decimation value		1 - 200 [1]
		ScanMode		PPI Scan / Sector RHI Scan / Volume Scan / Sector PPI Scan
		PPI Scan	EL angle [deg]	-2.0 - 90.0 [0.1]
			AZ rotation speed [rpm]	0.50 - 16.00 [0.01]
		Sector RHI Scan	EL rotation speed [rpm]	0.50 - 6.00 [0.01]
			AZ start angle [deg]	0.0 - 360.0 [0.1]
			AZ end angle [deg]	0.0 - 360.0 [0.1]
			AZ step angle [deg]	0.0 - 360.0 [0.1]
			EL start angle [deg]	-2.0. - 182.0 [0.1]
			EL end angle [deg]	-2.0. - 182.0 [0.1]
		Volume Scan	Volume scan period [min]	1(60/[h]) / 2(30/[h]) / 3(20/[h]) / 4(15/[h]) / 5(12/[h]) / 6(10/[h]) / 10(6/[h]) / 12(5/[h]) / 15(4/[h]) / 20(3/[h]) / 30(2/[h]) / 60(1/[h])
			Sync. scan mode	OFF / ON
			Sync. scan AZ start angle [deg]	0.0 - 360.0 [0.1]
			Sync. scan start time (UTC)	YYYY.MM.DD_HH:MM:SS
			EL transition speed mode	Auto / Manual
			EL transition speed [rpm]	0.5 - 6.0 [0.1]
			AZ rotation speed [rpm]	0.5 - 16.0 [0.1]
			EL angle 0 [deg]	-2.0 - 90.0 [0.1]
			↓	↓
			EL angle 31 [deg]	-2.0 - 90.0 [0.1]
		Sector PPI Scan	AZ rotation speed [rpm]	0.5 - 16.0 [0.1]
			AZ start angle [deg]	0.0 - 360.0 [0.1]
			AZ end angle [deg]	0.0 - 360.0 [0.1]
			EL angle 0 [deg]	-2.0 - 90.0 [0.1]
			↓	↓
			EL angle 31 [deg]	-2.0 - 90.0 [0.1]
	Units	Rotation speed		rpm / deg/sec

2) Advanced setting

This menu will display when [Alt]+[Ctrl] keys are pressed simultaneously and [Setting] menu is “clicked”.

Major menu	Medium menu	Key menu		Input value [unit]
Service	Radar	-		-
	Serial Number	Serial number		xxxxxxxxxxxx (no limit) [Indicte only]
		Product number		xxxx (4 digit) [Indicte only]
		Product name		xxxxxxxxxxxx (no limit) [Indicte only]
	Application Startup	Automatic connection		OFF / ON
		Automatic scheduled reboot		OFF / ON
		Schedule Date/Time		YYYY.MM.DD__HH:MM:SS
		Automatic TX after reboot		OFF / ON
	Zero position offset	Original EL position offset correction [deg]		-90.0 - 90.0 [0.1]
		AZ offset to north		0.00 - 360.00 [0.01]
	Network	-		-
	TX	PRF pattern		The number of registered patterns [Indicte only]
		Pulse set / No		2,3,5,6,11,12,20,21,22,24,28,29,50,52,53,55,56,61,62,90,93
		Pulse spec.	P0N_T [us]	Values are fixed with the pulse number
			Q0N_T [us]	
			Q0N_B [MHz]	
			PRF1 [Hz]	
			PRF2 [Hz]	
			A cutback (pulse1) [dB]	
			A cutback (pulse2) [dB]	
		IF cable length [m]		1 -20 [1]
	Interference Rejection	IR 1		OFF / ON
		IR 2		OFF / ON
	TX Sector Blank	Blank area 1		OFF / ON
		AZ start angle [deg]		0.00 - 360.00 [0.01]
		AZ end angle [deg]		0.00 - 360.00 [0.01]
		EL start angle [deg]		-2.00 - 182.00 [0.01]
		EZ end angle [deg]		-2.00 - 182.00 [0.01]
		Blank area 2		OFF / ON
		AZ start angle [deg]		0.00 - 360.00 [0.01]
		AZ end angle [deg]		0.00 - 360.00 [0.01]
		EL start angle [deg]		-2.00 - 182.00 [0.01]
		EZ end angle [deg]		-2.00 - 182.00 [0.01]
	Ground Clutter Rejection	GCR		OFF / 1 / 2
		Threshold EL angle [deg]		-2.00 - 90.00 [0.01]
	Ship Clutter Rejection	SCR		none
		Threshold EL angle [deg]		-2.00 - 90.00 [0.01]
	Doppler Velocity	Doppler Velocity Calculation		OFF / ON
		SQI threshold		0.00 - 1.00 [0.01]
	Signal Processing	Rainfall intensity estimation method		Zh / Zh,Ah / Kdp+Zh
		Rainfall intensity estimation correction by EL		OFF / ON
		Output data range resolution [m]		75 - 1000 [1]
		Antenna beam width (H) [deg]		0.01 - 20.00 [0.01]
		Antenna beam width (V) [deg]		0.01 - 20.00 [0.01]
		TX power (H) [W]		50.00 - 150.00 [0.01]
		TX power (V) [W]		50.00 - 150.00 [0.01]
		Antenna gain (H) [dBi]		30.0 - 40.0 [0.1]
		Antenna gain (V) [dBi]		30.0 - 40.0 [0.1]
		RX gain (H) [dB]		0.00 - 128.00 [0.01]
		RX gain (V) [dB]		0.00 - 128.00 [0.01]
		K square value		0.00 - 5.00 [0.01]
		ZDR offset correction [dB]		-10.00 - 10.00 [0.01]
		Rain output threshold [mm/h]		0.00 - 1.00 [0.01]
		Kdp output threshold (Kdp) [deg/km]		-1.00 - 10.00 [0.01]
		Kdp output threshold (Zh) [dBZ]		0.00 - 50.00 [0.01]
		Zh attenuation estimation coefficient (b1)		0.000 - 10.000 [0.001]
		Zh attenuation estimation coefficient (b2)		0.000 - 10.000 [0.001]
		Zdr attenuation estimation coefficient (d1)		0.0000 - 10.0000 [0.0001]
		Zdr attenuation estimation coefficient (d2)		0.000 - 10.000 [0.001]
		Air attenuation coefficient (Agas) [dB/km]		0.000 - 1.000 [0.001]
		Radiowave extinction threshold [dBZ]		0.00 - 50.00 [0.01]
		R(Zh)-method coefficient (B)		50.00 - 5000.00 [0.01]
		R(Zh)-method coefficient (β)		0.50-10.000 [0.001]
		R(Kdp)-method coefficient (a)		0.00-100.00 [0.01]
		R(Kdp)-method coefficient (b)		0.000 - 2.000 [0.001]
		R(Kdp)-method coefficient (c)		0.1 - 10.0 [0.1]
		Invalidity MP noise data		OFF / ON

4. WR_TOOL

4.1. WR_notice

Function:

WR_notice delivers the e-mail to the mail address specified when an error occurs and notifies WR2120 that an error has occurred.

Notification settings:

Click [WR_notice.exe] to start setting.

The transmission error information can be set the email address to send email when an error occurs. It is possible to set up to 6 e-mail destinations.

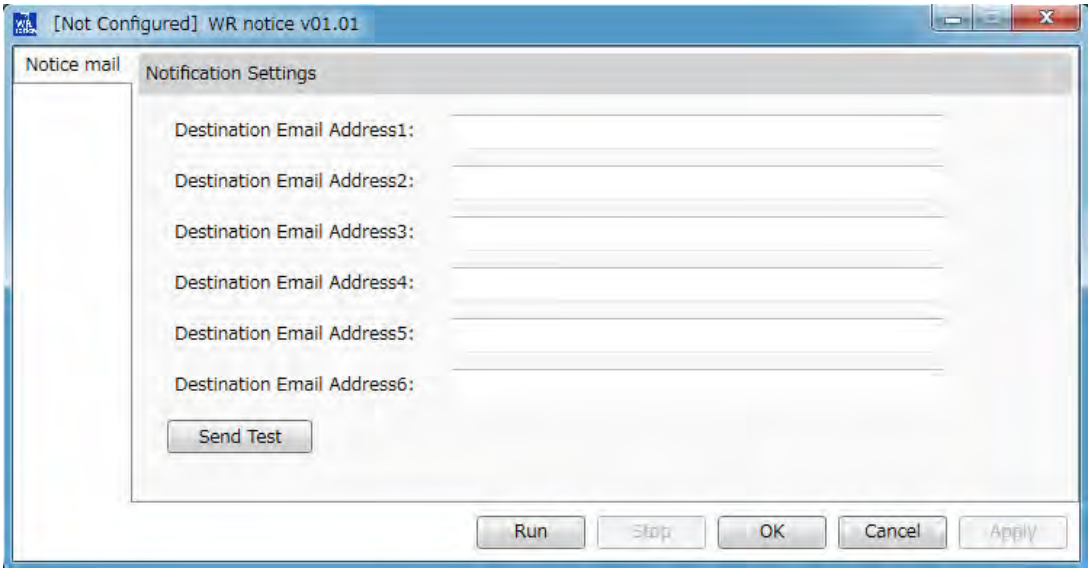


Figure 4.1: Basic Settings

1) Click [Stop] if this software is running.
2) Add/suppress email address from the list.
3) Click [OK] to valid the list.
4) Click [RUN] to start running the WR_notice function.

Run WR_notice:

Add WR_notice to Windows Startup to run WR_notice automatically when booting the DPU.

Copy the shortcut of WR_notice.exe to the startup folder described below,

Local Disk (C:) > Users > radar > AppData > Roaming > Microsoft > Windows > Start Menu > Programs > Startup

4.2. WR_transfer

Function:

WR_transfer.bat is observing RainMap and compresses the recorded files, distributes FTP, and copies.

Note: Register WR_transfer.exe file to the startup of Windows if it needs to transfer the recorded file by FTP or saved into external storage device.

1) File configuration

```
C:＼Users＼radar＼
FURUNO ———      WR_transfer.bat
          | —  AUTO.bat        File compression, move from recorded folder to each folder
          | —  AUTO_FTP.bat                    Transfer FTP file
          | —  AUTO_STOP.bat                   For stop bat
          | —  bin ———————— FtpTransfer.exe    FTP transfer file
                    | —      FTP_WRFTP.ini
                    | —      FtpTransfer.Core.dll
                    | —      FRD.Core.dll
                    | —      RainCopy.exe
                    | —       RainSave.exe
                    | —       SigCopy.exe
                    | —       gzip.exe

D:＼
WR_transfer ——— FTP ———— Folder for transfer (Temporary folder)
              | —  TMP ———— Folder for transfer (Temporary folder)
              | —  LOG ———— Folder of saving LOG file
```

2) Contents of bat file

1. Contents of WR_transfer.bat.

WR_transfer.bat provides two ways to start. One is a batch file (Auto.bat) that compresses a file when a recorded file of observation data is saved and copies the file to the specified folder. Another way is a batch file (Auto_FTP.bat) that transfer observation data file by FTP.

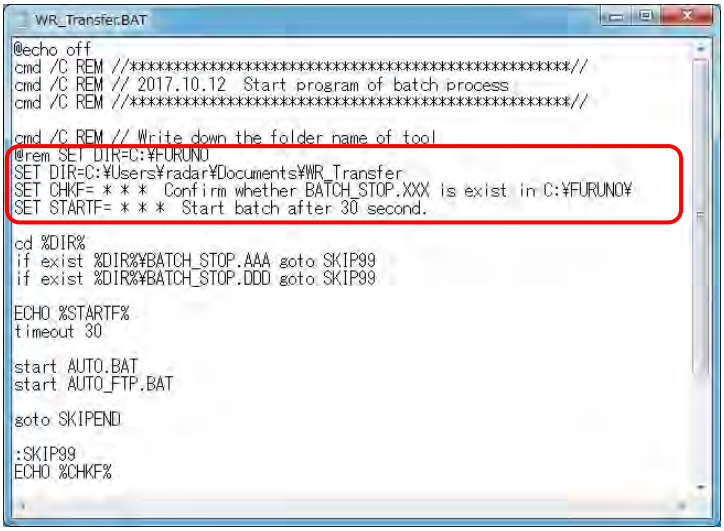


Figure 4.2: Sample of WR_transfer.bat

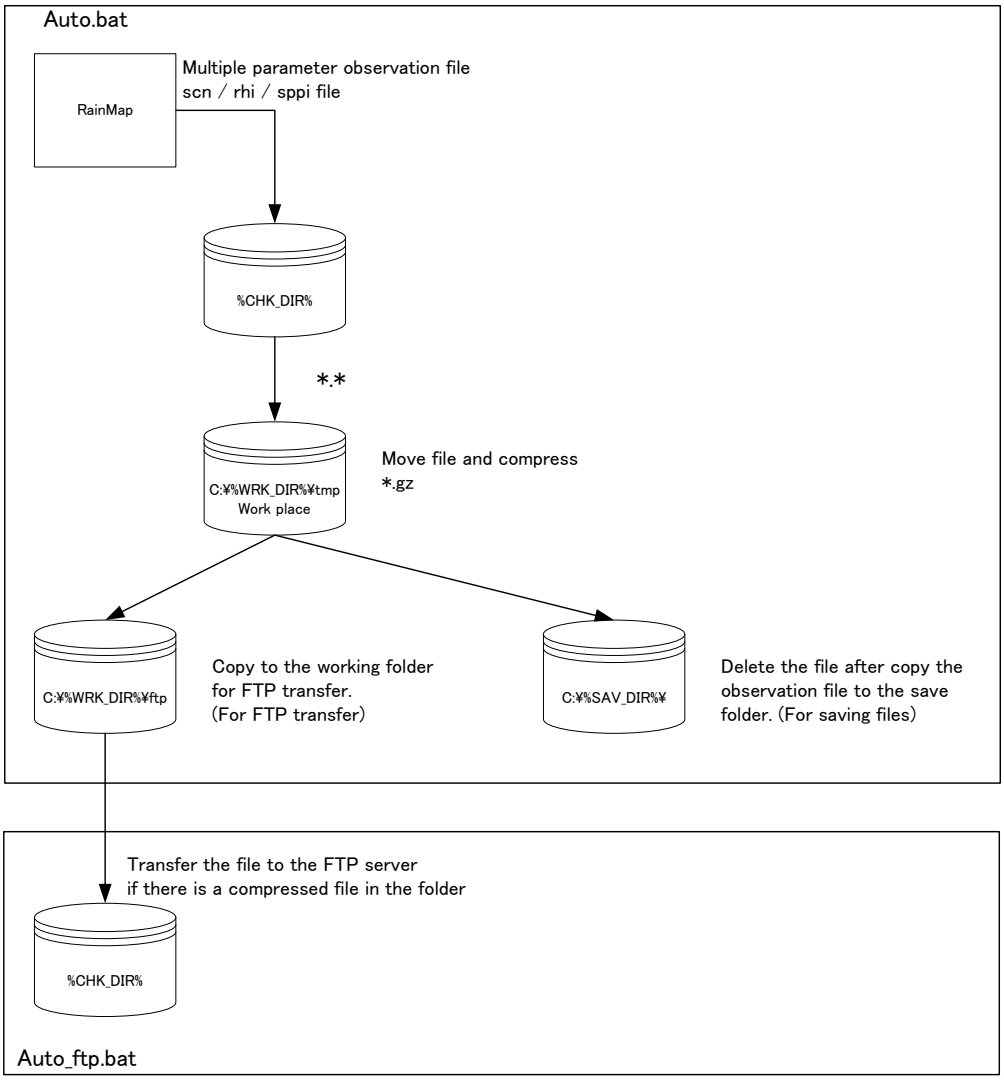


Figure 4.3: WR_transfer.bat processing contents

Setting of WR_transfer operating environment (no need to change)
Specify the drive and folder to start the WR_transfer.bat file.
Set the folder in which WR-transfer.bat runs (fixed) as a batch file that performs FTP transfer. Because of this copied file contains the observation data, please do not change this file.
SET DIR = C:＼Users＼radar＼FURUNO＼WR_transfer

2. Contents of AUTO.bat

Auto.bat compresses the file and will copy into the designated folder when recorded data of the observation data is saved.

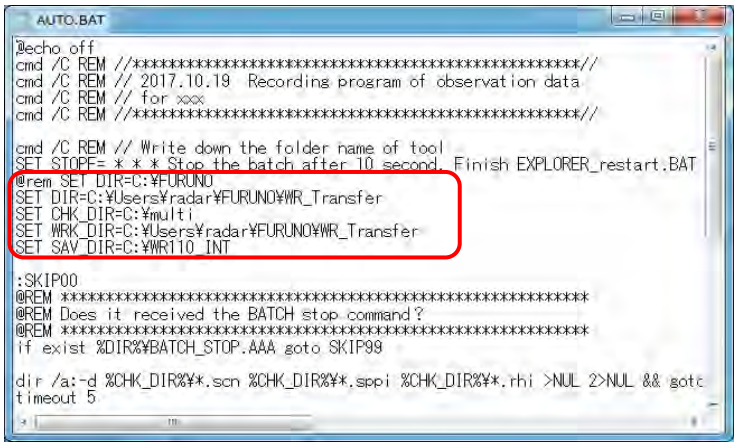


Figure 4.4: Sample of Auto.bat

2-1) AUTO.bat operation environment setting (no need to change)

It specified the folder that stores AUTO.bat, therefore do not change this setting item.

SET DIR = C: ＼ Users ＼ radar ＼ FURUNO ＼ WR_transfer

2-2) Designation of observation data recording folder

Specify the folder to records the observed data. Generally it will record the binary data of RainMap into the destination folder.

e.g.) If specifying the multi folder under the D drive, then

CHK_DIR = D: ＼ multi

2-3) Specify a batch file working folder

Create / delete files while batch file is processing. Specify the working folder.

e.g.) If the WR_transfer folder of the D drive is specified as the working folder, then

WRK_DIR = D: ＼ WR_transfer

2-4) Designation of observation data storage folder

Specify the destination to save the recorded file that compressed observation data. Create and save a folder with recorded date in the designated folder.

e.g.) If the WR2120 _ INT folder under the D drive is specified as the save folder, then

SAV_DIR = D: ＼ WR2120 _ INT

3. Set the AUTO_FTP

Auto_FTP.bat compresses and copies file to the specified folder when the recorded data of the observation data is saved. When performing FTP transfer, it is necessary to set the information of the FTP transfer destination in AUTO_FTP.bat (required).

