

FURUNO

**OPERATOR'S
MANUAL**

WEATHER RADAR

MODEL: **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.**

**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.

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 anyone wants to export this product, please contact us in advance.



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/m² exist are shown in the table below.

DO NOT approach closer than 9.1m (Safety standard is 10 W/m²) 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 breaker in the SPU 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 cord. 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 not impact the LCD glass. Serious injury may occur due to broken glass.

RADIATION 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: 03-142-3201-1
Code No.: 100-266-891-10

WR2120 Restrictions

There are restrictions frequency band;
CH1: 9422.5MHz, CH2: 9427.5MHz, CH3: 9432.5MHz, CH4: 9437.5MHz in the following countries:
Switzerland, Lithuania, and Slovakia.

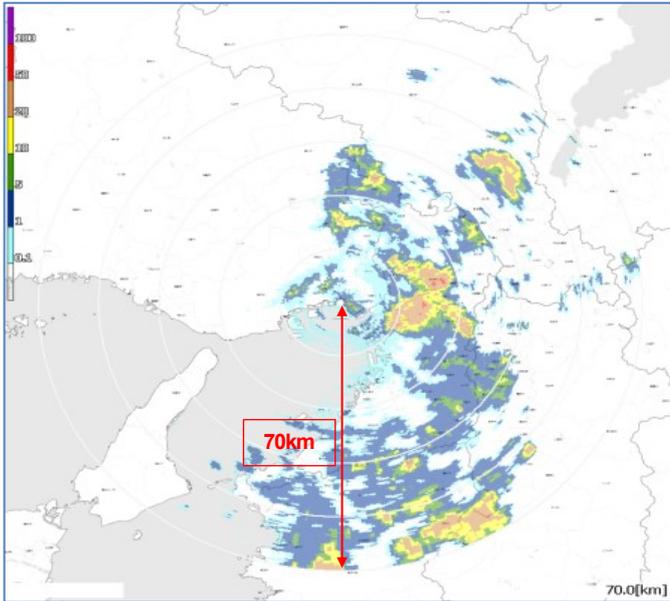
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SYSTEM OUTLINE

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



Notice:

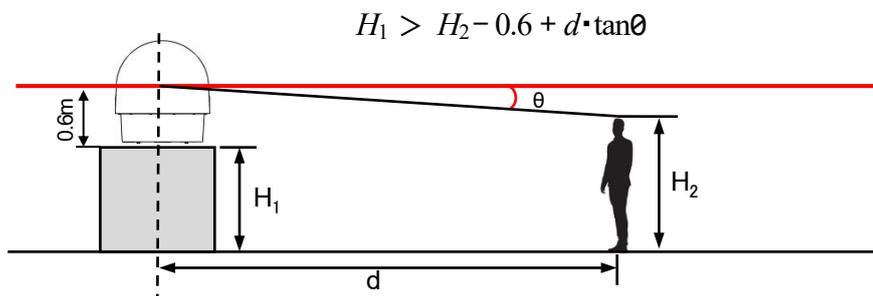
1. Do not go around the antenna area.
2. While installing antenna on a rooftop of building in urban area, it must be installed in the safety area and protected by a lightning rod(s) based on IEC 62305.
3. No obstacles should be around the antenna.

Safe distance:

- If H1 is taller than 2.0 meters, it is safe unless directly touching the antenna.
- If H1 is shorter than 2.0 meters, do not enter within a radius of 9.1 meters from the antenna. (Refer to the Radio Frequency Radiation Hazard on page ii)

Notes:

- 1> It based on the standard human height of 2 meters.
- 2> It is safe to follow this calculated value because it still has some extra safer margin.



e.g.: H_2 (Height) = 2 m,
 d (Distance between center of the antenna and human) = 9.1m,
 $\theta = 3.5^\circ$ (Minimum elevation is $-2^\circ + \text{half beam width } 1.5^\circ$)
 $H_2 - 0.6 + d \cdot \tan\theta = 2 - 0.6 + 9.1 \cdot \tan 3.5^\circ = 1.957 \text{ m} < H_1$
 Therefore, H_1 (Height of radar stand) = **2.0 m**,

SYSTEM CONFIGURATION

The observation system consists of an Antenna Unit (ATU), a Signal Processing Unit (SPU), and a Data Processing Unit (DPU)

1) ATU (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 SPU

2) SPU

This unit is a relay point of LAN cable (1000Base-TX Cat5e or better, must use **STP** (Shielded Twisted Pair) instead of UTP (Unshielded Twisted Pair) even to switches on the power of the ATU).

3) DPU (indoor unit)

DPU displays 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 or operate them on DPU, because it will cause an out of system resource problem. Only pre-installed application can be operated.

It is recommended to transport the observed data to the external storage, and then use WR_transfer (pre-installed) to send data by FTP server to share the observation data with the software which is installed in other PC.

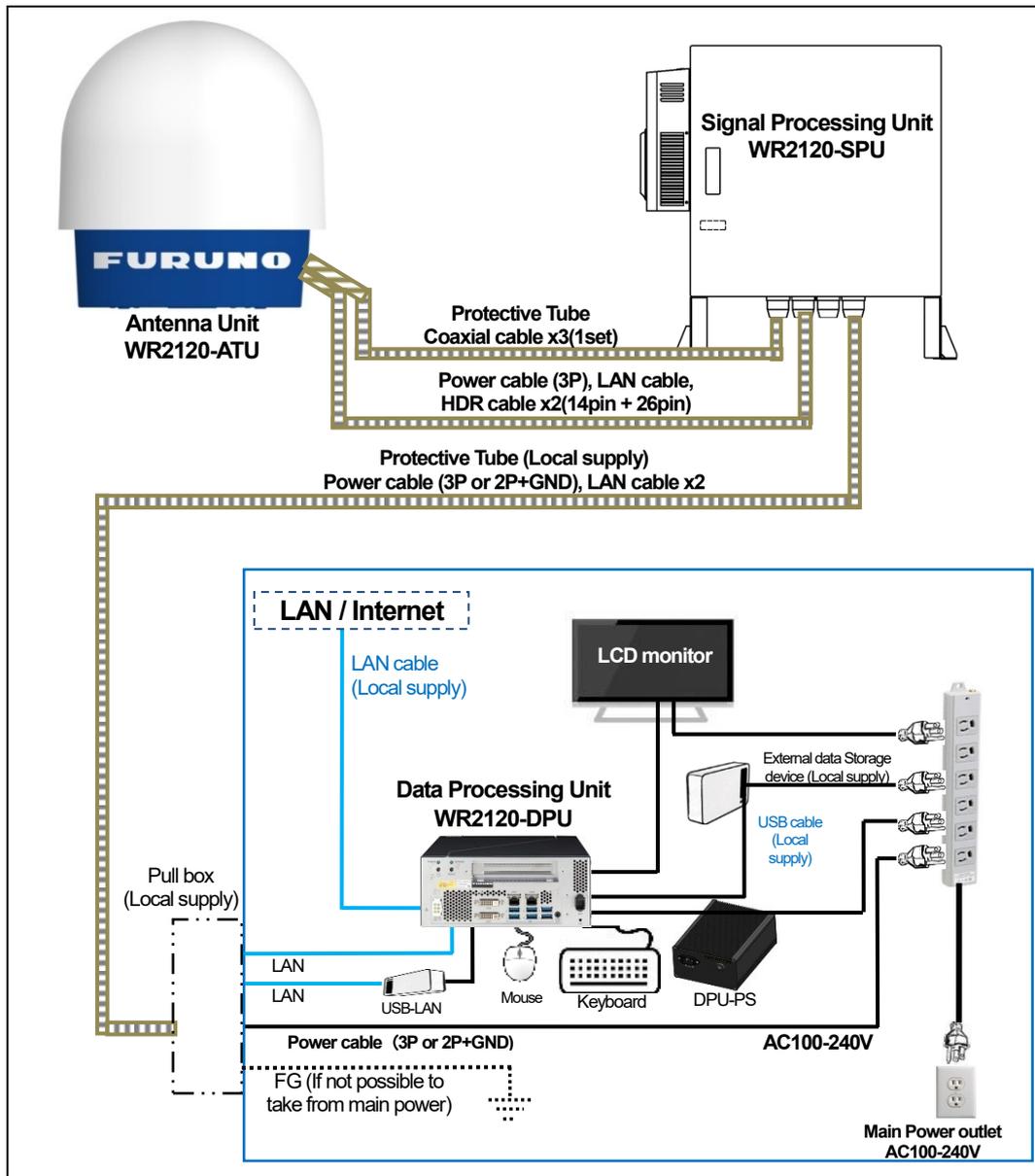


Image 1: System drawing

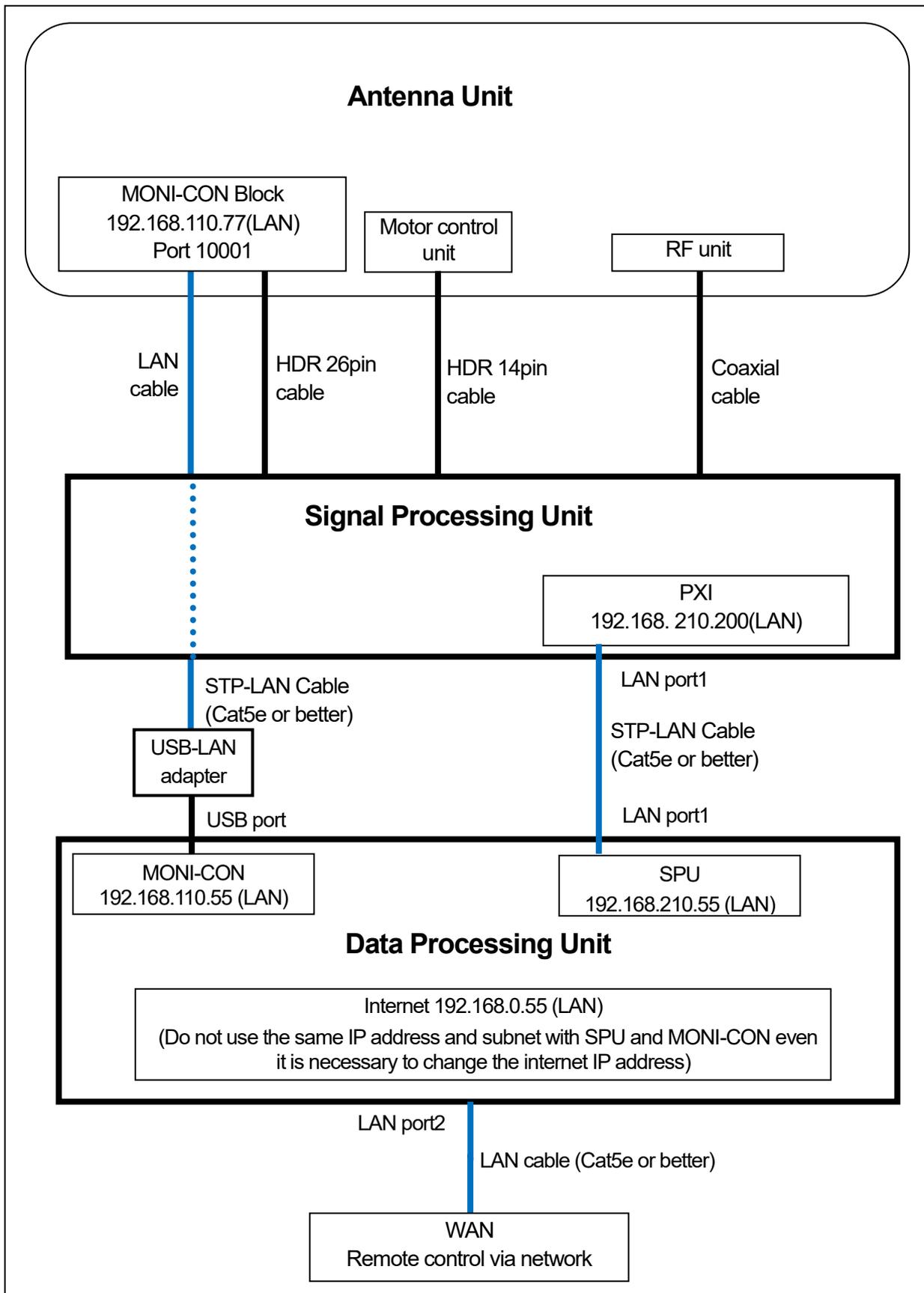


Image 2: Configuration diagram

Data Processing Unit

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 ($r\theta$) 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], ϕ_{dp} [deg], phv, W [m/s] (Refer to section 0 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\termpro.exe
Data output	
Output of data file	Output rate 1 to 60 minutes intervals

1. OPERATING PROCEDURE

1.1. Startup the Radar System

- 1) Turn on the power of the Data Processing Unit and place the main outlet to supply a power for the Antenna Unit and the Signal Processing Unit

< Caution >

For safety, make sure the breaker of the SPU is OFF before plug-in to the main outlet.



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



- 2) Turn on the breaker of the Signal Processing Unit



- 3) Start observation by the RainMap in the Data Processing Unit



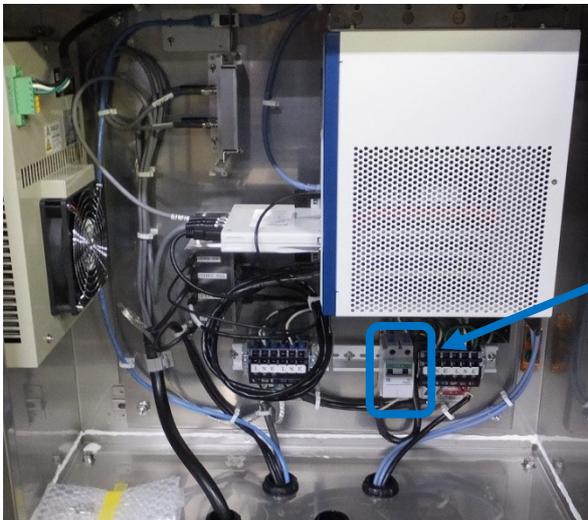
Radar outputs the data periodically with displaying images, and displays the data image.



In process

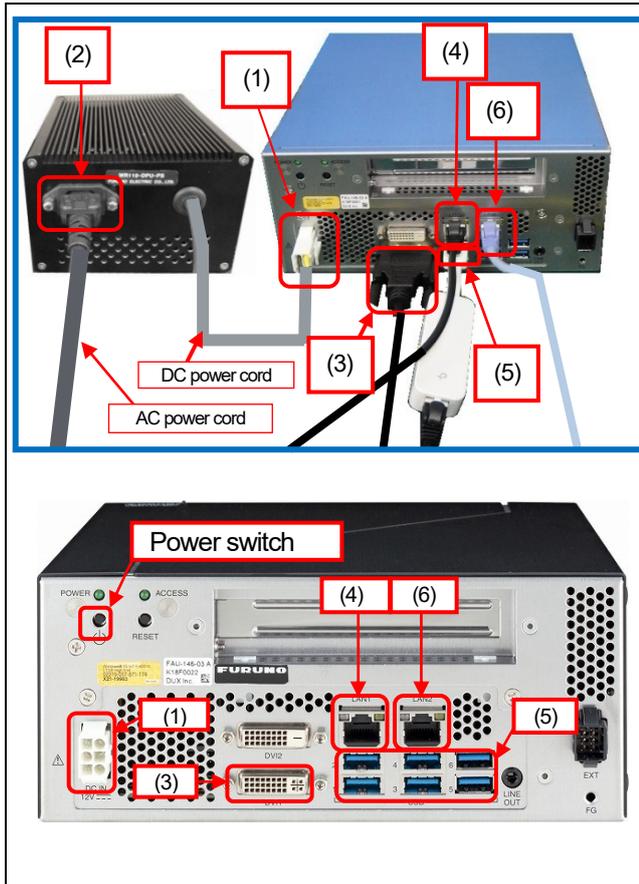


1. The breaker is in the Signal Processing Unit.



2. Turn ON/OFF the breaker for ATU/SPU.

1.2. Startup the Data Processing Unit



1. Cable connection

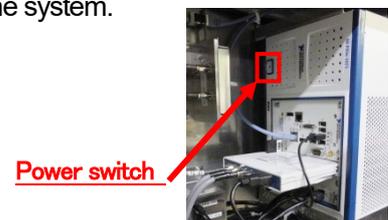
- (1) Connect DC power cord of DPU-PS to DPU.
- (2) Connect AC power cord to DPU-PS and AC power cable to electrical outlet.
- (3) Connect DVI cable from LCD monitor to DPU. Also connect the power cord from LCD monitor to a local power outlet.
- (4) Connect LAN cable from LAN port 1 of PXI (in SPU) to DPU LAN port 1.
- (5) Connect USB/LAN adapter that LAN side is from MONI-CON (inside the ATU). Other USB ports are using for keyboard, mouse, and external HDD.
- (6) Connect LAN cable from router to LAN port 2 for using Internet. The router and the LAN cable for Internet is local supply.

2. Startup DPU

- 1) DPU will boot up automatically when plugged in the power cord of DPU-PS to the local outlet [Default setting].
- 2) Enter the user name and password if DPU is asking for login (Refer to section 2)

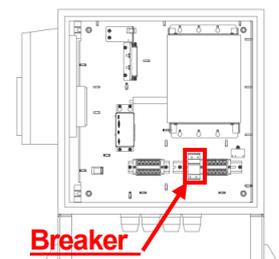
1.3. Shut down the Radar System

- 1) Press the power switch 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.
- 2) Shut down the breaker in the SPU.



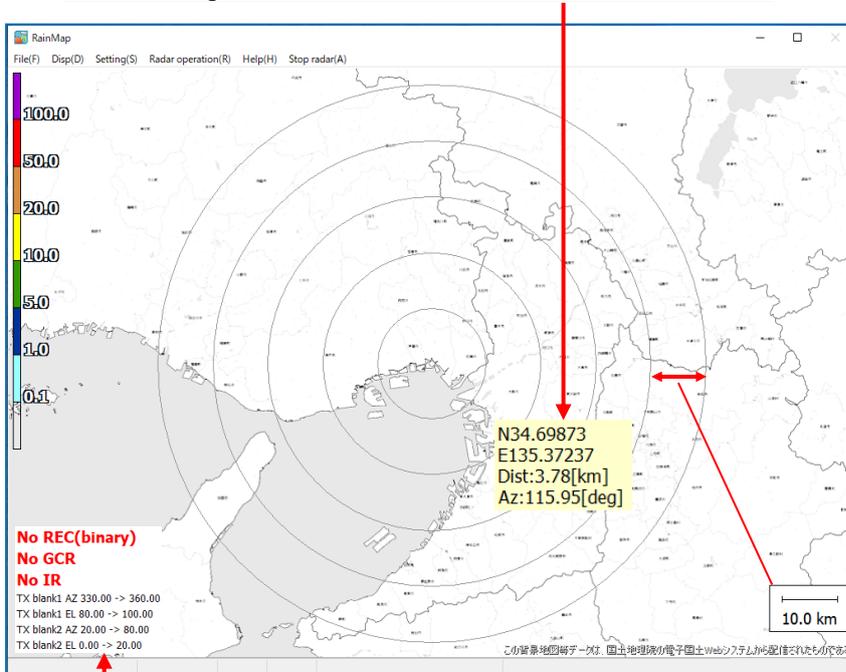
1.4. Reboot SPU

- 1) Press the power switch 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.
- 2) Wait for 1 minute and then press the power button again to turn the power on.



2. RainMap OPERATION

- 1) Turn on the power of DPU to start Windows®. Enter the user name and password.
 User name: radar
 Password: radar
- 2) The RainMap will display after startup.
- 3) When right-clicked a mouse on a map of the RainMap, following information will indicate:
Latitude/Longitude, distance from radar, and azimuth direction.



It will indicate due to the following "O" setting:

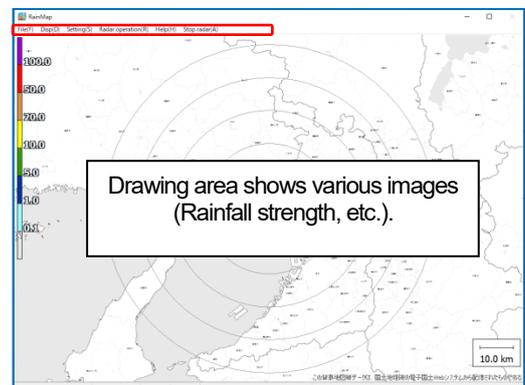
Setting items	ON	OFF
TX sector blank (1, 2)	O	X
Binary data in data acquisition	X	O
Ground clutter rejection	X	O
Interference rejection	X	O

This display range shows the range between each circle. It can change at [Setting] -> [Display] -> [Display range]

➤ 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)



2.1. File

Replay files...:

This function will launch playback software called RainPlay. It opens and plays the stored data files scn, scnX, gz, etc. (Refer to section 3 for RainPlay instructions)

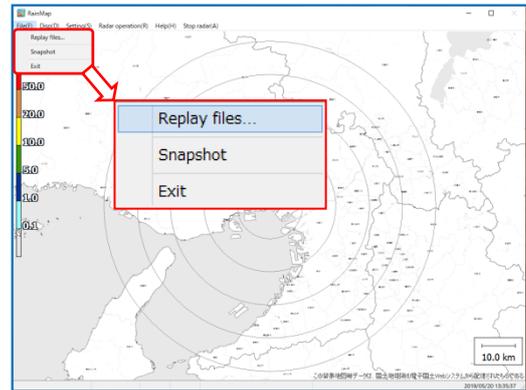
[Note: gz is the compressed binary file]

Snapshot:

Capture the screen in jpg file format.

Exit:

Close the RainMap software

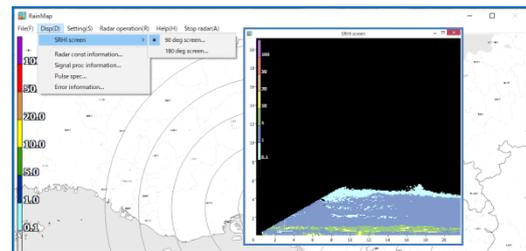


2.2. Disp

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. information:

Indicate the radar constant setting information.

Radar const information	
Serial number	1000-9000-0xxx
Product number	1xxx
RF [MHz]	9432.50
Origin EL position offset correction [deg]	0.0
AZ offset to north	0.00
Antenna beam width (H) [deg]	2.70
Antenna beam width (V) [deg]	2.70
TX power (H) [W]	100.00
TX power (V) [W]	100.00
Antenna gain (H) [dBi]	34.0
Antenna gain (V) [dBi]	34.0

Signal proc. Information:

Indicate a current signal processing settings information.

Signal proc information	
IR 1	ON
IR 2	ON
GCR	1
Threshold EL angle [deg]	20.00
SCR	OFF
Threshold EL angle [deg]	20.00
SQI threshold	0.00
Rainfall intensity estimation method	Kdp+Zh
Rainfall intensity estimation correction by EL	OFF
Output data range resolution [m]	75
K square value	0.93
ZDR offset correction [dB]	0.00
Rain output threshold [mm/h]	0.00
Kdp output threshold (Kdp) [deg/km]	0.30
Kdp output threshold (Zh) [dBZ]	30.00
Zh attenuation estimation coefficient (b1)	0.293
Zh attenuation estimation coefficient (b2)	1.101
Zdr attenuation estimation coefficient (d1)	0.0298
Zdr attenuation estimation coefficient (d2)	1.293
Air attenuation coefficient (Agas) [dB/km]	0.010
Radiowave extinction threshold [dBZ]	30.00
R(Zh)-method coefficient (B)	200.00
R(Zh)-method coefficient (β)	1.600
R(Kdp)-method coefficient (a)	19.60
R(Kdp)-method coefficient (b)	0.815
R(Kdp)-method coefficient (c)	1.2
Invalidity MP noise data	OFF

Pulse spec.:

Indicate a current pulse specification.

Pulse spec.	
Key	Value
fNo	1
P0N pulse width [us], resolution [m]	0.5, 75
Q0N pulse width [us]	20
Q0N modulation band width [MHz], resolution [m]	4, 75
PRF1 [Hz]	2000
PRF2 [Hz]	1600
A-threshold (pulse1) [dB]	-200
A-threshold (pulse2) [dB]	-200
phv noise level (pulse1) [dB]	-200
phv noise level (pulse2) [dB]	-200
Observation range [km]	30

Error information:

Indicate the 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.

Error information		
Error date & time [UTC]	Error code	Error content
[2019/05/29 09:33:24]	8013	System abnormality (Motor Control (ACK Start))
[2019/05/29 09:33:24]	7010	Undefined
[2019/05/29 09:33:22]		ANT monitor
[2019/05/29 09:33:22]		ANT control
[2019/05/29 09:33:21]		MONO CON
[2019/05/29 06:40:59]	E404	System abnormality (APC firing search failure)
[2019/05/29 06:35:14]	W507	Power supply abnormality (Stop FAN)-Resolved-
[2019/05/29 06:35:14]	7010	Undefined-Resolved-
[2019/05/29 06:35:14]	W507	Power supply abnormality (Stop FAN)
[2019/05/29 06:35:09]	8013	System abnormality (Motor Control (ACK Start))

2.3. Setting

Display:

Select and confirm display settings.

Data acquisition:

Select and confirm record settings.

Radar site location:

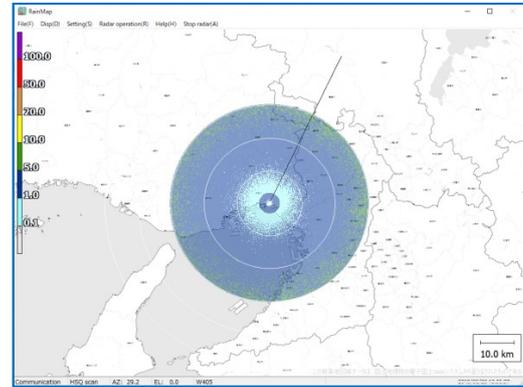
Select and confirm antenna location settings.

