S2E-19-0114_OM_WR2120_10

FURUNO

OPERATOR'S MANUAL

COMPACT X-BAND DUAL POLARIMETRIC DOPPLER WEATER RADAR

Model **WR2120**

(Product Name: WEATHER RADAR)

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 be read and follow the descriptions in this manual. Wrong operation or maintenance can be canceled 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 to the dealer about replacement.
- The contents of this manual and equipment specifications can be changed without notice.
- The example screens (or illustrations) shown in this manual might be different from the screens as display. The screen may depend on a 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.
- The following concern acts as our importer in Europe, as defined in Directive 2014/53/EU.
  - Name: FURUNO DEUTSCHLAND GmbH
  - Address: Siemensstrasse 33 25462 Rellingen, Germany
- The following concern acts as our importer in UK, as defined in SI 2016/1025 as amended SI 2019/470.
  - Name: FURUNO (UK) LTD.
  - Address: West Building Penner Road Havant Hampshire P09 1QY, U.K.
- All brand and product names are trademarks, registered trademarks, or service marks of their respective holders.

How to discard this product

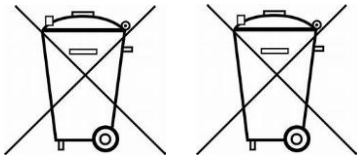
Discard this product according to local regulations for the disposal of industrial waste. For disposal in the USA, see the homepage of the Electronics Industries Alliance (http://www.eiae.org/) for the correct method of disposal.

How to discard a used battery

Some FURUNO products have a battery(ies). To see if your product has a battery, see the chapter on Maintenance. IF a battery is used, tape the + and – terminals of the battery before disposal to prevent fire, heat generation caused by short circuit.

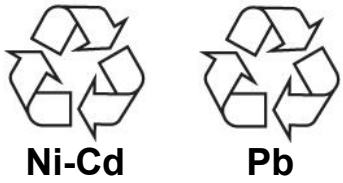
In the European Union

The crossed-out trash can symbol indicates that all types of batteries must not be discarded in standard trash, or at a trash site. Take the used batteries to a battery collection site according to your national legislation and the Batteries Directive 2006/66/EU.



In the USA

The Mobius loop symbol (three chasing arrows) indicates that Ni-Cd and lead-acid rechargeable batteries must be recycled. Take the used batteries to a battery collection site according to local laws.



In the other countries

There are no international standards for the battery recycle symbol. The number of symbols can increase when the other countries make their own recycle symbols in the future.

⚠ SAFETY INSTRUCTIONS

Follow the safety instructions listed below and throughout this manual to prevent damage to the equipment or vessel and to prevent harm to the operator or other personnel on-board. The results of failing to follow the instructions and guidelines outlined herein are listed below.

The operator must read the applicable safety instructions before attempting to 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.

(Examples of symbols)

⚠ Warning, Caution ⃠ Prohibitive Action ❗ Mandatory Action

⚠ DANGER

Radio Frequency Radiation Hazard

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

Radiator	10 W/m ^{2}
Distance from Antenna	9.1 m

⚠ WARNING

Do not open the radome.
Electrical shock can occur. Only qualified personnel may work inside the equipment. Turn off the breaker in the SPU when it is necessary to open the radome.

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.

⚠ WARNING

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.

⚠ WARNING

Use only the specified power cord.
Fire or damage to the equipment can result if a different cable is used. When it is necessary to open the radome.

Ground power supply.
Electrical shock or operation malfunction can occur.

When a thunderbolt is expected, do not approach or touch the system.
There is a possibility of receiving an electric shock. Safety of personnel 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 may not protect radar or personnel in the vicinity.

Install the radar lower than 2,000m altitude.
When the radar is installed above 1,000m, the life of the equipment becomes shorter due to deterioration of oil seals and grease leakage. This is especially true with ball bearings in motors, fans, and spindles. Install the radar lower than 2,000m altitude.

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

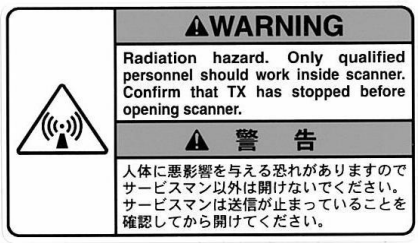
⚠ CAUTION

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

Ensure the installation location is suitable for the system.
To prevent performance degradation and failure.

WARNING LABEL

Warning labels are attached to the equipment. Do not remove the 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

The following frequency bands are prohibited in Switzerland, Lithuania, and Slovakia
CH1: 9422.5MHz
CH2: 9427.5MHz
CH3: 9432.5MHz
CH4: 9437.5MHz

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FOREWORD

A word to WR2120 Owners
Congratulations on your choice of the FURUNO the Dual Polarization of the Weather radar WR2120. We are confident you will see why the FURUNO name has become synonymous with quality and reliability. Thank you for considering and purchasing FURUNO equipment.

Features

FURUNO has decades of technical expertise in marine Radar development and is the clear leader in this industry. FURUNO, in close collaboration with many universities and other business organizations has now developed Radar solutions for meteorological monitoring and analysis. FURUNO's high resolution, compact X-band Doppler Weather Radar has proven essential for forecasting localized weather disturbances and other specialized applications including fire and volcanic ash detection. With new tools and solutions specifically designed for weather forecasting and observation, FURUNO's objective is to provide safety to individuals and their property by presenting highly detailed information of potential meteorological events.
The key features of the WR2120 are

- The precision rain observation & accurate measurements:
  The Dual Polarization of the WR2120 recovers signal intensity loss and attenuation caused by heavy rain.
- Particle classification:
  Several data such as echo strength or phase difference, provided by the WR2120, can be utilized to assess the nature of the detected particle and deduct whether it is Snow, Hail or Rain.
- Easy installation:
  - Very compact and lightweight (ø1m, 65 kg).
  - No heavy equipment required for installation.
  - Compatible with regular power outlet.
- Reduced operating costs:
  - Reliable, less maintenance, long life solid-state transmission device.
  - Low power consumption (100V, 200W).
- High resolution & accurate measurements:
  - Outputs dual polarimetric information (Zdr, Kdp) for computing diameter of precipitation particles as well as discriminating types of precipitation (rain, snow, and etc.).
  - 3D scan to observe the vertical structure of a cumulonimbus.
- Various software applications available:
  - Various data formats used in major software packages, such as Baron Lynx and Vaisala IRIS Focus, are available.
- Carbon fiber antenna dish:
  - Reduction of the antenna weight.
  - Reduction of damage and mechanical stress due to shocks and vibrations.