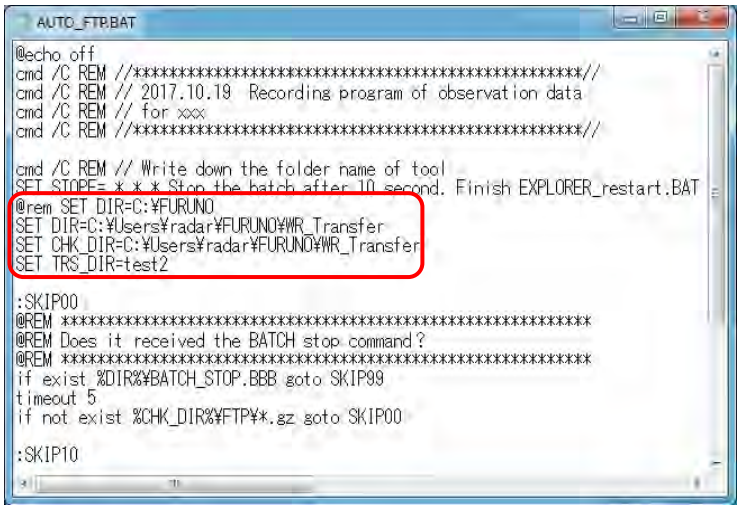


Figure 4.5: Sample of Auto_FTP

3-1) AUTO_FTP.bat operation environment setting (no need to change)
It specified the folder that stores AUTO_FTP.bat. Please do not change this item.
DIR = C: ＼ Users ＼ radar ＼ FURUNO ＼ WR_transfer

3-2) Set the observation data file reception monitoring
e.g.) If the FTP destination folder is set to drive D drive WR_transfer ＼ FTP, then
CHK_DIR = D: ＼ WR_transfer ＼ FTP

3-3) Set the FTP destination folder
Specify the FTP destination folder of the observation data file.
e.g.) If the FTP destination folder is set to test 2, then TRS_DIR = test 2

4. Set the FTP_WR_FTP.ini
Set information of FTP server.

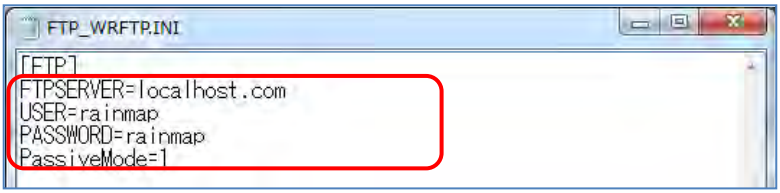


Figure 4.6: Sample of FTP_WR_FTP.ini

4-1) Set the FTP server
Specify the name or IP address of the FTP server.
e.g.) If using localhost as FTP server, then
FTPSERVER = localhost

4-2) Set the FTP user
Set the FTP user name and password.
e.g.) If the FTP user is a xrain user, and the password xrain is set by the xrain user, then
USER = rainmap FTP user name
PASSWORD = rainmap FTP password

4-3) Set the passive mode
0: Active mode (Default: 0), 1: Passive mode
e.g.) If passive mode is set to passive mode
PASSIVEMODE=1

5. Set when not transferring FTP
It is necessary to change two files, WR_transfer.bat and AUTO.bat when FTP transfer is not performed.

5-1) Change the WR_transfer.bat
Change the setting of not to let AUTO_FTP.BAT start when WR_transfer.bat is calling.
Change it as follows:
Before change: start AUTO_FTP.BAT
After change: @rem start AUTO_FTP.BAT

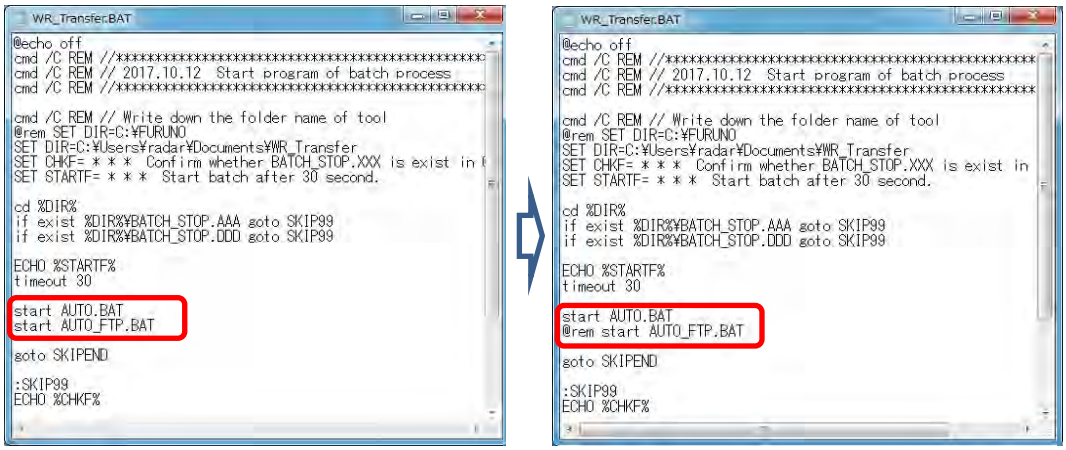


Figure 4.7: Sample of WR_transfer.bat (Before -> After)

5-2) Change the AUTO.BAT.

5-3) Make changes to stop RainCopy.exe from starting.

Change it as follows:

Before change: %DIR%＼bin＼RainCopy.exe %WRK_DIR%…

After change: @rem %DIR%＼bin＼RainCopy.exe %WRK_DIR%…

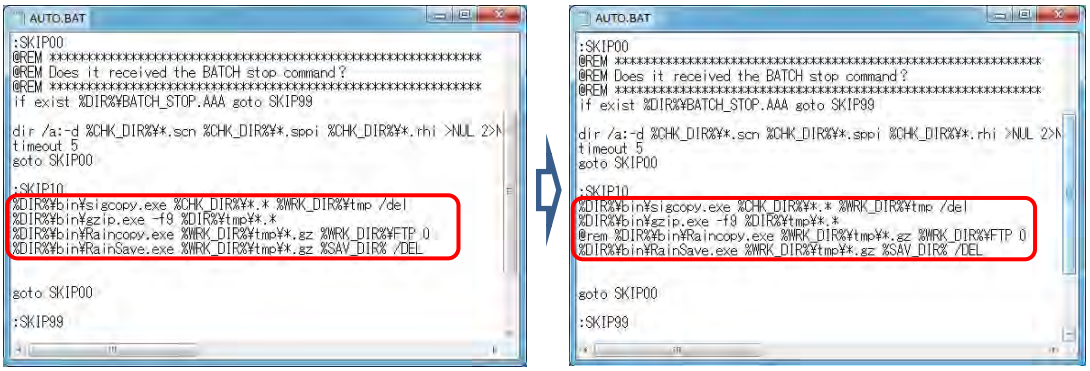


Figure 4.8: Sample of AUTO.bat (Before -> After)

6. Do not copy a file

Change 2 points of AUTO.bat as follows when not to copy a file.

6-1) Save a file to the saving folder

Do not start rainSave.exe which is saving the file into the destination folder.

Before change: %DIR%＼bin＼RainCopy.exe %WRK_DIR%…

After change: @rem %DIR%＼bin＼RainSave.exe %WRK_DIR%…

6-2) Delete a work file

Add processing to delete the work file.

Additional row: DEL /Q %WRK_DIR%＼tmp＼*.gz

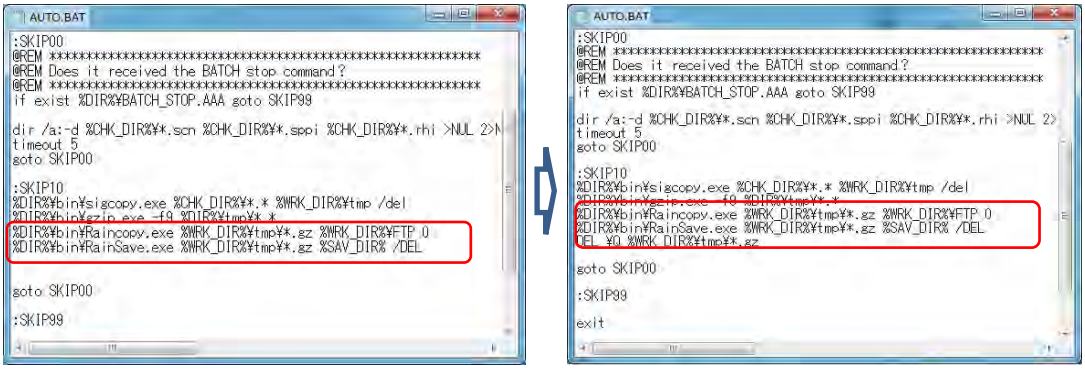


Figure 4.9: Sample of AUTO.bat (Before -> After)

7. FTP transfer. Do not copy a file.

Make not to start AUTO_FTP.BAT and AUTO.bat called from WR_transfer.bat when not transfer FTP or copy as follows.

Before change: start AUTO.BAT

start AUTO_FTP.BAT

After change: @rem start AUTOBAT

@rem start AUTO_FTP.BAT

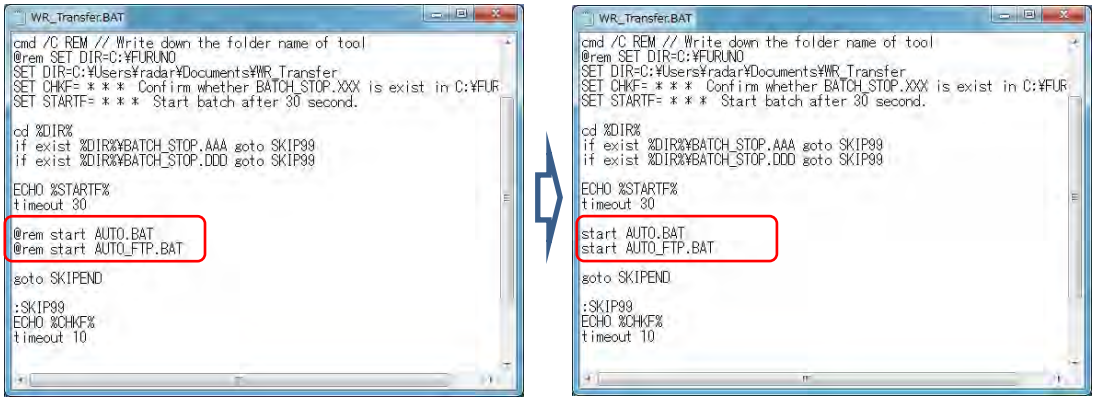


Figure 4.10: Sample of WR_transfer.bat (Before -> After)

8. FTP transfer. Stop copy a file

Start AUTO_STOP.bat in the folder as follows when stop batch file for file transfer and copy.

Check file: C:＼Users＼radar＼FURUNO＼WR_transfer

Notice: Uncompressing software must be installed in the PC to open and check the .gz file.

9. For WR_transfer.bat to startup when rebooting the computer

Copy the shortcut of WR_transfer.bat to the startup folder described below,

Local Disk (C:) > Users > radar > AppData > Roaming > Microsoft > Windows > Start Menu > Programs > Startup

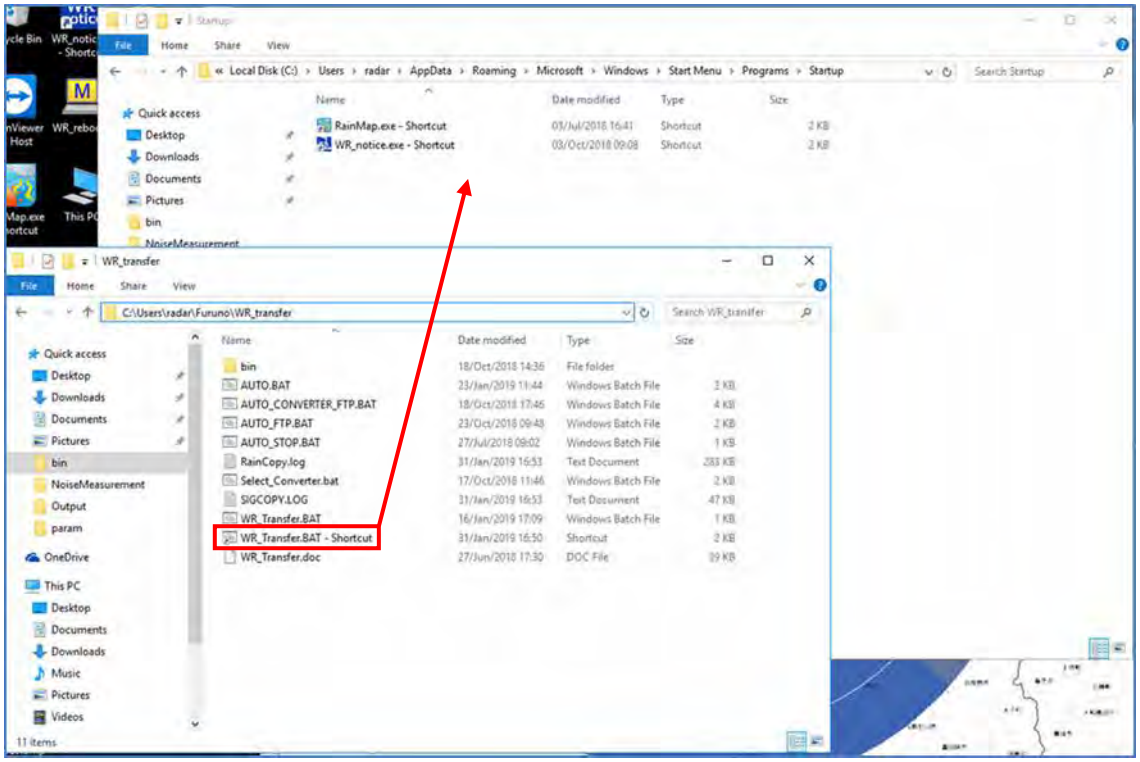


Figure 4.11: Copy the shortcut of WR_transfer.bat to the startup folder

3) Trouble shooting

If copy or FTP transfer process is not working properly, please check whether two batch files of AUTO.bat and AUTO_FTP.bat are running (Generally two command prompts are running. Only one command prompt will run if FTP is not transferred). It needs to check the contents of the operation if it is no copying or FTP transferring even though two command prompts are in operation. However, since contents of processing are not shown at the command prompt at present, it would not know which processing is not working properly. Make the following changes to indicate the processing contents at the command prompt to investigate the failure, and correct the setting.

Before change: @echo off

After change: @rem @echo off

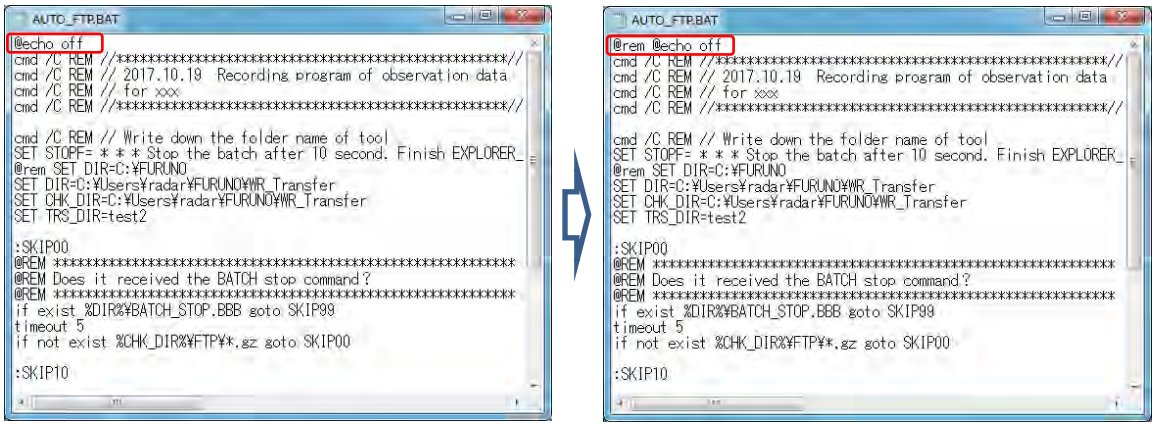


Figure 4.12: Sample of AUTO_FTP.bat (Before -> After)

4) Data converter

1. Outlines

- Data converter for ODIM HDF5 is installed in
  "C:＼Users＼radar＼Furuno＼SCN2HDF5_Converter＼"
  The executable file is SCN2HDF5_Converter.exe.
- Data converter for CF/Radial 1.4 is installed in
  "C:＼Users＼radar＼Furuno＼SCN2CfRadial_Converter＼".
  The executable file is SCN2CfRadial_Converter.exe.
- The configuration file, config.txt is stored in each installation folder.

2. To enable the data converter

The data converters are launched and controlled by the following batch files, where stored in "C:＼Users＼radar＼Furuno＼WR_transfer＼".

[AUTO.BAT]

To enable the data converter, edit the line surrounded by the red square below, step 1;

Before> @rem %DIR%¥bin¥sigcopy.exe %CHK_DIR%¥*.* %SCNFILES%

After> %DIR%¥bin¥sigcopy.exe %CHK_DIR%¥*.* %SCNFILES%

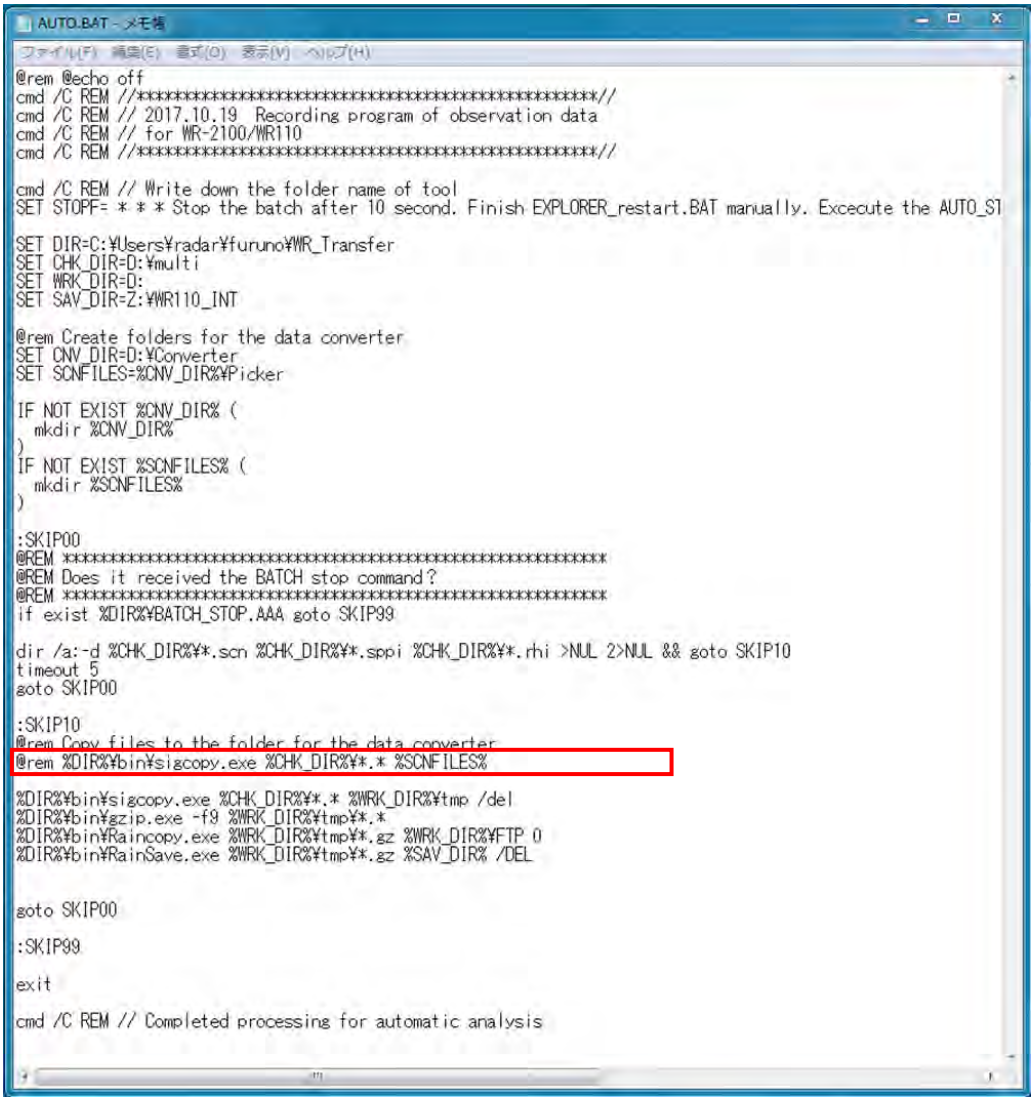


Figure 4.13: Sample of AUTO.BAT

[AUTO_CONVERTER_FTP.BAT]

- It launches and controls the data converters.
- It transfers the converted files to the FTP server.