Scan:

Setup scans mode pattern and details.

Units:

Setup the radar indicator rotation speed.



1) Display

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

Display range [km]:

Setup the radar range display.

Display data type:

Setup radar data output parameter.

- **R [mm/h]:** Intensity of rainfall
- **Zh [dBZ]:** Reflection intensity factor of horizontal polarization wave.
- **Zh_corr [dBZ]:** Attenuation corrected Zh of the horizontal polarity data
- **Zv [dBZ]:** Reflection factor of the vertical polarimetric radar
- **V [m/s]:** Doppler velocity
- **Zdr [dB]:** Radar reflection factor of difference between Zh and Zv
- **Zdr_corr [dB]:** Corrected differential reflectivity
- **Kdp [deg/km]:** Propagation phase difference rate of change
- **Φdp [deg]:** Differential Phase Shift (cross polarization)
- **phv:** 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 the sweep line indicator on screen.

Radiowave shielding area:

It indicates the area where radio waves cannot reach due to the topography.

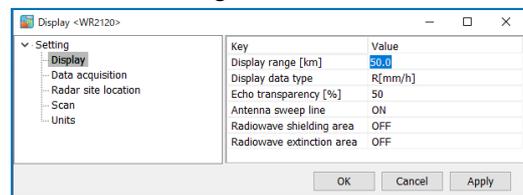
Select the radio wave shielding (sector blanking) area.

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]



Key	Value
Display range [km]	50.0
Display data type	R[mm/h]
Echo transparency [%]	Zh[dBZ]
Antenna sweep line	Zh_corr[dBZ]
Radiowave shielding area	Zv[dBZ]
Radiowave extinction area	V[m/s]
	Zdr[dB]
	Zdr_corr[dB]
	Kdp[deg/km]
	Φdp[deg]
	phv
	W[m/s]

Radiowave extinction area:

It judges whether or not the returned reflected wave is worthy of evaluation and indicates the area with undeserving by dual polarization parameter analysis.

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).

[Note: Setting file (Clip_RainMap.csv in param folder) is necessary]

[Brief explanation]

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 7.3 for detail of shielding area.

About antenna rotation:

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

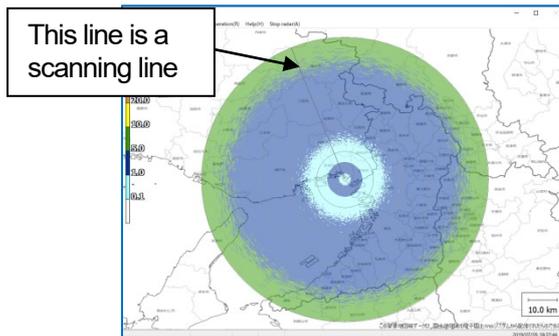


Figure 2.1: Antenna rotation

2) Data acquisition

Screen capture (JPEG):

Select ON or OFF to whether capture displayed screen data (jpeg).

Screen capture save path:

Setup a folder location to save captured screen data. Save data to D drive or other than C drive.

Screen capture period:

Setup a time interval to save captured screen data.

CSV:

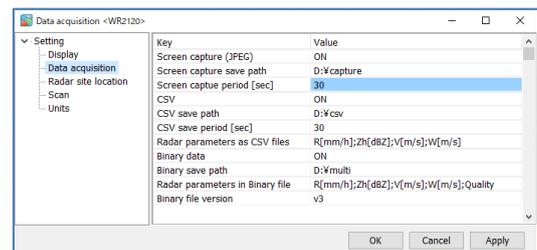
Turn ON or OFF to save data in CSV file format. (Refer to section 7.1 for detail of CSV file format)

CSV save path:

Setup a folder to save the CSV data. Save data to D drive or other than C drive.

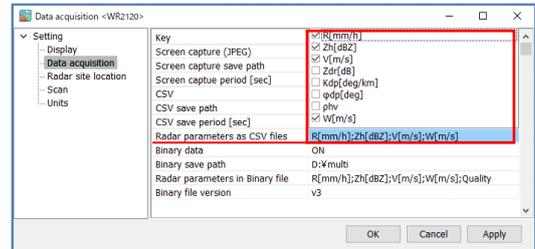
CSV save period [sec]:

Setup an interval time to save the CSV data.



Radar parameters as CSV files:

Select type of parameter(s) from following to save in CSV file: R [mm/h], Zh [dBZ], V [m/s], Zdr[dB], Kdp[deg/km], ϕ dp[deg], phv, W [m/s]

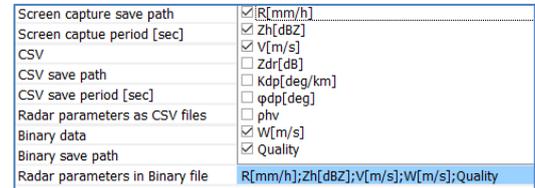


Binary data:

Turn ON or OFF to record in binary data format (Refer to section 7.2 or 7.3 for detail of binary file format)

Binary save path:

Setup a folder to save the binary data. Save data to D drive or other than C drive.



Radar parameters in Binary file:

Select type of parameter(s) from following:

R [mm/h], Zh [dBZ], V [m/s], Zdr[dB], Kdp[deg/km], ϕ dp[deg], phv, W [m/s], Quality

[Note: R cannot be deselected]

Binary file version:

Select a type of file format version from below.

- v3: Use Legacy format. Refer to section 7.2 for detail.
- v10: Refer to section 7.3 for detail.

3) Radar site Location

This menu items will reflect changes even during observation.

Latitude [deg]:

Enter latitude of radar installed location.

Longitude [deg]:

Enter longitude of radar installed location.

Altitude [m]:

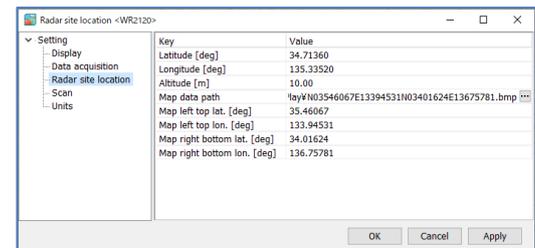
Enter the altitude of radar installed location.

Map data path:

Setup a background map for RainMap. The RainMap program displays map as a cylindrical projection layer.

Map left top lat [deg]:

The latitude of left top corner of "Map image" will setup automatically. [Do not touch]



Map left top lon [deg]:

The longitude of left top corner of "Map image" will setup automatically. [Do not touch]

Map right bottom lat [deg]:

The latitude of bottom right corner of "Map Image" will setup automatically. [Do not touch]

Map right bottom lon [deg]:

The longitude of bottom right corner of "Map Image" will setup automatically. [Do not touch]

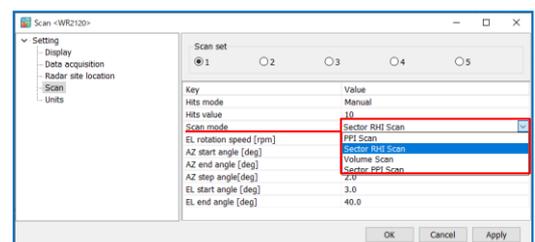
4) Scan

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] button from drop-down menu of [Radar operation] again for reflecting the changes in the scan setting while observing.

[Refer to section 0 for radar operation such as [STBY] and [TX]]



Hits mode:

Set a sample value for calculating Zh, Zdr, ϕdp, and phv. Recommendation is using “Auto” mode.

- **Auto:** It will determine and adjust the antenna rotation speed and PRF to proper values. Higher hit value (lower rotation speed) brings higher accuracy.

$$\text{Hit Value} = 0.3 \frac{[PRF]}{[\text{Rotation Speed in rpm}]} = 1.8 \frac{[PRF]}{[\text{Rotation Speed in } \frac{\text{deg}}{\text{sec}}]}$$

[e.g., 10 rpm = 60 deg/sec]

- **Manual:** Adjust the value manually at “Hits value”. Signal processing will be set by this hit value.

Hits value:

Enter the value for the hits mode when setup manual at “Hits mode”.

Scan mode:

Select the scan mode of antenna. For PPI and Volume scan modes, lower azimuth direction rotation speed will observe higher accuracy.

On the other hand, fast rotation speed will cause low accuracy.

Table 2.1

Scan mode	Extension (V3 or V10)
PPI scan	ppi or ppix
Sector RHI scan	rhi or rhix
Volume Scan	scn or scnX
Sector PPI scan	sppi or sppix

A recommendation is to maintain observation accuracy on rotation speed less than 7.0 [rpm]. (Refer to Table 2.8)

PPI scan brief overview [2D data]**[Plan Position Indicator scan]**

It scans a continuous equiangular with 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 settings:

Observe 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 brief overview [3D data] (Refer to Figure 2.2)**[Sector Range Height Indicator scan]**

It 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.

Table 2.3

Example of settings:

The RainMap setting should be entered as shown in Table 2.3 to observe the parameters shown below:

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

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 brief overview [3D data] (Refer to Figure 2.3)

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 are also 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.

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.

Example of settings:

When observing these 6 elevation angles (3.5 / 5.5 / 9.0 / 12.0 / 16.2 / 22.0 [deg]) every one minute, they can be observed within a 58 second period by using settings in Table 2.4.

(Rotation set to 7.0 [rpm] in azimuth direction)

Notes:

- 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.
- 2> Elevation movement azimuth rotation speed [deg] is fixed at 6.0 deg.
- 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.

Table 2.4

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

Sector PPI scan brief overview (Refer to Figure 2.4)
[Sector Plan Position Indicator scan]

It scans 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 2.5 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.

Notes:

- 1> Elevation movement azimuth rotation speed [deg] is fixed at 6.0 deg.
- 2> It is necessary to set more than 0.1 [deg] between AZ start angle and the end angle, and for also between each EL angle.

Table 2.5

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

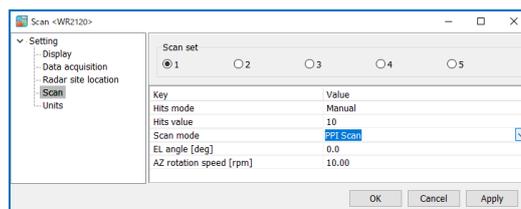
[PPI Scan] mode menu

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] mode menu

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.

AZ step angle [deg]:

Set quantity of antenna rotation while changing azimuth angle.

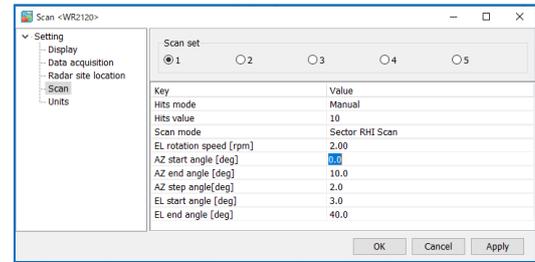
EL end angle [deg]:

Set elevation end angle for observation area.

EL start angle [deg]:

Set elevation start angle for observation area.

[Note: It is necessary to set more than 0.1 [deg] between AZ/ EL start angle and the end angle, and also AZ step angle]



[Volume Scan] mode menu

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])

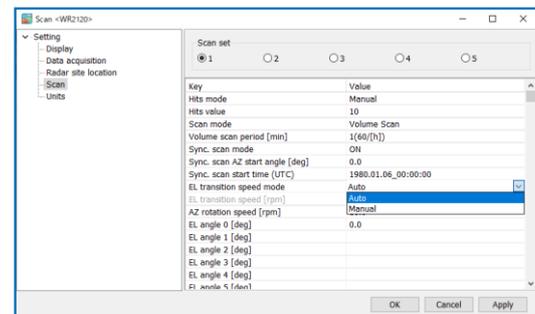
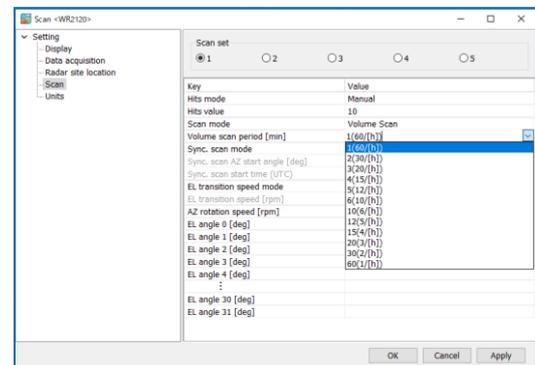
e.g., volume scan will activate every 2 minutes if 2(30/[h]) selected. (It activates 30 times per hour), the measurement start time will be; 00, 02, 04, ..., 58 seconds in Data Processing Unit.

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 observation.

AZ rotation speed [rpm]:

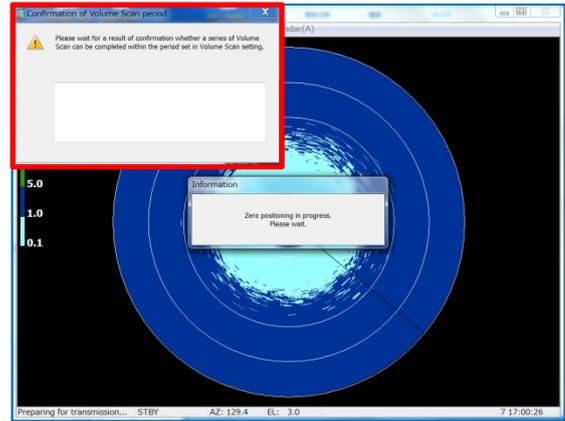
Set volume azimuth rotation speed for each elevation.

EL angle 0 – 31 [deg]:

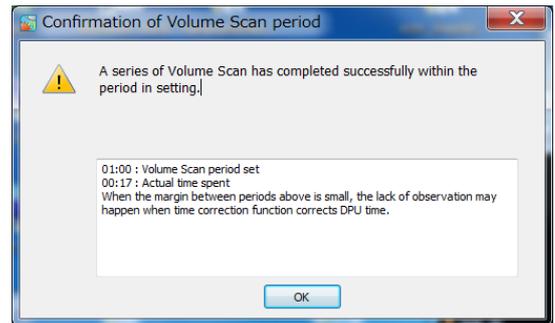
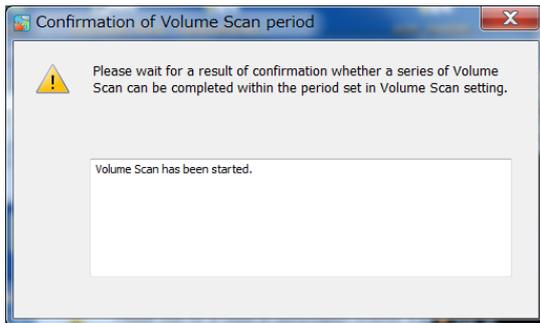
Set each elevation variation, up to 32 different values. It automatically sorted in ascending order of elevation setting value.

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:

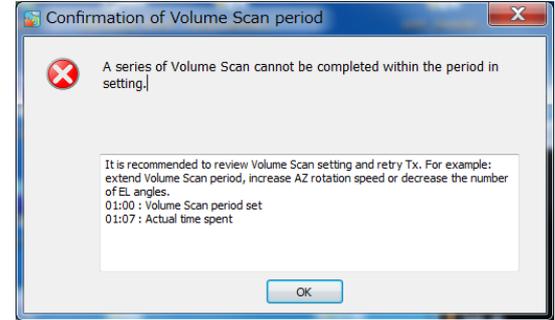
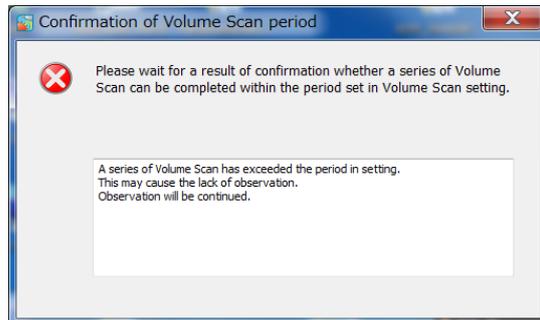


Image of observation timing:

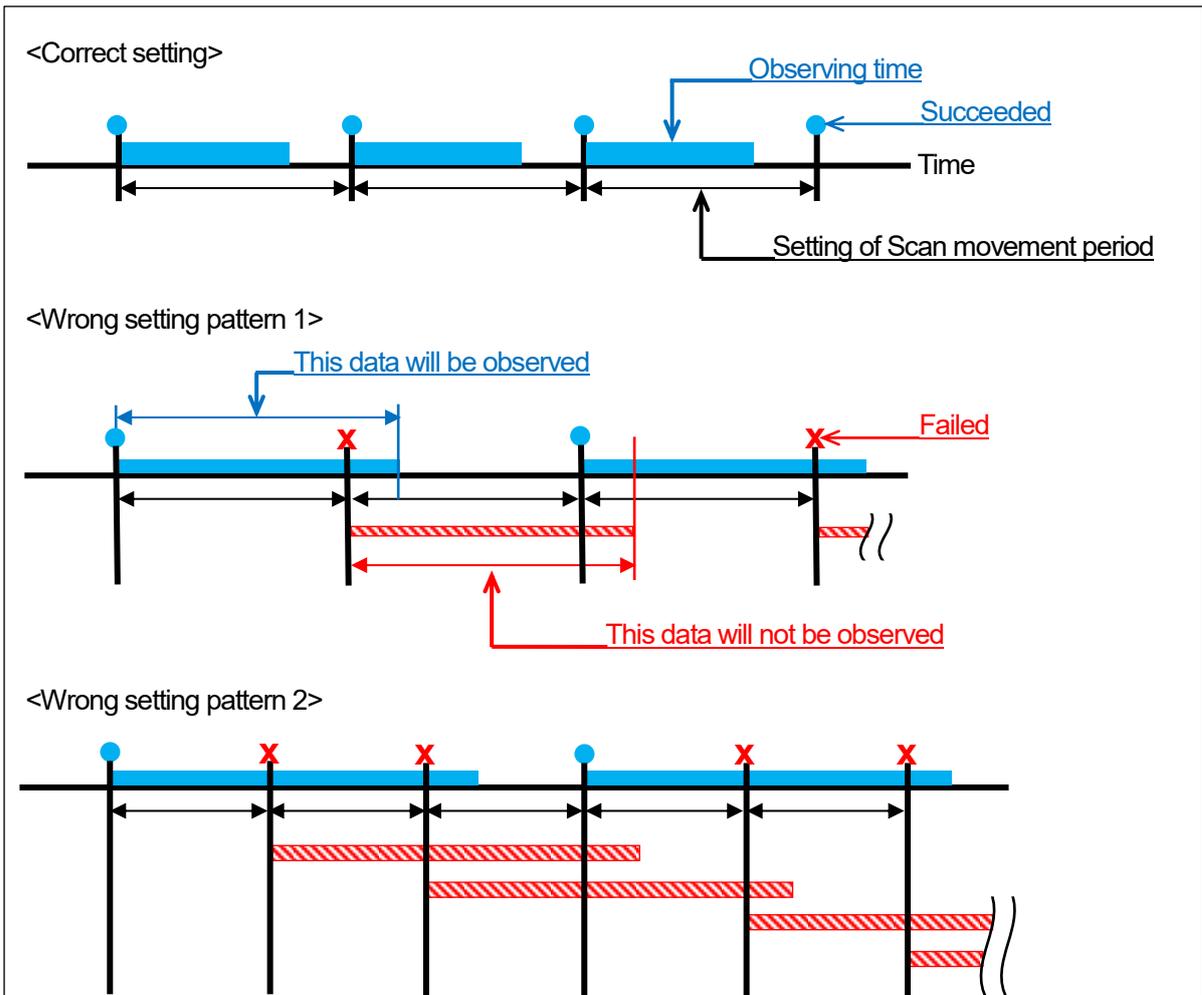


Image of elevation timing:



- (1) AZ rotation speed [rpm]
- (2) EL transition speed [rpm]

[Sector PPI Scan] mode menu

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.

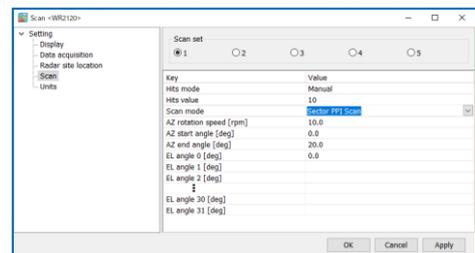


Table 2.6: Rotation speed range

Scan mode	Item	Range
PPI	AZ rotation speed	0.5 to 16.0rpm
Sector RHI	EL rotation speed	0.5 to 6.0rpm
Volume Scan	EL transition speed	0.5 to 6.0rpm
Volume Scan	AZ rotation speed	0.5 to 16.0rpm
Sector PPI	AZ rotation speed	0.5 to 16.0rpm