Program No.

MAIN Application: 8450002-06.**
**: denotes minor modification.

Software Version

The software version is shown on the [Version Information] window.
This manual revision is compatible with the following software versions:

- RainMap v06.18
- RainPlay v02.05

CE/UKCA declaration

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

Disclosure of Information about China RoHS

With regards to China RoHS information for our products, please refer to our website. (www.furuno.com).

Security Export Control

- This device is valid for export-controlled goods of Japan.
- Principle, export, sale, and transfer for foreign user list subjects established by the Japanese government is prohibited.
- 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, ex-port is prohibited.
- To export this product, please contact us in advance.

Software used in this product

This equipment uses the following open-source software and information of copyright:

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

- zlib 1.2.11

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

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

- NetCDF-C 4.6.1

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

3) Following OSS is used in the data converter of NEXRAD Level2 and UF.

- Radx C++ Package (20160809)

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  National Center for Atmospheric Research (NCAR)
  Boulder, Colorado, USA
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  2) Redistributions of source code must retain the above copyright notice, this list of conditions and the following disclaimer.
  3) Redistributions in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.
  4) Neither the name of UCAR nor the names of its contributors, if any, may be used to endorse or promote products derived from this software without specific prior written permission.
  DISCLAIMER: THIS SOFTWARE IS PROVIDED "AS IS" AND WITHOUT ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

- Dirent

  The MIT License (MIT)
  Copyright (c) 1998-2019 Toni Ronkko.
  https://raw.githubusercontent.com/tronkko/dirent/master/LICENSE

4) 7-zip is installed in DPU.

・7-zip
Copyright (C) 1999-2024 Igor Pavlov.
The license terms are shown in DPU. C.:\Program Files\7-Zip\License.txt

5) TeamViewer is installed in DPU.

・TeamViewer
Copyright (C) 2005-2017 TeamViewer GmbH
The license terms are shown in DPU. C:\Program Files (x86)\TeamViewer\License.txt

6) National Instruments Software is installed in DPU.

・NI System Configuration
Copyright (C) 2010-2017 National Instruments. All rights reserved.
The license terms are shown in DPU. C:\Program Files (x86)\National Instruments_Legal Information

7) Map screen of the RainMap

・Japanese map contributor is Geospatial Information Authority of Japan.
・Other countries map contributor is Open Street Map.

8) Following OSS is used in the WR_notice

・MVVM Light Toolkit
Copyright (c) 2009 - 2018 Laurent Bugnion

9) OpenSSH for Windows is installed in DPU and SPU.

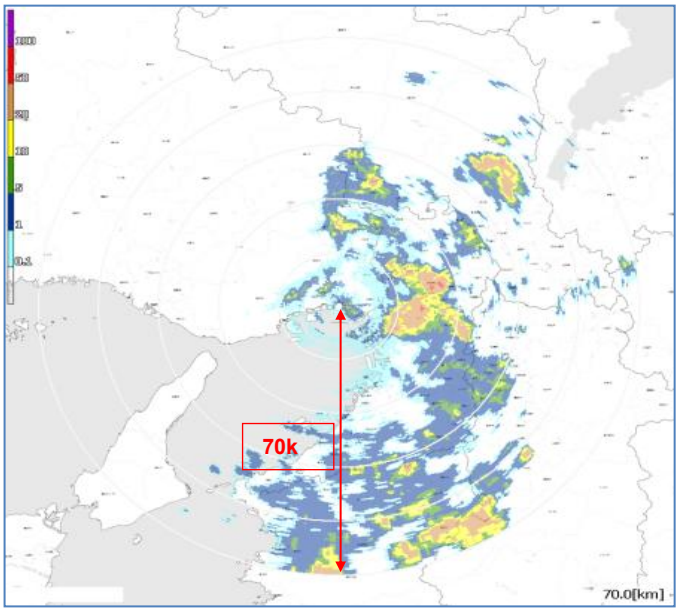
・OpenSSH
OpenSSH is copyrighted by the respective developers.
The license term is shown in DPU. C:\Windows\System32\OpenSSH\LICENSE.txt

10) Windows 10 SDK is installed in SPU.

・Windows 10 SDK
The license term refers to APPX.8.

SYSTEM OUTLINE

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





Notice on radar use:

- Do not approach the antenna area while the radar is in operation.
- For the antenna unit installed on a rooftop in an urban area, the area must be protected from citizens and be equipped with lightning rod(s) based on IEC 62305.
- No obstacles should be around the antenna.

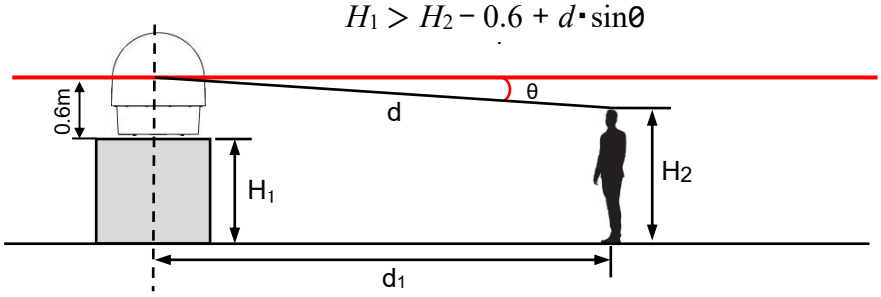
Safe distance:

- If H1 is taller than 2.0 meters, the area surrounding the antenna is safe other than directly touching the antenna.
- If H1 is shorter than 2.0 meters, do not approach the antenna unit within a radius of 9.1 meters. (See the Radio Frequency Radiation Hazard in the Safety Instructions.)

Note 1: Based on the standard human height of 2 meters.

Note 2: The calculated value includes a safety margin.