[WR_Tnansfer.BAT]

- To enable the data converter, edit the line surrounded by the red square below, step 2;
  Before> @rem start AUTO_CONVERTER_FTP.BAT
  After> start AUTO_CONVERTER_FTP.BAT
- After step 1 and step 2 described above, restart the computer.

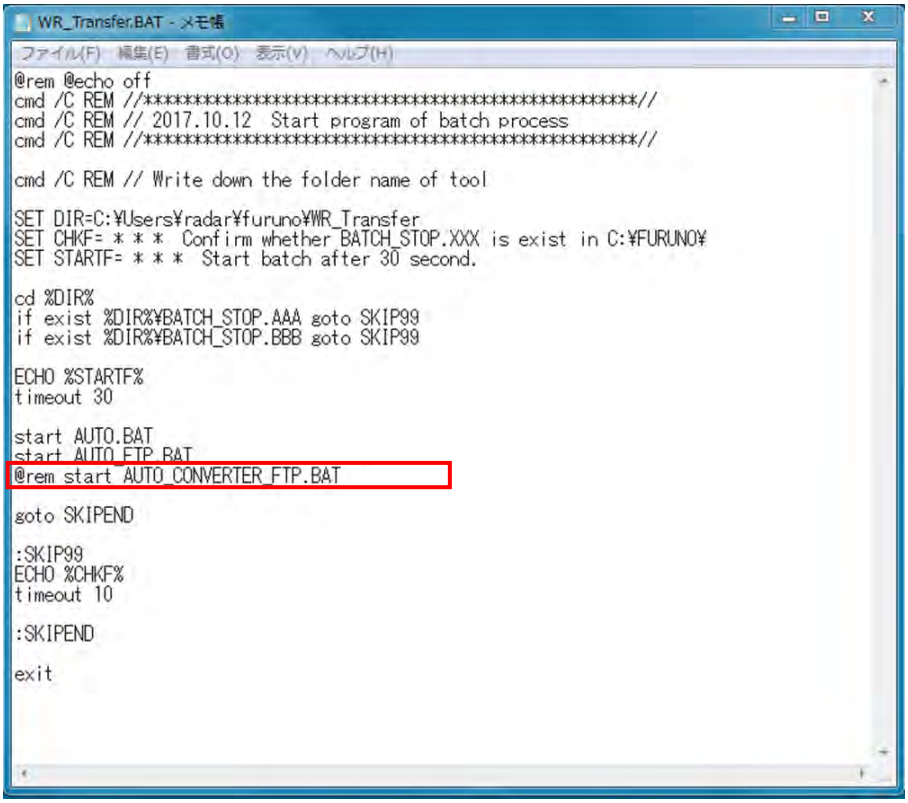


Figure 4.14: Sample of WR_Tnansfer.BAT

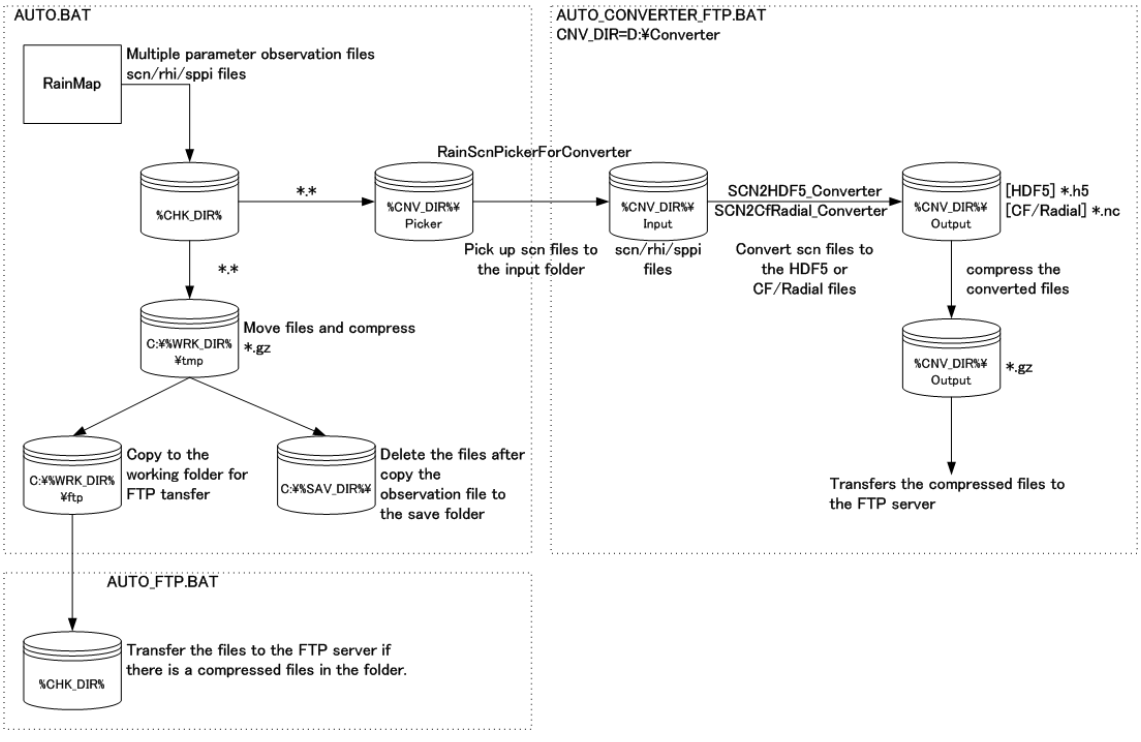
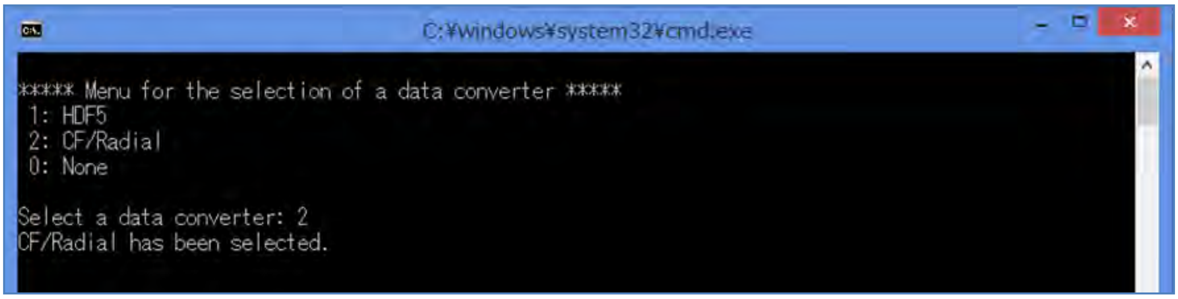


Figure 4.15: Data flow for data converter

3. To select a single data converter

Only one data converter can be used at one time. Select a data converter according to following procedures.

- Launch the batch file Select_Converter.bat.
  "C:＼Users＼radar＼Furuno＼WR_transfer＼Select_Converter.bat"
- Select one data converter from three options described below.

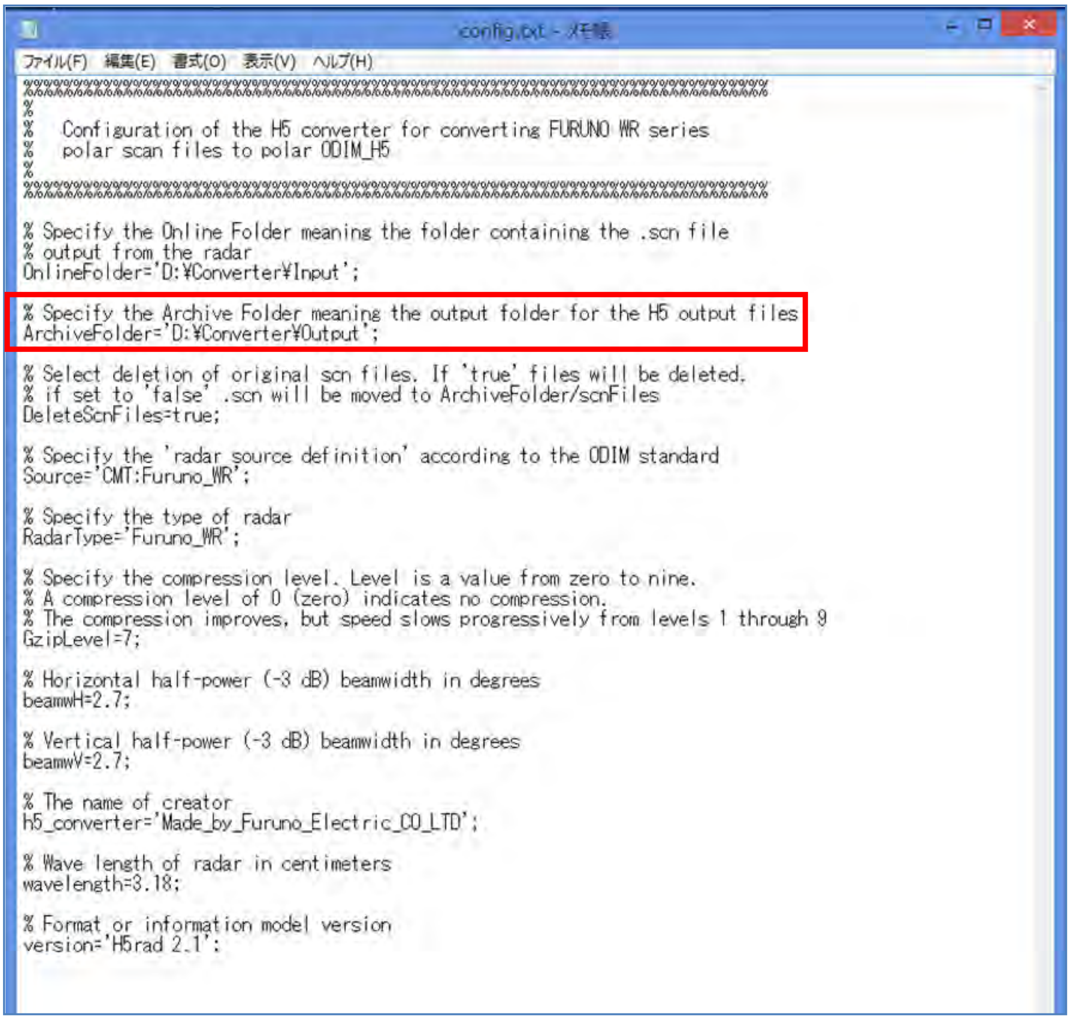


```
C:¥windows¥system32¥cmd.exe

***** Menu for the selection of a data converter *****
 1: HDF5
 2: CF/Radial
 0: None

Select a data converter: 2
CF/Radial has been selected.
```

Figure 4.16: Sample of Select_Converter.bat

4. To change the output folder

- Converted files are output in the folder which is assigned as "ArchiveFolder" in the configuration file, config.txt.
- In order to change the output folder, edit the parameter, "ArchiveFolder".
- From the performance point of view, "ArchiveFolder" is recommended to be located on a separate drive such as D-drive and not on the system drive (C-drive).



```
config.txt - メモ帳
ファイル(F) 編集(E) 書式(O) 表示(V) ヘルプ(H)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
%   Configuration of the H5 converter for converting FURUNO WR series
%   polar scan files to polar ODIM_H5
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

% Specify the Online Folder meaning the folder containing the .scn file
% output from the radar
OnlineFolder='D:¥Converter¥Input';

% Specify the Archive Folder meaning the output folder for the H5 output files
ArchiveFolder='D:¥Converter¥Output';

% Select deletion of original scn files. If 'true' files will be deleted.
% if set to 'false' .scn will be moved to ArchiveFolder/scnFiles
DeleteScnFiles=true;

% Specify the 'radar source definition' according to the ODIM standard
Source='CMT:Furuno_WR';

% Specify the type of radar
RadarType='Furuno_WR';

% Specify the compression level. Level is a value from zero to nine.
% A compression level of 0 (zero) indicates no compression.
% The compression improves, but speed slows progressively from levels 1 through 9
GzipLevel=7;

% Horizontal half-power (-3 dB) beamwidth in degrees
beamwH=2.7;

% Vertical half-power (-3 dB) beamwidth in degrees
beamwV=2.7;

% The name of creator
h5_converter='Made_by_Furuno_Electric_CO_LTD';

% Wave length of radar in centimeters
wavelength=3.18;

% Format or information model version
version='H5rad 2.1';
```

Figure 4.17: Sample of configuration file, config.txt

5. Output messages

Each converter outputs following messages to log files which are stored in each installation folder.
The file's names are SCN2HDF5_Converter.log and SCN2CfRadial_Converter.log.

STARTUP: output in launching

FINISHED: output when each processing is finished normally

ERROR: output if any errors occur

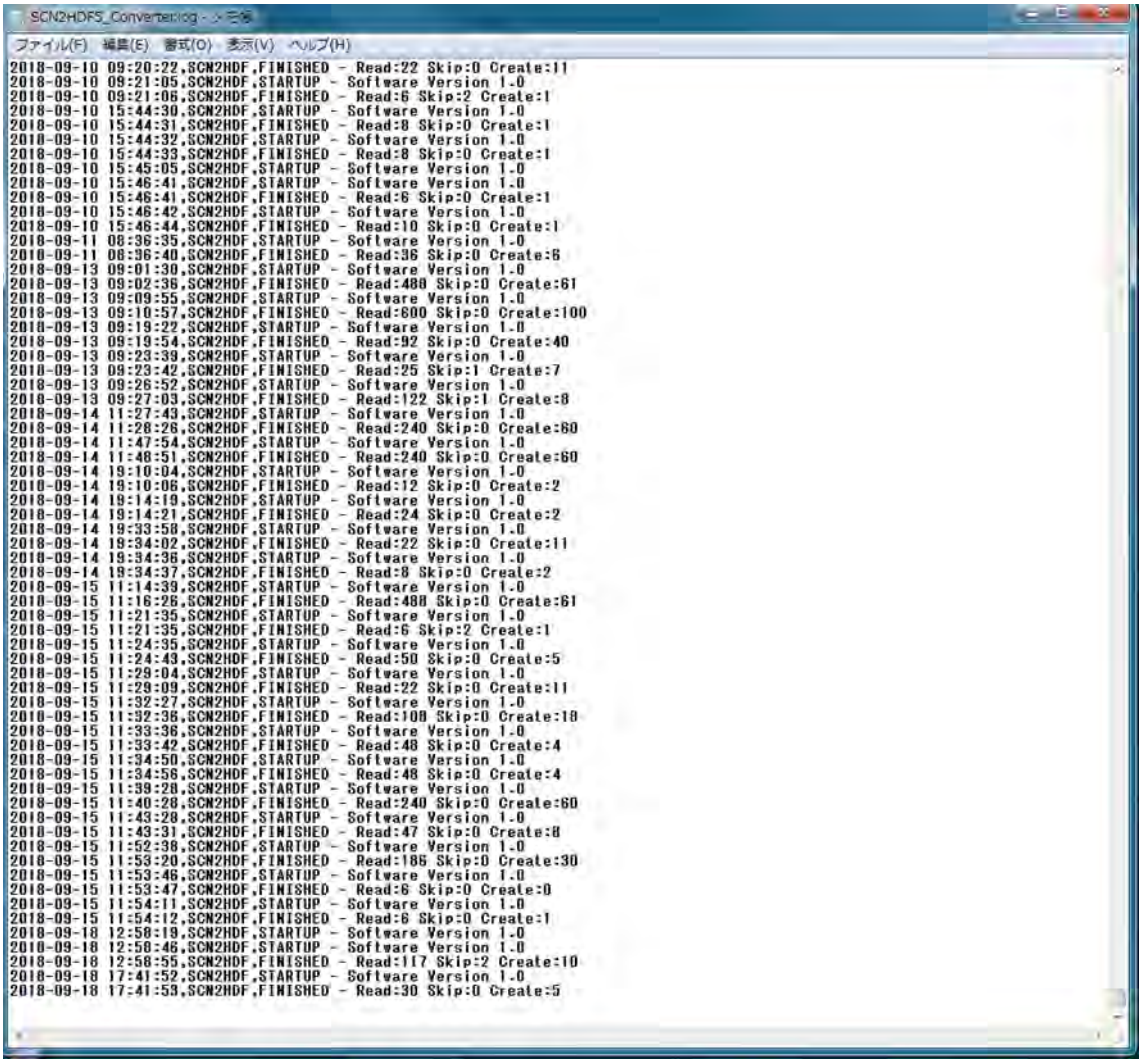
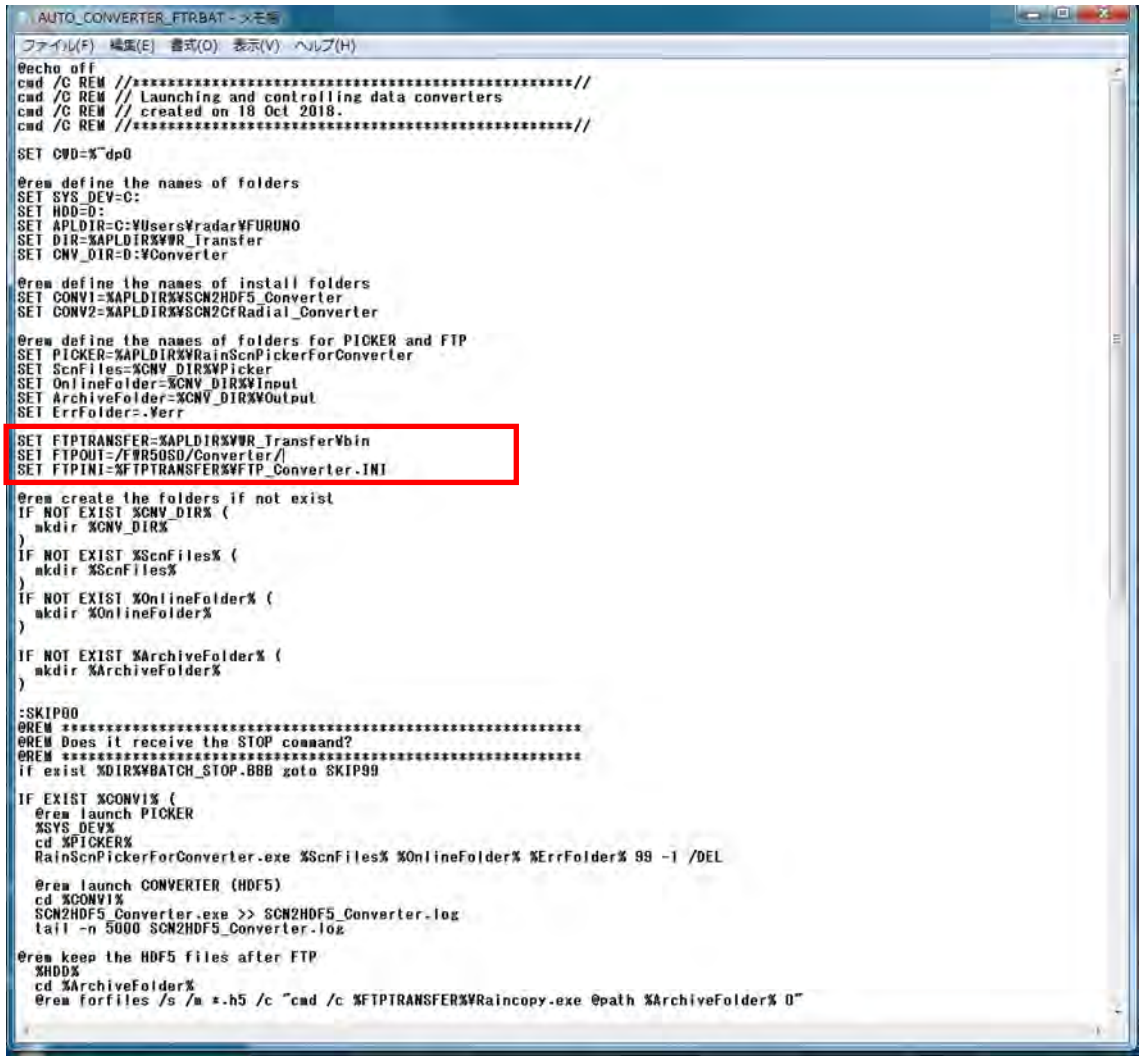