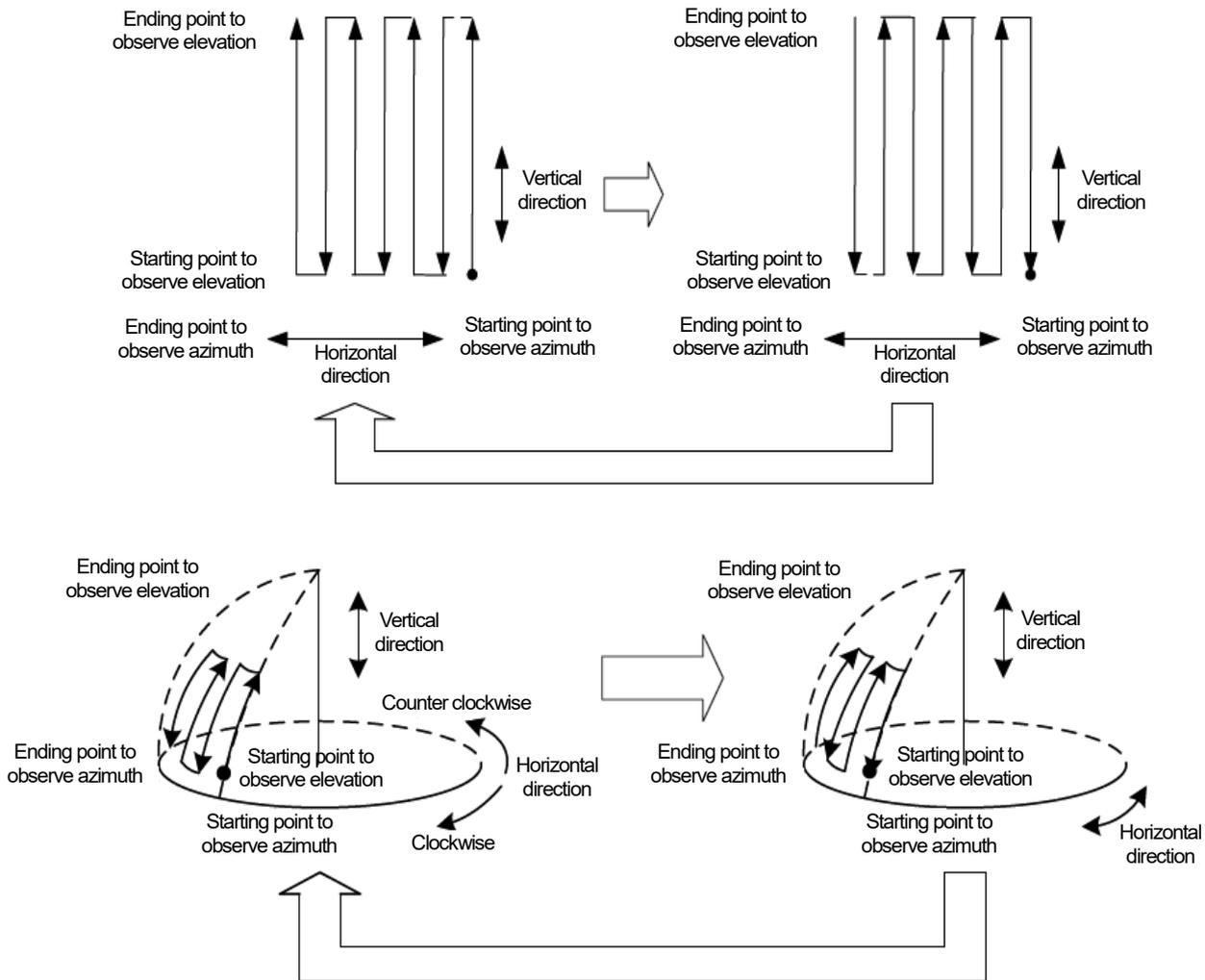


Figure 2.2: SRHI Scan mode

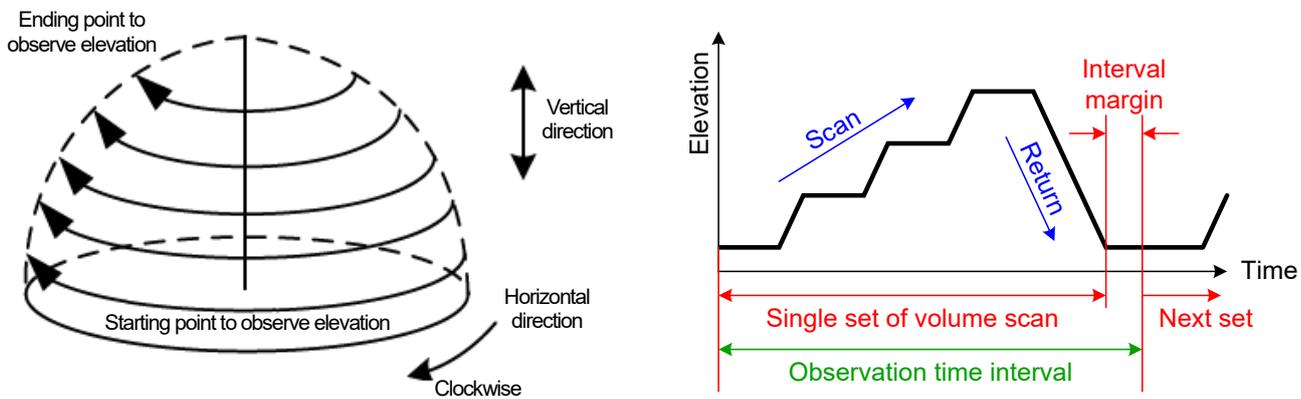


Figure 2.3: Volume Scan mode

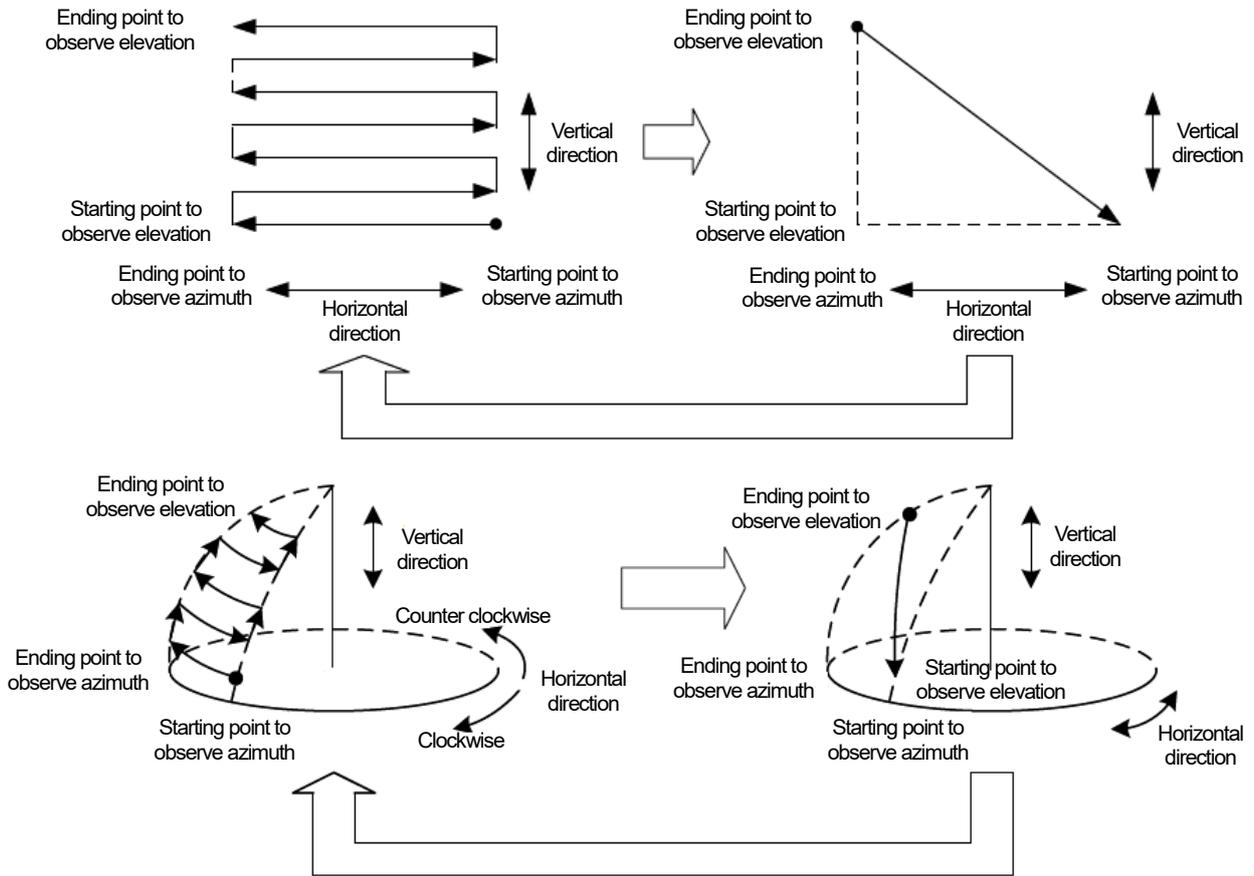
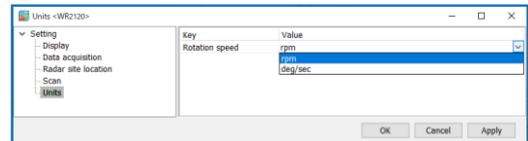


Figure 2.4: SPPI Scan mode

5) Units

Rotation speed:

Select the type of rotation speed indicator either rpm or deg/sec.



2.4. Advanced Setting

2.4.1. Setting

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

Once the radar is start observing by click [TX], it cannot be able to open the advance setting menu until click [STBY] or [Stop radar] to stop observation.

1) Display

Echo update:

Select the echo display update type.

• No Update:

Radar echo will not display on screen.

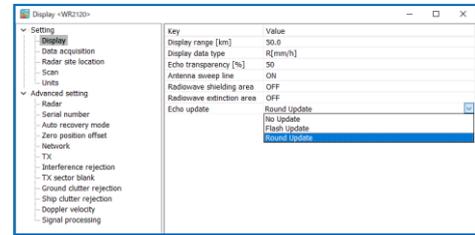
Stop updating the screen while connecting by remote may reduce traffic volume of DPU.

• Flash Update:

Radar echo display will only update after one full rotation.

• Round Update (Default setting):

Keep continuously updating the Radar echo display in real-time. (Default setting)



2) Scan

Sweep decimation mode:

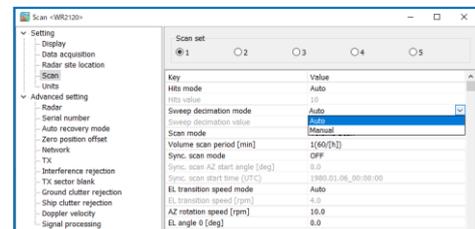
Select either "Auto" or "Manual" mode in sweep decimation. It is strongly recommended using in "Auto" mode.

• Auto:

Adjust the radar sweep output interval from antenna rotation speed and transmission PRF properly.

• Manual:

Set an interval value of sweep decimation to output sweep.



Sweep decimation value:

Enter an interval value of sweep decimation to output sweep. It can only enter when select manual on sweep decimation mode.

Note:

If make sweep decimation value small when using PPI scan, one round of azimuth direction data will be increased. One the other hand, if sweep decimation value is bigger, then one round of azimuth direction will be decrease. Therefore it may cause bad effect and warning No55 to radar operation if set a value of sweep decimation is small.

2.4.2. Advanced Setting

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

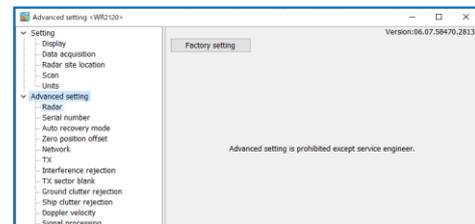
1) Radar: Only for the manufacturer use.

2) 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.



3) Auto recovery mode

Auto recovery from OS shutdown detection:

- **ON:** RainMap will automatically restore to its former state before shutdown when accidentally OS (DPU) has restarted.
- **OFF:** This function will be off.



Auto recovery from SPU connection failure:

- **ON:** It will recover by the file registered in “Auto recovery software for SPU connection failure” when the connection between RainMap and SPU has failed several times and not reconnected.
[Notice: This function is unsupported for WR2120]
- **OFF:** This function will be off.

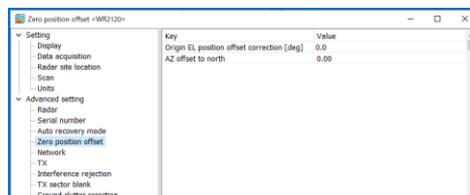
Auto recovery software for SPU connection failure:

Unsupported function for WR2120.

4) Zero position offset

Origin EL position offset correction [deg]

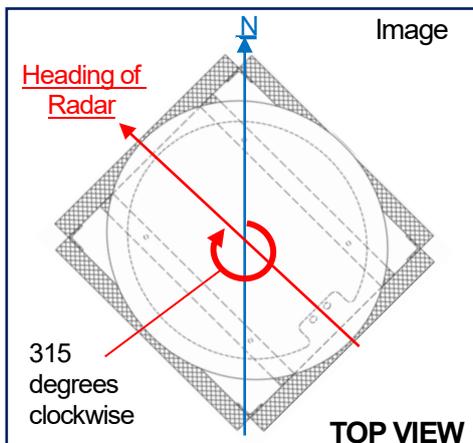
Setup the original horizontal level for an elevation offset to adjust the level.



AZ offset to north:

Setup an azimuth offset angle clockwise from north to heading of radar.

e.g., heading of radar is 315 degrees (measured value). The value to input into “Azimuth Offset to north” is 315 degrees. Clarify that set as a positive degree offset from north to the azimuth.



5) Network: Only for the manufacturer use.

6) TX

PRF pattern:

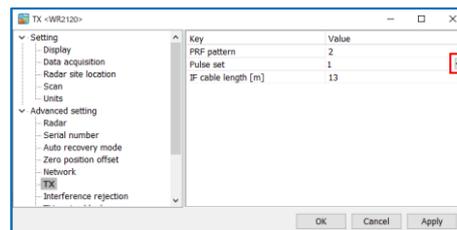
Select PRF pattern from 1 to 3. Details are written in Table 2.7.

It has click [Apply] to complete this setting before select the pulse set, or else specification in the pulse spec menu will not be reflected.

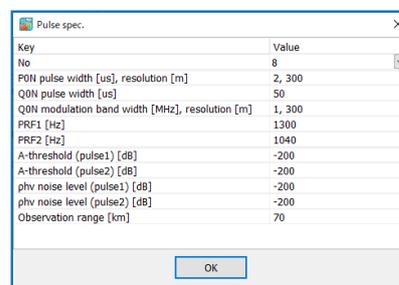
Pulse set:

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. However it is recommended to set the A-threshold value by the Renew A-threshold function (Refer to section 2.8).



- P0N pulse width [us], resolution [m]: Non-modulation pulse width and range resolution
- Q0N pulse width [us]: Modulation pulse width
- Q0N modulation band width [MHz], resolution[m]: Modulation bandwidth and range resolution.
- PRF 1 [Hz]: Short cycle for dual cycle signal processing.
- PRF 2 [Hz]: Long cycle for dual cycle signal processing.
- A-threshold (pulse 1) [dB]: P0N.
- A-threshold (pulse 2) [dB]: Q0N.
- phv noise level (pulse1) [dB]: Short pulse of phv noise level.
- phv noise level (pulse2) [dB]: Long pulse of phv noise level.
- Observation range [km]: No.1 = 30km, No.2 = 30km, No.3 = 50km, No.4 = 70km, No.5 = 50km, No.6 = 30km, No.7 = 50km, No.8 = 70km



Notes:

- 1> Refer to Table 2.7 for Pulse spec value.
- 2> A-threshold is to eliminate a background noise of received signal.
- 3> Select a pulse set number, and it is necessary to click [OK] button after change any value on [Pulse spec.] for reflecting the setting to the parameter.
- 4> P0N: Sequence of pulses without modulation (CW) used for short range detection
- 5> Q0N: Sequence of frequency modulated pulses used for long range detection.

IF cable length [m]:

Enter the actual length of signal cable between Antenna Unit and Signal Processing Unit.
e.g., if ordered 10m then it will be 13m because it has to add 3m for the length that laying inside ATU and SPU.

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 METEOROLOGICAL 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 it 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

PRF-Pulse No.	RX	Non-modulation pulse width	Short pulse range	Modulation pulse width		PRF1	PRF2	Range Resolution	Sensitivity	PRF
	[km]	[μ s]	[km]	[μ s]	[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

Notes:

- 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 recorded 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.

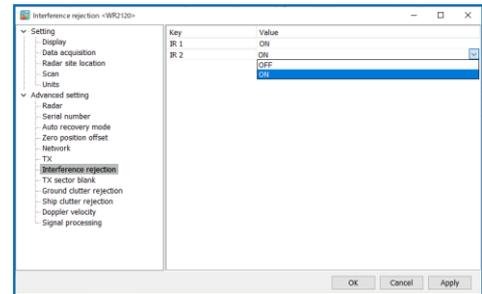
PRF1 High: 1700 to 2000Hz (Doppler range ±54.6 to ±64.2m/s)
 PRF1 Middle: 1300 to 1700Hz (Doppler range ±41.7 to ±54.6m/s)
 PRF1 Low: 1100 to 1300Hz (Doppler range ±35.2 to ±41.7m/s)

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

7) 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 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]

8) TX sector blank

Blank area 1 and 2:

Select ON or OFF to activate the sector blank.

AZ start angle [deg]:

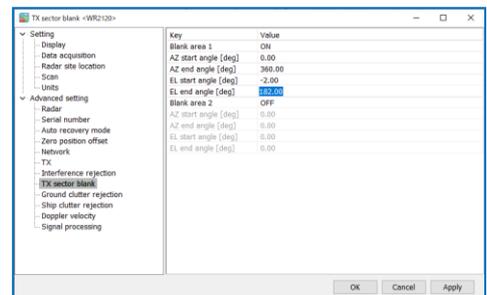
Setup a starting angle of azimuth for sector blank.

AZ end angle [deg]:

Setup the ending angle of azimuth for sector blank.

EL start angle [deg]:

Setup the starting angle of elevation for sector blank.



EL end angle [deg]:

Setup the ending angle of elevation for sector blank.

Note:

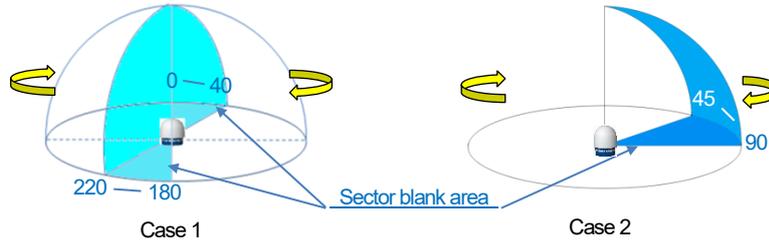
Because EL end angle can be set up to 182 degrees, it will sector blank the opposite side -2 to 90 degrees either.

Case 1:

If setup sector blank of AZ 0 to 40 and EL -2 to 182, AZ of between 180 to 220 degrees will also stop transmit when observing the radar.

Case 2:

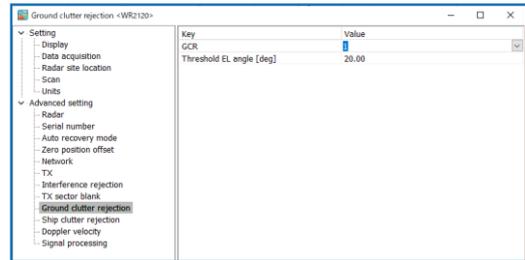
If setup sector blank of AZ 45 to 90 and EL -2 to 90, then opposite side will not stop transmit.



9) Ground clutter rejection

GCR:Select “OFF”, “1”, or “2” to whether remove ground clutter as a target if elevation is lower than the setting.

- **OFF:** Ground clutter will not be rejected.
- **1:** Reject the ground clutter by using observed data with MTI (Moving Target Indicator) process.
- **2:** Reject the ground clutter of Rain data based on data of Reference folder (scr, scrx). (Refer to section 2.8. 4) for detail of reference data)



Threshold EL angle [deg]:

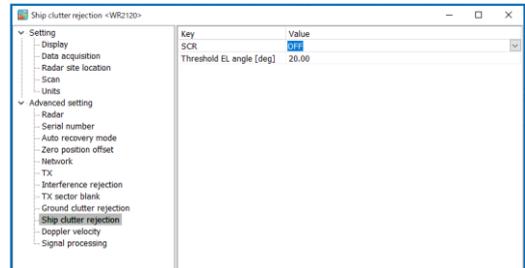
Setup the threshold elevation angle. MTI processing is applied below the threshold elevation angle.

10)Ship clutter rejection

SCR:

Select “OFF” or “ON” to whether remove ship clutter as a target if elevation is lower than the setting.

- **OFF:** Ship clutter will not be rejected.
- **ON:** Reject the ship clutter by using observed data



Threshold EL angle [deg]:

Setup the threshold elevation angle. SCR processing is applied below the threshold elevation angle.

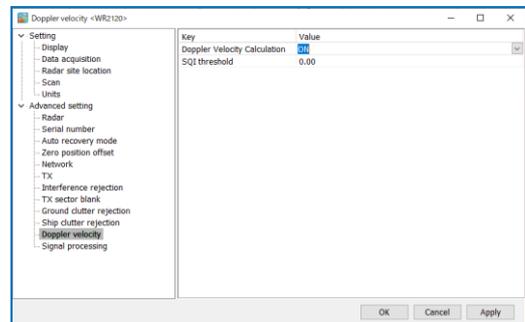
11)Doppler velocity

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). This is the correlation between the signal and its Doppler lag. If the measured SQI at a bin is greater than the threshold, then the Doppler velocity and width are "passed" for SQI.



12) Signal processing

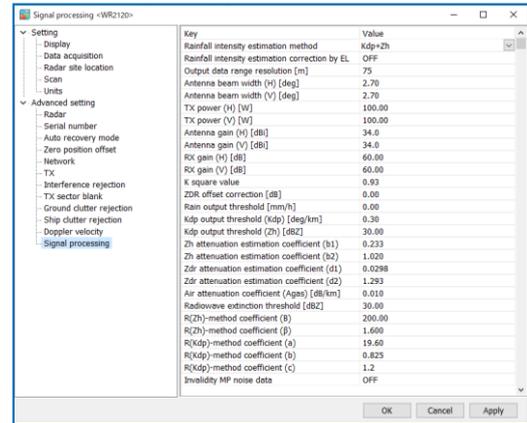
Rainfall intensity estimation method:

Select a Rainfall intensity estimation type.
(Refer to section 2.4.3)

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:

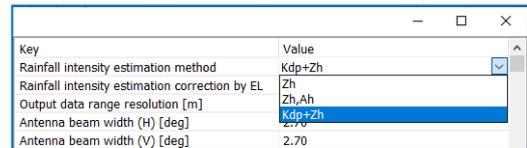
Select either "ON" or "OFF" to correct rainfall intensity estimation by degree of elevation.

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 setting on the resolution of pulse setting.

However, required data cannot 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)

TX power (V) [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 PON and VON. Change the setting to around 0.5 [mm/h] if it is annoying. If user 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: $Z = BR^\beta$

Here, Z [mm⁶/m³] 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.

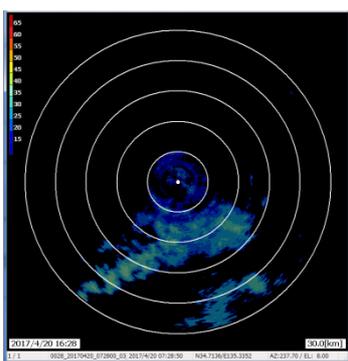
R (Kdp)-method coefficient (a), (b), (c):

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

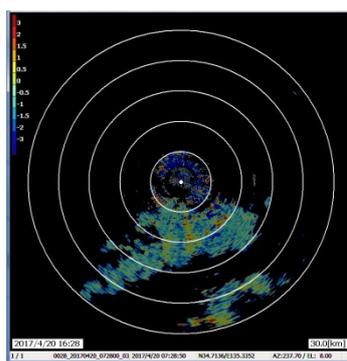
Calculation method: $\text{Rain (Kdp)} = c \times a \times \text{Kdp}^b$

Invalidity MP Noise data:

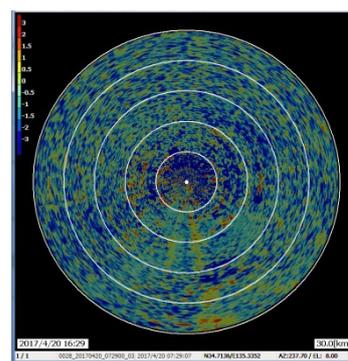
This is the function to invalid Zdr, ρ_{hv} , ϕ_{dp} , Kdp when Zh is under A cutback value. Invalid the noise of Multiple Parameter by ON/OFF switch.



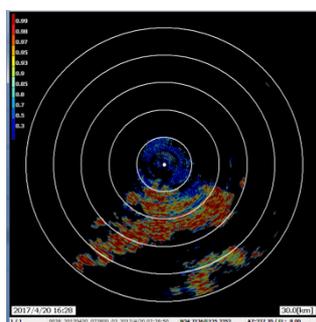
Zh



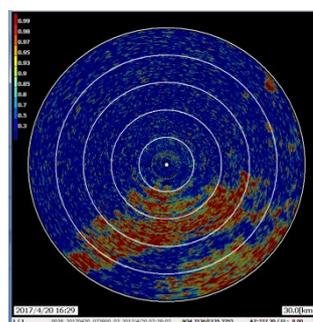
Zdr
Invalid MP Noise "ON"



Zdr
Invalid MP Noise "OFF"



ϕ_{dp}
Invalid MP Noise "ON"



ϕ_{dp}
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.)

2.4.3. 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,

$$\text{Rain}(Zh) = \left(\frac{1}{B}\right)^{\frac{1}{\beta}} \times 10^{\frac{Zh}{10 \times \beta}}$$

- 2) Parameters “B” and “β” are able to set from advanced setting. Default value of “B” is 200. ”β” is 1.6. Zh unit is using dBZ.

Zh, Ah decay correction method

- 1) Calculate Zh_{corr} from Zh and Ah

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

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

- 2) Where, the parameters b1, b2 and range bin data resolution Δr are able to set from advanced setting. 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.

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

Kdp+Zh method

- 1) Calculate the rainfall intensity R from “Kdp” or from “Zh”. This will be selected by thresholds setting of RainMap. In addition, calculation from Kdp can be selected to use elevation or not at “Rainfall intensity estimation correction by EL” in the “Signal processing” under the advanced setting of RainMap.

(With elevation correction [OFF])

$$\text{Rain}(Kdp) = c \times a \times Kdp^b$$

(With elevation correction [ON])

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

- 2) Where, the parameters a, b, and c are able to set from advanced setting. Default values are 19.6, 0.825 and 1.2, respectively.

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

- 3) Where, the parameters $th(Kdp)$ and $th(Zh)$ are able to set from advanced setting. Default values are 0.3 [deg/km], and 30 [dBZ], respectively.

2.5. Radar operation

Connect:

Connect the network between DPU and SPU.

Disconnect:

Disconnect the network between DPU and SPU.

TX:

Transmit and receive signals for observation.

STBY:

Stop and standby transmit and receive signals.

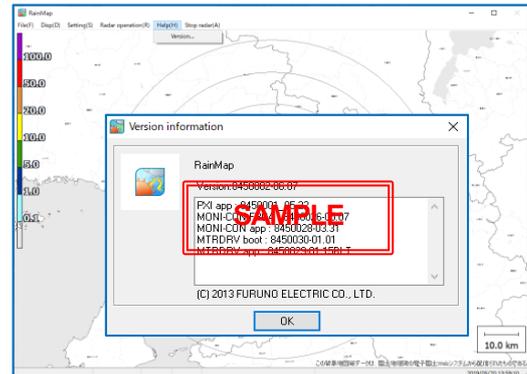


2.6. Help

Version:

Indicate connecting devices and version of software.
(RainMap, PXI App / MONI-CON FPGA / MONI-CON App / MTRDRV Boot / MTRDRV App)

[Note: It indicates only when radar operation is connected]



2.7. Stop radar

Stop radar:

Stop both radar motor and TX.



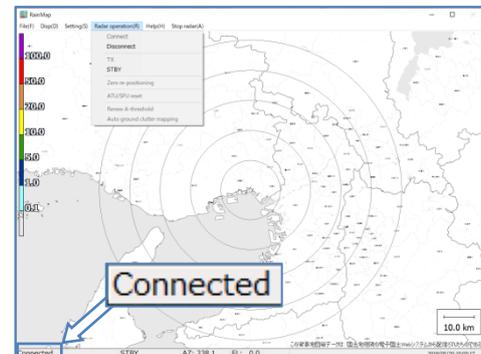
2.8. Radar Adjustment

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

- Step1: Turn on the power of Data Processing Unit.
- Step2: Software will start automatically.
- Step3: Click [Connect] button to start radar operation.
[Connect] will be displayed in the left bottom.
- Step4: Click [TX] button to start observation.
- Step5: Radar echoes will display with rotate scanning line after on-screen message "[Initializing]".
- Step6: Click [STBY] button to stop observation.
- Step7: Click [Disconnect] button to disconnect from radar.

Notice:

- The following commands will not operate without connecting radar:
 - Radar operation (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 mechanical origin (zero point) direction if an azimuth or elevation failure occurs.

2) ATU/SPU reset

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

3) Renew A-threshold

This function measures the noise power of the radar. The noise power is used to determine the threshold levels of each pulse setting therefore the noise data can be removed.

Click [Renew A-threshold] to adjust the noise level after clicked [Connect] in the pull-down menu of [Radar operation]. It will start receiving radar and then stop automatically after adjustment. Also it will overwrite to A-threshold.

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 for taking a correct ground clutter data.

Please setup the following:

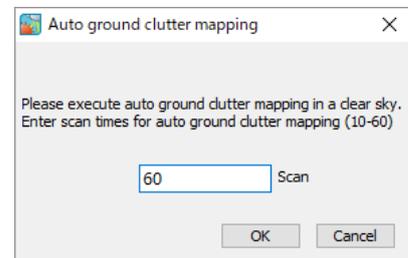
- Setting -> Advanced setting -> Ground clutter rejection -> GCR: 1

Pressing [Ctrl] + [Alt] + click [Radar operation] simultaneously, and click [Auto ground clutter mapping] to start measurement after above setup is completed.