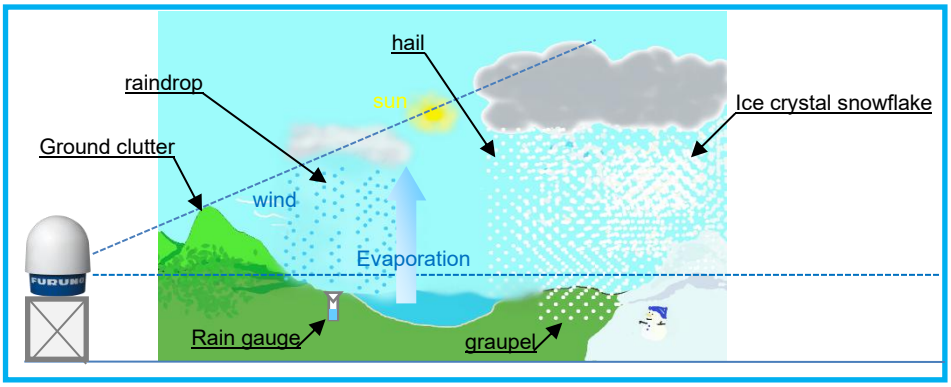
$$H_1 > H_2 - 0.6 + d \cdot \sin\theta$$



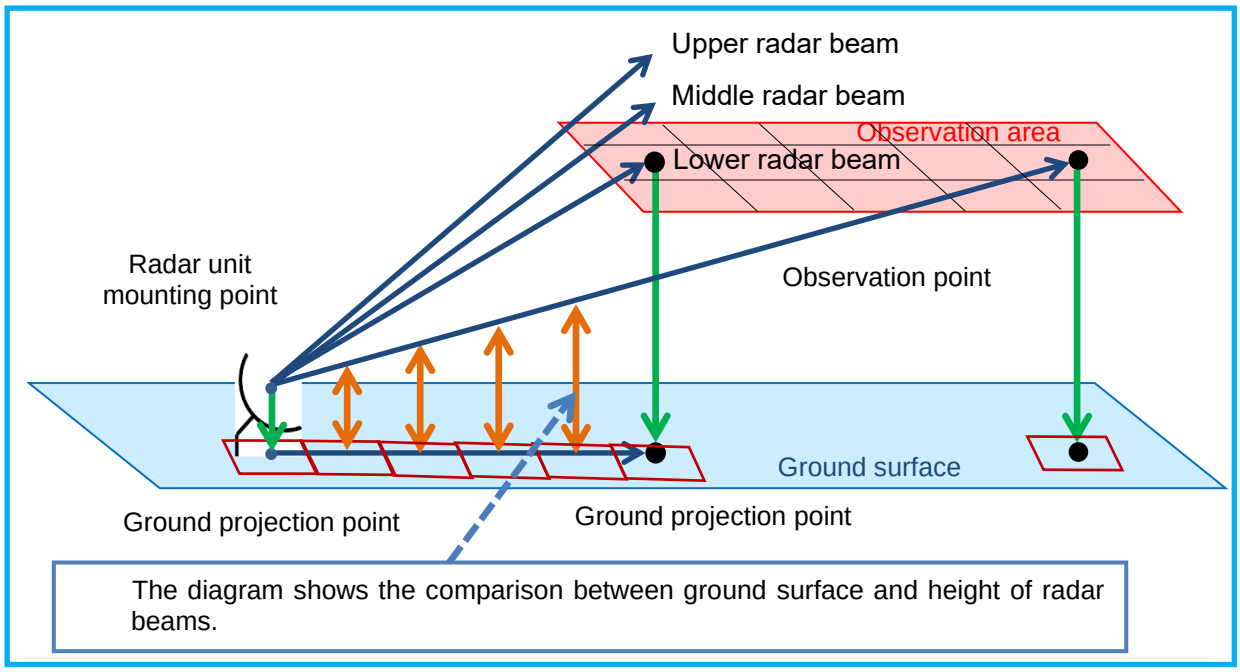
e.g.: H_2 (Height) = 2 m,
d (Distance between center of the antenna and human) =9.1m,
θ=3.5° (Minimum elevation is -2° - half beam width 1.5°)
H_2 - 0.6 + d·sinθ = 2 - 0.6 + 9.1·sin3.5° = 1.957 m < H_1
Therefore, H_1 (Height of radar stand) = **2.0** m
d_1 = d·cosθ = 9.1·cos3.5° = 9.08m (d_1 is the safe horizontal distance. Do not approach the antenna closer than this distance)

Radar observation summary:

Weather radar observes the development of rain clouds outputs the intensity of precipitation, the speed of rain clouds (Doppler speed) and observes rainfall phenomena. It is capable of high-resolution rain observation, rain cloud, precipitation density and speed observation.

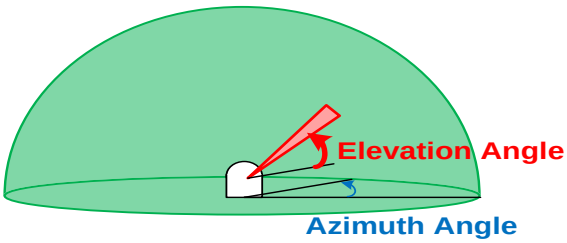


The area sampled by the radar increases with distance. The wider the beam the greater the likelihood of sampling a mixture of precipitation types and a greater the likelihood of sampled both inside and outside a cloud. Obstacles can also block a portion of the radar beam resulting in an artificially high-power return.



Required accuracy for leveling:

Although 0.2 degrees is an acceptable level, it may cause a 104.9m difference at a 30km distance from radar. For best target accuracy make mount level 0.0 to 0.1 degrees.