Figure 4.18: Sample of log file, SCN2HDF5_Converter.log

6. Enable FTP transfer of converted files

(1) Setup FTP configurations

- Setup FTP_Converter.INI. See section 4.2.4. Set the FTP_WR_FTP.ini
  "C:＼Users＼radar＼Furuno＼WR_transfer＼bin"
- Define the output folder on the FTP server.
  For example: SET FTPOUT=/FWR50S0/Converter/



```
AUTO_CONVERTER_FTP.BAT - メモ帳
ファイル(F)  編集(E)  書式(O)  表示(V)  ヘルプ(H)
@echo off
cmd /C REM //*****************************************************//
cmd /C REM // Launching and controlling data converters
cmd /C REM // created on 18 Oct 2018.
cmd /C REM //*****************************************************//

SET CWD=%~dp0

@rem define the names of folders
SET SYS_DEV=C:
SET HDD=D:
SET APLDIR=C:¥Users¥radar¥FURUNO
SET DIR=%APLDIR%¥¥R_Transfer
SET CNV_DIR=D:¥Converter

@rem define the names of install folders
SET CONV1=%APLDIR%¥¥SCN2HDF5_Converter
SET CONV2=%APLDIR%¥¥SCN2CfRadial_Converter

@rem define the names of folders for PICKER and FTP
SET PICKER=%APLDIR%¥¥RainScnPickerForConverter
SET ScnFiles=%CNV_DIR%¥¥Picker
SET OnlineFolder=%CNV_DIR%¥¥Input
SET ArchiveFolder=%CNV_DIR%¥¥Output
SET ErrFolder=.¥err

SET FTPTRANSFER=%APLDIR%¥¥R_Transfer¥bin
SET FTPOUT=/FWR50S0/Converter/
SET FTPINI=%FTPTRANSFER%¥¥FTP_Converter.INI

@rem create the folders if not exist
IF NOT EXIST %CNV_DIR% (
  mkdir %CNV_DIR%
)
IF NOT EXIST %ScnFiles% (
  mkdir %ScnFiles%
)
IF NOT EXIST %OnlineFolder% (
  mkdir %OnlineFolder%
)

IF NOT EXIST %ArchiveFolder% (
  mkdir %ArchiveFolder%
)

:SKIP00
@REM ************************************************************
@REM Does it receive the STOP command?
@REM ************************************************************
if exist %DIR%¥BATCH_STOP.BBB goto SKIP99

IF EXIST %CONV1% (
  @rem launch PICKER
  %SYS_DEV%
  cd %PICKER%
  RainScnPickerForConverter.exe %ScnFiles% %OnlineFolder% %ErrFolder% 99 -1 /DEL

  @rem launch CONVERTER (HDF5)
  cd %CONV1%
  SCN2HDF5_Converter.exe >> SCN2HDF5_Converter.log
  tail -n 5000 SCN2HDF5_Converter.log

@rem keep the HDF5 files after FTP
  %HDD%
  cd %ArchiveFolder%
  @rem forfiles /s /m *.h5 /c "cmd /c %FTPTRANSFER%¥Raincopy.exe @path %ArchiveFolder% 0"
```

Figure 4.19: Sample of AUTO_CONVERTER_FTP.BAT

(2) To keep the converted files after FTP, edit the batch file as described below.

AUTO_CONVERTER_FTP.BAT - メモ帳

ファイル(F) 編集(E) 書式(O) 表示(V) ヘルプ(H)

```
:SKIP00
@REM ************************************************************
@REM Does it receive the STOP command?
@REM ************************************************************
if exist %DIR%¥BATCH_STOP.BBB goto SKIP99

IF EXIST %CONV1% (
  @rem launch PICKER
  %SYS_DEV%
  cd %PICKER%
  RainScnPickerForConverter.exe %ScnFiles% %OnlineFolder% %ErrFolder% 99 -i /DEL

  @rem launch CONVERTER (HDF5)
  cd %CONV1%
  SCN2HDF5_Converter.exe >> SCN2HDF5_Converter.log
  tail -n 5000 SCN2HDF5_Converter.log

@rem keep the HDF5 files after FTP
  %HDD%
  cd %ArchiveFolder%
  forfiles /s /m *.h5 /c "cmd /c %FTPTRANSFER%¥Raincopy.exe @path %ArchiveFolder% 0"
  forfiles /s /m *.h5 /c "cmd /c %FTPTRANSFER%¥gzip.exe -f9 @path"
  %FTPTRANSFER%¥FtpTransfer.exe %ArchiveFolder%¥*.gz %FTPOUT% /DEL /F=%FTPINI%

@rem remove the HDF5 files after FTP
  @rem forfiles /s /m *.h5 /c "cmd /c %FTPTRANSFER%¥sigcopy.exe @path %ArchiveFolder% /DEL"
  @rem forfiles /s /m *.h5 /c "cmd /c %FTPTRANSFER%¥gzip.exe -f9 @path"
  @rem %FTPTRANSFER%¥FtpTransfer.exe %ArchiveFolder%¥*.gz %FTPOUT% /DEL /F=%FTPINI%
  @rem forfiles /c "cmd /c rmdir /Q @path >NUL 2>NUL"

) ELSE IF EXIST %CONV2% (
  @rem launch PICKER
  %SYS_DEV%
  cd %PICKER%
  RainScnPickerForConverter.exe %ScnFiles% %OnlineFolder% %ErrFolder% 99 -i /DEL

  @rem launch CONVERTER (CF/Radial)
  cd %CONV2%
  SCN2CfRadial_Converter.exe >> SCN2CFRADIAL_Converter.log
  tail -n 5000 SCN2CFRADIAL_Converter.log

@rem keep the CF/Radial files after FTP
  %HDD%
  cd %ArchiveFolder%
  forfiles /s /m *.nc /c "cmd /c %FTPTRANSFER%¥Raincopy.exe @path %ArchiveFolder% 0"
  forfiles /s /m *.nc /c "cmd /c %FTPTRANSFER%¥gzip.exe -f9 @path"
  %FTPTRANSFER%¥FtpTransfer.exe %ArchiveFolder%¥*.gz %FTPOUT% /DEL /F=%FTPINI%

@rem remove the CF/Radial files after FTP
  @rem forfiles /s /m *.nc /c "cmd /c %FTPTRANSFER%¥sigcopy.exe @path %ArchiveFolder% /DEL"
  @rem forfiles /s /m *.nc /c "cmd /c %FTPTRANSFER%¥gzip.exe -f9 @path"
  @rem %FTPTRANSFER%¥FtpTransfer.exe %ArchiveFolder%¥*.gz %FTPOUT% /DEL /F=%FTPINI%
  @rem forfiles /c "cmd /c rmdir /Q @path >NUL 2>NUL"

) ELSE (
  %HDD%
  cd %ScnFiles%
  del *.scn *.sppi *.rhi >NUL 2>NUL
  echo None converter has been selected.
  timeout 30
)

%SYS_DEV%
cd %C¥D%
goto SKIP00
```

Figure 4.20: Sample of AUTO_CONVERTER_FTP.BAT

(3) To remove the converted files after FTP, edit the batch file as described below.

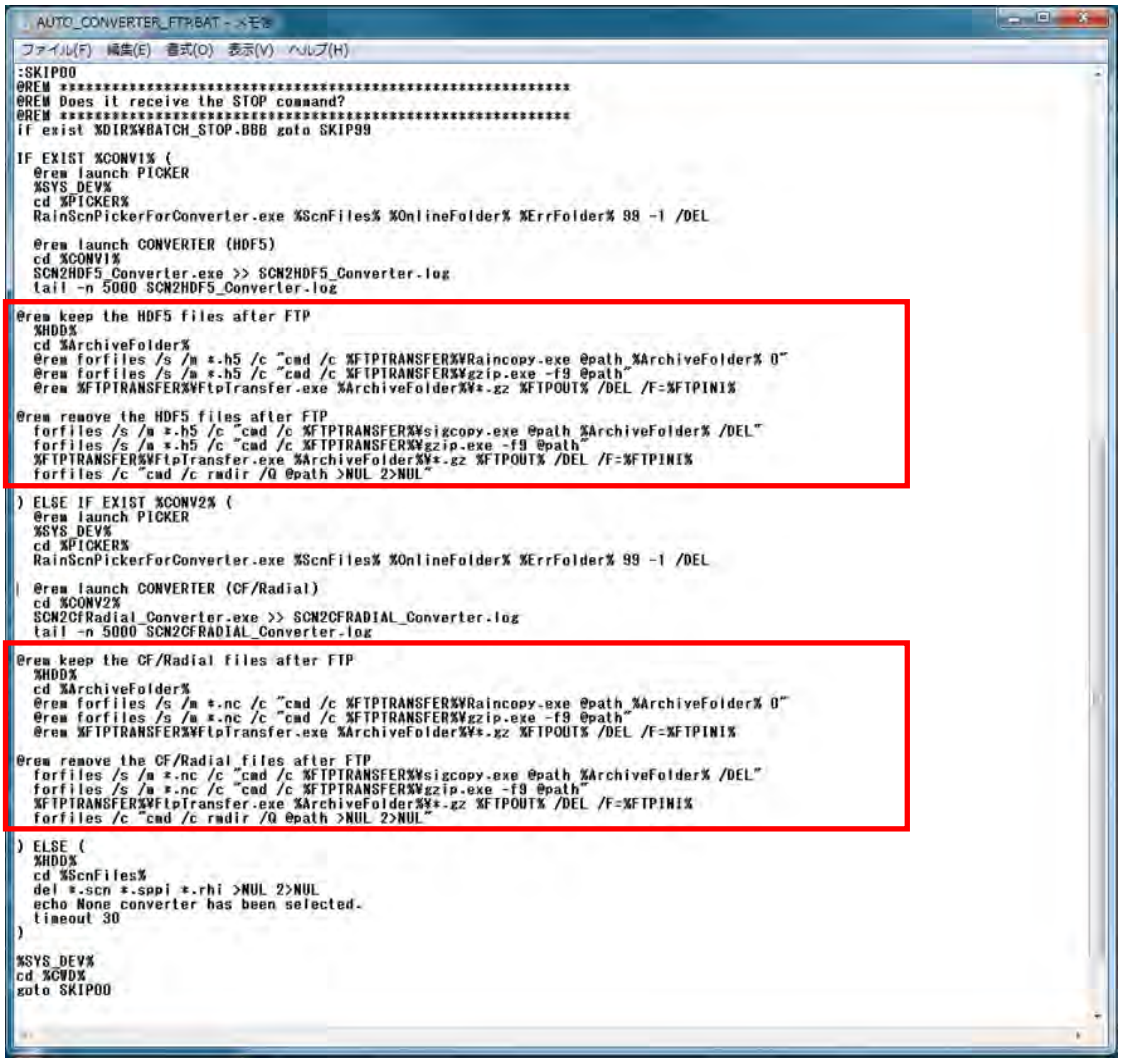


Figure 4.21: Sample of AUTO_CONVERTER_FTP.BAT

7. For WR_transfer.bat to startup when rebooting the computer

Copy the shortcut of WR_transfer.bat to the startup folder described below,
Local Disk (C:) > Users > radar > AppData > Roaming > Microsoft > Windows > Start Menu > Programs > Startup (See Figure 4.11)

8. Acknowledgment for OSS (Open Source Software)

Following OSS is used in the data converter of ODIM HDF5.

・HDF5 1.10.2

HDF5 (Hierarchical Data Format 5) Software Library and Utilities
Copyright (c) 2006-2018, The HDF Group.
NCSA HDF5 (Hierarchical Data Format 5) Software Library and Utilities
Copyright (c) 1998-2006, The Board of Trustees of the University of Illinois.
https://support.hdfgroup.org/ftp/HDF5/releases/COPYING

・zlib 1.2.11

Version 1.2.11, January 15th, 2017
Copyright (C) 1995-2017 Jean-loup Gailly and Mark Adler

Following OSS is used in the data converter of CF/Radial 1.4.

・NetCDF-C 4.6.1

Copyright (C) 1993-2017
University Corporation for Atmospheric Research/Unidata.
https://www.unidata.ucar.edu/software/netcdf/copyright.html

5. OUTPUT DATA FORMAT

5.1. Data File Type 1(csv)

1) Record unit

Adds a file to folder in computer for each setting cycle (e.g. 60 sec.)

It is possible to set up a log folder.

2) Record file name

Outputs file extension: csv

Form: DATE_TIME_DATAKIND.csv (YYYYMMDD_HHMMSS_xx.csv).

e.g.) Output the Rainfall intensity “01/10/2012 9:37:26” → "20121001_093726_Rain.csv".

Output data types are shown below:

R: Rainfall intensity [mm/h]
Zhh: Reflective intensity (Horizontal) [dBZ]
Zvv: Reflective intensity (Vertical) [dBZ]
V: Doppler velocity [m/s]
Zdr: Radar reflection factor difference [dB]
Kdp: Propagation phase difference rate of change [deg/km]

3) Data format (csv)

Row	Data	e.g.
1	Record date (date of DPU)	01/10/2012 9:37:26
2	Latitude [deg] (+:N, -:S)	34.713607 deg
3	Longitude [deg] (+:E, -:W)	135.335231 deg
4	The total number of sweeps (MAX 8192)	797 number
5	Data mark of the direction of distance (MAX 1028)	525 point
6	Resolution of the direction of distance [m]	100 m
7	Azimuth direction (θ) [deg] (The angle of azimuth for every sweep)	0.44 deg
8	Elevation direction (θ) [deg] (The angle of elevation for every sweep)	0.00deg
9 to MAX	Range direction (r) [BIN] Data mark of the distance direction +7 (Variable length is depends on a number of antenna rotations)	 row 532 (=525 point + 7row)

2012/10/1 9:37 <- Log Date/Time (PC Time)
34.713607 <- Latitude [Degree] (+:N, -:S)
135.335231 <- Longitude [Degree] (+:E, -:W)
797 <- Total Sweep value (Max: 8192)
525 <- Data point of range direction (Max: 1028)
96 <- Resolution of range distance [m]

Model of file name is Date Time data type.csv(YYYYMMDD HHMMSS xx.csv)
E.g.) The case of output rain-fall intensity occurred on 2012/10/01 9:37:26 would become

Direction of azimuth (θ) "Variable length" →

Range (r) "Variable length" ↓

0.04	0.44	0.92	1.32	<- Azimuth of every each sweep [degree] ->				3.65	4.04	4.48	4.92	5.41	5.84	6.28	6.72	7.21
0.00	0.00	0.00	0.00	<- Elevation of every each sweep [degree] ->				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.1	0.1	0.1	0.1	0.1	0.2	0.0	0.0	0.0	0.1	0.1	0.2	0.0	0.1	0.0	0.0	0.0
0.2	0.2	0.2	0.3	0.4	0.5	0.0	0.1	0.1	0.2	0.4	0.4	0.1	0.2	0.0	0.0	0.1
0.2	0.3								0.2	0.5	0.5	0.1	0.2	0.0	0.0	0.1
0.2	0.3								0.2	0.5	0.5	0.1	0.2	0.0	0.0	0.1
0.3	0.3								0.3	0.6	0.6	0.2	0.2	0.0	0.0	0.1
0.3	0.4								0.3	0.6	0.7	0.2	0.2	0.0	0.0	0.1
0.3	0.4								0.3	0.7	0.7	0.2	0.3	0.0	0.0	0.1
0.3	0.4								0.3	0.8	0.8	0.2	0.3	0.0	0.0	0.2
0.4	0.5								0.4	0.8	0.9	0.2	0.3	0.1	0.0	0.2
0.4	0.5								0.4	0.9	0.9	0.2	0.3	0.1	0.0	0.2
0.4	0.5	0.5	0.7	0.9	1.2	0.1	0.3	0.2	0.4	1.0	1.0	0.3	0.4	0.1	0.0	0.2
0.5	0.6	0.5	0.8	1.0	1.3	0.1	0.3	0.2	0.5	1.0	1.1	0.3	0.4	0.1	0.0	0.2
0.5	0.6	0.5	0.8	1.0	1.4	0.1	0.3	0.2	0.5	1.1	1.2	0.3	0.4	0.1	0.0	0.2
0.5	0.6	0.6	0.9	1.1	1.5	0.1	0.4	0.2	0.5	1.2	1.2	0.3	0.4	0.1	0.0	0.2
0.6	0.7	0.6	0.9	1.2	1.6	0.1	0.4	0.2	0.1	1.2	1.3	0.3	0.5	0.1	0.0	0.3
0.6	0.7	0.5	1.0	0.3	1.7	0.1	0.2	0.2	0.1	1.3	1.4	0.4	0.5	0.1	0.0	0.3
0.6	0.1	0.1	1.0	0.1	0.7	0.1	0.1	0.2	0.1	1.4	1.5	0.2	0.5	0.1	0.0	0.3
0.3	0.1	0.1	1.1	0.1	0.1	0.1	0.1	0.2	0.0	1.5	1.5	0.0	0.6	0.1	0.0	0.3
0.0	0.1	0.0	1.1	0.2	0.1	0.2	0.0	0.2	0.1	1.5	1.3	0.0	0.6	0.0	0.0	0.3
0.0	0.0	0.0	1.2	0.1	0.1	0.2	0.0	0.2	0.2	1.6	0.3	0.0	0.6	0.0	0.0	0.2
0.0	0.0	0.0	1.3	0.0	0.1	0.2	0.0	0.2	0.2	1.7	0.3	0.0	0.4	0.0	0.1	0.1
0.1	0.0	0.0	1.3	0.0	0.1	0.2	0.0	0.2	0.2	1.8	0.3	0.1	0.0	0.0	0.1	0.1
0.1	0.0	0.0	1.1	0.0	0.1	0.2	0.0	0.3	0.2	1.8	0.2	0.1	0.0	0.0	0.0	0.2
0.1	0.0	0.0	0.1	0.0	0.1	0.2	0.0	0.3	0.2	1.9	0.2	0.1	0.0	0.1	0.0	0.2
0.1	0.0	0.0	0.1	0.0	0.1	0.2	0.1	0.3	0.2	0.2	0.1	0.1	0.0	0.1	0.0	0.2
0.1	0.0	0.0	0.1	0.0	0.1	0.2	0.3	0.3	0.1	0.1	0.1	0.0	0.0	0.1	0.0	0.1
0.1	0.0	0.1	0.1	0.0	0.5	0.2	0.3	0.3	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
0.0	0.1	0.1	0.1	0.0	0.6	0.2	0.1	0.3	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.1
0.0	0.1	0.0	0.0	0.0	0.6	0.2	0.0	0.1	0.0	0.0	0.2	0.0	0.1	0.0	0.0	0.0