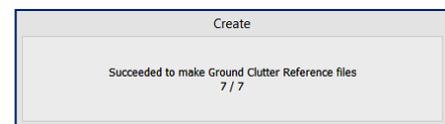
32 elevations are possible and can be setup by Volume scan mode to measure up to 32 elevations automatically.

(1) Setup the number of times to run scenario: Setup a number of times to scan from 10 to 60 (Larger scan number (e.g., 60) 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, scrx) is created. Restart RainMap after measurement completed (Refer to the right sample screen).



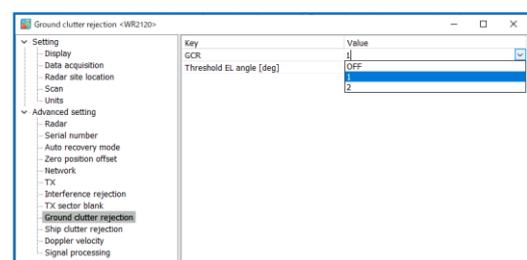
Data format of measured "scrx" file is same as "scnx" file ("scr" is "scn"). It can see by the RainPlay. File directory: "Windows(C) > Users > Radar > Furuno > RainMap_RainPlay > Reference"

e.g., radar may take up to 3 hours to complete measurements and create reference map data.

- Go to "Scan" setting menu.
- Select "Volume scan" on Scan mode.
- Setup "1(60/[h]) [min]" on Volume scan period [min].
- Setup EL angle from 0 to 5 as follows: 3deg, 6deg, 9deg, 12deg, 15deg, 20deg
- Setup "10.00" on AZ rotation speed. (Recommends to use the setting of use speed)
- Go to "Ground clutter rejection" setting menu.
- Select "1" in GCR".
- Click "Auto ground clutter mapping" in the pull-down menu of "Radar operation" to start operation.
- Setup the scan measurement to "60" when popup menu of "Auto ground clutter mapping" is indicating before starting ground clutter measurement. (It will be the maximum)

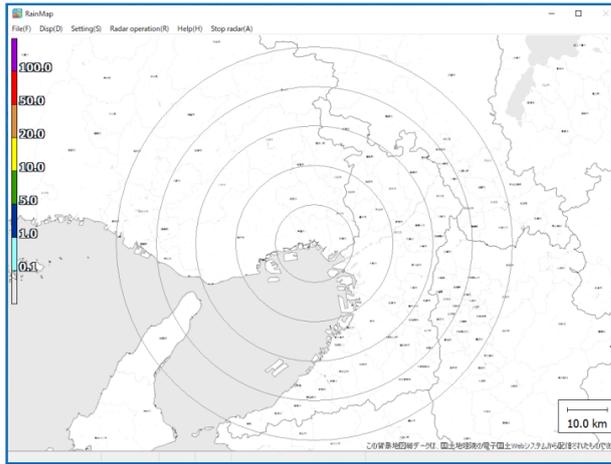
Notes:

- 1> It may have a delay while RainMap saves the new measured data into RainMap when generating a ground clutter.
- 2> Created reference map data will be used only when selecting "2" on GCR.

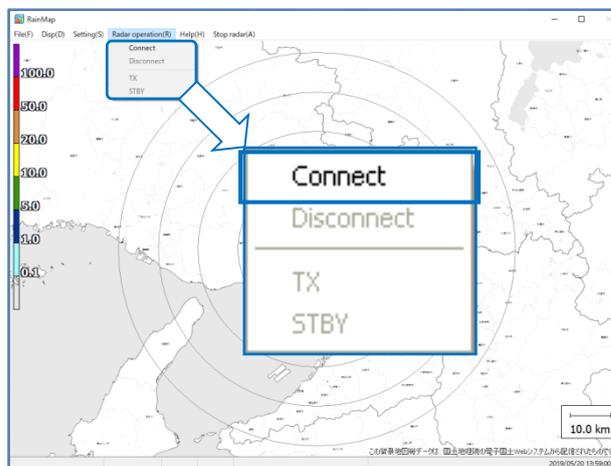


2.9. Operation Process

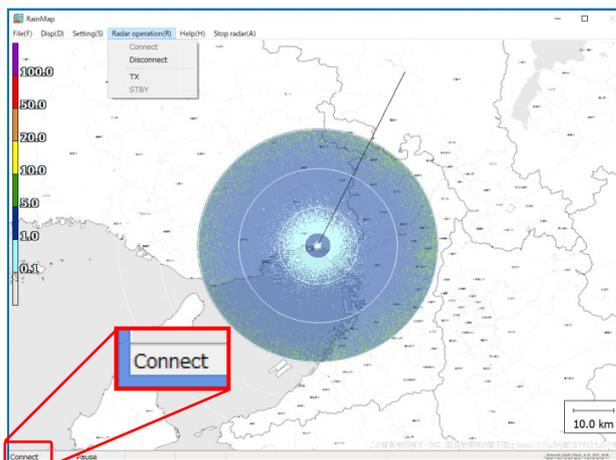
1) Start rainfall observation



Setup the observation parameters.
(Pulse spec, Data acquisition, Scan mode, and others)

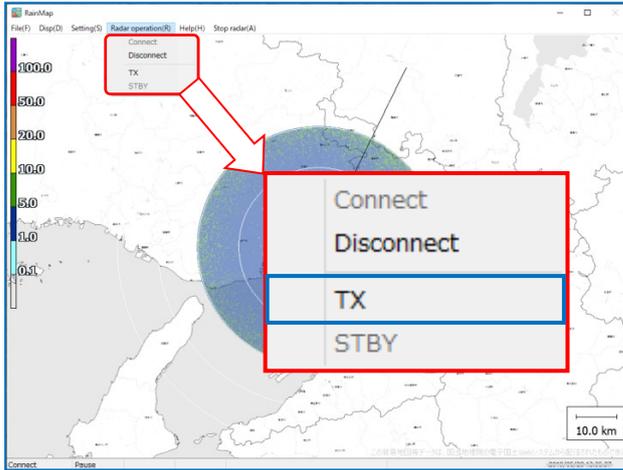


Click [Connect] from [Radar operation]
pull-down menu.



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

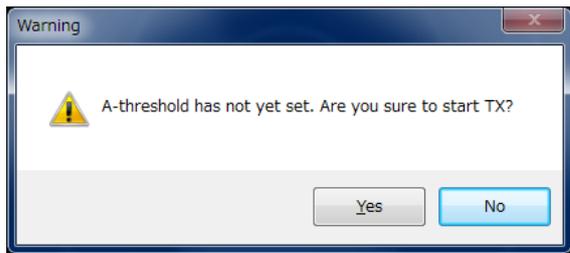




Click [TX] from [Radar operation] pull-down menu.

It is already done the noise measurement or A-threshold adjustment.

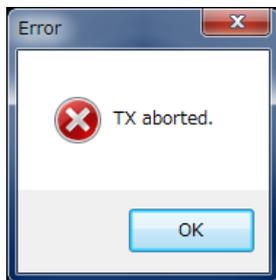
No



Note:

This message will not be indicated during a state of factory setting because A-threshold has been setup.

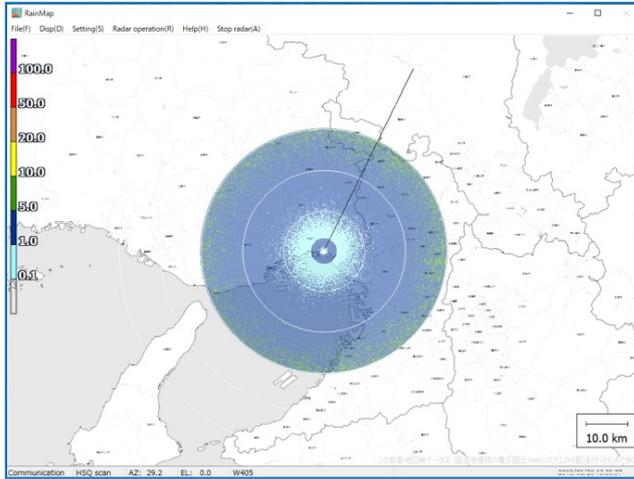
No



Yes

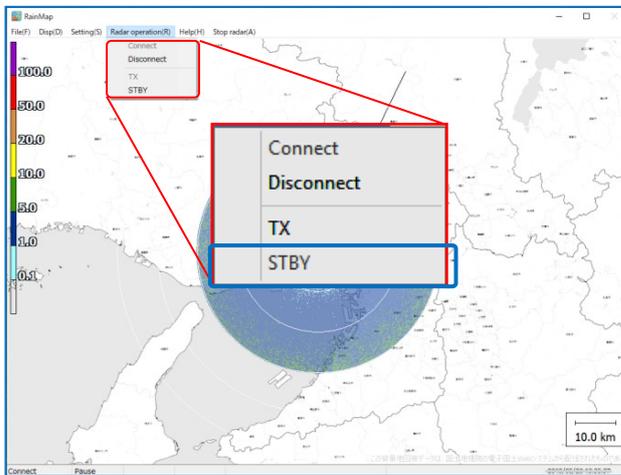
Yes



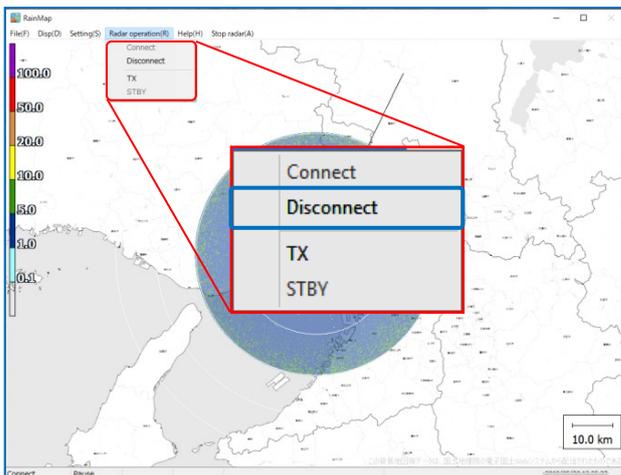


Start operation of radar and display observed information on the screen.
The recorded data is saved in the data storage device.

2) Stop rainfall observation

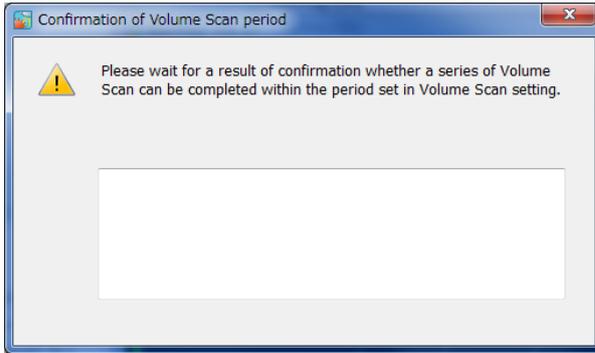


Click [STBY] to stop the radar operation.



Click [Disconnect] to close ATU.

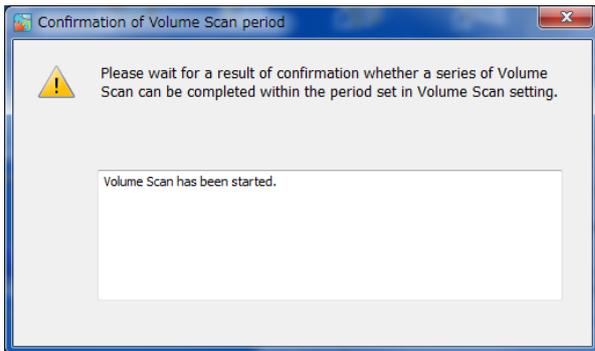
3) Volume scan observation



Start Volume Scan with the process of step 1)

Note:

This pop-up window will indicate only right after changed the scan setting. Moreover it will not indicate again when restart the same scan setting.

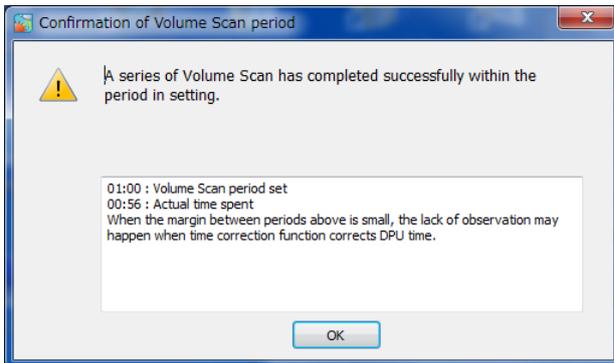


Scan will start on time

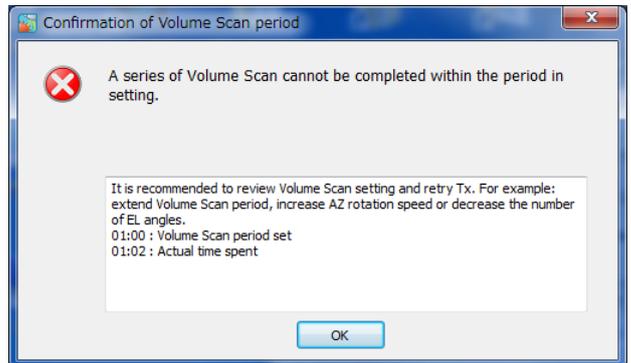
Does Volume Scan period will finish on time?

Yes

No



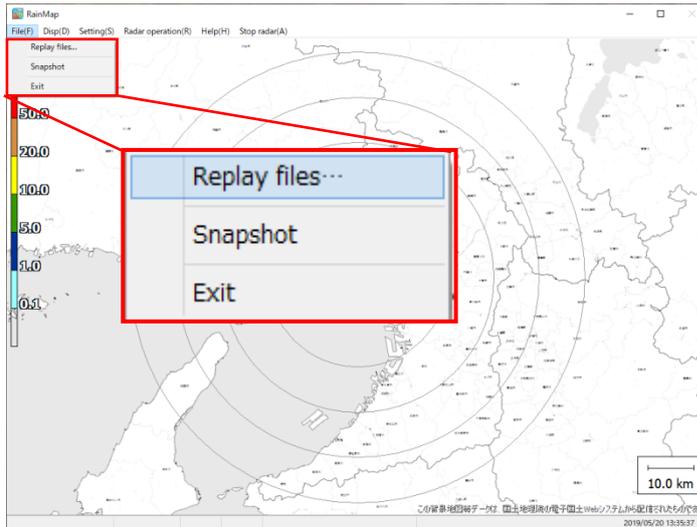
Volume scan has completed successfully.



Volume scan has been failed, therefore please check the setting and restart it again.

2.10. Observation Data Operation

1) Start playing the Observation Data



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



Go to section 3

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.

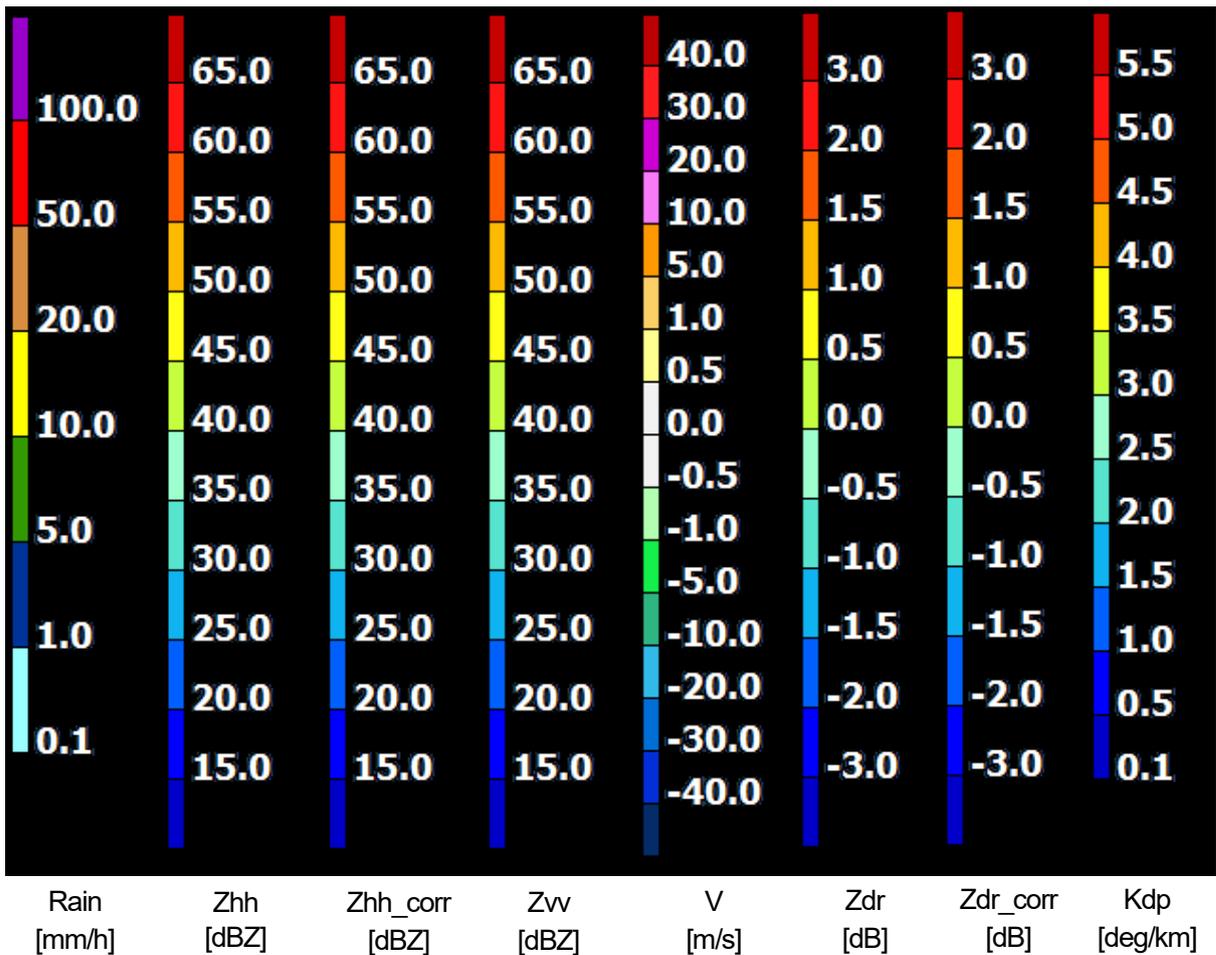


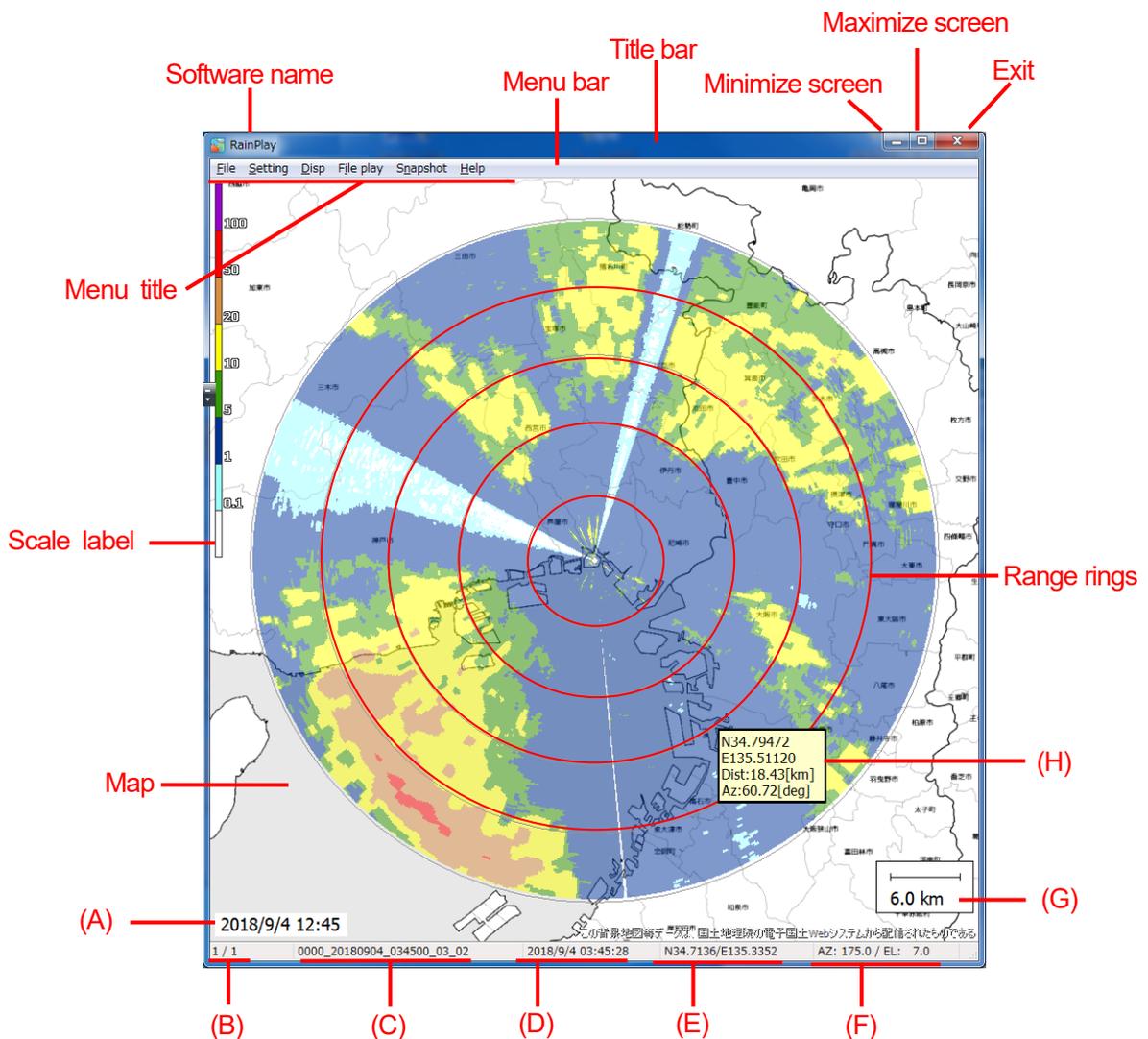
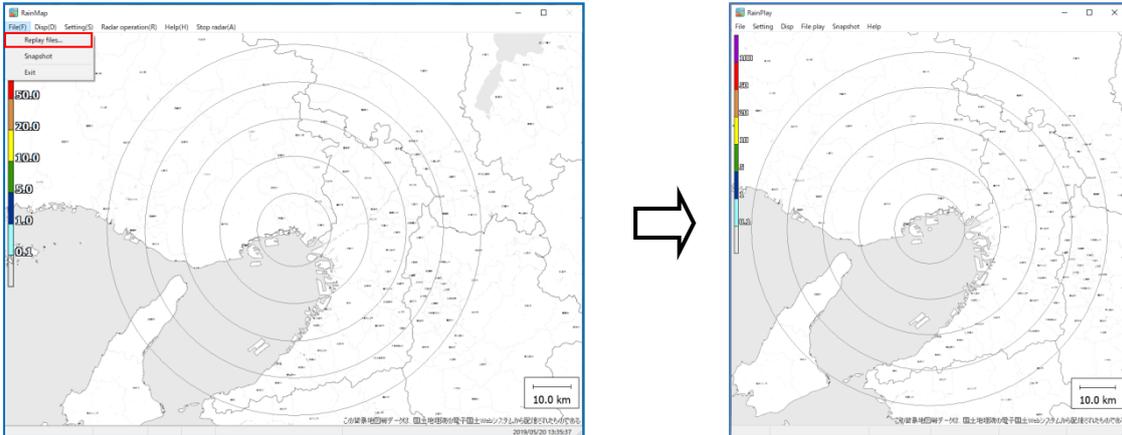
Figure 2.5: Scale label indication

3. RainPlay OPERATION

RainPlay will display after selecting [File play] on RainMap.

It is also possible to use RainPlay.exe from "RainMap_RainPlay" folder even when RainMap is activated.

File directory: "Windows(C) > Users > Radar > Furuno > RainMap_RainPlay > RainPlay.exe"



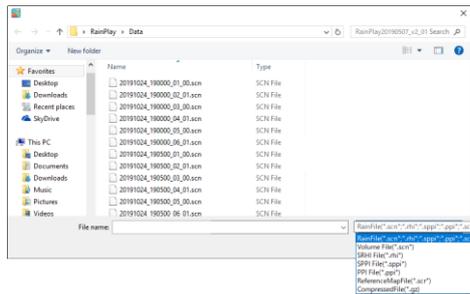
- (A) Computer acquired date/time (Local time)
- (B) Play file number / display number
- (C) Play file name
- (D) Acquired date/time (UTC)
- (E) Radar location
- (F) Start location of acquired Azimuth/Elevation

- (G) Range scale-bar.
- (H) Pop-up the following information by keep pressing the mouse left button.
(Latitude, Longitude, Distance from center, and Azimuth)

3.1. File

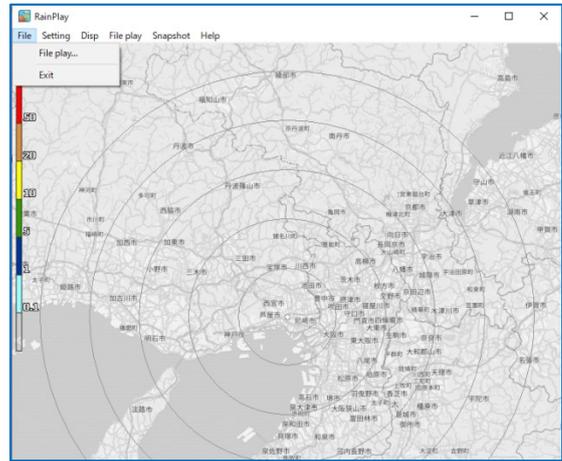
1) File play:

Select files of binary data (scn; rh, etc) to play (Slide show) on the screen.
(Refer to section 7 for detail of file format)



2) Exit:

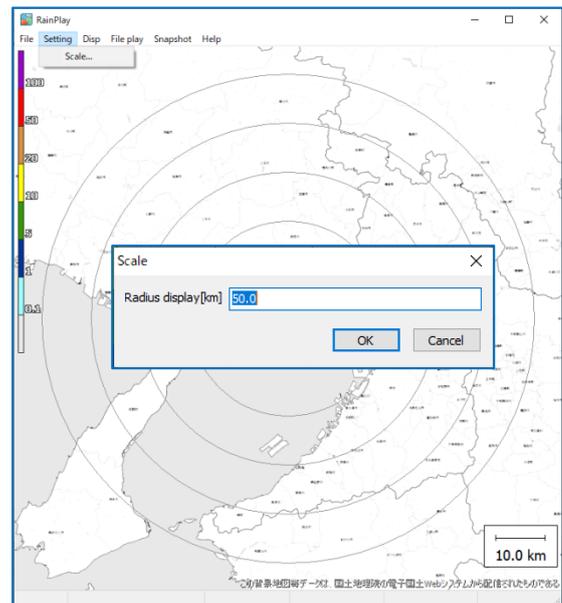
Close the software



3.2. Setting

1) Scale:

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



3.3. Disp

1) Select:

Select a data type to display.