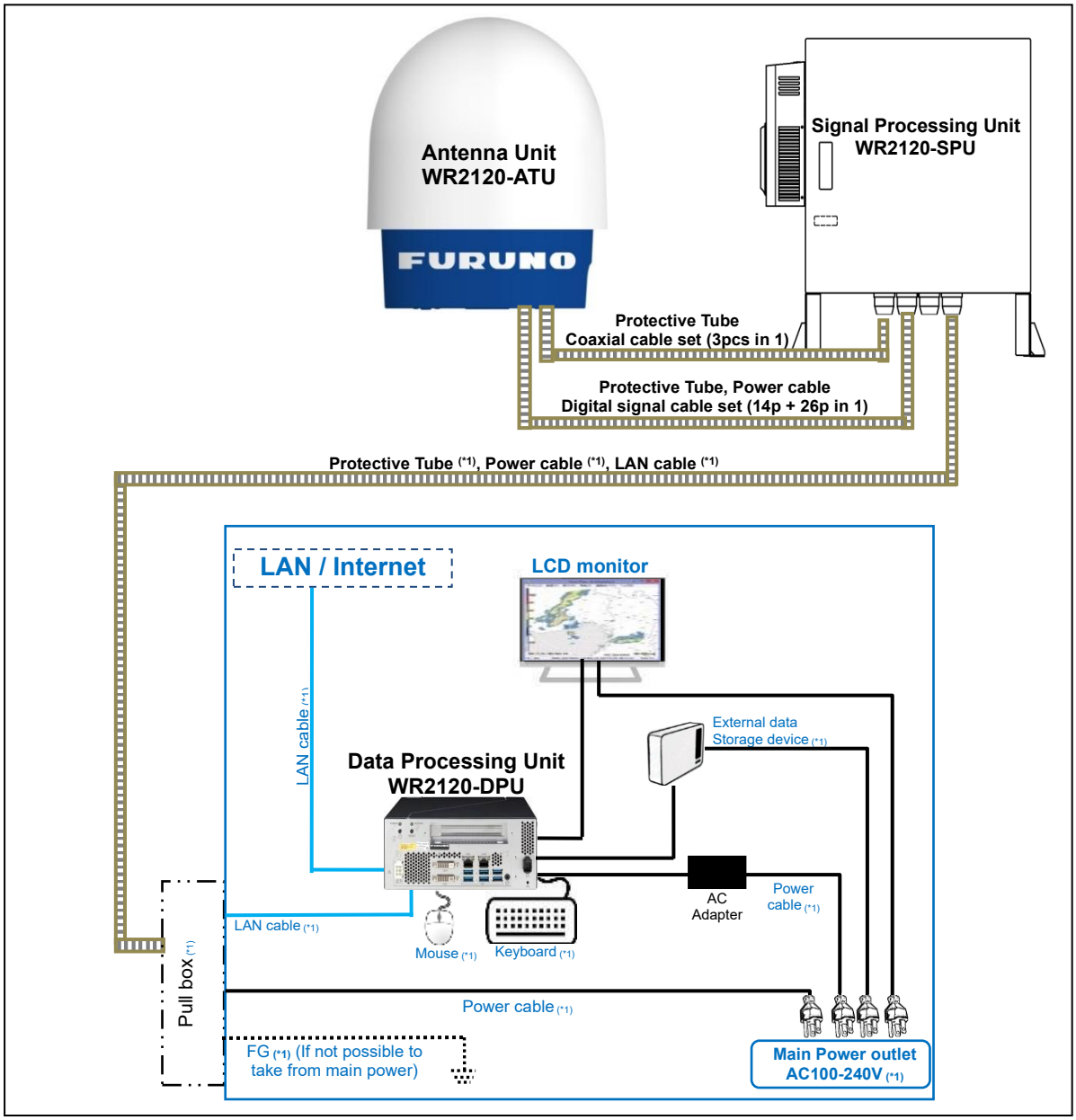


SYSTEM CONFIGURATION

The observation systems consist with three units.

- **Antenna Unit (ATU)**
  Radome is to provide protection for enclosed physical environment. Inside the radome, there is the antenna that rotates and radiates the radio waves. The radiated waves are backscattered by particles on the propagation path, return to the antenna, and are processed by RF converter to transfer the signals to the Signal Processing Unit.
- **Signal Processing Unit (SPU)**
  This unit is a device that processes the signal received by the ATU to generate observation values and controls the ATU. It also replaces the ATU power switch.
- **Data Processing Unit (DPU)**
  Data Processing Unit is displaying radar data and operates the weather radar.
  User needs to prepare the external storage device for recording the weather observation data if necessary.

Note: Do not install any software into DPU or operate them, because it will cause an out of system resource problem. Only pre-installed application can be operated on DPU. It is recommended to use WR_transfer (pre-installed) to send the observation data to an FTP server or external storage and then use the observation data with third-party software installed on another PC.



*1: Local supply, please prepare the product at local.

Software specification:

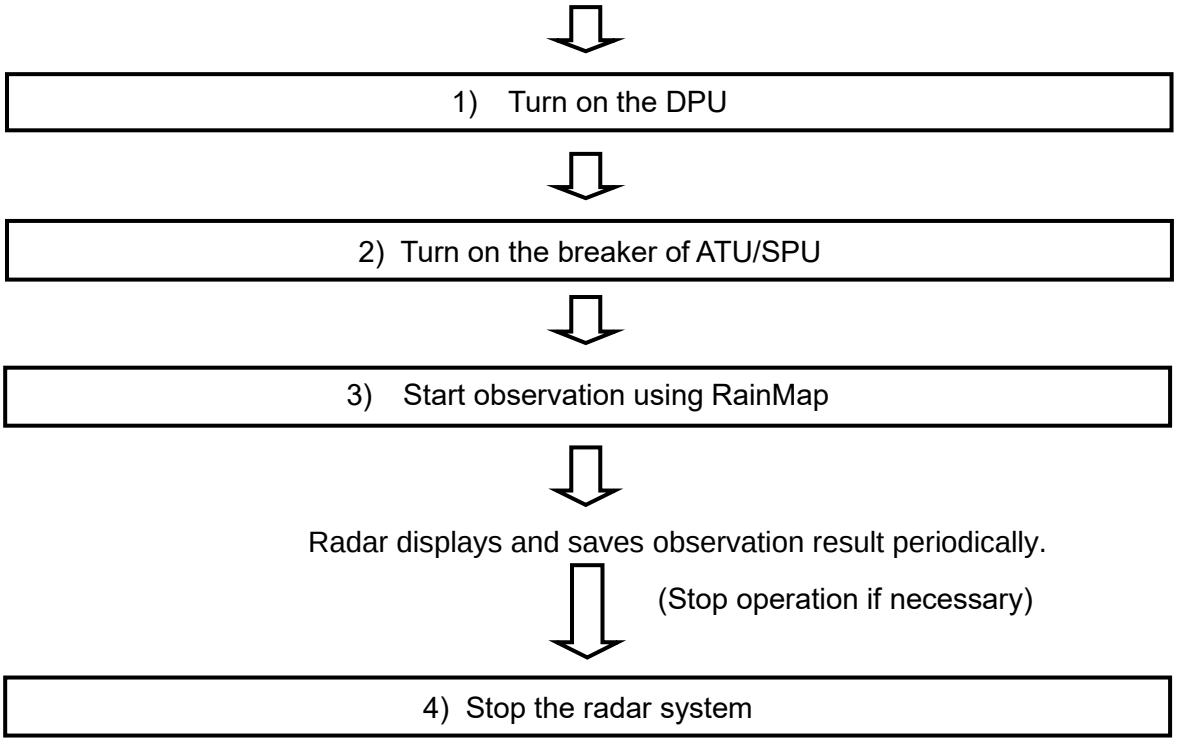
Items	Descriptions
Software	
RainMap	Radar control and data acquisition
RainPlay	Display the saved acquisition data
Each software is in the following folder: C:\Users\radar\Furuno\RainMap_RainPlay	
Data display	
Observational date and time	Local time display corresponding to the time zone of Windows®
Maximum distance displayed	70 km
Display scale	0.5-70 km
Polar coordinate display (rθ) Coloration	Maximum 15 colors in table (Maximum 16 values including no color)
Map display	
Map file extension	bmp, png
Display status	
Observation parameter	R [mm/h], Zh [dBZ], Zh_corr [dBZ], Zv [dBZ], V [m/s], Zdr [dB], Zdr_corr [dBZ], Kdp[deg/km], φdp[deg], ρhv, W [m/s], CCOR [dB], SNR [dB], SQI, UZh [dBZ], UZv [dBZ] (See section 2.3 for more information)
Radar operating status	Displays observation status and azimuth / elevation
Radar operational settings	
Scan mode	PPI, Volume, Sector PPI/RHI, Scenario Scan,
Interference Rejection	Selects interference rejection
Ground clutter (topographical) Interference rejection	Selects ground clutter rejection
Transmission mask function	Selects sector blanking area
Elevation angle (-2 to 182 degrees)	Selects a specified elevation angle
Setting of radar constant (Transmission pulse width, rainfall intensity conversion constant B, and β)	Setting requires for calculation of observation data
Data manipulation	
Save displayed data	Save in a chronological order unit (Time based file name)
Play displayed data	Play the saved observation file
Data output	
Output of data file	Output rate 1 to 60 minutes intervals