[Data type](xx)

Rain	Raill-fall intensity [mm/h]
Zhh	Reflectivity factor of Horizontal to Horizontal [dBZ]
Zvv	Reflectivity factor of Vertical to Vertical [dBZ]
DS	Doppler speed [m/s]
Zdr	Difference reflectivity[dB]
Kdp	Specific differential phase [deg/km]

Sample of Output Data:

1: PPI, 2:Spiral scan(SPI), 3:Sector RHI, 4:HSQ

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	2014/10/9 13:26	1													
2	34.7266														
3	135.238														
4	445														
5	502														
6	100														
7	0.18	0.66	1.19	1.85	2.37	2.86	3.3	3.87	4.39	5.05	5.58	6.02	6.5	7.08	7.6
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9															
10															
11															
12															
13															
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0.1	0.2	0.2	0.2	0.1	0	0	0	0	0	0	0	1.7	2
16	0	0.1	0.2	0.2	0.2	0.1	0	0	0	0	0	0	0	1.5	1.9
17	0.2	0	0.7	0.9	0.9	0.6	1.4	1.6	1.7	1.7	0.4	0.2	1.6	3.9	4.5
18	0.2	0	0.4	0.5	0.6	0.4	1.4	1.5	1.6	1.6	0.3	0.1	1.4	2.3	2.5
19	0	0.1	0.1	0	0	0	0	0.8	1	1.1	1.1	0.6	0.1	2.1	2.8
20	0	0.3	0.4	0.2	0.2	0.1	0.1	2.4	3.1	3.3	3.3	1.4	2.7	5.9	6.6
21	0	0.3	0.2	0.2	0.2	0	0	0.9	1.1	1.2	1.2	0.4	1.9	4.8	5.4
22	0	0	0	0	0	0	0	0	0.1	0.1	0.1	0	0	0.7	0.8
23	0.1	0.3	0.3	0.3	0.2	0	0	0	0.1	0	0	0	1.1	1.6	1.8
24	0	0.3	0.4	0.5	0.3	0.1	0	0.1	0.1	0.1	0.1	0	1.3	2.8	3.2
25	0	0.3	0.4	0.4	0.3	0.1	0	0.3	0.4	0.4	0.2	0	0.5	1.6	1.9
26	0	0	0	0	0	0	0	0.1	0.1	0.1	0	0	0.5	0.9	1.1
27	0	0	0	0	0	0	0	0.3	0.3	0.3	0.1	0	0.1	1	1.1
28	0	0.2	0.3	0.4	0.3	0.1	0	0.3	0.3	0.3	0.1	0	0.4	1.2	1.4
29	0	0.3	0.4	0.4	0.4	0.1	0	0.2	0.2	0.1	0	0	0.4	1.3	1.5
30	0	0	0	0	0	0	0	0.5	0.6	0.4	0.2	0	0.3	0.7	0.7
31	0	0	0	0	0	0	0.2	0.3	0.3	0.3	0.2	0	0.1	0.5	0.6
32	0	0.1	0.1	0.1	0	0	0.5	0.7	0.8	0.8	0.4	0.1	0.1	0.8	1
33	0	0.1	0.1	0.1	0	0	0.1	0.6	0.7	0.7	0.5	0.1	0.1	0.5	0.6
34	0	0.3	0.4	0.4	0.1	0	0.2	0.6	0.7	0.7	0.5	0.1	0.2	1.1	1.3
35	0	0.5	0.6	0.6	0.1	0	0	0.5	0.7	0.7	0.6	0.1	0	0.7	0.8
36	0	0.4	0.3	0.4	0.1	0	0	0.4	0.6	0.6	0.1	0	0.2	0.4	0.5
37	0	0	0	0	0	0	0	0.1	0.3	0.2	0	0	0.2	0.8	1
38	0	0	0	0	0	0	0	0.2	0.4	0.3	0.1	0	0.2	0.8	0.9
39	0	0.2	0.2	0.4	0.1	0	0	0	0.1	0.1	0	0	0	0.5	0.7
40	0	0.2	0.2	0.4	0.1	0	0	0.1	0.2	0.2	0.1	0	0.2	0.5	0.6

5.2. Data File Type 2 [scn v3] (legacy format)

1) Record unit

Each scn file includes one scan data (e.g. one completed azimuth rotation) which is stored in a capture folder specified in RainMap acquisition setting.
Note: (*2) is only for Dual Polarimetric Dopplar.

2) Record file name

File name: Product number (xxxx) (*1) _ Scenario start time (YrMoDa _ HrMinSec) _ Elevation angle number (##) [deg] _ Tx pulse type (**) .scn
File name extension: .scn, .rhi, .sppi,
xxxx_YYYYMMDD_hhmmss_##_** .scn
e.g.: 0001_20130514_123400_01_00
Product number: alphanumeric
Scenario start time: UTC

Elevation angle number is numbered from the lowest angle as 01, 02, 03···

Tx pulse type
00: pulse modulation, 01: frequency modulation (pulse compression), 02: 00 + 01 (alternative)
*File format of “rhi” and “sppi” are also same.

The case of SRHI, File name: Product number + Scenario start time (YrMoDaHrMinSec) + Serial order (rhi)
Product number + Scenario start (YrMoDaHrMinSec) + Serial order
e.g..: 0001_20170714_140100_001.rhi
SRHI azimuth start to end point or end to start point will be scenario start YrMoDaHrMinSec. Serial order will be changed by every azimuth (It will add serial order by moving upper and lower direction of elevation.

3) Data format

Binary format (Byte order: Little-endian)

Block	Item	Detail	Size [byte]	Off-set	Data type
Header	Size of header	e.g. 80 [Byte] (*1)	2	2	unsigned short
	Production type information and Version of data format	3	2	4	unsigned short
	DPU Log time: year	e.g. 2013	2	6	unsigned short
	DPU Log time: month	e.g. 05	2	8	unsigned short
	DPU Log time: day	e.g. 15	2	10	unsigned short
	DPU Log time: hour	e.g. 18	2	12	unsigned short
	DPU Log time: minute	e.g. 30	2	14	unsigned short
	DPU Log time: second	e.g. 00	2	16	unsigned short
	Latitude: degree	e.g. 34 (N. Lat: +, S. Lat:-)	2	18	signed short
	Latitude: minute	e.g. 44	2	20	unsigned short
	Latitude: second	e.g. 59.999 (1000 times level)	2	22	unsigned short
	Longitude: degree	e.g. 135 (E. Lon: +, W. Lon.-)	2	24	signed short
	Longitude: minute	e.g. 21	2	26	unsigned short
	Longitude: second	e.g. 59.999 (1000 times level)	2	28	unsigned short
	Antenna Altitude (Upper)	Range Upper: 0 - 65535	2	30	unsigned short

Block	Item	Detail	Size [byte]	Off-set	Data type
Header	Antenna Altitude (Lower)	Range Lower: 0 - 9999 Altitude[cm]＝ (Upper) x 10000＋ (Lower) e.g. 123456[cm]＝12 x 10000 ＋3456	2	32	unsigned short
	Antenna rotation speed (Azimuth)	e.g. 10.0 (10 times level of [rpm])	2	34	unsigned short
	PRF1	e.g. 1600.0 (10 times level of [Hz])	2	36	unsigned short
	PRF2	e.g. 2000.0 ([Hz] 10 times level)	2	38	unsigned short
	Noise level (Pulse Modulation) - Horizontal polarization	e.g. -62.00 (100 times level of [dBm])	2	40	signed short
	Noise level (Frequency Modulation) - Horizontal polarization	e.g. -62.00 (100 times level of [dBm]) Note: This value is invalid for the single polarization	2	42	signed short
	Total number of sweep: L	e.g. 720 [qty]	2	44	unsigned short
	Number of range direction data: M	e.g. 300 [qty]	2	46	unsigned short
	Resolution of range direction	e.g. 100.00 (100 times level of [m])	2	48	unsigned short
	Constant radar: Mantissa (Horizontal polarization)	Range: -999999999 - 999999999	4	52	signed long
	Constant radar: Characteristic (Horizontal polarization)	Range: Characteristic:-32768 - 32767 Constant＝ (Mantissa) x 10^ (Characteristic) e.g. 9.876E-9＝9876 x 10^-12	2	54	signed short
	Constant radar: Mantissa (Vertical polarization)	Same as above (Same as horizontal polarization) Note: This value is invalid for the single polarization	4	58	signed long
	Constant radar: Characteristic (Vertical polarization)		2	60	signed short
	Azimuth Offset	e.g. 200.00 ([deg] x 100) Offset value of North and radar direction of origin	2	62	unsigned short
	Record UTC time: year (*1)	e.g. 2013	2	64	unsigned short
	Record UTC time: month (*1)	e.g. 05	2	66	unsigned short
	Record UTC time: day (*1)	e.g. 15	2	68	unsigned short
	Record UTC time: hour (*1)	e.g. 09	2	70	unsigned short
	Record UTC time: minute (*1)	e.g. 30	2	72	unsigned short
	Record UTC time: second (*1)	e.g. 00	2	74	unsigned short
	Record item (*1)	e.g. WR110: 33159 (dec) bit0: Rain, bit1: Zhh, bit2: V, bit7: W, bit8: quality information bit15: w/ ATT10dB e.g. WR-2100: 33279 (dec) bit0: Rain, bit1: Zhh, bit2: V, bit3: Zdr, bit4: Kdp, bit5: phi-dp, bit6: rho-hv, bit7: W, bit8: quality information, bit9-14: reserved, bit15: w/ ATT10dB	2	76	unsigned short
	Tx pulse blind area (*1)	e.g. 7500 [m]	2	78	unsigned short
	Tx pulse specification (*1)	e.g. 8	2	80	unsigned short

Block	Item	Detail	Size [byte]	Off-set	Data type
Observation angularity information	Information ID	e.g. 6 [byte]	2	82	unsigned short
	Azimuth *Angle from initial position of ATU	Range: 0 - 359.99 100 times level of [deg] Initial position: 0 deg	2	84	unsigned short
	Elevation	Range: -3.00 - 180.00 100 times level of [deg] Horizontal: 0deg, Elevation: +, Dip: -	2	86	signed short
Observed data	Observed data size	e.g. 5402 [byte]	2	88	unsigned short
	Rain (Rainfall intensity)	Range: 0 - 65535 Calculation formula N is a recording level. Rain[mm/h]= (N-32768)/100 Rain Range: -327.67 - 327.67mm/h Resolution: 0.01mm/h N=0 is invalid	2 x Range direction data mark	-	unsigned short
	Zhh (Reflective intensity Horizontal polarization)	Range: 0 - 65535 Calculation formula N is a recording level. Zhh[dBZ]= (N-32768)/100 Zhh Range: -327.67 - 327.67dBZ Resolution: 0.01dBZ N=0 is invalid	2 x Range direction data mark	-	unsigned short
	V (Doppler velocity)	Range: 0 - 65535 Calculation formula N is a recording level. V[m/s]= (N-32768)/100 V Range: -327.67 - 327.67m/s Resolution: 0.01m/s N=0 is invalid	2 x Range direction data mark	-	unsigned short
	W (Doppler velocity spectrum width)	Range: 0 - 65535 Calculation formula N is a recording level. W[m/s]= (N-1)/100 W Range: 0.00 - 655.34m/s Resolution: 0.01m/s N=0 is invalid	2 x Range direction data mark		unsigned short
	Quality information (*1)	e.g. 2 bit0: signal shielding, bit1: signal extinction, bit2: clutter reference, bit3-5: clutter reference (0: Less than 0.1mm, 1: 0.1mm or more, 2: 1.0mm or more, 3: 5.0mm or more, 4: 0.0mm or more, 5: 20.0mm or more, 6: 50.0mm or more, 7: 100.0mm or more) bit6: pulse blind area bit7: sector blank bit8: 1 fixed (bit3-7 show additional) bit9-15: reserved	2 x Range direction data mark		unsigned short

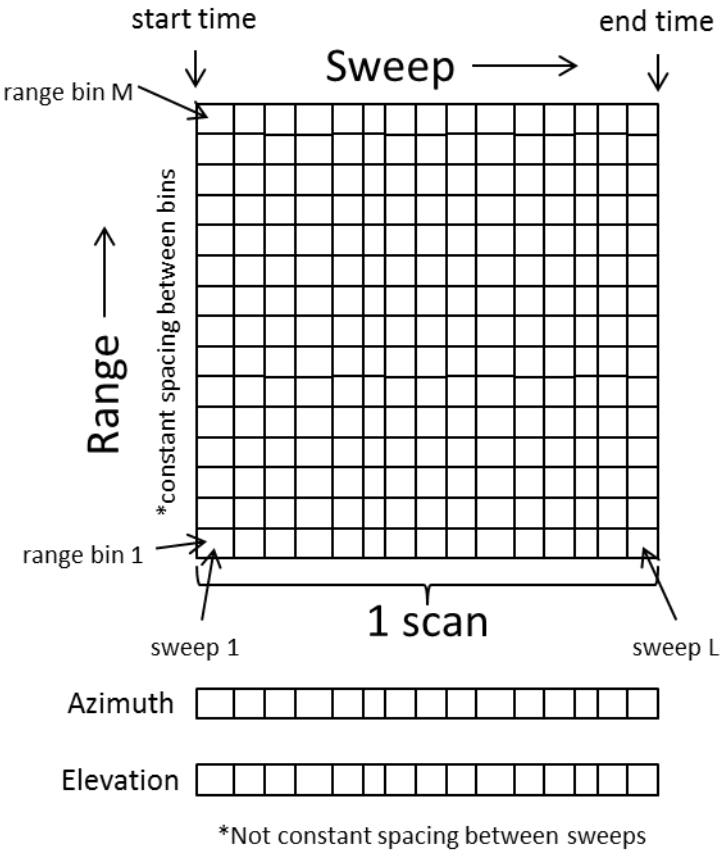
Block	Item	Detail	Size [byte]	Off-set	Data type
Observation angularity information	sweep 1	Range direction data 1			
Observation data	sweep 1	Range direction data 1			
|	|	|			
|	sweep 1	Range direction data M			
|	sweep 1	Range direction data M			
|	sweep 2	Range direction data 1			
|	sweep 2	Range direction data 1			
|	|	|			
|	sweep 2	Range direction data M			
|	sweep 2	Range direction data M			
|	Sweep L	Range direction data 1			
|	Sweep L	Range direction data 1			
|	|	|			

5.3. Data File Type 3 [scn v10]

1) Record unit

Each scnx file includes one scan data (e.g. one completed azimuth rotation) which is stored in a capture folder specified in RainMap acquisition setting.

2) Define of data dimensions



3） Record file name

File name extension: “.scnx””.rhix””.sppix””.ppix”
File name: xxxx_YYYYMMDD_hhmmss_###
Example) 0001_20180910_183000_000.scnx
xxxx: Product number
YYYYMMDD_hhmmss: Scenario start time (UTC)
###(for Volume scan): Angle number is numbered from the lowest EL angle as 000, 001, 002, …
###(for SPPI scan): Angle number is numbered from the lowest EL angle as 000, 001, 002, …
###(for PPI scan): Always 000
###(for SRHI scan): Angle number is numbered from the start AZ angle as 000, 001, 002, …

4) Data format

Binary format (Byte order: Little-endian)

Block	Item		Detail	Size [byte]	Off-set	Data type
Header	Size of header		156 [byte]	2	2	unsigned short
	Version of data format		10	2	4	unsigned short
	Scan start time (UTC)	Year	e.g. 2018	2	6	unsigned short
		Month	e.g. 09	1	7	unsigned char
		Day	e.g. 10	1	8	unsigned char
		Hour	e.g. 18	1	9	unsigned char
		Minute	e.g. 30	1	10	unsigned char
		Second	e.g. 00	1	11	unsigned char
		Spare	0	1	12	-
	Scan start time (UTC)	Year	e.g. 2018	2	14	unsigned short
		Month	e.g. 09	1	15	unsigned char
		Day	e.g. 10	1	16	unsigned char
		Hour	e.g. 18	1	17	unsigned char
		Minute	e.g. 30	1	18	unsigned char
		Second	e.g. 50	1	19	unsigned char
		Spare	0	1	20	-
	Time Zone (include daylight-saving time)		e.g. +9.00 (JST) e.g. -6.00 (CST) e.g. -5.00 (CDT) e.g. +9.30 (ACST) e.g. +8.45 (ACWST) (100 times level. The fractional part represents minute.)	2	22	signed short
	Product number		e.g. 0000	2	24	unsigned short
	Model type		1:WR-50 2:WR-2100 3:WR110 4:WR2120	2	26	unsigned short
	Latitude		e.g. 34.71360 (N. Lat: +, S. Lat:-) (100000 times level of [deg])	4	30	signed long
	Longitude		e.g. 135.33520 (E. Lon: +, W. Lon.-) (100000 times level of [deg])	4	34	signed long
	Antenna Altitude		e.g. 10000 [cm]	4	38	signed long
	Azimuth Offset		e.g. 200.00 (100 times level of [deg]) (Offset value of North and radar direction of origin)	2	40	unsigned short
	TX frequency		e.g. 9432.50 (100 times level of [MHz])	4	44	unsigned long
	Polarization mode		1: single-H 2: Simultaneous-dual	2	46	unsigned short