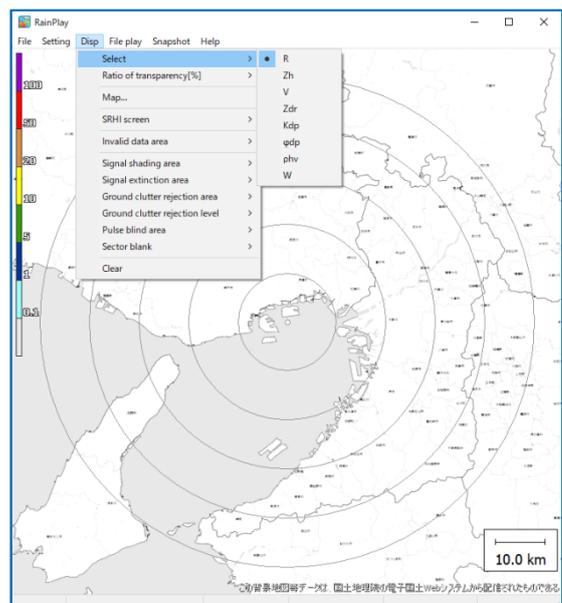
- **R:** Intensity of rainfall
- **Zh:** Reflection intensity factor of horizontal polarization wave
- **V:** Doppler velocity
- **Zdr:** Radar reflection factor difference between Zh and Zv
- **Kdp:** Propagation phase difference rate of change
- **φdp:** Differential Phase Shift (cross polarization)
- **phv:** Co-polar correlation coefficient
- **W:** Doppler velocity spectrum width

2) Ratio of transparency [%]:

Set the echo returns transparency.

3) Map:

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



- 4) **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)
- 5) **Invalid data area:**

Turn ON/OFF the invalid data area indication.
- 6) **Signal shading area:**

Select the signal shading area indication.
OFF: Hidden, 1: Grayed out, 2: Gray scale
- 7) **Signal extinction area:**

Select the signal extinction area indication beyond the strong rain area.
OFF: Hidden, 1: Grayed out, 2: Gray scale
- 8) **Ground clutter rejection area:**

Select the ground clutter rejection indication area.
OFF: Hidden, 1: Grayed out, 2: Gray scale
- 9) **Ground clutter rejection level:**

Select the level of ground clutter rejection, 0 to 7.
- 10) **Pulse blind area:**

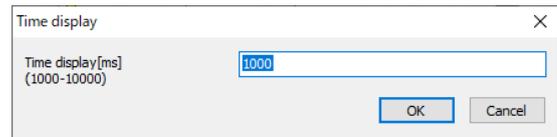
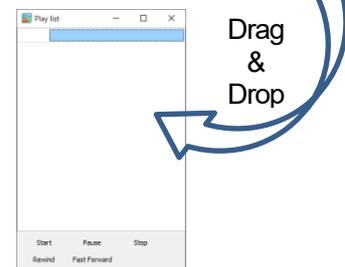
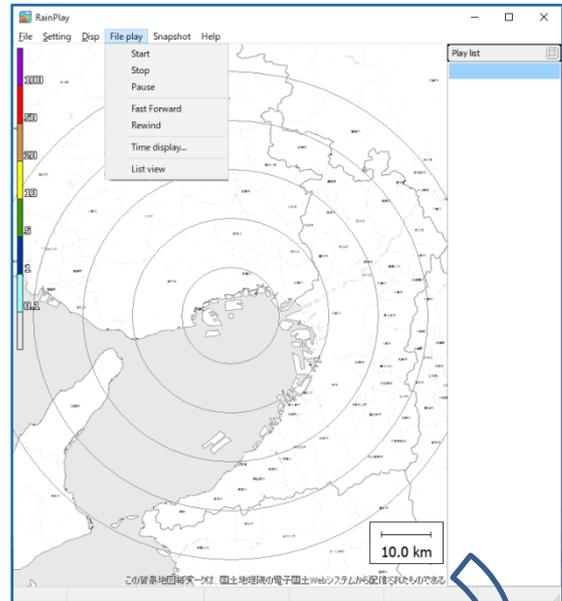
Select the pulse blind area indication zone.
OFF: Hidden, 1: Grayed out, 2: Gray scale
- 11) **Sector blank:**

Select the sector blank indication.
OFF: Hidden, 1: Grayed out, 2: Gray scale
- 12) **Clear:**

Rain file data will be cleared from screen.

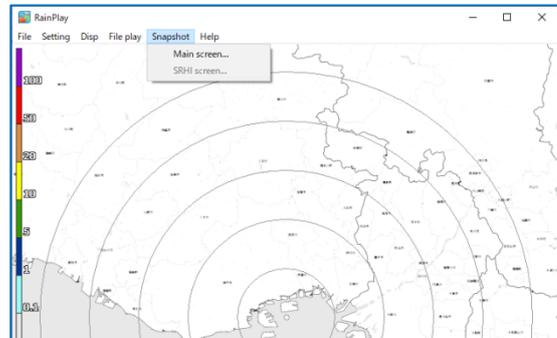
3.4. File Play

- 1) **Start:**
Start plays the binary data.
- 2) **Stop:**
Stops play.
- 3) **Pause:**
Pauses play.
- 4) **Fast Forward:**
Fast-forwards play.
- 5) **Rewind:**
Rewind play.
- 6) **Time display:**
Setup a time display in pop-up window between 1,000 - 10,000 [ms].
- 7) **List view:**
Show the play list on right side of screen.
List view (Play list) can move out from side of RainPlay main screen but cannot move back.



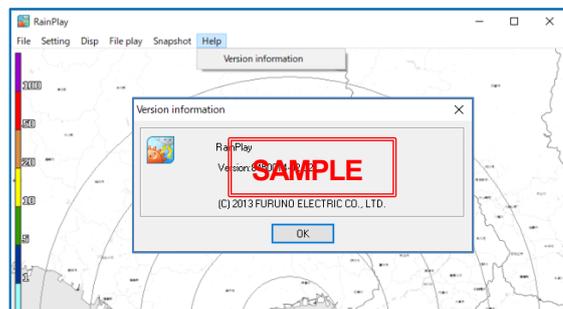
3.5. Snapshot

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



3.6. Help

- 1) **Version information:**
It shows the version information of this software.



4. RainMap SETTING TABLE

This is a table of RainMap settings.

4.1. Setting

This is a basic menu when clicked [Setting] menu.

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	
	Data acquisition	Screen capture (JPEG)	OFF / ON	
		Screen capture save path	D:\<exe pass>\RecData\capture	
		Screen capture period [sec]	0 - 3600 [1]	
		CSV	OFF / ON	
		CSV save path	D:\<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	D:\<exe pass>\RecData\multi	
		Radar parameters in Binary file	R[mm/h] / Zh[dBz] / V[m/s] / Zdr[dB] / Kdp(deg/km) / φ dp(deg) / phv / W[m/s] / Quality	
	Radar site location	Binary file version	v3 / v10	
		Latitude [deg]	-90.00000 - 90.00000 [0.00001]	
		Longitude [deg]	-180.00000 - 180.00000 [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]	-180.00000 - 180.00000 [0.00001]	
		Map right bottom lat. [deg]	-90.00000 - 90.00000 [0.00001]	
	Map right bottom lon. [deg]	-180.00000 - 180.00000 [0.00001]		
	Scan	Scan set	1 - 5	
		Hits mode	Auto / Manual	
		Hits value	1 - 500 [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]
		Volume Scan	EL start angle [deg]	-2.0 - 182.0 [0.1]
			EL end angle [deg]	-2.0 - 182.0 [0.1]
			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])
			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]
			↓	↓
		Sector PPI Scan	EL angle 31 [deg]	-2.0 - 90.0 [0.1]
			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]	
	↓		↓	
	Units	Rotation speed	rpm / deg/sec	

4.2. Advanced Setting

This menu will display when pressed [Alt]+[Ctrl] keys + clicked [Setting] menu simultaneously.

Major menu	Medium menu	Key menu	Input value [unit]
Setting	Display	Echo update	No Update / Flash Update / Round Update
	Scan	Sweep decimation mode	Auto / Manual
Advanced setting	Scan	Sweep decimation value	1 - 200 [1]
	Radar	-	-
Serial Number	Serial Number	Serial number	xxxx-xxxx-xxxx [Indicte only]
		Product number	xxxx (4 digit) [Indicte only]
Product name		WR2120 [Indicte only]	
Auto recovery mode	Auto recovery from OS shutdown		OFF / ON
	Auto recovery from SPU connection failure		OFF / ON
	Auto recovery software for SPU connection failure		C:\<exe pass>WR_rebooter_vx.xcustom.ttl
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	PRF pattern		1 - 3 [1]
	Pulse set / No		1 - 8
TX	Pulse spec.	P0N pulse width [us], resolution [m]	Values are fixed with the pulse number
		Q0N pulse width [us]	
		Q0N modulation band width [MHz], resolution [m]	
		PRF1 [Hz]	
		PRF2 [Hz]	
		A-threshold (pulse1) [dB]	
		A-threshold (pulse2) [dB]	
		phv noise level (pulse1) [dB]	
		phv noise level (pulse2) [dB]	
		Observation range [km]	
Interference rejection	IF cable length [m]		1 - 23 [1]
	IR 1	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		OFF / ON
	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 - 655 [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 - 1.0000 [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

4.3. 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. The setting of RainMap is saving in the following directory. It recommends to add the date in the back of file name (e.g., RainMap.ini -> RainMap_2019.0707.ini):

“Windows(C) > Users > Radar > AppData > Local > Furuno > RainMap.ini”

4.4. Software Version

Information of the software version is displayed on software screen panel.

This manual revision is for the following software version:

- RainMap v06.08
- RainPlay v02.02

5. WR_tools

5.1. WR_notice

1) Function:

WR_notice delivers notice email with the error code to email address specified when errors occur in WR2120-ATU/SPU and responds to alive monitoring email to notify whether WR2120-DPU is alive or not. This function needs WR2120 to connect internet. WR_notice will not detect TX stopped.

Note: It needs to have a user's email account and it has to setup an email address of destination written on next step.

2) Notification settings:

Click [WR_notice.exe] to start setting.



WR_notice will start in background and clock the icon in taskbar.

Set an email address in order to receive error information from WR_notice when an error occurs. It is possible to set up to 6 email destinations. This lists also works as the white list of the live monitoring email, too.

- (1) Click [Stop] if this software is running.
- (2) Add/suppress email address from the list.
- (3) Click [Apply] to valid the list.

Click "Send Test" button and "Yes" to receive test email. The test email will be sent to the email address listed in "Destination Email Address from 1 to 6".

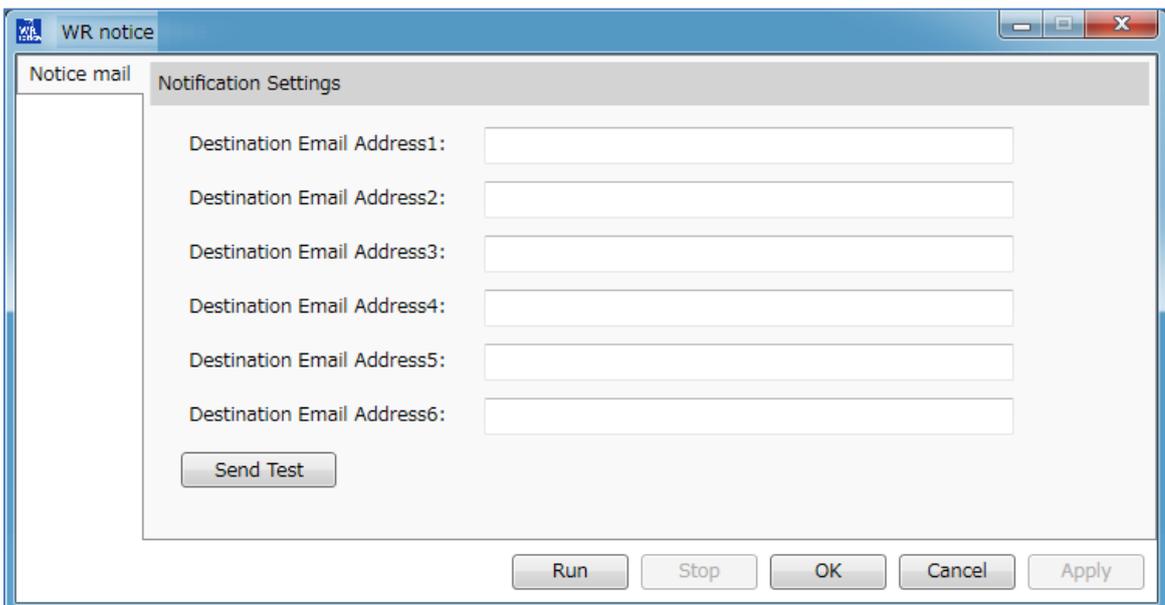


Figure 5.1: Basic Settings

The test will be succeeded when receiving the email from

****@wrnotice.furunolutions.com

It may take a few minutes to receive the email.

**** is the radar product number which can be referred in RainMap

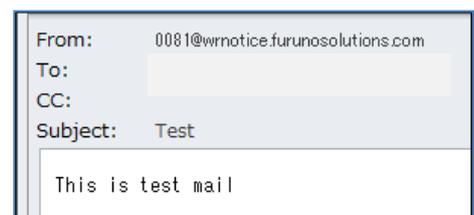


Figure 5.2: Sample of test email

3) Run WR_notice:

(1) Setup on Startup.

Add shortcut on desktop [WR_notice] to Windows Startup to run WR_notice automatically every time 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

(2) Click [WR_notice] on desktop to open this software.

(3) Click [RUN] to start running the WR_notice function.

The email will notify the error code. (Refer to section 9.3)



Figure 5.3:
Sample of error email

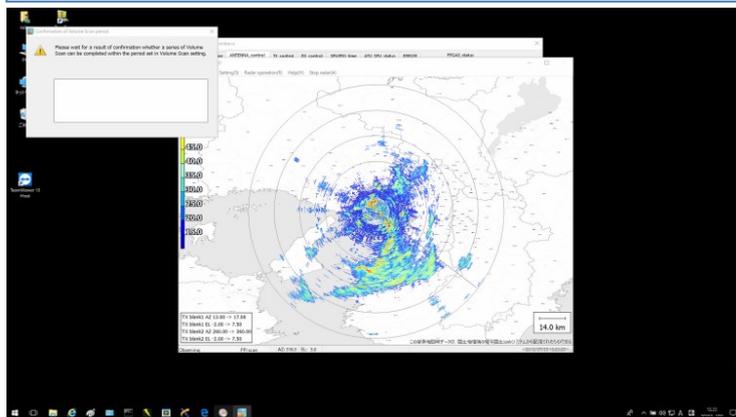


Figure 5.4:
Sample of DPU screen capture
attached in the error email

4) Alive monitoring email

WR_notice will respond to the email from the email which address is listed in “Destination Email Address 1-6” with the email title of “WR alive?”. When DPU (and WR_notice) is working, WR_notice will respond “I’m alive” in a few minutes after sending the alive monitoring email, otherwise no response.

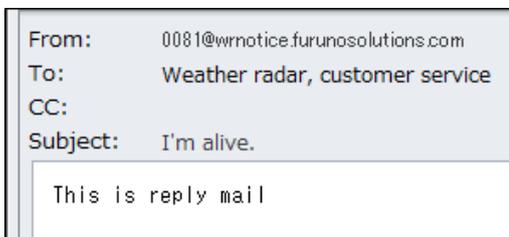


Figure 5.5:
Sample of alive email

Note:

When to send the alive monitoring email to WR_notice, the sender email address should be 'wr_service@furuno.co.jp', and also this email address should be listed in Destination Email Address in [Information mail] tab.

5.2. WR_transfer

WR_transfer consists of some batch files and programs.

Providing functions are as follows:

- Compress observed binary data
- Transfer the compressed data using FTP
- Convert data file format and transfer using FTP

Compression is very effective for saving storage capacity. It just minimizes by compressing files and stores them in to a local storage.

There is a solution to meet the demands for users who wants to observe files in their own server is using FTP transfer.

In some case, user wants to use third party software to check and analyze data. However some format converters are available for this type of demand.

Note: Do not install any software into DPU or operating them on DPU because it will cause an out of system resource problem. Only pre-installed application can be operated by utilizing application locker function in windows. It is recommended that once transporting the data to the external storage e.g. FTP server by WR_transfer, and share the observation data with the software installed in other PC.

5.2.1. 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
```

5.2.2. Contents of bat file

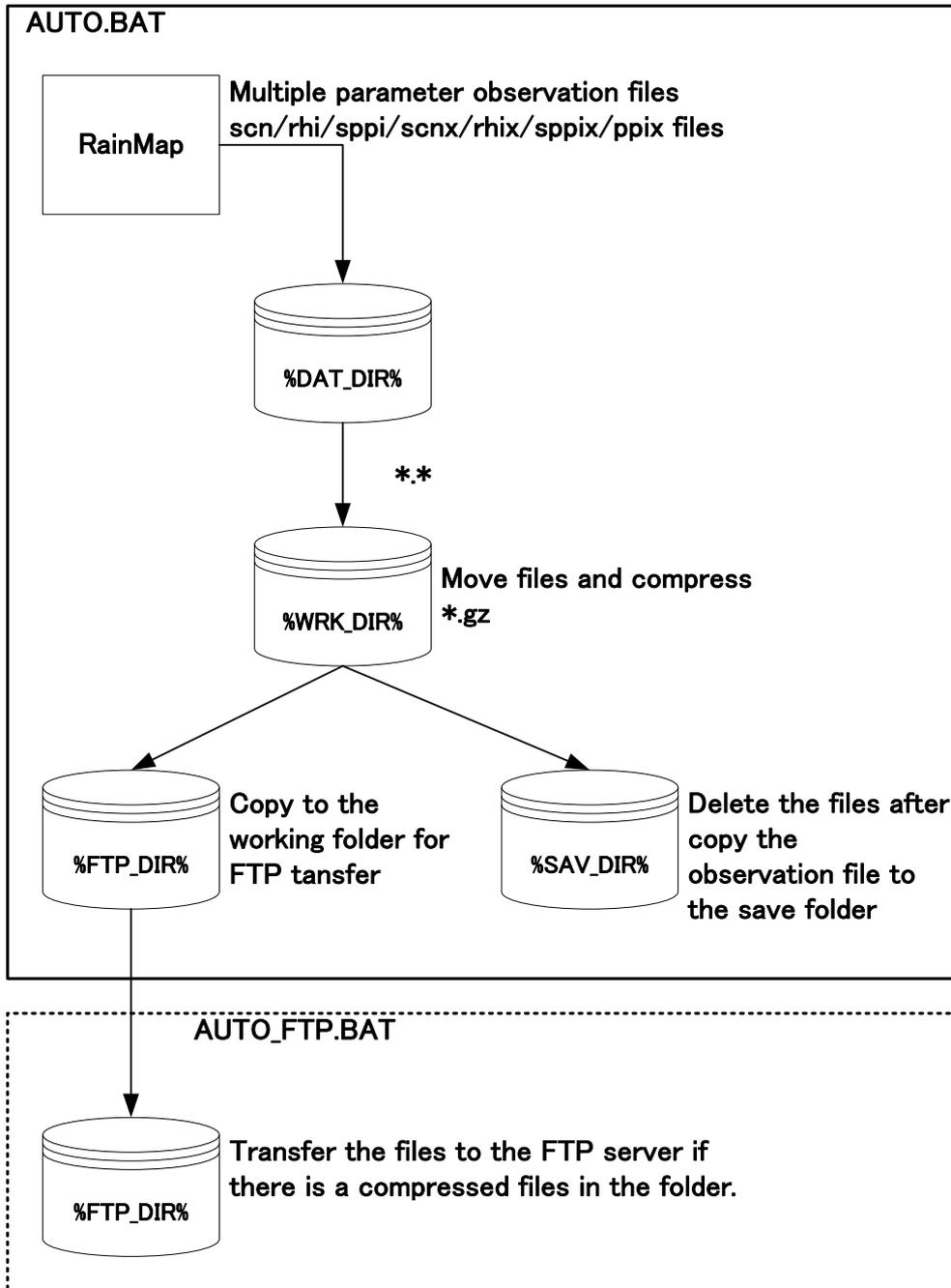


Figure 5.6: WR_transfer.bat processing contents

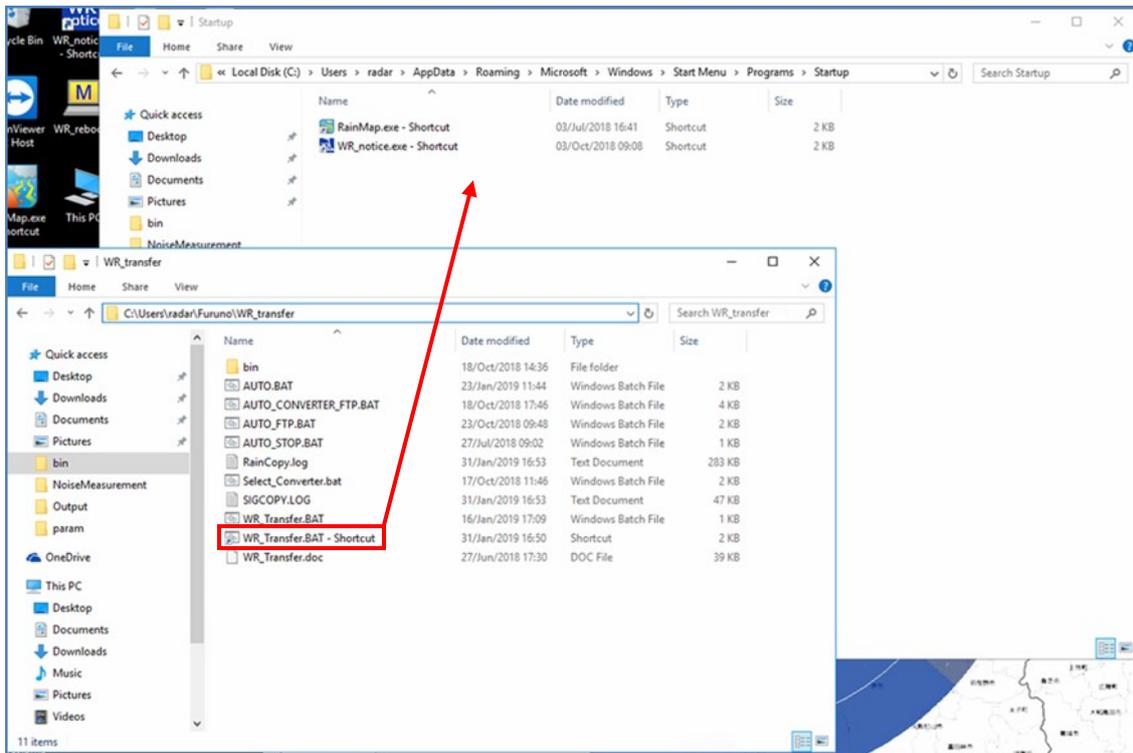


Figure 5.7: Copy the shortcut of WR_transfer.bat to the startup folder

I. Necessary Preparations

Some preparation is necessary to use this software.

- 1) Make a folder(dir) for storing data and set this in to the RainMap
 - Make and set this up properly
 - Binary files are necessary for this software
- 2) Make a folder(dir) for storing data into target FTP server
 - This software is not able to make folder. It needs to prepare a remote folder and set up properly.

II. Setting Files

It uses two setting files;

One is general setting file including folder settings and function switch, named "INIT.BAT".