1. ACTIVATION PROCEDURE

1.1. Operational sequence to startup the Radar System

< Caution >

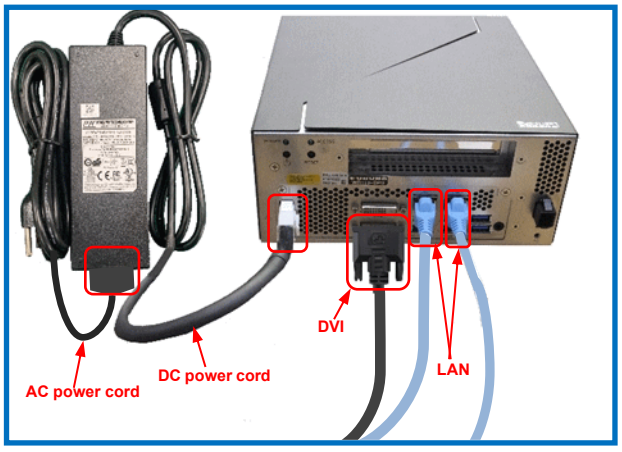
For safety, make sure the breaker of the SPU is OFF before plugging in the system (to power outlet).



1.2. How to Startup the Data Processing Unit (DPU)

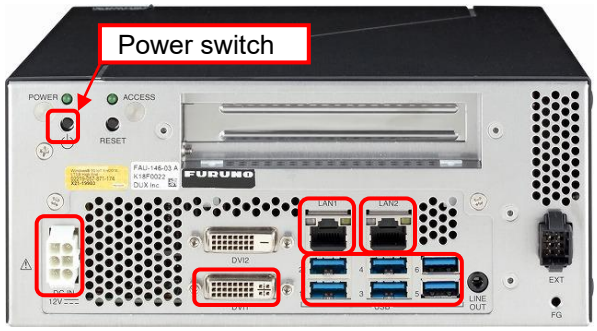
1) Confirm the cable connection

Confirm that all cables are correctly connected as shown in the figure at right. Refer to the Installation Manual for detail of cable connection.



2) Startup DPU

1) The DPU boots up automatically when the power cable of the DPU (AC Adapter) is plugged into a local power outlet.
2) Enter the username and password if DPU asks for login (See chapter 2 for login information)

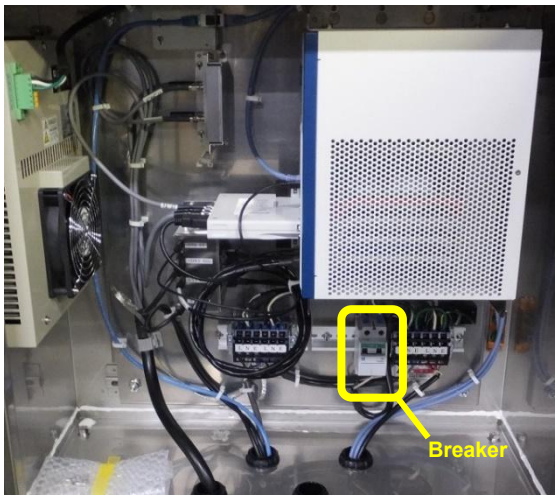


1.3. How to Startup the Signal Processing Unit (SPU)

1) The breaker is in the SPU.
2) Turn ON the breaker for the ATU/SPU.



inside



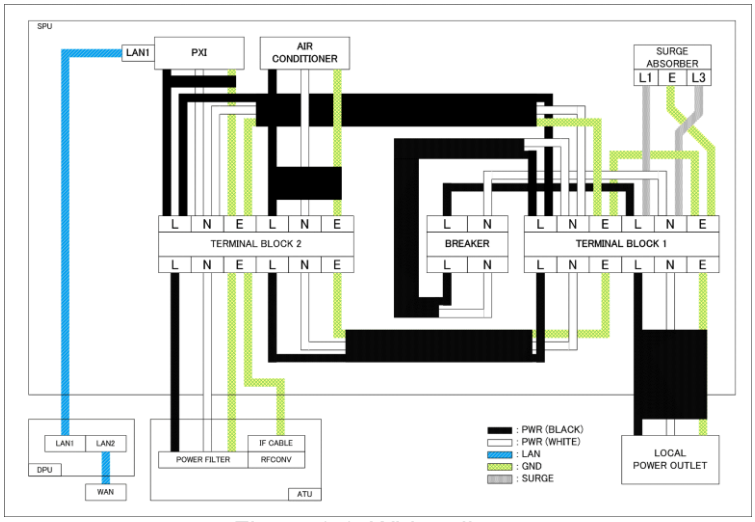
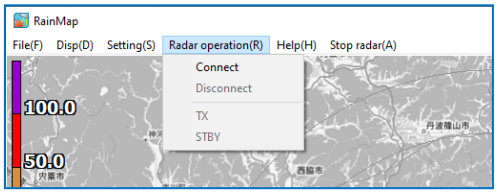


Figure 1-1: Wiring diagram

1.4. How to Start Radar Observation

1) RainMap start up after the DPU is powered.
2) Select [Radar operation] from the menu bar, then select [Connect].
3) [Connect] appears in the task bar (bottom left of screen) when the DPU is connected to the SPU.
4) Select [Radar operation] from the menu bar, then select [TX] to start the observation.
5) After radar initialization is completed ([Initialization] appears on the screen), scan line and radar echoes appear on RainMap.