Block	Item	Detail	Size [byte]	Off-set	Data type
Header	Antenna gain H	e.g. 34.0 (10 times level of [dBi])	2	48	unsigned short
	Antenna gain V	e.g. 34.0 (10 times level of [dBi])	2	50	unsigned short
	Half-power beam width H	e.g. 2.70 (100 times level of [deg])	2	52	unsigned short
	Half-power beam width V	e.g. 2.70 (100 times level of [deg])	2	54	unsigned short
	TX power H(*6)	e.g. 75.0 (10 times level of [W])	2	56	unsigned short
	TX power V(*6)	e.g. 75.0 (10 times level of [W])	2	58	unsigned short
	Radar const. H(*4)	e.g. -131.0 (10 times level of [dB]) (Logged [m/mW])	2	60	signed short
	Radar const. V(*4)	e.g. -131.0 (10 times level of [dB]) (Logged [m/mW])	2	62	signed short
	Noise power H (Short pulse)	e.g. -60.0 (10 times level of [dBZ@1m])	2	64	signed short
	Noise power H (Long pulse)	e.g. -75.0 (10 times level of [dBZ@1m])	2	66	signed short
	Threshold power (Short pulse)	e.g. -56.0 (10 times level of [dBZ@1m])	2	68	signed short
	Threshold power (Long pulse)	e.g. -71.0 (10 times level of [dBZ@1m])	2	70	signed short
	Tx pulse specification	e.g. 8	2	72	unsigned short
	PRF mode	1: Single PRF PRF1 enable. 2: Dual PRF PRF1, PRF2 enable. 3. Triple PRF PRF1, PRF2, PRF3 enable.	2	74	unsigned short
	PRF1	e.g. 2000.0 (10 times level of [Hz])	2	76	unsigned short
	PRF2	e.g. 1600.0 ([10 times level of Hz])	2	78	unsigned short
	PRF3	e.g. 1400.0 (10 times level of [Hz])	2	80	unsigned short
	Nyquist velocity(*5)	e.g. 64.2 (10 times level of [m/s])	2	82	unsigned short
	Sample number	e.g. 64 (number of samples used for making the 1 sweep data)	2	84	unsigned short
	Tx pulse blind length	e.g. 300 [m]	2	86	unsigned short
	Short pulse width	e.g. 1.00 (100 times level of [μs])	2	88	unsigned short
	Short pulse modulation bandwidth	e.g. 0.00 (100 times level of [MHz])	2	90	unsigned short
	Long pulse width	e.g. 30.00 (100 times level of [μs])	2	92	unsigned short
	Long pulse modulation bandwidth	e.g. 2.00 (100 times level of [MHz])	2	94	unsigned short
	Pulse switch point	e.g. 5000 [m]	2	96	unsigned short
	Observation mode	1. PPI 2. SRHI 3. Volume 4. SPPI	2	98	unsigned short
	Antenna rotation speed (Scanning direction)	e.g. 7.5 (10 times level of [rpm])	2	100	unsigned short
	Number of sweep direction data	e.g. 720 [qty]	2	102	unsigned short

Block	Item		Detail	Size [byte]	Off-set	Data type
Header	Number of range direction data		e.g. 300 [qty]	2	104	unsigned short
	Resolution of range direction		e.g. 100 [m]	2	106	unsigned short
	Current scan number		e.g. 0 [st, nd, rd, th] (starting with 0)	2	108	unsigned short
	Total number of scans comprising the volume		e.g. 6 *only Volume scan, SPPI (starting with 1)	2	110	unsigned short
	Rainfall intensity estimation method		1 : Zh 2 : Zh, Kr 3 : Zh, Ah 4 : Kdp + Zh	2	112	unsigned short
	Z-R coefficient “B”		e.g. 200.0 (10 times level)	2	114	unsigned short
	Z-R coefficient “β”		e.g. 1.60 (100 times level)	2	116	unsigned short
	Kdp-R coefficient “a”		e.g. 19.60 (100 times level)	2	118	unsigned short
	Kdp-R coefficient “b”		e.g. 0.825 (1000 times level)	2	120	unsigned short
	Kdp-R coefficient “c”		e.g. 1.20 (100 times level)	2	122	unsigned short
	Zh attenuation correction method		1. none 2. Kr 3. Kdp	2	124	unsigned short
	Zh attenuation correction coefficient “b1”		e.g. 0.233 (1000 times level)	2	126	unsigned short
	Zh attenuation correction coefficient “b2”		e.g. 1.020 (1000 times level)	2	128	unsigned short
	Zdr attenuation correction coefficient “d1”		e.g. 0.0298 (10000 times level)	2	130	unsigned short
	Zdr attenuation correction coefficient “d2”		e.g. 1.293 (1000 times level)	2	132	unsigned short
	Air attenuation (one way)		e.g. 0.010 (1000 times level of [dB/km])	2	134	unsigned short
	Output threshold of Rain		e.g. 0.5 (10 times level of [mm/h])	2	136	unsigned short
	Record item (*1)		e.g. 33279 bit0: R, bit1:Zh, bit2:V, bit3: Zdr, bit4:Kdp, bit5:φdp, bit6: ρhv, bit7:W, bit8: Quality information, bit9 ~ 14:reserved bit15: 1 (fixed)	2	138	unsigned short
	Signal Processing Flag (*3)		e.g. 7 bit0: GCR(MTI) bit1: GCR(Ref) bit2: SCR bit3: Extended DOP bit4: GCR(V) bit5: GCR(Zdr) bit6: GCR(ρhv) bit7 ~ 15:reserved	2	140	unsigned short
	Used clutter reference file (*2)	Year	e.g. 2017 If GCR(Ref) is off, value is 0.	2	148	unsigned short
		Month	e.g. 12	1	149	unsigned char
		Day	e.g. 31	1	150	unsigned char
		Hour	e.g. 23	1	151	unsigned char
		Minute	e.g. 59	1	152	unsigned char
		Second	e.g. 00	1	153	unsigned char
		Spare	0	1	154	-
	Reserved Block		reserved	8	156	-

Block	Item	Detail	Size [byte]	Off-set	Data type
Angle Information block	Angle Information block size	6 [byte]	2	158	unsigned short
	Azimuth (Angle from initial position of ATU)	Range: 0 ~ 359.99 (100 times level of [deg]) (Initial position: 0 deg)	2	160	unsigned short
	Elevation	Range: -2.00 ~ 182.00 (100 times level of [deg]) (Horizontal: 0deg, Elevation: +, Dip: -)	2	162	unsigned short
Observed data block	Observed data block size	e.g. 16796[byte]	2	164	unsigned short
	R (Rainfall rate) (*1)	Calculation formula N is a recording level. R[mm/h]= (N-32768)/100 R Range: -327.67 ~ 327.67mm/h Resolution: 0.01mm/h N=0 is invalid	2×M	*	unsigned short
	Zh (Reflectivity factor Horizontal polarization) (*1)	Calculation formula N is a recording level. Zh[dBZ]= (N-32768)/100 Zh Range: -327.67 ~ 327.67dBZ Resolution: 0.01dBZ N=0 is invalid	2×M	*	unsigned short
	V(Doppler velocity) (*1)	Calculation formula N is a recording level. V[m/s]= (N-32768)/100 V Range: -327.67 ~ 327.67m/s Resolution: 0.01m/s N=0 is invalid	2×M	*	unsigned short
	Zdr(Differential reflectivity) (*1)	Calculation formula N is a recording level. Zdr[dB]= (N-32768)/100 Zdr Range: -327.67 ~ 327.67dB Resolution: 0.01dB N=0 is invalid	2×M	*	unsigned short
	Kdp(Specific differential phase) (*1)	Calculation formula N is a recording level. Kdp[deg/km]= (N-32768)/100 Kdp Range: -327.67 ~ 327.67deg/km Resolution: 0.01deg/km N=0 is invalid	2×M	*	unsigned short
	φdp(Differential phase) (*1)	Calculation formula N is a recording level. φdp[deg]=360x(N-32768)/65535 φdp Range: -179.9972 ~ 179.9972deg Resolution: 0.0055deg N=0 is invalid	2×M	*	unsigned short
	ρhv(Correlation coefficient between Zh and Zv) (*1) * Corrected by S/N	Calculation formula N is a recording level. ρhv[no unit]=2 x (N-1)/65534 ρhv Range:0.0 ~ 2.0 Resolution: 0.0000030 N=0 is invalid	2×M	*	unsigned short
	W(Doppler Spectrum width) (*1)	Calculation formula N is a recording level. W[m/s]= (N-1)/100 W Range: 0.00 ~ 655.34m/s Resolution: 0.01m/s N=0 is invalid	2×M	*	unsigned short

Block	Item	Detail	Size [byte]	Off-set	Data type
Observed data block	Quality information (*1)(*3)	bit0: Signal shading, bit1: Signal extinction, bit2: Clutter reference, bit3 ~ 5: Ground clutter quantity (0: Less than 0.1mm, 1: More than 0.1mm, 2: More than 1.0mm, 3 : More than 5.0mm, 4: More than 10.0mm, 5: More than 20.0mm, 6: More than 50.0mm, 7: More than 100.0mm) bit6: Pulse blind area bit7: Sector blank bit8: R(Kdp)_Enable bit9: Extended DOP1 bit10: Extended DOP2 bit11: GCR(V) bit12: GCR(Zdr) bit13: GCR(ρhv) bit14 ~ bit15: reserved	2×M	*	unsigned short
Angle information	Sweep 1	Angle Information 1			
Observed data	Sweep 1	Observed data R			
	·	·			
	Sweep 1	Observed data W			
	Sweep 1	Observed data Quality			
·	Sweep 2	Angle Information 2			
·	Sweep 2	Observed data R			
·	·	·			
·	·	·			
·	Sweep 2	Observed data W			
·	Sweep 2	Observed data Quality			
·	Sweep L	Angle Information L			
·	Sweep L	Observed data R			
·	·	·			
·	·	·			
·	Sweep L	Observed data W			
·	Sweep L	Observed data Quality			

(*1) Only valid types are saved in the observed data block.

(*2)"YYYYMMDDhhmmss" of Clutter reference filename is stored.

(*3)

GCR(MTI): Ground Clutter Rejection by Moving Target Indicator.
SCR: Ship Clutter Rejection.
GCR(Ref): Ground Clutter Rejection by Using Clutter reference map.
Extended DOP: Anti-aliase Doppler velocity (post-process) *Now unsupported.
GCR(V): Ground Clutter Rejection by Using 0 Doppler velocity * Now unsupported.
GCR(Zdr): Ground Clutter Rejection by Using Zdr * Now unsupported.
GCR(ρhv): Ground Clutter Rejection by Using ρhv * Now unsupported.
R(Kdp)_Enable: This flag turns ON at the point where Rain is calculated using Kdp. * Now unsupported.

(*4) Derivation of the radar calibration constant.

$$C = 10\log_{10}\left(\frac{2^{10}(\log_e 2)\lambda^2}{\pi^3|K|^2 P_t \theta_h \theta_v 300\tau}\right) - 2G + Loss$$

λ : Wavelength [m]
$|K|^2$: Dielectric factor
P_t : Transmitted power [mW]
θ_h : Horizontal -3 dB antenna beamwidth [rad]
θ_h : Vertical -3 dB antenna beamwidth [rad]
τ : Pulse width [μs]
G : Antenna gain [dBi]
$Loss$:Loss of system [dB]
This definition of the radar constant is based on the following radar equation.

$$dBZ = C + 20\log_{10}r + 10\log_{10}P_r + 180$$

r : Distance from the radar [m]
P_r : Received power [mW]

(*5) In Dual or Triple PRF case, Nyquist velocity is expand by multi PRF method.

(*6) This value is antenna-end output power. It contains the waveguide (TX chain) loss.

5.4. Data Size

1) Standard setting of single scan size (one complete azimuth rotation).

Header		Observation angularity information		Observation data				Range direction data		Total sweep		Quantity of every scan
80	+	((6	+	2)	+	(18	x	e.g. 1000))	x	e.g. 720	=	12,960,088 byte

2) File size per hour
12,960,088 byte x 3600 sec. / 6 sec. = approx. 7.8GB (7,776,052,800)

3) File size at 30 days
7,776,052,800 byte x 30 days x 24 hrs. = approx. 5.6TB

Notice:
Basically data capacity can be compressed around 50 to 70%. However the compression ratio depends on weather condition (Clear weather data will compress into smaller file than active weather data).
If the user would like to decrease the actual data size, some data must be eliminated to reduce generated file size. Data settings can be adjusted in RainMap to reduce the range of data points and the sweep time per rotation.
For “csv” format one file will be generated for each checked item and each scan rotation and output to csv file.
All normal configured data required for csv file format will be saved in each file regardless of the individual checked fields to ensure structured file information..

Sample setting:

Azimuth scan speed: 3 rpm
Vertical scan speed: 6 deg./sec.
Elevation angles: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 25, 30 and 40 degrees (13 angles)
Volume scan interval: 5 min.

Required speed = 13 x 15.55784 x 8 / (5 x 60) = 5.39 [Mbps]

Additional explanation:

The weather radar has narrow beam called “pencil beam”. Both horizontal and vertical planes on beam width of pencil beam are the same.

In order to capture accurate data it is necessary to scan hemisphere over the radar while changing its elevation angle as shown on Figure 5.1.

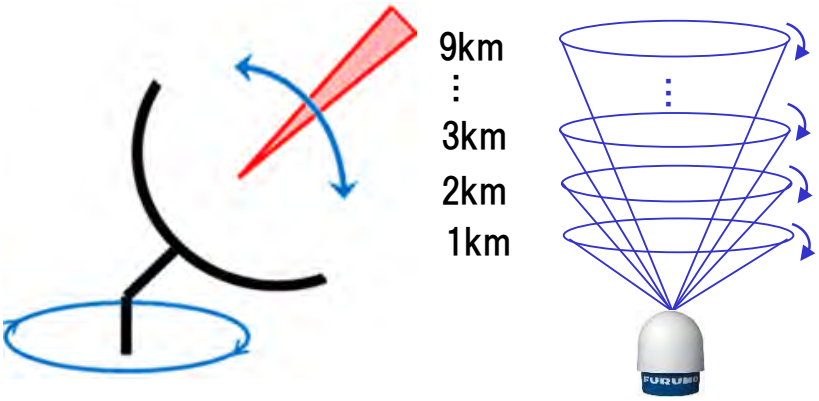


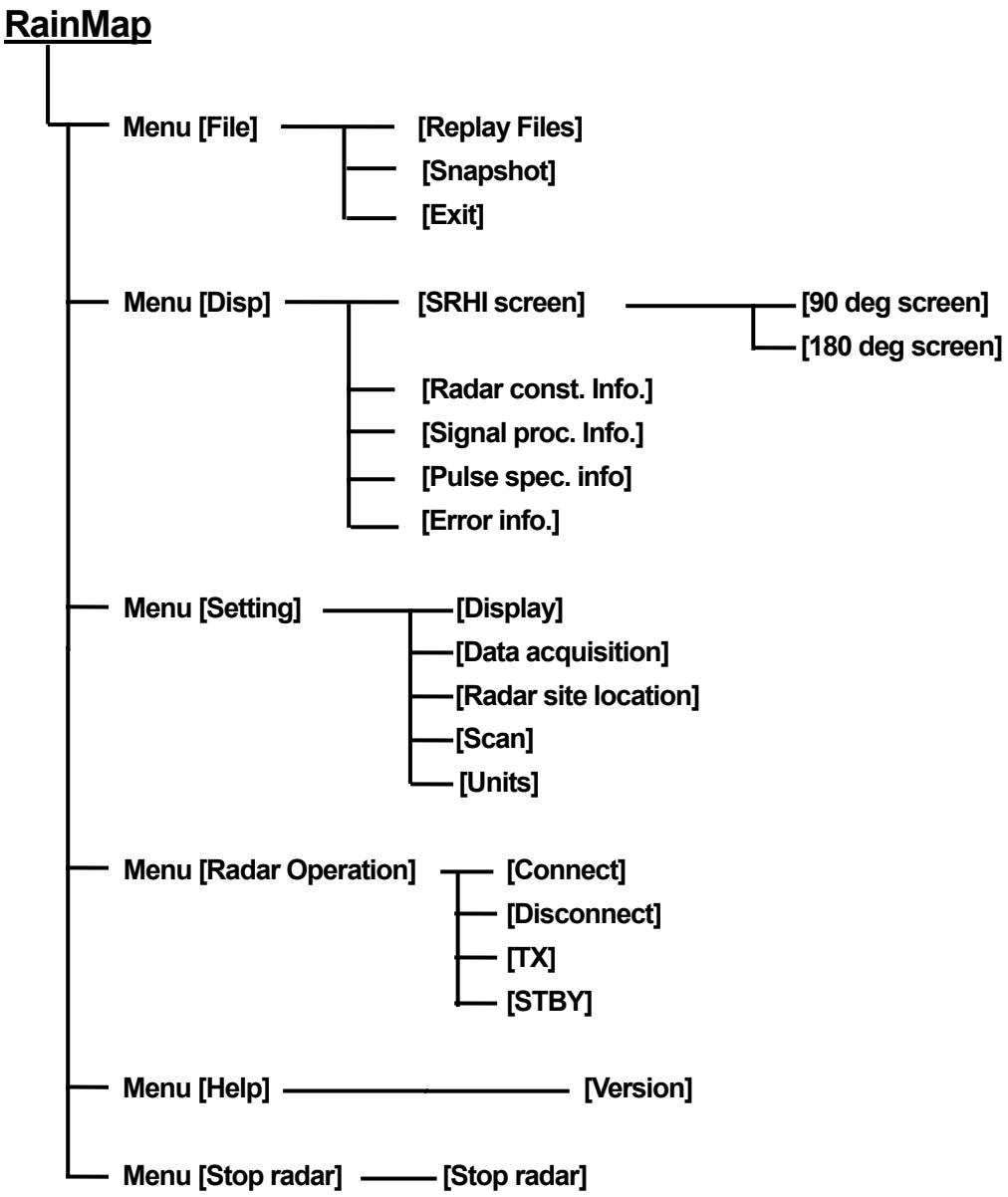
Figure 5.1: Basic volume scan

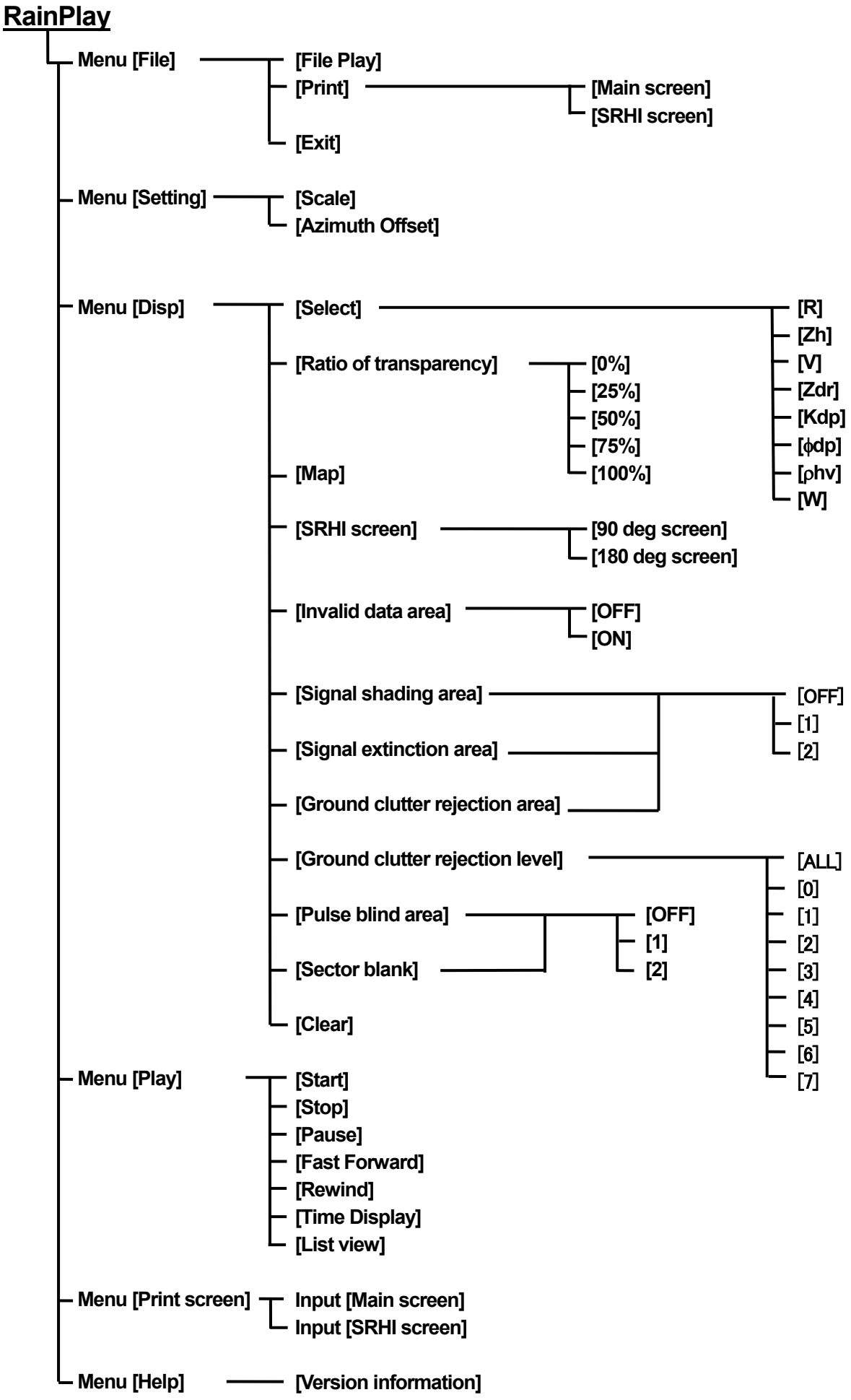
The WR2120 radar will output the data files for each elevation angle. When using eight elevation angles, eight data files will be generated that will require up to 15.55784 MB, however this depends on settings.