```

@REM Set install folder of WR_Transfer
SET DIR=C:\Users\RADAR\FURUNO\WR_Transfer

@REM Set data storing folder of the RainMap
SET DAT_DIR=D:\RecData\multi

@REM Set data storing folder
SET SAV_DIR=D:\RadarData

@REM Set working folder
SET WRK_DIR=D:\WR_Transfer

@REM Set converter folder
SET CNV_DIR=D:\Converter

@REM Set target folder on FTP server
SET TRS_DIR=radar

@REM Set Enable(1) / Disable(0) of Data Store
SET SAV_SW=0

@REM Set Enable(1) / Disable(0) of FTP Transfer
SET FTP_SW=0

@REM Set Enable(1) / Disable(0) of Data Conversion
SET CNV_SW=0

```

III. From line 7 to 32 are necessary to set the line as shown above. Descriptions of each variable are shown in Table 5.1.

Table 5.1: Description of INIT.BAT

Variable	Description
DIR	Install folder of the WR_transfer
DAT_DIR	Data storing folder set by the RainMap
SAV_DIR	Data storing folder in local or remote drive
WRK_DIR	Working folder for the WR_transfer
CNV_DIR	Working folder for File Converter
TRS_DIR	Remote folder on target FTP server
SAV_SW	Switch for Data Sore ("1" stands for enable)
FTP_SW	Switch for FTP transfer ("1" stands for enable)
CNV_SW	Switch for File Converter ("1" stands for enable)

IV. Another one is to place FTP_WRFTP.INI into %DIR%\bin\ folder.
Set IP address or name of target FTP server, given user name, and password for the user.
Recommendation of using as a default value on Passive Mode is "1".

```

[FTP]
FTPSERVER=127.0.0.1
USER=user
PASSWORD=pass
PassiveMode=1

```

V. Description of Behavior

This software will run as below:

- 1) Copy observed data from **DIR** to **WRK_DIR\TMP** and compress it.
 - Copy the oldest files of 10 minutes before
This function provides a solution to transfer a huge amount of files after recovery from connection line or server failure.
 - Copied files in last 10 minutes.
 - Delete observed files in **WRK_DIR\TMP** after compression
- 2) (SAV_SW: 1) Make hierarchy in **SAV_DIR** using radar number, date, and store.
Copy the compressed file from **WRK_DIR\TMP** to **SAV_DIR**
- 3) (FTP_SW: 1) Copy the compressed file from **WRK_DIR\TMP** to **WRK_DIR\FTP**
 - Transfer the compressed data from **WRK_DIR\FTP** to target server
 - Delete the compressed data in **WRK_DIR\FTP** after transfer finished properly
- 4) (CNV_SW: 1) Move observed data from **WRK_DIR\TMP** to **CNV_DIR**
 - Convert files in **CNV_DIR** to target format and compress
 - Transfer the compressed data from **CNV_DIR** to target server
 - Delete the compressed data in **CNV_DIR** after transfer finished properly

5.2.3. 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

```

@echo off
cmd /C REM //*****//
cmd /C REM // 2017.10.19 Recording program of
observation data
cmd /C REM // for WR-2100\WR110\WR2120
cmd /C REM //*****//

call %~dp0\INIT.BAT

:SKIP00
@REM *****
@REM Does it received the BATCH stop command ?
@REM *****
if exist %DIR%\BATCH_STOP.BBB goto SKIP99
timeout 5
if not exist %FTP_DIR%\*.gz goto SKIP00

:SKIP10
@REM ### $$$ delete before gz upload ###
%BIN_DIR%\FtpTransfer.exe
/%TRS_DIR%\*$$$ %FTP_DIR%\tmp /GET /DEL
/F=%BIN_DIR%\FTP_WRFTP.INI
del %FTP_DIR%\tmp* /Q

@REM ### gz, etc... upload ###
%BIN_DIR%\FtpTransfer.exe %FTP_DIR%\*.gz
/%TRS_DIR% /DEL /F=%BIN_DIR%\FTP_WRFTP.INI
/MAXLINE=90000

goto SKIP00
  
```

```

@rem @echo off
cmd /C REM //*****//
cmd /C REM // 2017.10.19 Recording program of
observation data
cmd /C REM // for WR-2100\WR110\WR2120
cmd /C REM //*****//

call %~dp0\INIT.BAT

:SKIP00
@REM *****
@REM Does it received the BATCH stop command ?
@REM *****
if exist %DIR%\BATCH_STOP.BBB goto SKIP99
timeout 5
if not exist %FTP_DIR%\*.gz goto SKIP00

:SKIP10
@REM ### $$$ delete before gz upload ###
%BIN_DIR%\FtpTransfer.exe
/%TRS_DIR%\*$$$ %FTP_DIR%\tmp /GET /DEL
/F=%BIN_DIR%\FTP_WRFTP.INI
del %FTP_DIR%\tmp* /Q

@REM ### gz, etc... upload ###
%BIN_DIR%\FtpTransfer.exe %FTP_DIR%\*.gz
/%TRS_DIR% /DEL /F=%BIN_DIR%\FTP_WRFTP.INI
/MAXLINE=90000

goto SKIP00
  
```

Figure 5.8: Sample of AUTO_FTP.bat (Before -> After)

5.2.4. Data converter

I. 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.

II. Enable the data converter

The data converters are launched and controlled by the following batch files stored in the folder,
C:\Users\RADAR\FURUNOWR_Transfer (%DIR%).

[INIT.BAT]

To enable the data converter, set the CNV_SW value as "1" as described below.

```
@REM Set install folder of WR_Transfer
SET DIR=C:\Users\RADAR\FURUNOWR_Transfer

@REM Set data storing folder of the RainMap
SET DAT_DIR=D:\RecData\multi

@REM Set data storing folder
SET SAV_DIR=D:\RadarData

@REM Set working folder
SET WRK_DIR=D:\WR_Transfer

@REM Set converter folder
SET CNV_DIR=D:\Converter

@REM Set target folder on FTP server
SET TRS_DIR=radar

@REM Set Enable(1)/ Disable(0) of Data Store
SET SAV_SW=0

@REM Set Enable(1)/ Disable(0) of FTP Transfer
SET FTP_SW=0

@REM Set Enable(1)/ Disable(0) of Data Conversion
SET CNV_SW=1
```

[AUTO_CONVERTER_FTP.BAT]

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

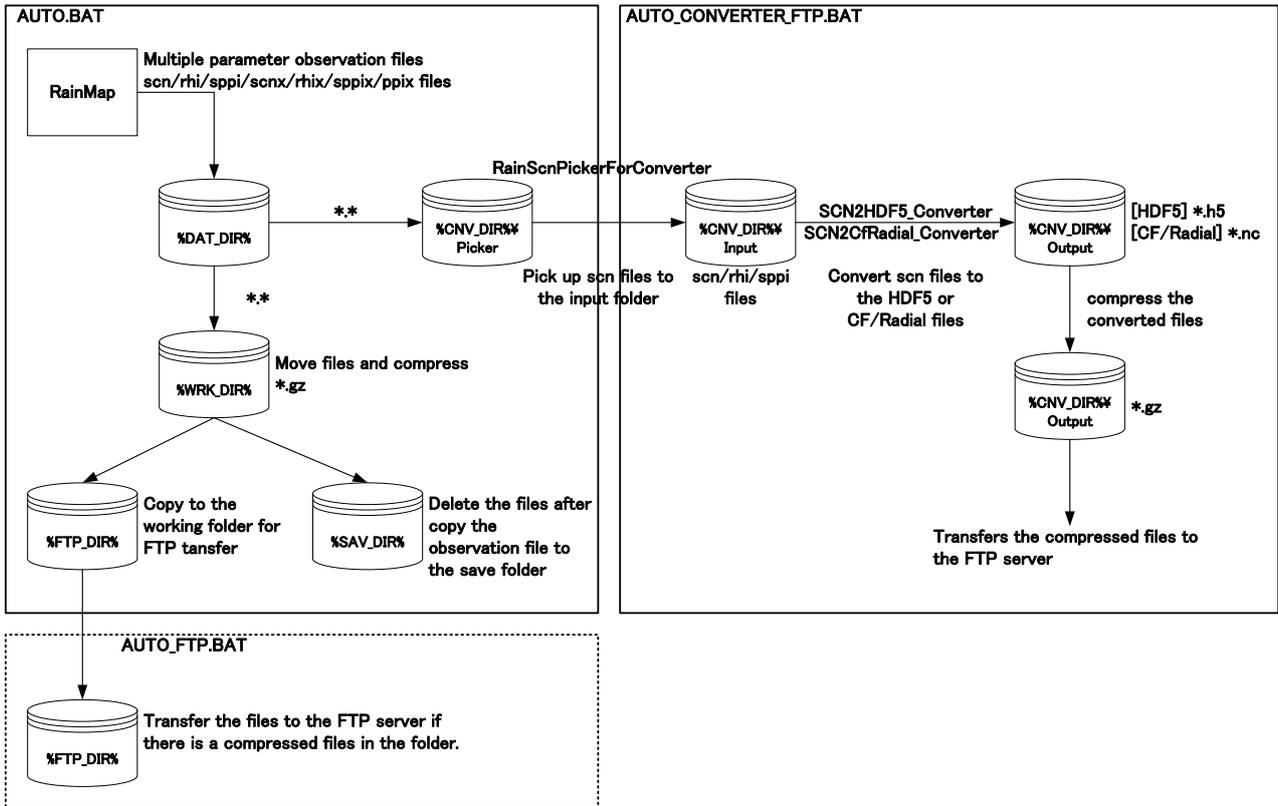


Figure 5.9: Data flow for data converter

III. Select a single data converter

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

- Launch the batch file Select_Converter.bat.
"%DIR%\Select_Converter.bat"
- Select one data converter from three options described below.

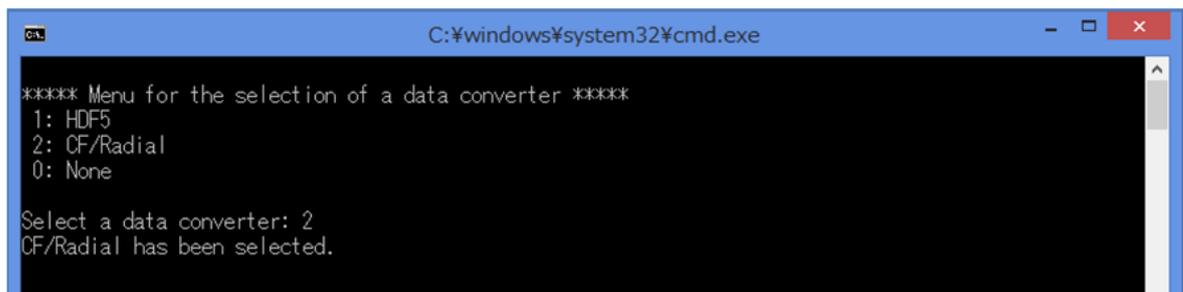


Figure 5.10: Sample of Select_Converter.bat

IV. 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).

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
% 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';

% Name of the acquisition task or product generator
task=";
```

Figure 5.11: Sample of configuration file, config.txt

V. Output messages

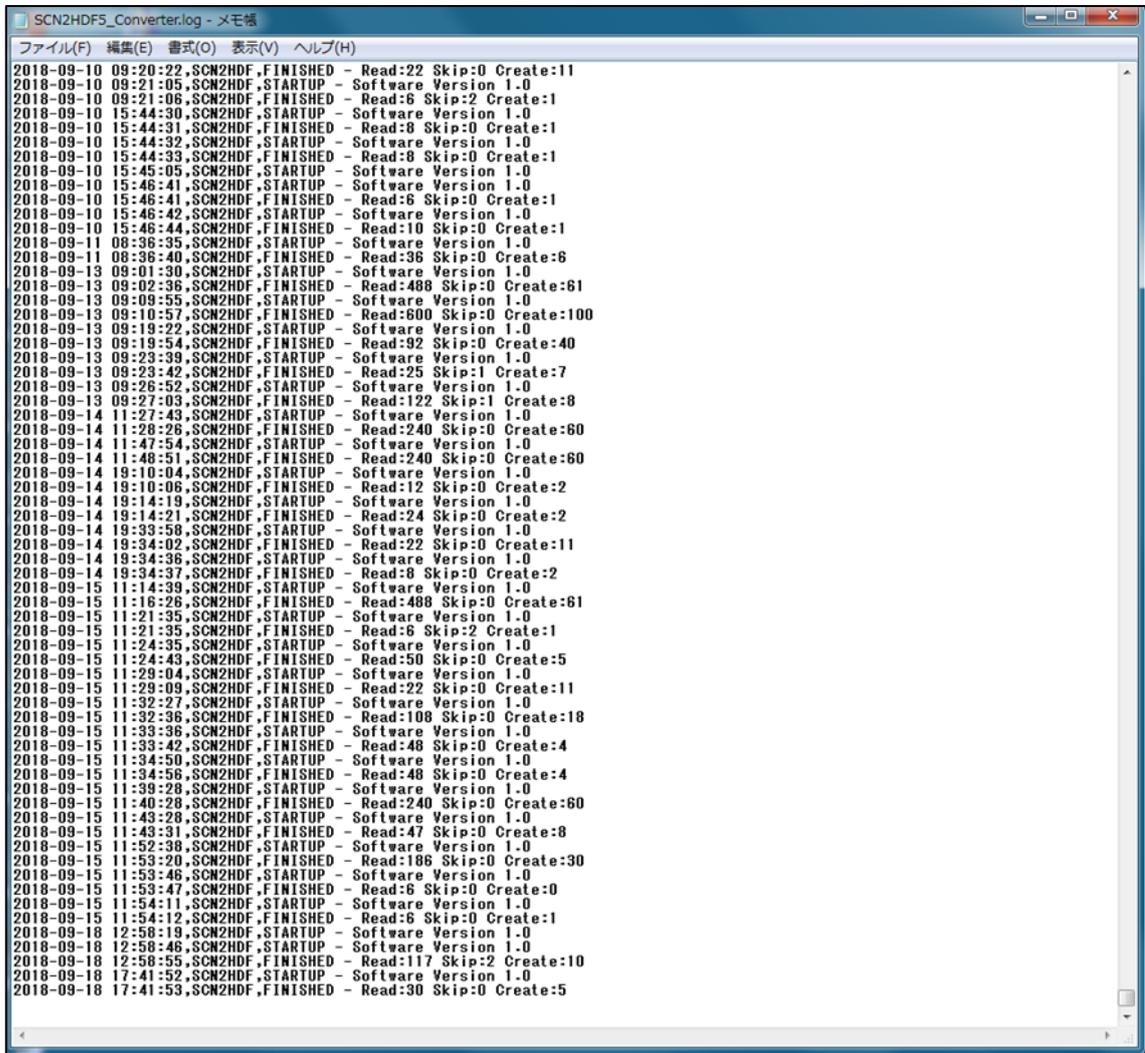
Each converter outputs following messages to log files which are stored in each installation folder.

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



```
SCN2HDF5_Converter.log - メモ帳
ファイル(F) 編集(E) 書式(O) 表示(V) ヘルプ(H)
2018-09-10 09:20:22,SCN2HDF,FINISHED - Read:22 Skip:0 Create:11
2018-09-10 09:21:05,SCN2HDF,STARTUP - Software Version 1.0
2018-09-10 09:21:06,SCN2HDF,FINISHED - Read:6 Skip:2 Create:1
2018-09-10 15:44:30,SCN2HDF,STARTUP - Software Version 1.0
2018-09-10 15:44:31,SCN2HDF,FINISHED - Read:8 Skip:0 Create:1
2018-09-10 15:44:32,SCN2HDF,STARTUP - Software Version 1.0
2018-09-10 15:44:33,SCN2HDF,FINISHED - Read:8 Skip:0 Create:1
2018-09-10 15:45:05,SCN2HDF,STARTUP - Software Version 1.0
2018-09-10 15:46:41,SCN2HDF,STARTUP - Software Version 1.0
2018-09-10 15:46:41,SCN2HDF,FINISHED - Read:6 Skip:0 Create:1
2018-09-10 15:46:42,SCN2HDF,STARTUP - Software Version 1.0
2018-09-10 15:46:44,SCN2HDF,FINISHED - Read:10 Skip:0 Create:1
2018-09-11 08:36:35,SCN2HDF,STARTUP - Software Version 1.0
2018-09-11 08:36:40,SCN2HDF,FINISHED - Read:36 Skip:0 Create:6
2018-09-13 09:01:30,SCN2HDF,STARTUP - Software Version 1.0
2018-09-13 09:02:36,SCN2HDF,FINISHED - Read:488 Skip:0 Create:61
2018-09-13 09:09:55,SCN2HDF,STARTUP - Software Version 1.0
2018-09-13 09:10:57,SCN2HDF,FINISHED - Read:600 Skip:0 Create:100
2018-09-13 09:19:22,SCN2HDF,STARTUP - Software Version 1.0
2018-09-13 09:19:54,SCN2HDF,FINISHED - Read:92 Skip:0 Create:40
2018-09-13 09:23:39,SCN2HDF,STARTUP - Software Version 1.0
2018-09-13 09:23:42,SCN2HDF,FINISHED - Read:25 Skip:1 Create:7
2018-09-13 09:26:52,SCN2HDF,STARTUP - Software Version 1.0
2018-09-13 09:27:03,SCN2HDF,FINISHED - Read:122 Skip:1 Create:8
2018-09-14 11:27:43,SCN2HDF,STARTUP - Software Version 1.0
2018-09-14 11:28:26,SCN2HDF,FINISHED - Read:240 Skip:0 Create:60
2018-09-14 11:47:54,SCN2HDF,STARTUP - Software Version 1.0
2018-09-14 11:48:51,SCN2HDF,FINISHED - Read:240 Skip:0 Create:60
2018-09-14 19:10:04,SCN2HDF,STARTUP - Software Version 1.0
2018-09-14 19:10:06,SCN2HDF,FINISHED - Read:12 Skip:0 Create:2
2018-09-14 19:14:19,SCN2HDF,STARTUP - Software Version 1.0
2018-09-14 19:14:21,SCN2HDF,FINISHED - Read:24 Skip:0 Create:2
2018-09-14 19:33:58,SCN2HDF,STARTUP - Software Version 1.0
2018-09-14 19:34:02,SCN2HDF,FINISHED - Read:22 Skip:0 Create:11
2018-09-14 19:34:36,SCN2HDF,STARTUP - Software Version 1.0
2018-09-14 19:34:37,SCN2HDF,FINISHED - Read:8 Skip:0 Create:2
2018-09-15 11:14:39,SCN2HDF,STARTUP - Software Version 1.0
2018-09-15 11:16:26,SCN2HDF,FINISHED - Read:488 Skip:0 Create:61
2018-09-15 11:21:35,SCN2HDF,STARTUP - Software Version 1.0
2018-09-15 11:21:35,SCN2HDF,FINISHED - Read:6 Skip:2 Create:1
2018-09-15 11:24:35,SCN2HDF,STARTUP - Software Version 1.0
2018-09-15 11:24:43,SCN2HDF,FINISHED - Read:50 Skip:0 Create:5
2018-09-15 11:29:04,SCN2HDF,STARTUP - Software Version 1.0
2018-09-15 11:29:09,SCN2HDF,FINISHED - Read:22 Skip:0 Create:11
2018-09-15 11:32:27,SCN2HDF,STARTUP - Software Version 1.0
2018-09-15 11:32:36,SCN2HDF,FINISHED - Read:108 Skip:0 Create:18
2018-09-15 11:33:36,SCN2HDF,STARTUP - Software Version 1.0
2018-09-15 11:33:42,SCN2HDF,FINISHED - Read:48 Skip:0 Create:4
2018-09-15 11:34:50,SCN2HDF,STARTUP - Software Version 1.0
2018-09-15 11:34:56,SCN2HDF,FINISHED - Read:48 Skip:0 Create:4
2018-09-15 11:39:28,SCN2HDF,STARTUP - Software Version 1.0
2018-09-15 11:40:28,SCN2HDF,FINISHED - Read:240 Skip:0 Create:60
2018-09-15 11:43:28,SCN2HDF,STARTUP - Software Version 1.0
2018-09-15 11:43:31,SCN2HDF,FINISHED - Read:47 Skip:0 Create:8
2018-09-15 11:52:38,SCN2HDF,STARTUP - Software Version 1.0
2018-09-15 11:53:20,SCN2HDF,FINISHED - Read:186 Skip:0 Create:30
2018-09-15 11:53:46,SCN2HDF,STARTUP - Software Version 1.0
2018-09-15 11:53:47,SCN2HDF,FINISHED - Read:6 Skip:0 Create:0
2018-09-15 11:54:11,SCN2HDF,STARTUP - Software Version 1.0
2018-09-15 11:54:12,SCN2HDF,FINISHED - Read:6 Skip:0 Create:1
2018-09-18 12:58:19,SCN2HDF,STARTUP - Software Version 1.0
2018-09-18 12:58:46,SCN2HDF,STARTUP - Software Version 1.0
2018-09-18 12:58:55,SCN2HDF,FINISHED - Read:117 Skip:2 Create:10
2018-09-18 17:41:52,SCN2HDF,STARTUP - Software Version 1.0
2018-09-18 17:41:53,SCN2HDF,FINISHED - Read:30 Skip:0 Create:5
```

Figure 5.12: Sample of log file, SCN2HDF5_Converter.log

VI. Enable FTP transfer of converted files

- 1) Setup FTP configurations
 - Setup FTP_Converter.INI in "%DIR%\bin\" folder.

```
[FTP]
FTPSEVER=127.0.0.1
USER=user
PASSWORD=pass
PassiveMode=1
LOGDIR=D:\Converter\Output
```

Set IP address or name of target FTP server, given user name, and password for the user. It can use Passive Mode when to set the value as "1". Set the folder name LOGDIR where the FTP log file is stored.

- Define the output folder on the FTP server.
For example: SET FTPOUT=/

```
@echo off
cmd /C REM //*****//
cmd /C REM // Launching and controlling data converters
cmd /C REM // created on 27 June 2019.
cmd /C REM // FURUNO ELECTRIC CO., LTD.
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%\WR_Transfer
SET CNV_DIR=%HDD%\Converter

@rem define the names of install folders
SET CONV1=%APLDIR%\SCN2HDF5_Converter
SET CONV2=%APLDIR%\SCN2CfRadial_Converter
SET CONV3=%APLDIR%\SCN2NEXRAD_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

@REM *****
@REM  FTP settings
@REM *****
SET FTPTRANSFER=%APLDIR%\WR_Transfer\bin
SET FTPOUT=/
SET FTPINI=%FTPTRANSFER%\FTP_Converter.INI

@rem Is FTP enabled ? (true/false)
SET ENABLE_FTP=false
```

1) 

Figure 5.13: Sample of AUTO_CONVERTER_FTP.BAT

- 2) Enable the FTP transfer, edit the line surrounded by the red square below;
 Before change> SET ENABLE_FTP=false
 After change> SET ENABLE_FTP=true

- 3) Keep the converted files after FTP, edit the line surrounded by the red square below;
 Before change> SET FTP_DEL=true
 After change> SET FTP_DEL =false

```

@echo off
cmd /C REM //*****//
cmd /C REM // Launching and controlling data converters
cmd /C REM // created on 27 June 2019.
cmd /C REM // FURUNO ELECTRIC CO., LTD.
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%\WR_Transfer
SET CNV_DIR=%HDD%\Converter

@rem define the names of install folders
SET CONV1=%APLDIR%\SCN2HDF5_Converter
SET CONV2=%APLDIR%\SCN2CfRadial_Converter
SET CONV3=%APLDIR%\SCN2NEXRAD_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

@REM *****
@REM  FTP settings
@REM *****
SET FTPTRANSFER=%APLDIR%\WR_Transfer\bin
SET FTPOUT=/
SET FTPINI=%FTPTRANSFER%\FTP_Converter.INI

@rem Is FTP enabled ? (true/false)
SET ENABLE_FTP=false

@rem Are data files deleted after FTP ? (true/false)
SET FTP_DEL=true

@REM *****
@REM  --- DO NOT EDIT BELOW ---

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

```

Figure 5.14: Sample of AUTO_CONVERTER_FTP.BAT

6. SHIELDING AREA DATA FILE FORMAT

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".

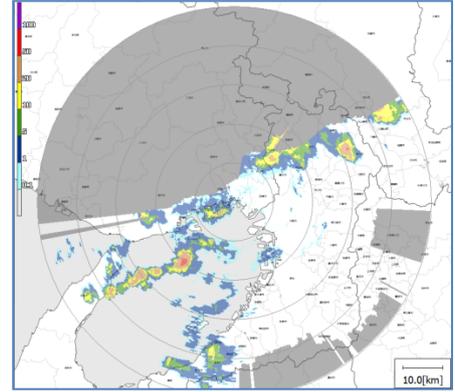


Figure 6.1:
Image of Radio wave shielding area

Header (reference and formula values):

Each column of header (red frame of column 1 to 4, row 2 in Figure 6.2) 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 6.2) 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.