Note: In cold weather, if the radar does not transmit after turning on the ATU, wait for a while with the power on and then try [TX] again.





1.5. How to Shut down the Radar System

1) Select [Radar operation] from the menu bar, then select [STBY] to stop the antenna unit. Select [Radar operation] from the menu bar, then select [Disconnect] to end communication with the ATU/SPU.



Note: [STBY] can also be done by selecting [Stop radar] from the menu bar.

2) Turn off the breaker (circuit protector) in the SPU.

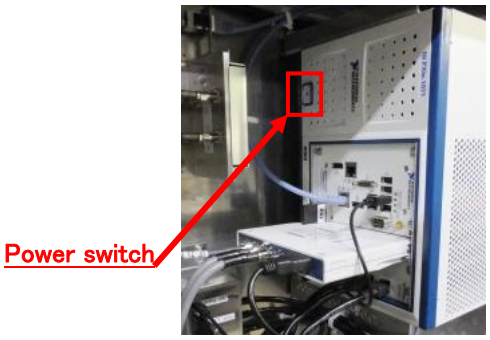
Note: Be sure to follow the shutdown procedure exactly as shown here, to prevent radar failure.



1.6. How to Reboot only SPU

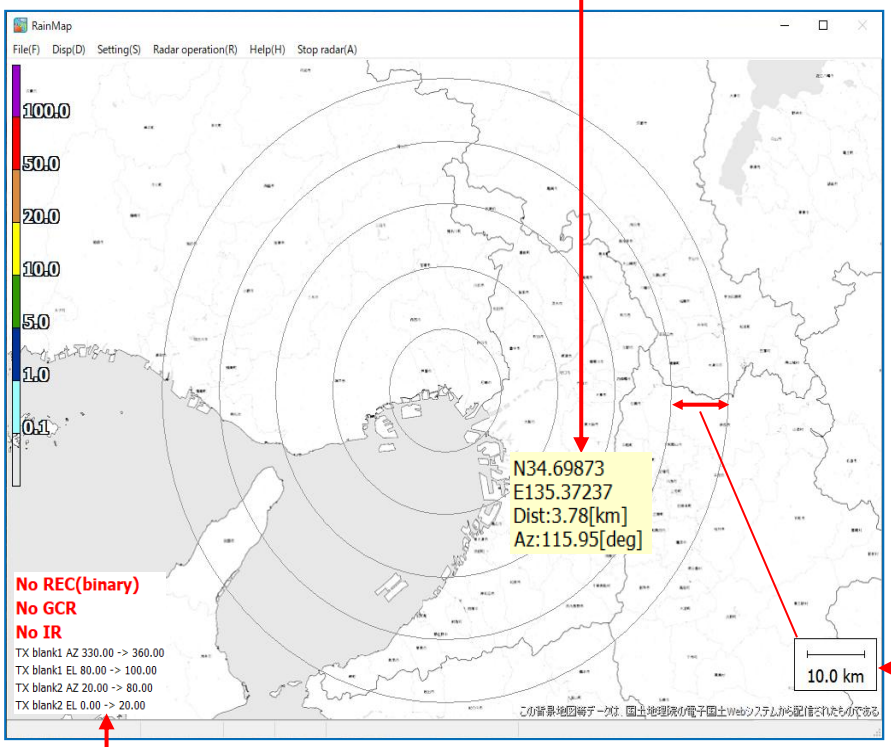
1) Turn off the power switch of the SPU to turn off the system. Confirm that the lamp inside the PXI (inside the SPU) is red, indicating the PXI is off.

2) Wait one minute, then press the power button again to turn the power on.



2. RainMap OPERATION

1) Turn on the DPU to start Windows®. Enter the username and password.
   - Be sure to login the radar with the "radar" account.
   - The DPU will automatically logs in with "radar" account after powering on.
   - The login password for the radar account is "radar". (It is not necessary to enter the password at startup)
2) When RainMap appears on the screen, right click anywhere on the display area of RainMap will show the following information of the location:
   Latitude/Longitude, distance from radar, and azimuth direction.



This indication shows the distance between each range ring.
The distance between rings can be changed:
[Setting] -> [Display] -> [Display range]

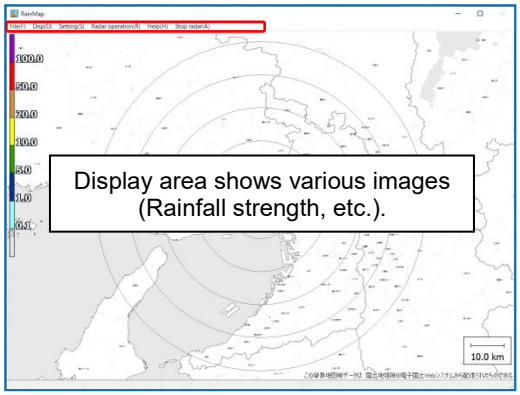
Show when item is selected “Yes”.

Setting items	ON	OFF
Binary data in data acquisition	No	Yes
Ground clutter rejection	No	Yes
Interference rejection	No	Yes
TX sector blank (1, 2)	Yes	No

➢ **Menu bar**

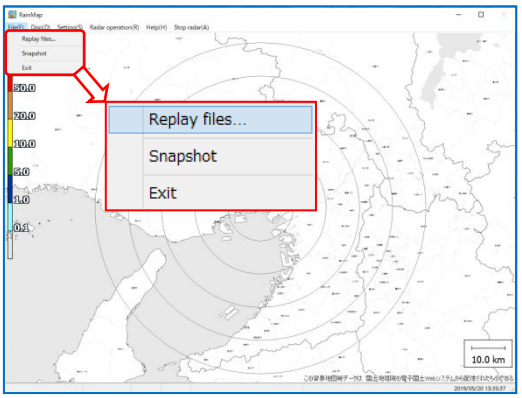
The menu bar at the top of the screen contains the following menus.

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



2.1. File Menu

Replay files…: Launches the RainPlay software, which opens and replays the stored data files (scn, scnx, gz, and other). (See chapter 4 for RainPlay instructions)
Note: gz is the compressed binary file.



Snapshot: Capture the screen in jpeg file format.