Requirement of the data transfer speed is decided by the time span needed to make one set of volume scan data. This time span will depend on the scanning speed of antenna.

Within this document we present some examples of scanning strategies and generated data size calculations. The minimum transfer speed requirement will be calculated using these total file sizes and the time span of one volume scan.

6. MENU TREE


RainMap
Menu [File]
[Replay Files]
[Snapshot]
[Exit]
Menu [Disp]
[SRHI screen]
[90 deg screen]
[180 deg screen]
[Radar const. Info.]
[Signal proc. Info.]
[Pulse spec. info]
[Error info.]
Menu [Setting]
[Display]
[Data acquisition]
[Radar site location]
[Scan]
[Units]
Menu [Radar Operation]
[Connect]
[Disconnect]
[TX]
[STBY]
Menu [Help]
[Version]
Menu [Stop radar]
[Stop radar]


RainPlay
Menu [File]
[File Play]
[Print]
[Main screen]
[SRHI screen]
[Exit]
Menu [Setting]
[Scale]
[Azimuth Offset]
Menu [Disp]
[Select]
[R]
[Zh]
[V]
[Zdr]
[Kdp]
[ϕdp]
[ρhv]
[W]
[Ratio of transparency]
[0%]
[25%]
[50%]
[75%]
[100%]
[Map]
[SRHI screen]
[90 deg screen]
[180 deg screen]
[Invalid data area]
[OFF]
[ON]
[Signal shading area]
[Signal extinction area]
[Ground clutter rejection area]
[OFF]
[1]
[2]
[Ground clutter rejection level]
[ALL]
[0]
[1]
[2]
[3]
[4]
[5]
[6]
[7]
[Pulse blind area]
[Sector blank]
[OFF]
[1]
[2]
[Clear]
Menu [Play]
[Start]
[Stop]
[Pause]
[Fast Forward]
[Rewind]
[Time Display]
[List view]
Menu [Print screen]
Input [Main screen]
Input [SRHI screen]
Menu [Help]
[Version information]

7. MAINTENANCE

7.1. Troubleshooting

STATE	CONTENT/PROCEDURE
Cannot turn the power on	1. Make sure that the power cable has not loosened. 2. Make sure that the contact of the power cable plug has not stained. 3. Make sure that the power cable has not damaged. 4. Make sure that the circuit breaker in the Junction Unit is “ON”.
Thermo electric air conditioner stopped	Please call for service.
- No radar echo indication - SPU Failure - System Failure	1. Stop radar operation to [Stop motor] from RainMap. Restart the RainMap if not possible to click the [Stop motor] under [Stop radar operation] menu because of failure. [Stop motor] will send a reset command to SPU, MONI-CON, motor driver, and itself to release from error. 2. Use WR_rebooter to reset the radar hardware & software 3. Turn OFF/ON the circuit breaker in SPU (Refer to section 1.3).
Error code indication	1. Restart RainMap and Radar (turn OFF/ON the power). 2. Call for service and tell error code.

7.2. Error Code List

Code	Content
E001	Abnormality detected in system [Serial Com (MONI-CON)]
E002	Abnormality detected in system [Serial Com (ANTcontrol)]
E003	Abnormality detected in system [Serial Com (ANTmonitor)]
E004	TCP error
E005	Abnormality detected in system [Detected TCP data missing]
E006	Abnormality detected in system [Serial data (ANTmonitor)]
E013	Abnormality detected in system [Motor Control (ACK Start)]
E014	Abnormality detected in system [Motor Control (ACK Stop)]
E016	Abnormality detected in system [Motor Control (ACK INIT0)]
E017	Abnormality detected in system [Motor Control (ACK INIT1)]
E020	Abnormality detected in system [Motor Control (ACK Run)]
E027	Abnormality detected in system [Motor Control (Wait reply from motor1)]
E028	Abnormality detected in system [Motor Control (Wait reply from motor2)]
W039	Abnormality detected in system [Undefined Error]
E040	SPU abnormality [FPGA module access]
E041	SPU abnormality [IO module setting time out]
E042	SPU abnormality [FPGA setting]
E044	SPU abnormality [FAM_PLL lock time out]
E045	SPU abnormality [FAM_clock formation]
E058	SPU abnormality [FPGA module recognition]
E061	SPU abnormality [Tx setting]
E100	Abnormality detected in system [Serial Com (MONI-CON)]
E101	Abnormality detected in system [Serial Com (ANTcontrol)]
E102	Abnormality detected in system [Serial Com (ANTmonitor)]
E200	RFCONV abnormality [PLL unlock]
E210	HPA abnormality [Outside TX power regulation]
E212	HPA abnormality [Outside temperature regulation]
E312	Drive unit failure detected during zero positioning
E313	
E314	
E315	

Code	Content
E328	Drive unit failure detected during zero positioning
E329	
E330	
E331	
E344	Drive unit failure detected during weather observation
E345	
E360	
E361	
E365	MTRDRV failure detected [MPU no reply]
E368	MTRDRV failure detected [Command execution failure] **Notice:** Antenna is keep rotating sometime
E386	MTRDRV failure detected [Motor 1 current]
E387	MTRDRV failure detected [Motor 2 current]
E388	MTRDRV failure detected [Motor 3 current]
E400	MONI-CON failure detected [Monitor IC setting]
E401	MONI-CON failure detected [ADC self-test unpassed]
E402	
E403	MONI-CON failure detected [DAC self -test unpassed]
E404	System failure detected [APC timing search failure]
E408	MONI-CON failure detected [Command execution failure]
E800	System failure detected [Bad communication between DPU and SPU]

Level of failure codes:

E (Error): Large failure. It will stop radar operation.

W (Warning): Middle failure. It will not stop radar operation but needs maintenance or call to service engineer.

C (Caution): Light failure. Service engineer was able to repair simple failure.

7.3. Preventative Maintenance

PERIOD	ITEM	CHECK POINT	CONTENT/PROCEDURE
When needed	Visual check of the Radar radome surface.	Sea salt, oil, etc. adhered to the surface?	Wipe substances with a soft wet cloth. However since radome is made with FRP do not use hydrocarbon solvent including gasoline and ketone.
After six months, a strong wind or a thunderbolt	Visual check of the Radar radome damage	Any crack?	Please contact us after inspection for support.
After six months	Check protective tube	Any slack?	Please strengthen protective tube mount.

*Before starting any maintenance please make sure the radar system power is off.

7.4. Life Expectancy of Major Parts

This radar has consumable parts, and the table that follows shows the estimated life expectancy for the consumable parts. Life expectancy estimates are based on use under normal conditions. Request a FURUNO agent or dealer to replace the consumable parts, to get the best performance and longest possible life from the equipment.

Part	Type	Life expectancy
Antenna Unit		
MOTOR	SP MOTOR Assy	1 yr
HPA FAN	SP HPA-B Assy	5 yrs
SPU FAN	SP SPU Fan	5 yrs
Power Supply	SP POWER SUPPLY Assy	5 yrs
Data Processing Unit		
DPU (Main unit)	WR2120-DPU	5 yrs
Power Supply	DPU PS	5 yrs

Note: The table above shows the typical life-span used under normal conditions.

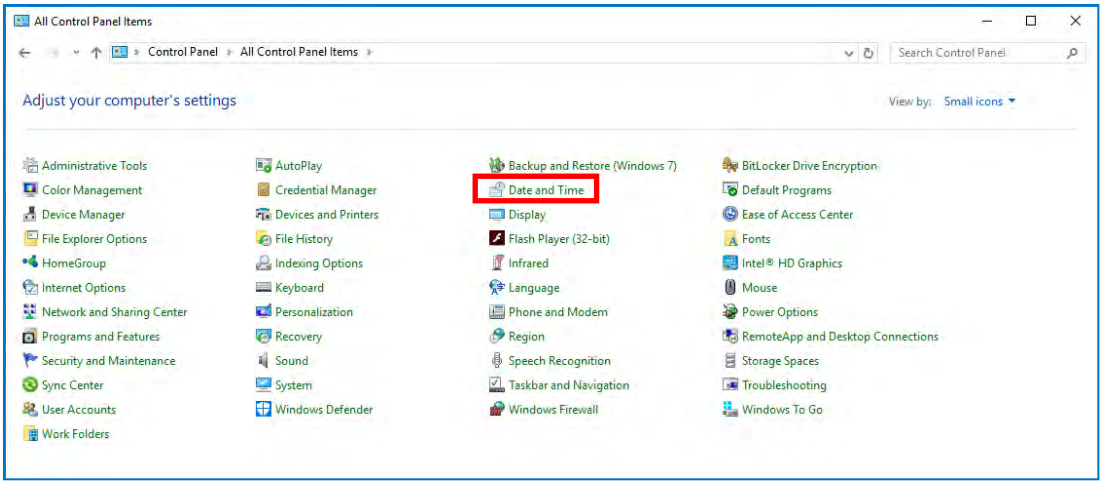
APPENDIX

A. DPU SETTING

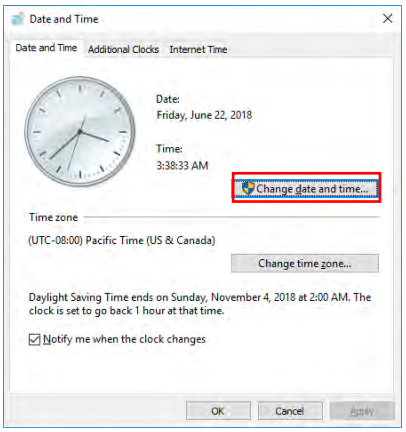
1. DPU Time Adjust Setting

It is important to keep maintaining the local time accurately that influence to the radar observation schedule and the time stamp of the data.

1) Open the control panel and click the “Date and Time”.

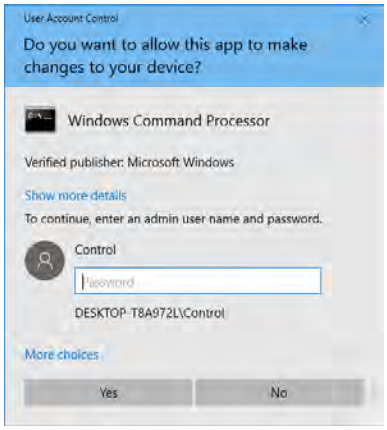


2) Click the [Change date and time].

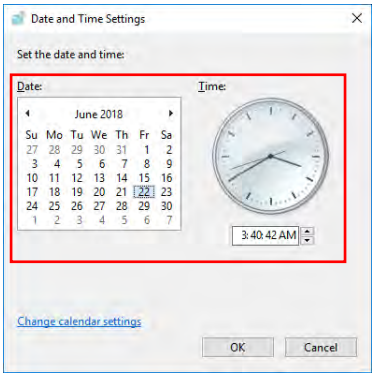


3) Enter the password of Control account

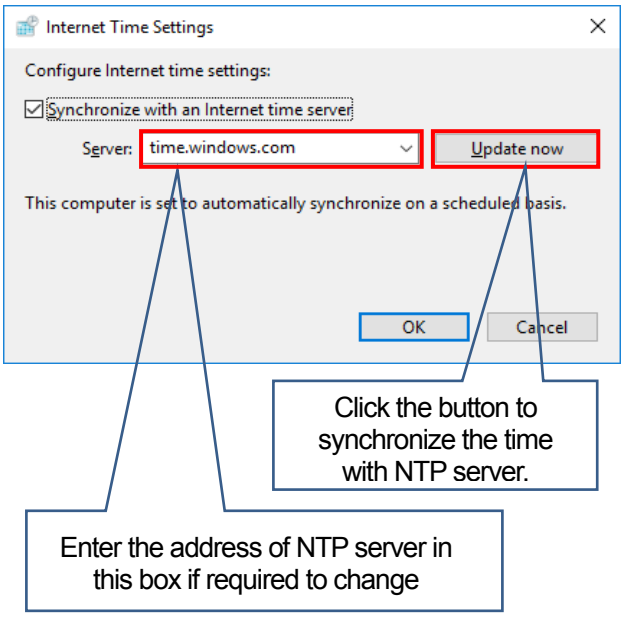
Note: Default password is “Admin”.



4) Case of correct the time by hand.



5) Case of correct the time by internet time.



2. Precaution of using DPU:

Regarding the “radar” account

1) Do not change the account name and the account password.
2) Account password must be “radar”
3) Do not give the right of administrator to the radar account.
4) You must use this account when you operate the weather radar.

Regarding the “Control” account

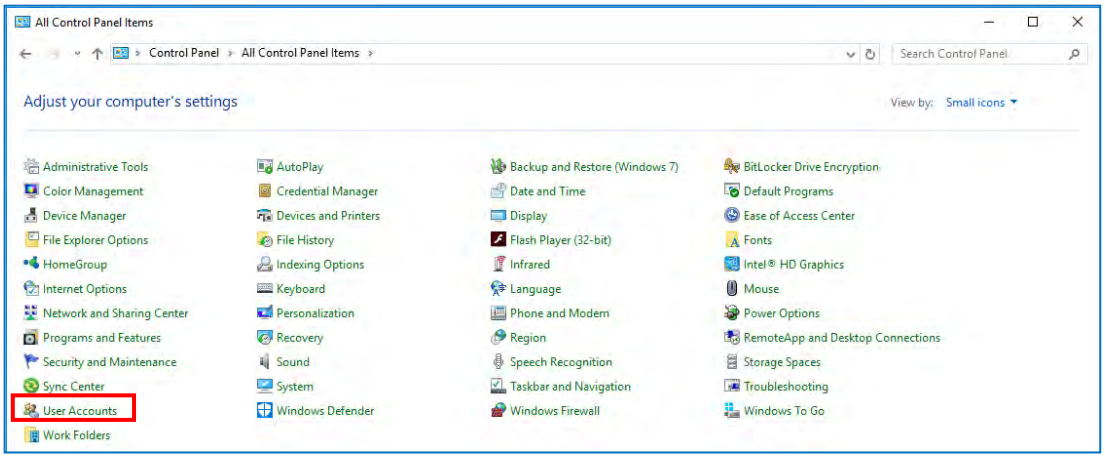
- This account is administrator account for user. You can perform operations that require administrator privileges by using this account, but it is not recommended.

Regarding the “Maintenance” account

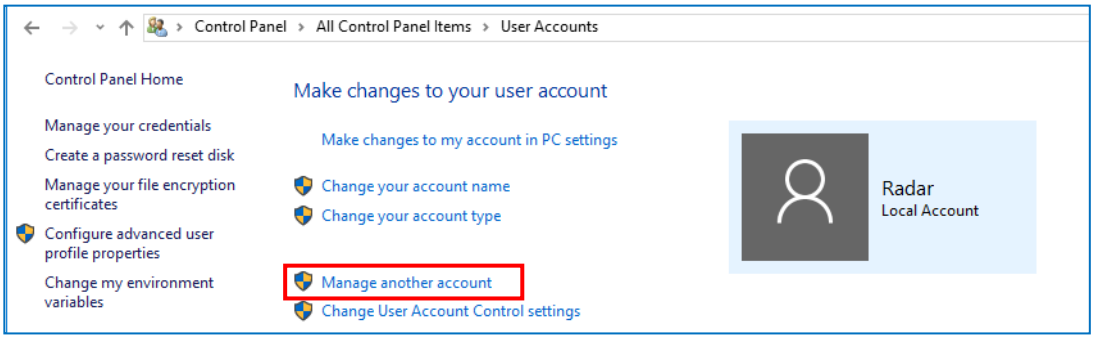
- This account is for manufacturer management. Do not change the account name and the account password.

3. DPU Account and Password setting

1) Open the control panel and click the “User Accounts”.

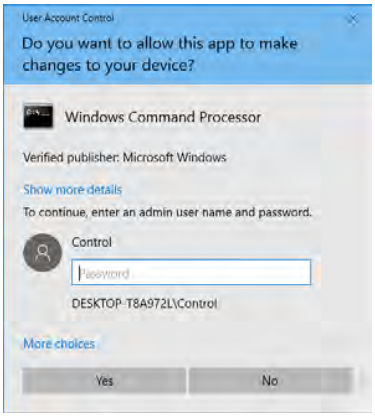


2) Click the “Manage another account”.



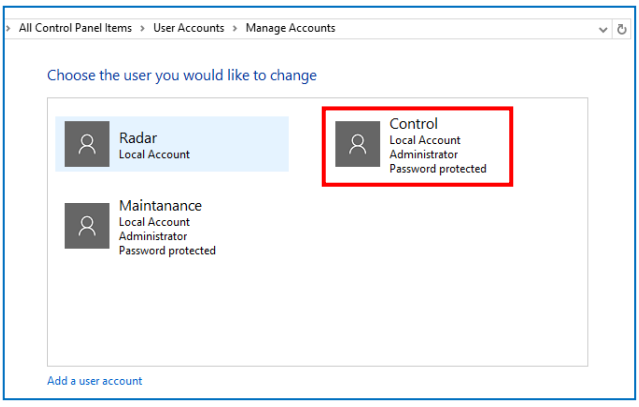
3) Enter the password of Control account

Note: Default password is “Admin”.