		Column									
	1	1	2	3	4	5	6	-	719	720	
	2	100	34.741	135.354	10	Header					
	3	Parameter									
	4										Latitude
	5	Range direction distance (m)				Azimuth Direction: (5-1) x 0.5=2[deg]					
	6										
	7		20	20	20	20					
	8										
	9										
	10	Range direction: (7-2) x 100=500[m]				Distance Direction: 500 [m] Azimuth Direction: 2 [deg] Shielding Elevation: 20 [deg]					
	11										

Figure 6.2: csv file structure

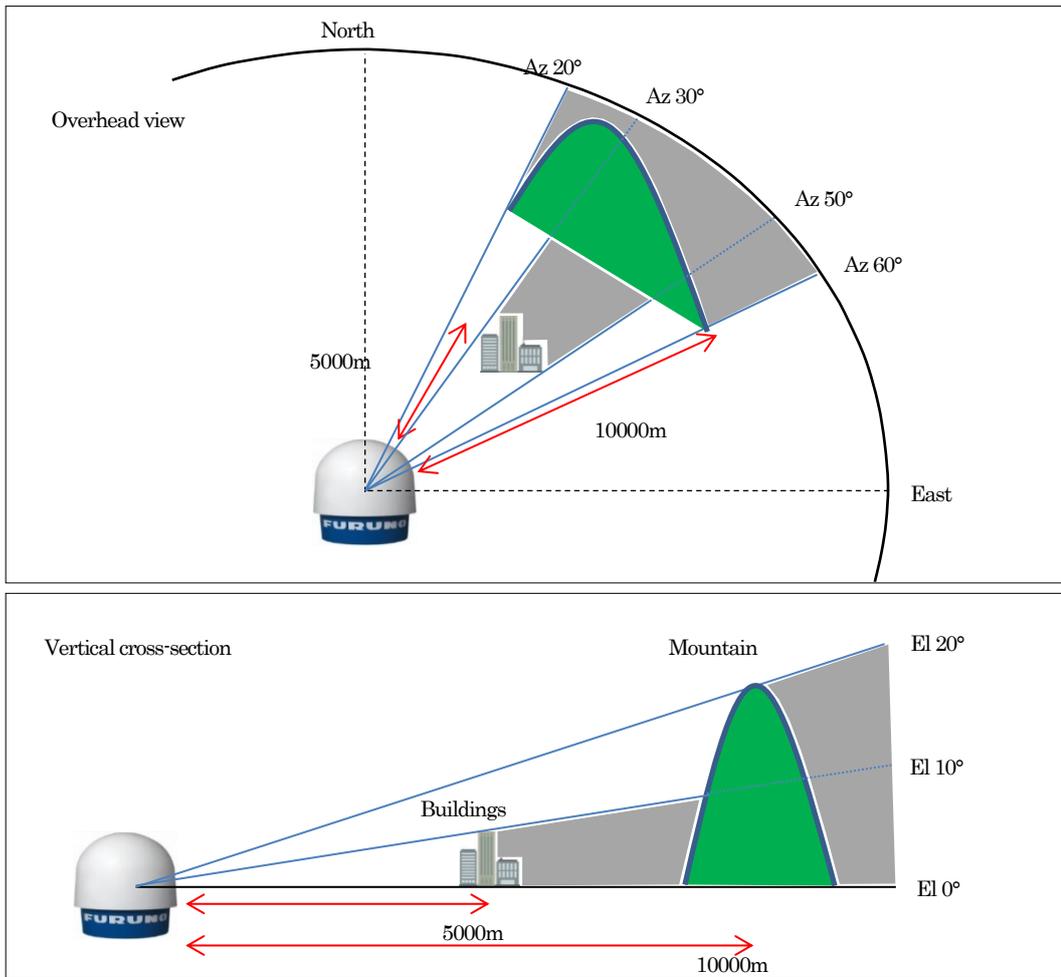


Figure 6.3: Example of radar view

Create parameters (green frame) in Figure 6.4 for the shielding of Figure 6.3. (When it is around 100m in a distance direction)

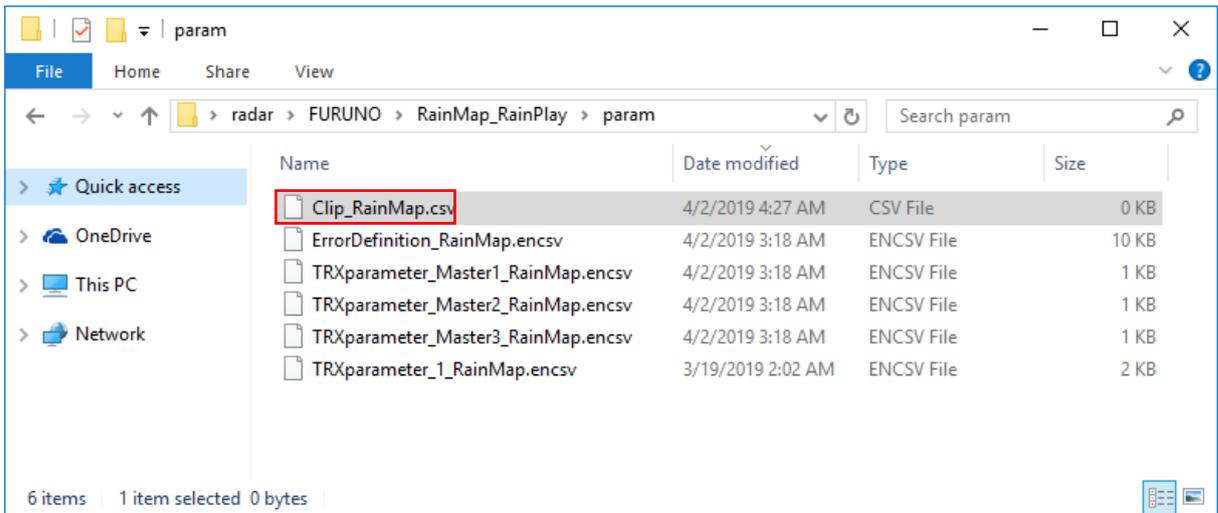
	0deg	...	19.5deg	20deg	...	29.5deg	30deg	...	49.5deg	Az 50deg	...	59.5deg	60deg	...	359.5deg	Azimuth	
0m	2	1	...	40	41	...	60	61	...	100	101	...	120	121	...	720	Column num.
...																	
4900m	51																
5000m	52							10	10	10							
...																	
9900m	101																
10000m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

Figure 6.4: csv file for sample2

In Figure 6.3 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.



7. OUTPUT DATA FORMAT

7.1. Data File Type 1 (csv)

1) Record unit

Add a file to folder in computer for each setting cycle (e.g., 60 sec.).
It is possible to set up a save folder.

2) Record file name

Outputs file extension: csv

Form: DATE_TIME_DATAKIND_ElevationAngle.csv (YYYYMMDD_HHMMSS_xx.###csv).

e.g., Output the Rainfall intensity "01/10/2012 9:37:26" → "20121001_093726_Rain_000.csv".

Output data types are shown below:

R: Rainfall intensity [mm/h]

Zh: Reflective factor (Horizontal) [dBZ]

Zv: Reflectivity factor (Vertical) [dBZ]

V: Doppler velocity [m/s]

Zdr: Radar reflectivity 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)

7.2. Data File Type 2 [Binary 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.

2) Record file name

xxxx_YYYYMMDD_hhmmss_##_.scn:**

scn: (Product number xxxx) + Scenario start (UTC yyyyymmddhhmmss)+(Elevation number ##)+ (Modulation method**)

Notes:

- 1> Elevation number is a starting elevation -> an ending elevation with sequence number from 01.
- 2> Modulation method: 00: Pulse modulation, 01: Frequency modulation (Pulse modulation), 02: 00+01(Alternate transmission)
e.g., 0001_20130514_123400_01_00.scn

xxxx_YYYYMMDD_hhmmss_##_.ppi:**

ppi: (Product number xxxx) + Acquisition start (UTC yyyyymmddhhmmss) + (00) + (Modulation method**)

Note:

Modulation method: 00: Pulse modulation, 01: Frequency modulation (Pulse modulation), 02: 00+01(Alternate transmission)
e.g., 0001_20130514_123400_00_00.ppi

xxxx_YYYYMMDD_hhmmss_###.sppi:

sppi: (Product number xxxx) + Scenario start (UTC yyyyymmddhhmmss)+(Elevation number ###)

Note:

Elevation number is a starting elevation -> an ending elevation with sequence number from 000.
e.g., 0001_20130514_123456_001.sppi

xxxx_YYYYMMDD_hhmmss_###.rhi:

rhi: (Product number xxxx) + Scenario start (UTC yyyyymmddhhmmss)+(Azimuth number ###)

Note:

Azimuth number is a starting Azimuth -> an ending azimuth (or ending azimuth -> starting azimuth) with sequence number from 000.
e.g., 0001_20130514_123456_001.rhi

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:-) Degrees from S0 deg to S1 deg are expressed -360 deg to -361 deg.	2	18	signed short
	Latitude: minute	e.g., 44	2	20	unsigned short
	Latitude: second	e.g., 59.999 (3 decimal places)	2	22	unsigned short
	Longitude: degree	e.g., 135 (E. Lon: +, W. Lon.-) Degrees from W0 deg to W1 deg are expressed -360 deg to -361 deg.	2	24	signed short
	Longitude: minute	e.g., 21	2	26	unsigned short
	Longitude: second	e.g., 59.999 (3 decimal places)	2	28	unsigned short
	Antenna Altitude (Upper)	Range Upper: 0 - 65535	2	30	unsigned short
	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 (1 decimal place of [rpm])	2	34	unsigned short
	PRF1	e.g., 1600.0 (1 decimal place of [Hz])	2	36	unsigned short
	PRF2	e.g., 2000.0 (1 decimal place of [Hz])	2	38	unsigned short
	Noise level (Pulse Modulation) - Horizontal polarization	e.g., -62.00 (2 decimal places of [dBm])	2	40	signed short
	Noise level (Frequency Modulation) - Horizontal polarization	e.g., -62.00 (2 decimal places 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 (2 decimal places 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	

Block	Item	Detail	Size [byte]	Off-set	Data type
Header	Constant radar: Mantissa (Vertical polarization)	Same as above (Same as horizontal polarization)	4	58	signed long
	Constant radar: Characteristic (Vertical polarization)	Note: This value is invalid for the single 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: Zh, bit2: V, bit7: W, bit8: quality information bit15: w/ ATT10dB e.g. WR-2120: 33279 (dec) bit0: Rain, bit1: Zh, 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	
Observation angularity information	Information ID	e.g., 6 [byte]	2	82	unsigned short
	Azimuth *Angle from initial position of ATU	Range: 0 - 359.99 (2 decimal places of [deg]) Initial position: 0 deg	2	84	unsigned short
	Elevation	Range: -2.00 - 182.00 (2 decimal places 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 directi on data mark	-	unsigned short
	Zh (Reflective factor Horizontal polarization)	Range: 0 - 65535 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 x Range directi on data mark	-	unsigned short

Block	Item	Detail	Size [byte]	Off-set	Data type
Observed data	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
	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 x Range direction data mark	*	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 x Range direction data mark	*	unsigned short
	Φdp (Differential phase) (*1)	Calculation formula N is a recording level. $\phi dp[deg] = 360 \times (N-32768) / 65535$ ϕdp Range: -179.9972 ~ 179.9972deg Resolution: 0.0055deg N=0 is invalid	2 x Range direction data mark	*	unsigned short
	ρ_{hv} (Correlation coefficient between Zh and Zv) (*1) * Corrected by S/N	Calculation formula N is a recording level. $\rho_{hv}[\text{no unit}] = 2 \times (N-1) / 65534$ ρ_{hv} Range: 0.0 ~ 2.0 Resolution: 0.0000030 N=0 is invalid	2 x Range direction data mark	*	unsigned short
	W (Doppler velocity 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: ground clutter reference bit3-5: ground clutter intensity 0: Less than 0.1mm/h 1: 0.1mm/h or more 2: 1.0mm/h or more 3: 5.0mm/h or more 4: 10.0mm/h or more 5: 20.0mm/h or more 6: 50.0mm/h or more 7: 100.0mm/h 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
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		

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 end 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) (2 decimal places. 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:-) (5 decimal places of [deg])	4	30	signed long	
	Longitude	e.g., 135.33520 (E. Lon: +, W. Lon.-) (5 decimal places of [deg])	4	34	signed long	
	Antenna Altitude	e.g. 10000 [cm]	4	38	signed long	
	Azimuth Offset	e.g. 200.00 (2 decimal places of [deg]) (Offset value of North and radar direction of origin)	2	40	unsigned short	
	TX frequency	e.g., 9432.50 (2 decimal places of [MHz])	4	44	unsigned long	
	Polarization mode	1: single-H 2: Simultaneous-dual	2	46	unsigned short	
	Antenna gain H	e.g., 34.0 (1 decimal place of [dBi])	2	48	unsigned short	
	Antenna gain V	e.g., 34.0 (1 decimal place of [dBi])	2	50	unsigned short	
Half-power beam width H	e.g., 2.70 (2 decimal places of [deg])	2	52	unsigned short		
Half-power beam width V	e.g., 2.70 (2 decimal places of [deg])	2	54	unsigned short		
TX power H ^(*6)	e.g., 75.0 (1 decimal place of [W])	2	56	unsigned short		
TX power V ^(*6)	e.g., 75.0 (1 decimal place of [W])	2	58	unsigned short		
Radar const. H ^(*4)	e.g., -131.0 (1 decimal place of [dB]) (Logged [m/mW])	2	60	signed short		

Block	Item	Detail	Size [byte]	Off-set	Data type
Header	Radar const. V ⁽⁴⁾	e.g., -131.0 (1 decimal place of [dB]) (Logged [m/mW])	2	62	signed short
	Noise power H (Short pulse)	e.g., -60.0 (1 decimal place of [dBZ@1m])	2	64	signed short
	Noise power H (Long pulse)	e.g., -75.0 (1 decimal place of [dBZ@1m])	2	66	signed short
	Threshold power (Short pulse)	e.g., -56.0 (1 decimal place of [dBZ@1m])	2	68	signed short
	Threshold power (Long pulse)	e.g., -71.0 (1 decimal place 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 (1 decimal place of [Hz])	2	76	unsigned short
	PRF2	e.g. 1600.0 (1 decimal place of [Hz])	2	78	unsigned short
	PRF3	e.g. 1400.0 (1 decimal place of [Hz])	2	80	unsigned short
	Nyquist velocity ⁽⁵⁾	e.g. 64.2 (1 decimal place 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 (2 decimal places of [μ s])	2	88	unsigned short
	Short pulse modulation bandwidth	e.g. 0.00 (2 decimal places of [MHz])	2	90	unsigned short
	Long pulse width	e.g. 30.00 (2 decimal places of [μ s])	2	92	unsigned short
	Long pulse modulation bandwidth	e.g. 2.00 (2 decimal places 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 (1 decimal place of [rpm])	2	100	unsigned short
	Number of sweep direction data	e.g. 720 [qty]	2	102	unsigned short
	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	

Block	Item	Detail	Size [byte]	Off-set	Data type	
Header	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 (1 decimal place)	2	114	unsigned short	
	Z-R coefficient "β"	e.g. 1.60 (2 decimal place)	2	116	unsigned short	
	Kdp-R coefficient "a"	e.g. 19.60 (2 decimal places)	2	118	unsigned short	
	Kdp-R coefficient "b"	e.g. 0.825 (3 decimal places)	2	120	unsigned short	
	Kdp-R coefficient "c"	e.g. 1.20 (2 decimal places)	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 (3 decimal places)	2	126	unsigned short	
	Zh attenuation correction coefficient "b2"	e.g. 1.020 (3 decimal places)	2	128	unsigned short	
	Zdr attenuation correction coefficient "d1"	e.g. 0.0298 (4 decimal places)	2	130	unsigned short	
	Zdr attenuation correction coefficient "d2"	e.g. 1.293 (3 decimal places)	2	132	unsigned short	
	Air attenuation (one way)	e.g. 0.010 (3 decimal places of [dB/km])	2	134	unsigned short	
	Output threshold of Rain	e.g. 0.5 (1 decimal place 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: phv, 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	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	-		
Angle Information block	Angle Information block size	6 [byte]	2	158	unsigned short	
	Azimuth (Angle from initial position of ATU)	Range: 0 ~ 359.99 (2 decimal places of [deg]) (Initial position: 0 deg)	2	160	unsigned short	
	Elevation	Range: -2.00 ~ 182.00 (2 decimal places of [deg]) (Horizontal: 0deg, Elevation: +, Dip: -)	2	162	unsigned short	

Block	Item	Detail	Size [byte]	Off-set	Data type
Observed data block	Observed data block size	e.g. 16796[byte]	2	164	unsigned short
	R (Rainfall rate)	Calculation formula N is a recording level. $R[\text{mm/h}] = (N-32768)/100$ 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. $Zh[\text{dBZ}] = (N-32768)/100$ 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. $V[\text{m/s}] = (N-32768)/100$ 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. $Zdr[\text{dB}] = (N-32768)/100$ 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. $Kdp[\text{deg/km}] = (N-32768)/100$ 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. $\phi dp[\text{deg}] = 360 \times (N-32768)/65535$ φdp Range: -179.9972 ~ 179.9972deg Resolution: 0.0055deg N=0 is invalid	2×M	*	unsigned short
	phv (Correlation coefficient between Zh and Zv) (*1) * Corrected by S/N	Calculation formula N is a recording level. $phv[\text{no unit}] = 2 \times (N-1)/65534$ phv 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. $W[\text{m/s}] = (N-1)/100$ 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/h 1: More than 0.1mm/h 2: More than 1.0mm/h 3: More than 5.0mm/h 4: More than 10.0mm/h 5: More than 20.0mm/h 6: More than 50.0mm/h 7: More than 100.0mm/h bit6: Pulse blind area bit7: Sector blank	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 is moving a target Indicator.

SCR: Ship Clutter Rejection.

GCR(Ref): Ground Clutter Rejection is using a clutter reference map.

(*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_v : Vertical -3 dB antenna beamwidth [rad]

τ : Pulse width [μ s]

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.

7.4. Data Size

- Standard setting of single scan size (one complete azimuth rotation). File size per hour
12,960,088 byte x 3600 sec. / 6 sec. = approx. 7.8GB (7,776,052,800)
- File size at 30 days
7,776,052,800 byte x 30 days x 24 hrs. = approx. 5.6TB

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

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.

1) 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 = $13 \times 15.55784 \times 8 / (5 \times 60) = 5.39$ [Mbps]

2) 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 7.1.

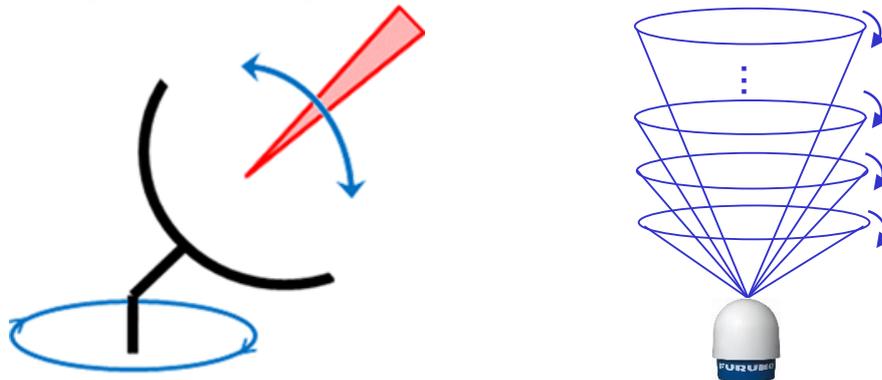


Figure 7.1: Basic volume scan

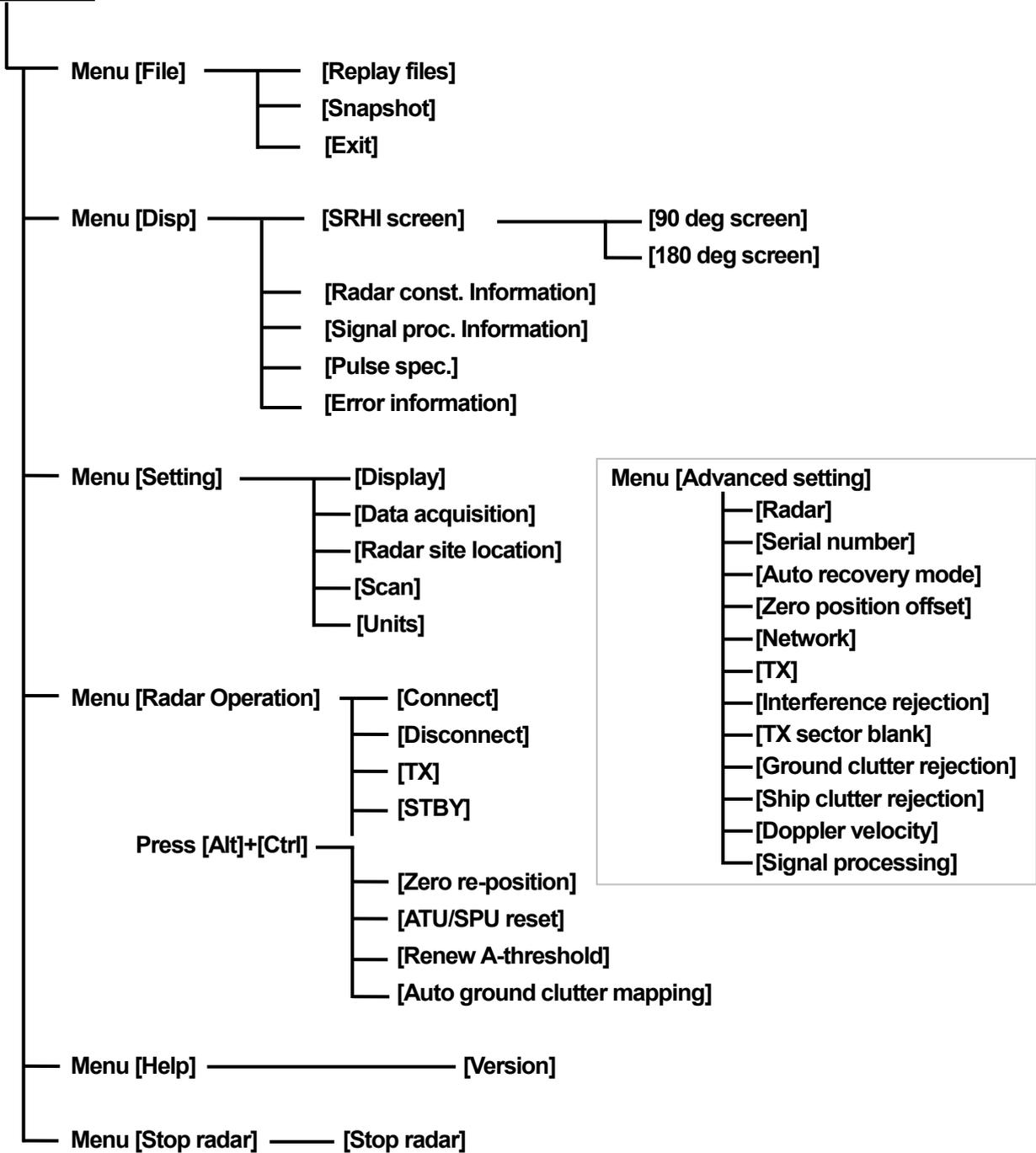
The WR2120 radar will output the data files for each elevation angle. When using eight elevation angles, eight data files will be generated that will require up to 15.55784 MB, however this depends on settings.

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.

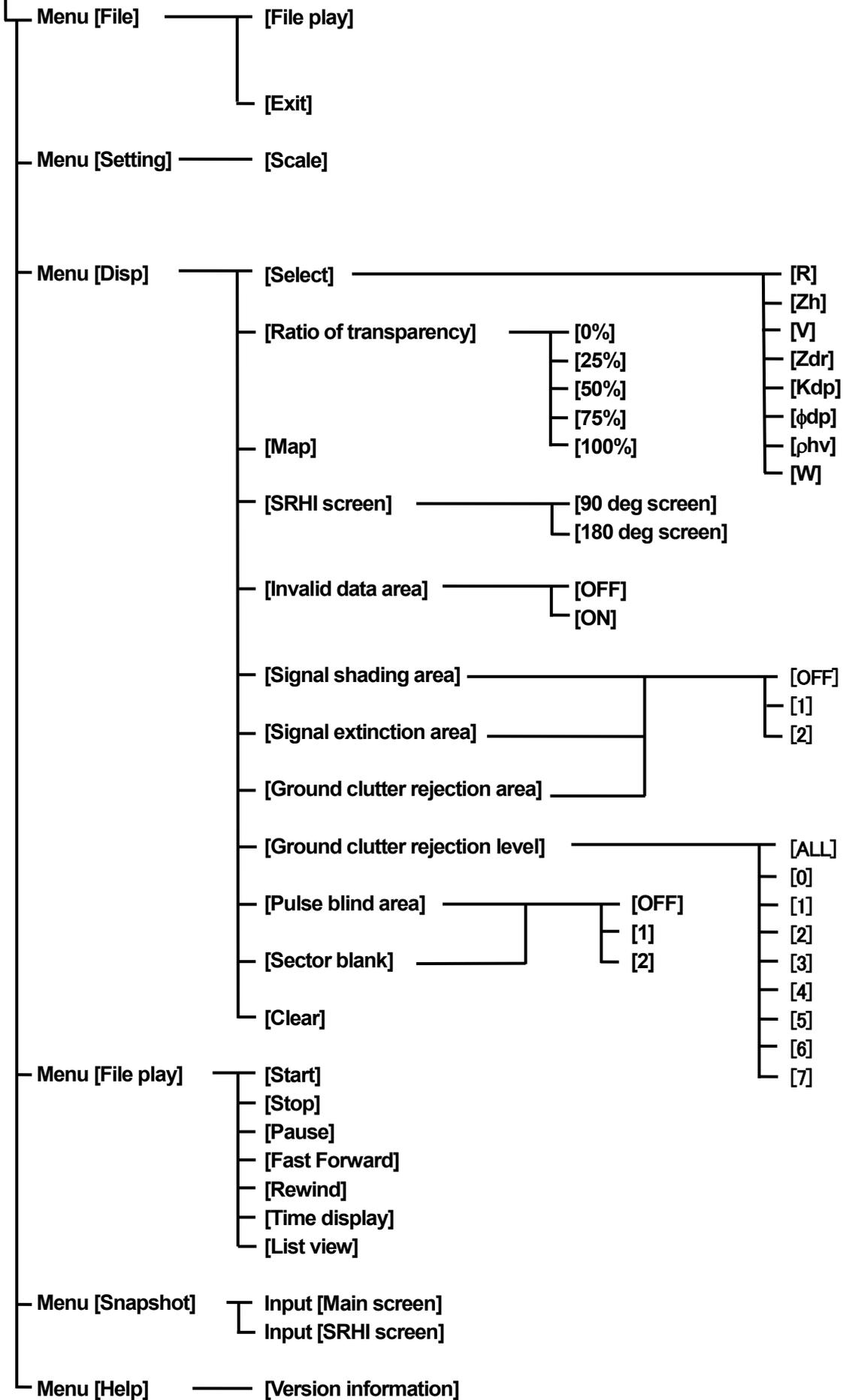
Within this document we present some examples of scanning strategies and generated data size calculations. The minimum transfer speed requirement will be calculated using these total file sizes and the time span of one volume scan.