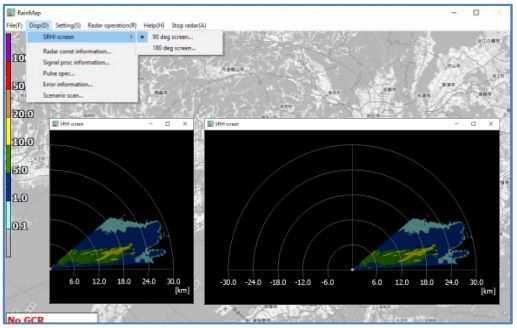
Exit: Close the RainMap software

2.2. Disp Menu

SRHI screen:

This screen is primarily used for SRHI scans.

- **90 degrees screen:** Displays SRHI echo at 90 degrees on sub screen.
- **180 degrees screen:** Displays SRHI echo at 180 degrees on sub screen.



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: Shows the signal processing settings.

Signal proc information

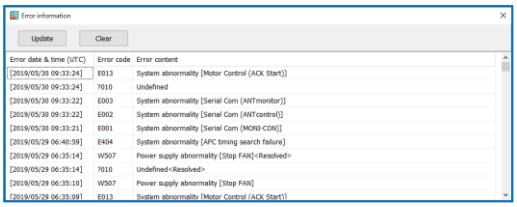
IR 1	ON
IR 2	ON
GCR	1
Threshold EL angle [deg]	20.00
SCR	OFF
Threshold EL angle [deg]	20.00
SQI threshold	0.00
Rainfall intensity estimation method	Kdp+Zh
Rainfall intensity estimation correction by EL	OFF
Output data range resolution [m]	75
K square value	0.93
ZDR offset correction [dB]	0.00
Rain output 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.: Shows the pulse specification.

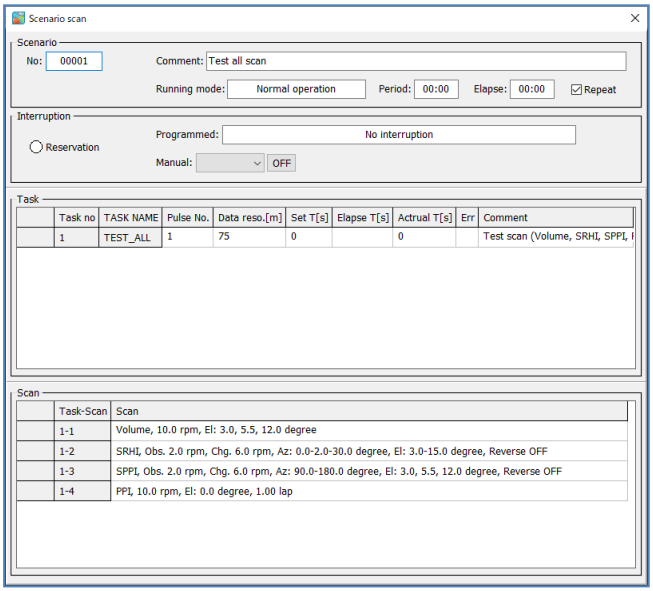
Pulse spec.

Key	Value
No	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: Shows the latest 50 (maximum) log error occurrences with date and time. Click the [Update] button to refresh the log to show the latest error information. Click the [Clear] button to clear error information.



Scenario scan: Combines four types of scans; PPI, Volume, SPPI, SRHI to scan for various observations.
Refer to the Scenario Scan Operator's Manual for detail.



2.3. Setting Menu

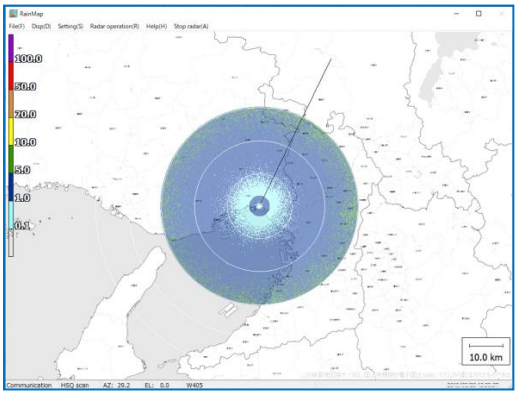
Display: Selects and confirms display settings.

Data acquisition: Selects and confirms recording settings.

Radar site location: Selects and confirms antenna location settings.

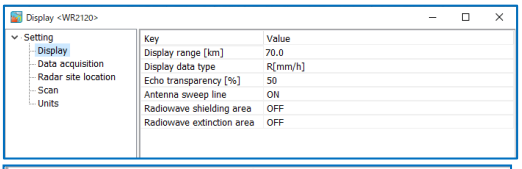
Scan: Select the scan mode patterns and details.

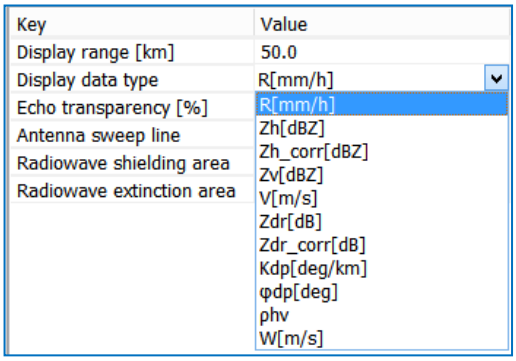
Units: Selects the antenna rotation speed unit.



2.3.1. Display

The items in this menu can be adjusted while observing the radar image.





Display range [km]: Sets the radar display range.

Display data type: Selects the observation data to display.

- **R [mm/h]:** Rainfall intensity.
- **Zh [dBZ]:** Reflectivity factor horizontal polarization wave.
- **Zh_corr [dBZ]:** Rain attenuation corrected Zh.
- **Zv [dBZ]:** Reflection factor of the vertical polarization wave.
- **V [m/s]:** Doppler velocity.
- **Zdr [dB]:** Radar reflection factor of difference between Zh and Zv.
- **Zdr_corr [dB]:** Rain attenuation corrected differential reflectivity.
- **Kdp [deg/km]:** Specific differential phase.
- **φdp [deg]:** Differential phase (cross polarization).
- **ρhv:** Correlation coefficient between Zh and Zv.
- **W [m/s]:** Doppler spectrum width.

Note: Some parameters can save into SCNv11 such as SNR and CCOR but cannot display in the RainMap. Please load the SCNv11 files into the RainPlay when display these parameters.

Echo transparency [%]: Set the degree of transparency for echo returns.

Antenna sweep line: Shows or hides the antenna sweep line on the screen.

Radiowave shielding area: Shows or hides the area(s) where radio waves cannot reach due to the topography.
- **OFF:** No shielding area displayed.
- **1:** Shielding area shown in gray.
- **2:** Shielding area shown in transparent gray (not transparent to SRHI).

Note: Configuration file (Clip_RainMap.csv in param folder) is necessary.