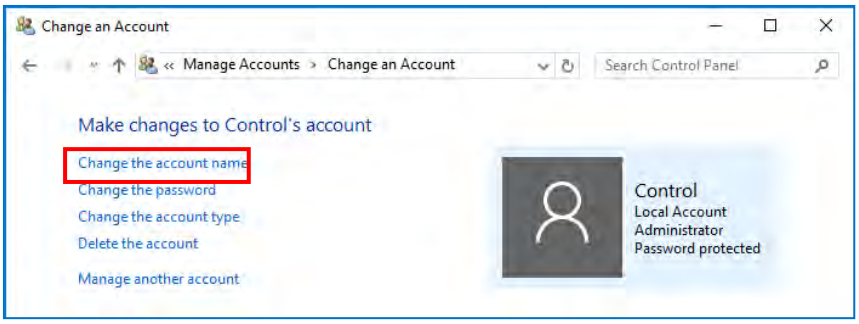


4) Click the account name “Control”.

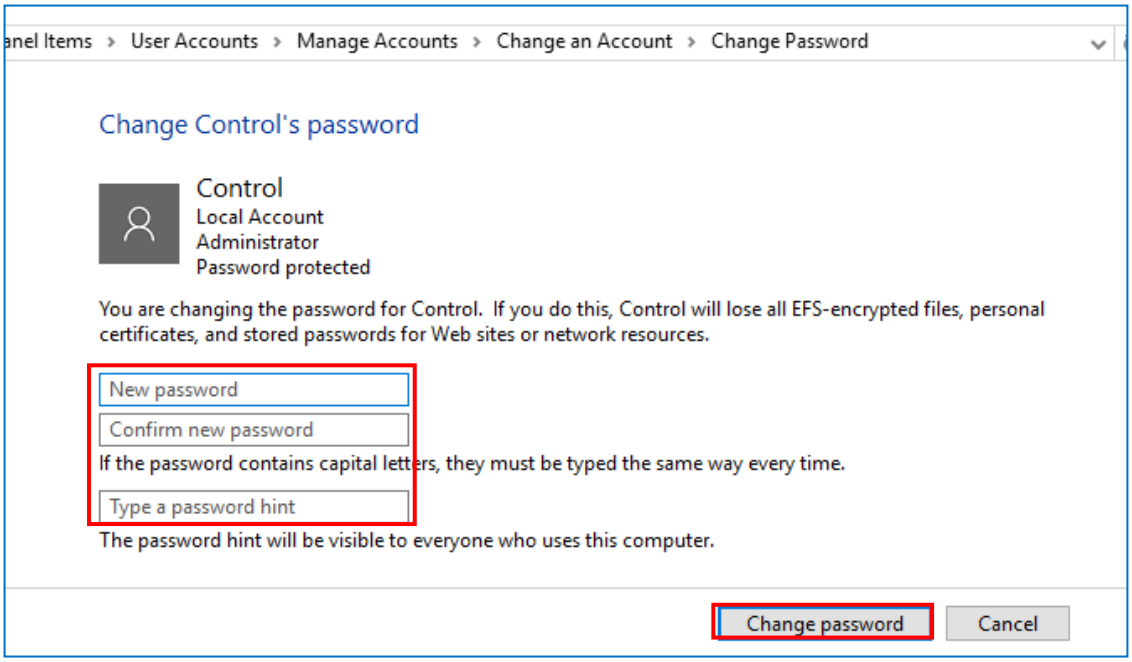
Caution: Do not touch the account of “maintenance”.



5) Click the “Change the password”.



6) Click the [Change password] button after entered the “New password”, “Confirm new password”, and “password hint”. Please keep your password somewhere safe.



4. Trademarks

Windows is a registered trademark of Microsoft Corporation in the United States and/or other countries.

5. Security Export Control

1) This device will be valid for export controlled goods of Japan.
2) Principle, export, sale, and transfer for foreign user list subjects established by the Japanese government, is prohibited.
3) Based on all other controls if the end-user or end use is involved in the development, manufacture and use of weapons of mass destruction or similar or if this involvement is suspected, export is prohibited.
4) If you want to export this product, please contact us in advance.

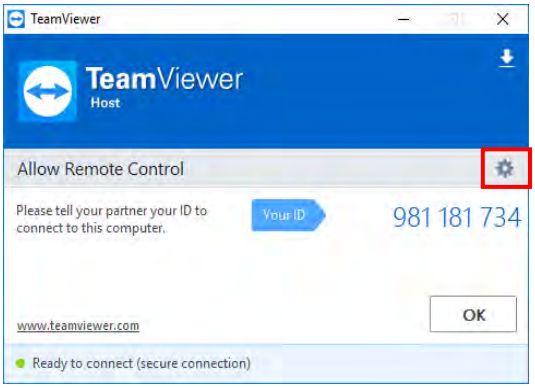
6. TeamViewer

NOTE: This software is the place allows using remote control via internet. If your facility is suddenly prohibited of using it, please uninstall this software. (Refer the Installation manual for uninstallion)

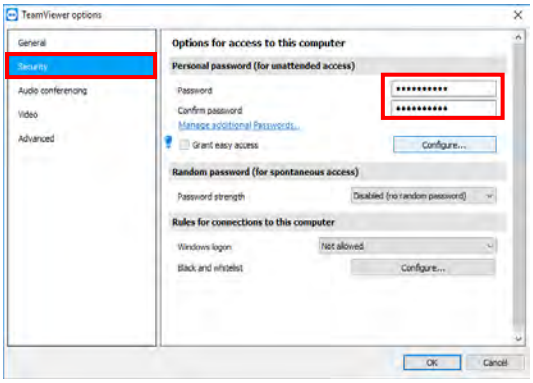
6.1. Security Setting

This is a process for changing the password of the "TeamViewer" for remote access. Factory default setting is "root". It is highly recommended to change the default password to reduce security risks.

1) Open the panel of TeamViewer and click the option "mark" button on the right center.

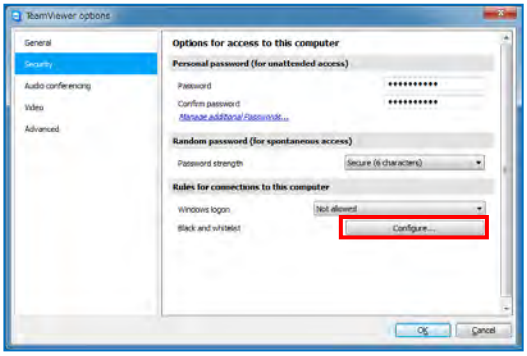


2) Click the "Security" from the options screen and enter any password.
Please keep your password somewhere safe.

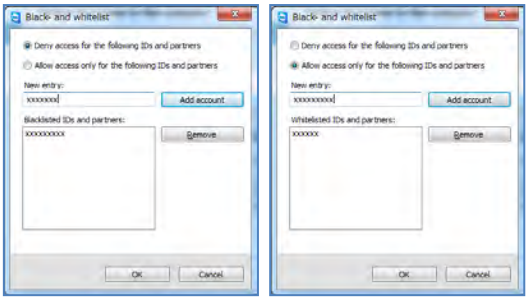


3) Click [Security] on the right list of [TeamViewer options]

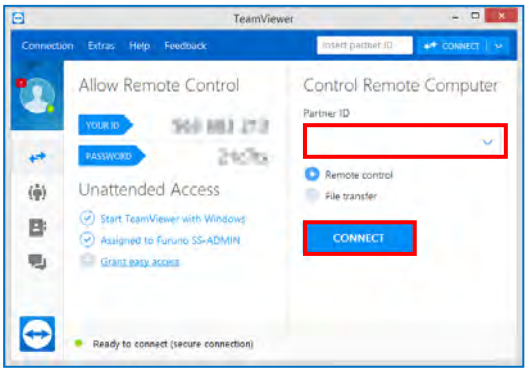
4) Click [Configure] of [Black and whitelist] under a menu of [Rules for connections to this computer].



5) If required register any ID's on the list for [Deny access for the following IDs and partners] or [Allow access only for the following IDs and partners] from Popup menu of [Black and whitelist].
We recommend you to enter the E-mail address of the local TeamViewer instead of ID for raising your security when adding account on Whitelist [Allow access only for the following IDs and partners].



6.2. Remote Control



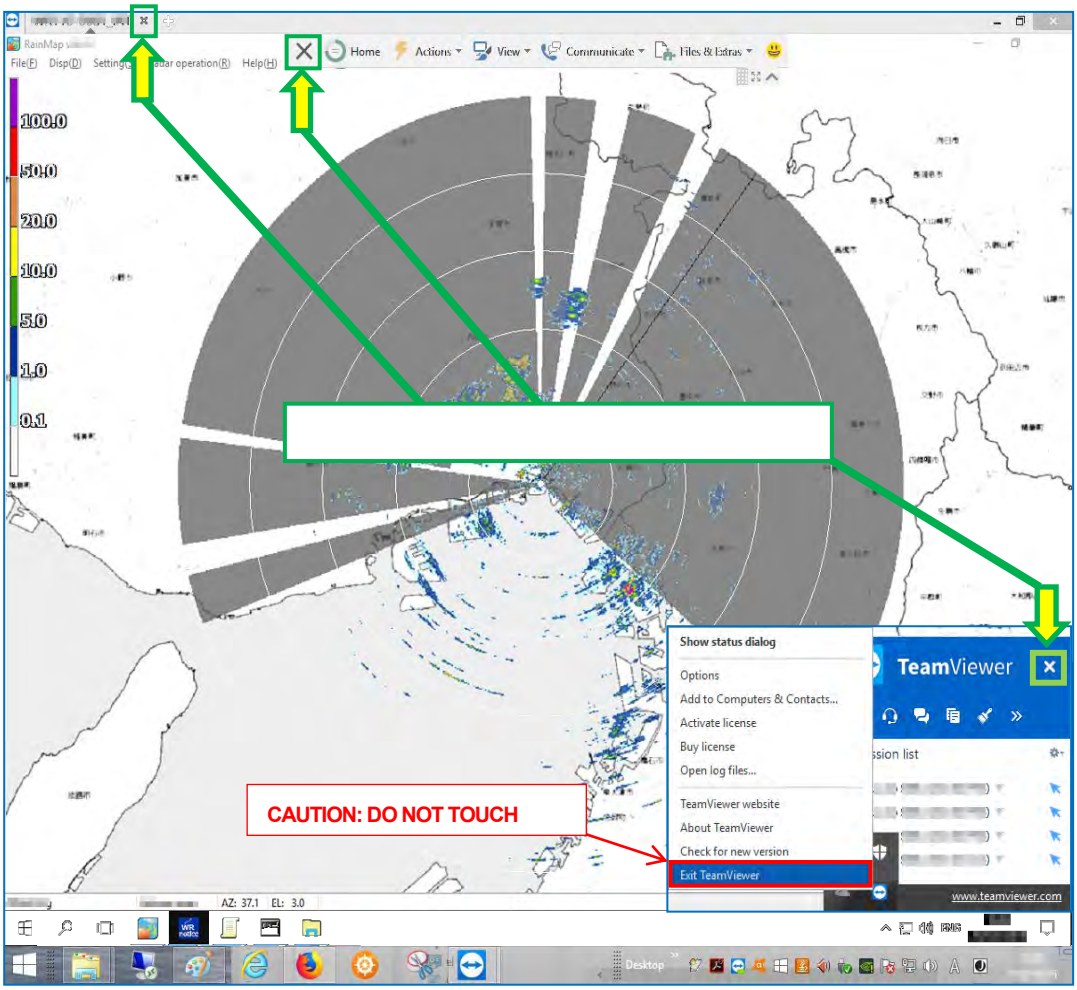
1) Click [CONNECT] after entered the target ID of host when access to the host side from the local pc.

2) Enter the password that set on the host side when it asked the password after accessed.

3) When the PC screen on the host side is displayed, it can operate in the same way as when using an ordinary PC.

4) Close the window by clicking one of the [X] for the following three locations on the screen for disconnecting the host side.

Caution: Never click “Exit TeamViewer” from the TeamViewer icon from the host side task bar. If you exit TeamViewer on the host side, you have to go to the site unless there is no PC connected to the site that possible to control using the remote access.



B. RADIO REGULATION INFORMATION

USA-Federal Communications Commission (FCC)

This device complies with the Code of Federal Regulation (CFR) Title 47, part 15 (Radio Frequency device) of the FCC Rules. The official rules are published and maintained by the Government Printing Office (GPO) in the Federal Register (OFR).

Operation is subject to the following two conditions: (1) This devise may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Caution: Exposure to Radio Frequency Radiation.

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment and meets the FCC radio frequency (RF) Exposure Guidelines in Supplement C to OET65.

This equipment should be installed and operated keeping the radiator at least 12.7m or more away from person's body.

This device must not be co-located or operating in conjunction with any other antenna or transmitter.

C. DECLARATION OF CONFORMITY

Bulgarian (BG)	С настоящото Furuno Electric Co., Ltd. декларира, че гореспоменат тип радиосъоръжение е в съответствие с Директива 2014/53/ЕС. Цялостният текст на ЕС декларацията за съответствие може да се намери на следния интернет адрес:
Spanish (ES)	Por la presente, Furuno Electric Co., Ltd. declara que el tipo de equipo radioeléctrico arriba mencionado es conforme con la Directiva 2014/53/UE. El texto completo de la declaración UE de conformidad está disponible en la dirección Internet siguiente:
Czech (CS)	Tímto Furuno Electric Co., Ltd. prohlašuje, že výše zmíněné typ rádiového zařízení je v souladu se směrnicí 2014/53/EU. Úplné znění EU prohlášení o shodě je k dispozici na této internetové adrese:
Danish (DA)	Hermed erklærer Furuno Electric Co., Ltd., at ovennævnte radioudstyr er i overensstemmelse med direktiv 2014/53/EU. EU-overensstemmelseserklæringens fulde tekst kan findes på følgende internetadresse:
German (DE)	Hiermit erklärt die Furuno Electric Co., Ltd., dass der oben genannte Funkanlagentyp der Richtlinie 2014/53/EU entspricht. Der vollständige Text der EU-Konformitätserklärung ist unter der folgenden Internetadresse verfügbar:
Estonian (ET)	Käesolevaga deklareerib Furuno Electric Co., Ltd., et ülalmainitud raadioseadme tüüp vastab direktiivi 2014/53/EL nõuetele. ELi vastavusdeklaratsiooni täielik tekst on kättesaadav järgmisel internetiaadressil:
Greek (EL)	Με την παρούσα η Furuno Electric Co., Ltd., δηλώνει ότι ο προαναφερθέντας ραδιοεξοπλισμός πληροί την οδηγία 2014/53/ΕΕ. Το πλήρες κείμενο της δήλωσης συμμόρφωσης ΕΕ διατίθεται στην ακόλουθη ιστοσελίδα στο διαδίκτυο:
English (EN)	Hereby, Furuno Electric Co., Ltd. declares that the above-mentioned radio equipment type is in compliance with Directive 2014/53/EU. The full text of the EU declaration of conformity is available at the following internet address:
French (FR)	Le soussigné, Furuno Electric Co., Ltd., déclare que l'équipement radioélectrique du type mentionné ci-dessusest conforme à la directive 2014/53/UE. Le texte complet de la déclaration UE de conformité est disponible à l'adresse internet suivante:
Croatian (HR)	Furuno Electric Co., Ltd. ovime izjavljuje da je gore rečeno radijska oprema tipa u skladu s Direktivom 2014/53/EU. Cjeloviti tekst EU izjave o sukladnosti dostupan je na sljedećoj internetskoj adresi:
Italian (IT)	Il fabbricante, Furuno Electric Co., Ltd., dichiara che il tipo di apparecchiatura radio menzionato sopra è conforme alla direttiva 2014/53/UE. Il testo completo della dichiarazione di conformità UE è disponibile al seguente indirizzo Internet:
Latvian (LV)	Ar šo Furuno Electric Co., Ltd. deklarē, ka augstāk minēts radioiekārta atbilst Direktīvai 2014/53/ES. Pilns ES atbilstības deklarācijas teksts ir pieejams šādā interneta vietnē:

Lithuanian (LT)	Aš, Furuno Electric Co., Ltd., patvirtinu, kad pirmiau minėta radijo įrenginių tipas atitinka Direktyvą 2014/53/ES. Visas ES atitikties deklaracijos tekstas prieinamas šiuo interneto adresu:
Hungarian (HU)	Furuno Electric Co., Ltd. igazolja, hogy fent említett típusú rádióberendezés megfelel a 2014/53/EU irányelvnek. Az EU-megfelelőségi nyilatkozat teljes szövege elérhető a következő internetes címen:
Maltese (MT)	B'dan, Furuno Electric Co., Ltd., niddikjara li msemmija hawn fuq-tip ta' tagħmir tar-radju huwa konformi mad-Direttiva 2014/53/UE. It-test kollu tad-dikjarazzjoni ta' konformità tal-UE huwa disponibbli f'dan l-indirizz tal-Internet li ġej:
Dutch (NL)	Hierbij verklaar ik, Furuno Electric Co., Ltd., dat het hierboven genoemde type radioapparatuur conform is met Richtlijn 2014/53/EU. De volledige tekst van de EU-conformiteitsverklaring kan worden geraadpleegd op het volgende internetadres:
Polish (PL)	Furuno Electric Co., Ltd. niniejszym oświadcza, że wyżej wymieniony typ urządzenia radiowego jest zgodny z dyrektywą 2014/53/UE. Pełny tekst deklaracji zgodności UE jest dostępny pod następującym adresem internetowym:
Portuguese (PT)	O(a) abaixo assinado(a) Furuno Electric Co., Ltd. declara que o mencionado acima tipo de equipamento de rádio está em conformidade com a Diretiva 2014/53/UE. O texto integral da declaração de conformidade está disponível no seguinte endereço de Internet:
Romanian (RO)	Prin prezenta, Furuno Electric Co., Ltd. declară că menționat mai sus tipul de echipamente radio este în conformitate cu Directiva 2014/53/UE. Textul integral al declarației UE de conformitate este disponibil la următoarea adresă internet:
Slovak (SK)	Furuno Electric Co., Ltd. týmto vyhlasuje, že vyššie spomínané rádiové zariadenie typu je v súlade so smernicou 2014/53/EÚ. Úplné EÚ vyhlásenie o zhode je k dispozícii na tejto internetovej adrese:
Slovenian (SL)	Furuno Electric Co., Ltd. potrjuje, da je zgoraj omenjeno tip radijske opreme skladen z Direktivo 2014/53/EU. Celotno besedilo izjave EU o skladnosti je na voljo na naslednjem spletnem naslovu:
Finnish (FI)	Furuno Electric Co., Ltd. vakuuttaa, että yllä mainittu radiolaitetyyppi on direktiivin 2014/53/EU mukainen. EU-vaatimustenmukaisuusvakuutuksen täysimittainen teksti on saatavilla seuraavassa internetosoitteessa:
Swedish (SV)	Härmed försäkrar Furuno Electric Co., Ltd. att ovan nämnda typ av radioutrustning överensstämmer med direktiv 2014/53/EU. Den fullständiga texten till EU-försäkran om överensstämmelse finns på följande webbadress:

Online Resource

http://www.furuno.com/en/support/red_doc

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