8. Menu Tree

RainMap



RainPlay



9. MAINTENANCE

9.1. Troubleshooting

STATE	CONTENT/PROCEDURE
Cannot turn the power on	<ol style="list-style-type: none"> 1. Make sure that the power cord has not loosened. 2. Make sure that the contact of the power cord plug has not stained. 3. Make sure that the power cord has not damaged. 4. Make sure that the breaker in the WR2120-SPU is "ON".
DPU has frozen or locked-up	<ol style="list-style-type: none"> 1. Press [Ctrl]+[Alt]+[Delete] simultaneously, then select application and click "End Task" to force quit. Do the same to all applications if possible. Next, restart DPU. 2. Press the reset button or keep pressing the power button of DPU for few seconds to turn off the power of DPU, then push the power button again to turn on the power of DPU. 3. Please call for service if it freezes again.
Thermo electric air conditioner stopped	Please call for service.
Following failure occurs: - No radar echo indication - SPU Failure - System Failure	<ol style="list-style-type: none"> 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. 2. [ATU/SPU reset] will send a reset command to SPU, MONI-CON, motor driver, and itself to release from error. (Refer to section 2.8) 3. Go to the next step if still fail. 4. Turn OFF/ON the breaker in SPU (Refer to section 1.4).
Error code indication	<ol style="list-style-type: none"> 1. Restart RainMap and Radar (turn OFF/ON the power). 2. Call for service and tell an error code.
The following error message will occur if startup the RainPlay during indicates RHI on RainMap. "Access violation at address XXX in module 'ig9iod32.dll'. Read of address 00000000".	It is about Intel graphic driver is causing a problem. <ol style="list-style-type: none"> 1. Open device manager of windows. 2. Open property of Intel HD graphic XXX in display adaptor. 3. Open driver's tab of property. 4. Click "Restore a driver", and then roll back a driver.

9.2. Log File Function

9.2.1. Error information log

There are two types of error log files create automatically and keep saving into the following directory:
 "Windows(C) > User > radar > AppData > Local > Furuno > RainMap >log"

1) RainMap_ErrorDisp.log

Error information up to 50 lines are saved in this log file. Once entries exceed 50 lines, additional error information overwrites older line entries.

2) RainMap ErrorHist.log

All past error information is saved in this log file.

9.2.2. RainMap.log

1) Log file information

- 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.

2) Limit of Log files

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

3) Log file 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_ErrorHist.log: Saves all previous failure information.

Detail of Log record contents: (Records 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	

9.3. 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)]
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)]
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]

Code	Content
E200	RFCONV abnormality [PLL unlock]
E210	HPA abnormality [Outside TX power regulation]
E212	HPA abnormality [Outside temperature regulation]
E312-315	Drive unit failure detected during zero positioning
E328-331	
E344-345	Drive unit failure detected during weather observation
E360-361	
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]

Note: The radar will automatically stop the operation when error occurs.

9.4. 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		
SP MOTOR Assy	PKP264D28B2 / PE2-050-010	10,000 hours
SP HPA FAN	WR2-CBL5	5 years
SP POWER SUPPLY Assy	AC6-2KHTN-00-XFN	5 years
Signal Processing Unit		
PXI Chassis	NI PXIe-1071	5 years
PXI Chassis fan	PXI Chassis Fan	5 years
SPU Air Conditioner Inner fan	FM-100BEC-IN	5 years
SPU Air Conditioner Outer fan	FM-100BEC-OUT	5 years
Data Processing Unit		
WR2120-DPU	FAU-146-03	5 years
DPU Power Supply	DPU-PS	5 years

Notes:

- 1> The table above shows the typical life-span used under normal conditions.
- 2> When the radar is installed above 1,000m, the life time will be shorter due to deterioration of oil seal and the grease leakage by low pressure, especially for ball bearings in the motors, fans, and spindles. The radar must be installed lower than 2,000m altitude.

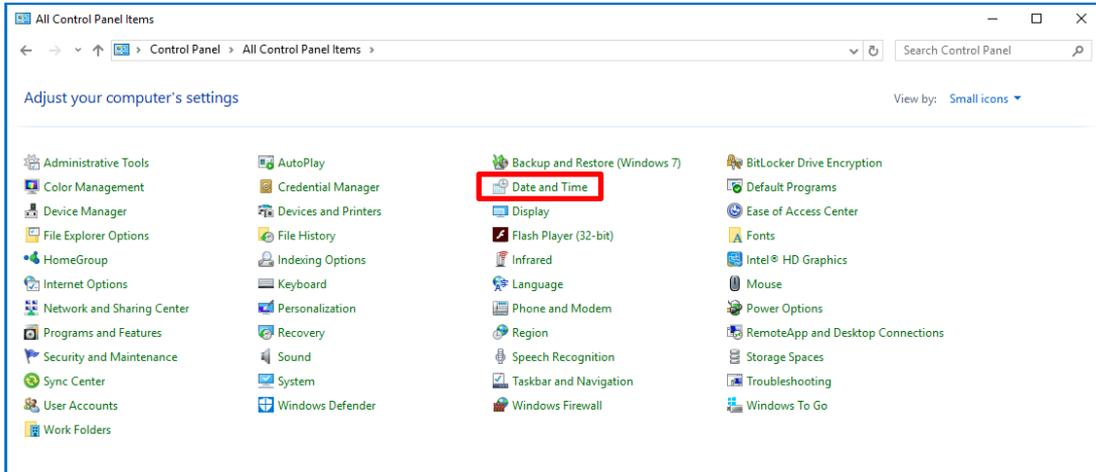
APPENDIX

A. DPU SETTING

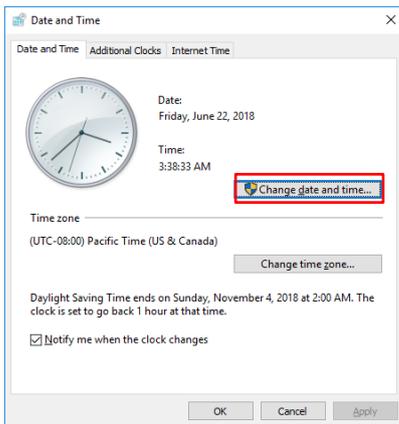
A.1. DPU Time Adjust Setting

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

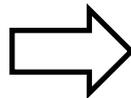
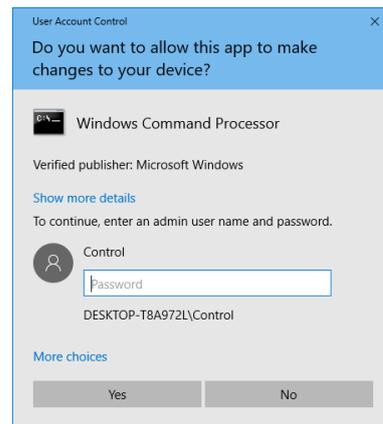
1) Open the control panel and click the "Date and Time".



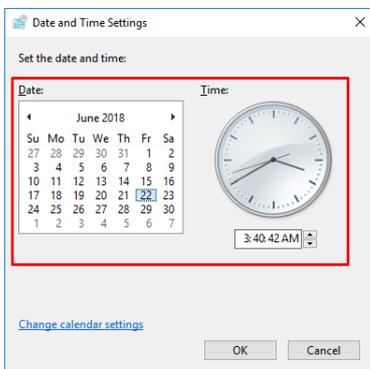
2) Click the [Change date and time].



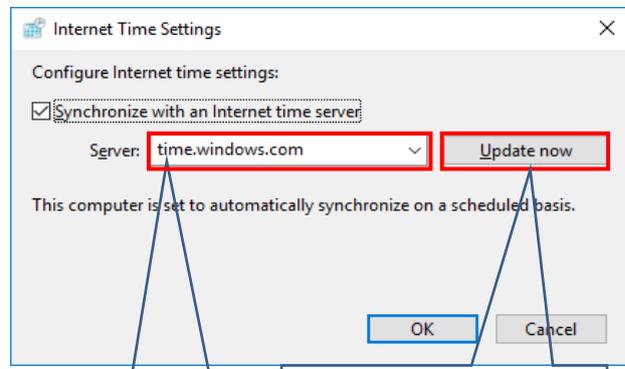
3) Enter the password of Control account
Default password: Admin



4) Case of correct the time by hand.



5) Case of correct the time by internet time.



Click the button to synchronize the time with NTP server.

Enter the address of NTP server in this box if required to change

A.2. DPU User Account

“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) It must use this account when operate the weather radar.

“Control” account

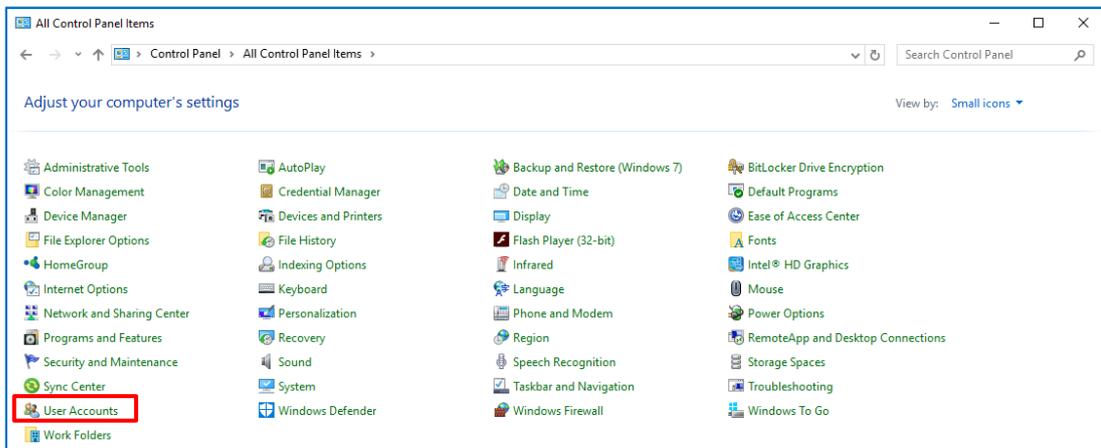
This account is administrator account for user. User can perform operations that require administrator privileges by using this account, but it is not recommended.

“Maintenance” account

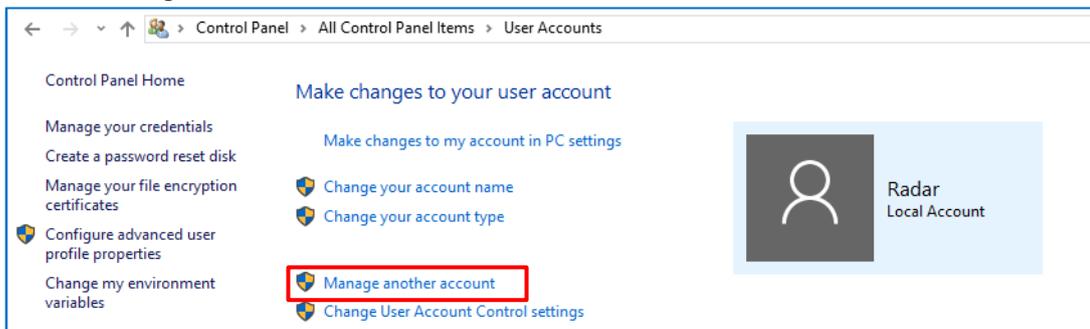
This account is for manufacturer management. Do not change the account name and the account password.

A.3. DPU Account and Password setting

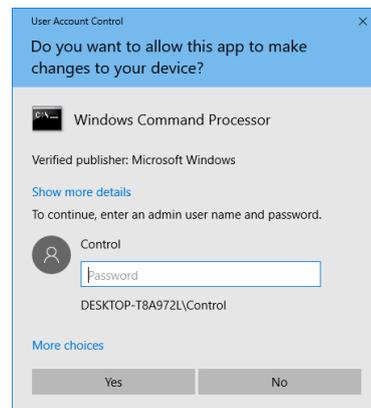
- 1) Open the control panel and click the “User Accounts”.



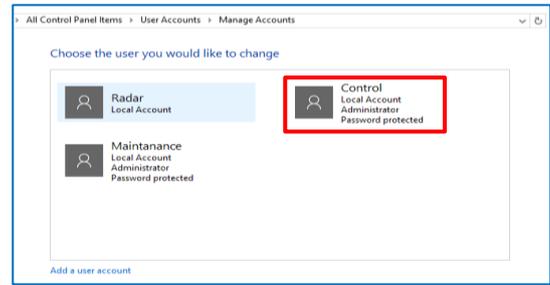
- 2) Click the “Manage another account”.



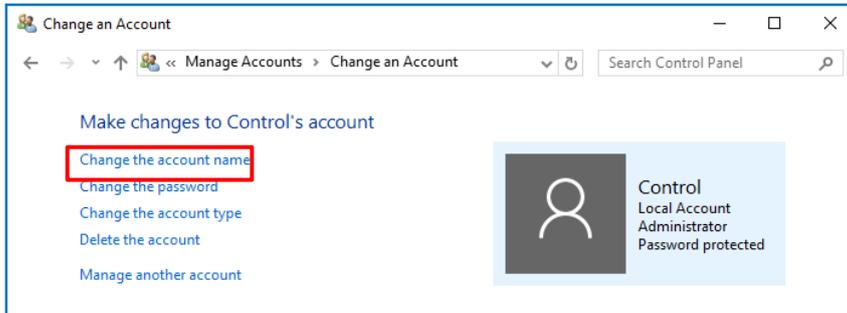
- 3) Enter the password of Control account
Default password: Admin



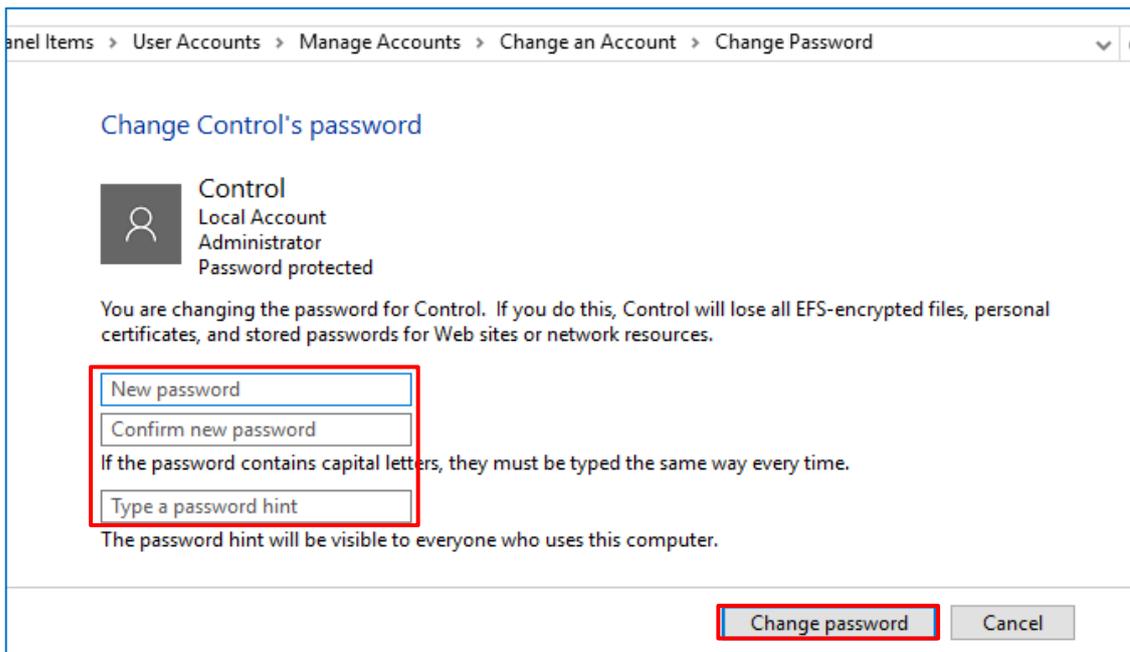
- 4) Click the account name "Control".
Notice: Do not touch the account of "maintenance".



- 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 the password somewhere safe.**



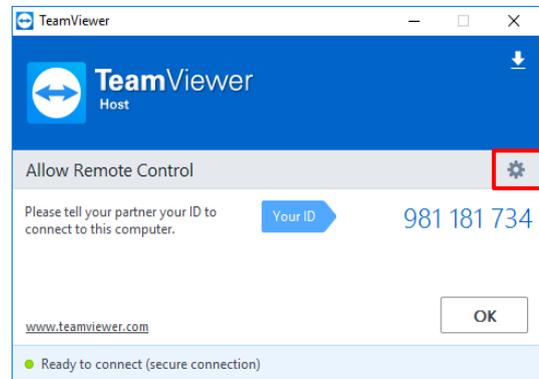
A.4. TeamViewer

This software is the place allows using remote control via internet. If suddenly the radar's facility is prohibited of using it, please uninstall this software. (Refer to the Installation manual of this uninstallation)

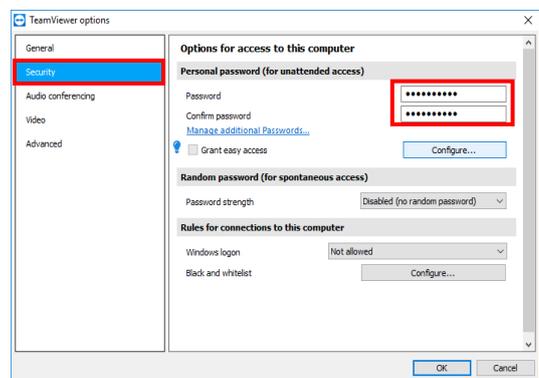
A.4.1. Security setting

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.

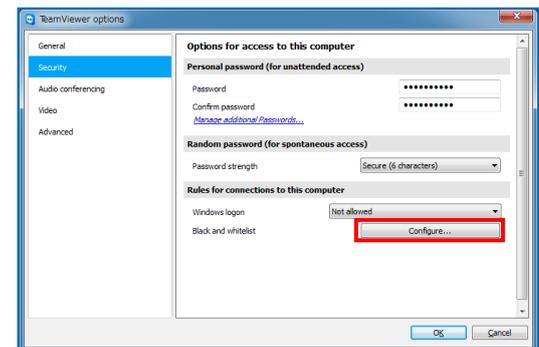


- 2) Click the "Security" from the options screen and enter any password. Please keep the password somewhere safe.



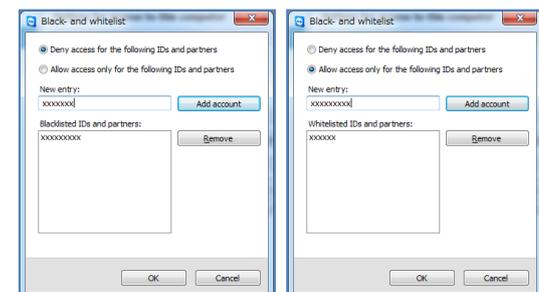
- 3) Click [Security] on the left list of [TeamViewer options]

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



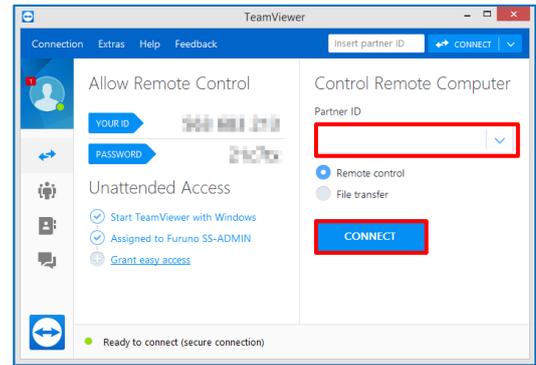
- 5) If required register any ID's on the list for [Deny access for the following IDs and partners] or [Allow access only for the following IDs and partners] from Popup menu of [Black and whitelist].

This recommendation is to enter the E-mail address of the local TeamViewer instead of ID for raising this security when adding account on Whitelist [Allow access only for the following IDs and partners].



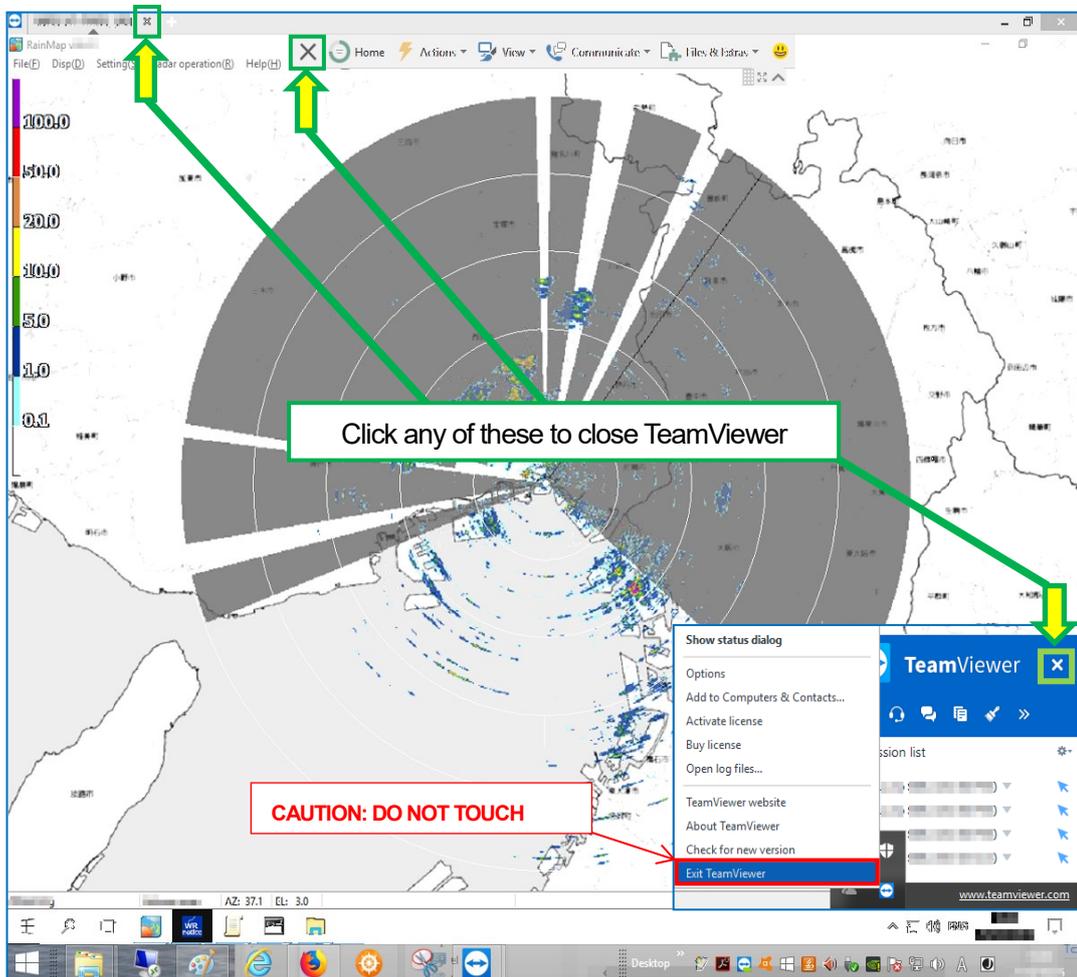
A.4.2. Remote control

- 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 exit TeamViewer on the host side, user has 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 device 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 9.1m 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. TRADEMARK INFORMATION

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Bulgarian (BG)	<p>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:</p>
Spanish (ES)	<p>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:</p>
Czech (CS)	<p>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:</p>
Danish (DA)	<p>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:</p>
German (DE)	<p>Hiermit erkläre 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:</p>
Estonian (ET)	<p>Käesolevaga deklareerib Furuno Electric Co., Ltd., et ülalmainitud raadioseadme tüüp vastab direktiivi 2014/53/EL nõuetele. ELi vastavusdeklaratsiooni täielik tekst on kättesaadav järgmisel internetiaadressil:</p>
Greek (EL)	<p>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:</p>
English (EN)	<p>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:</p>
French (FR)	<p>Le soussigné, Furuno Electric Co., Ltd., déclare que l'équipement radioélectrique du type mentionné ci-dessus est conforme à la directive 2014/53/UE. Le texte complet de la déclaration UE de conformité est disponible à l'adresse internet suivante:</p>
Croatian (HR)	<p>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:</p>
Italian (IT)	<p>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:</p>
Latvian (LV)	<p>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:</p>

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

- HDF5 1.10.2

HDF5 (Hierarchical Data Format 5) Software Library and Utilities

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NCSA HDF5 (Hierarchical Data Format 5) Software Library and Utilities

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<https://support.hdfgroup.org/ftp/HDF5/releases/COPYING>

- zlib 1.2.11

Version 1.2.11, January 15th, 2017

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

- NetCDF-C 4.6.1

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<https://www.unidata.ucar.edu/software/netcdf/copyright.html>

3) 7-zip is installed in DPU.

- 7-zip 18.05

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4) Tera Term is installed in DPU.

- Tera Term 4.99

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5) TeamViewer is installed in DPU.

- TeamViewer 13

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- NI System Configuration 17.5

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7) Map screen of the RainMap

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- Other countries map contributor is Open Street Map.

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- Fast $\exp(x)$ computation (with SSE2 optimizations).
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- Fast approximate function of float $\exp(\text{float})$ and float $\log(\text{float})$.
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