Radiowave extinction area: Determines whether the returned reflected wave is worthy of evaluation or not and shows or hides the area does not worthy of evaluation, using dual polarization parameter analysis.
- **OFF:** No extinction area displayed.
- **1:** Extinction area shown in gray.
- **2:** Extinction area shown in transparent gray (not be transparent to SRHI).

[About the shielding area and the antenna rotation]

Shielding area: There may be some areas where mountains or other obstructions are blocking the radio wave of radar. RainMap shows those areas in gray.

The display of the specified area in the "Clip_RainMap.csv" file is grayed out. See chapter 6 for the "Clip_RainMap.csv" file.

Antenna rotation: During PPI and Volume scan, the antenna is rotating clockwise based on the azimuth origin as shown in Figure 2-1.

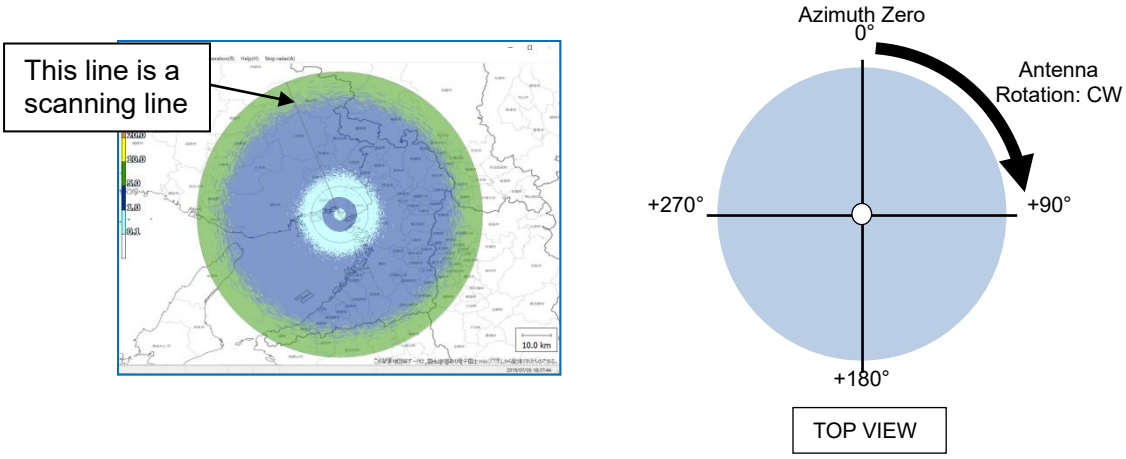
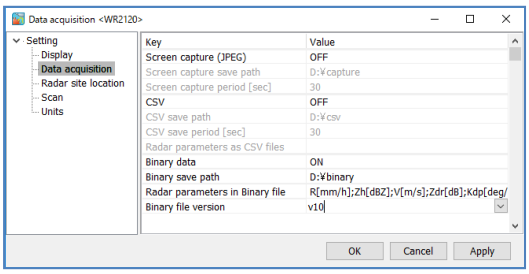


Figure 2-1: Antenna rotation

2.3.2. Data acquisition



Screen capture (JPEG): Select [ON] to capture screen data (jpeg format), or [OFF] to disable screen capture.

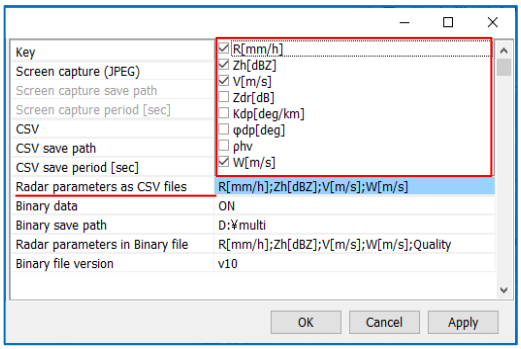
Screen capture save path: Selects the folder where to save captured screen data. Do not use the C drive.

Screen capture period: Selects the time interval to capture screen data.

CSV: Select [ON] to save data in CSV file format. (See section 7.1 for detail of CSV file format)

CSV save path: Selects the folder where to save the CSV data. Do not use the C drive.

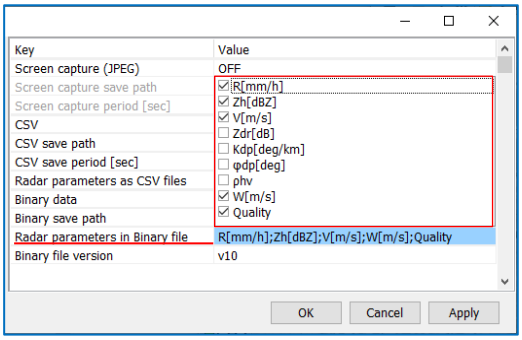
CSV save period [sec]: Selects the time interval to save the CSV data.



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

Binary data: Select [ON] to record in binary data format. (See section 7.2 for details about the binary file format)

Binary save path: Select the folder where to save the binary data. Do not use the C drive.

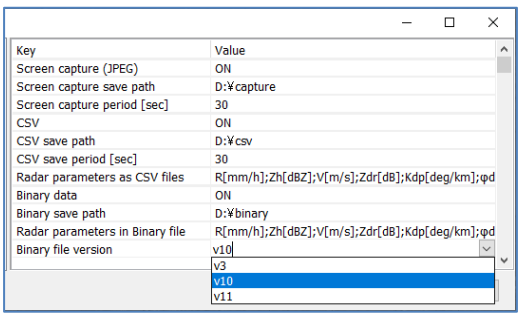


Radar parameters in Binary file: Select the type of parameter(s) from following:
R [mm/h], Zh [dBZ], V [m/s], Zdr[dB], Kdp[deg/km], φdp[deg], ρhv, W [m/s], Quality

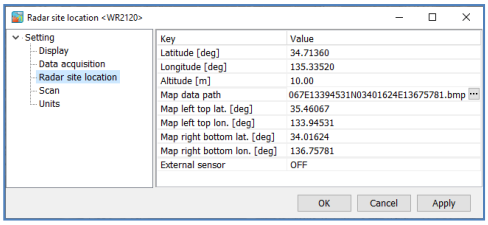
Note: R cannot be deselected.
Note: The following parameters can be selected in SCN v11: Zv [dBZ], Zh_corr [dBZ], Zdr_corr [dB], CCOR (Clutter collection ratio) [dB], SNR (Singal noise ratio) [dB], SQI (Signal quality index), UZh (Unfiltered reflectivity factor horizontal polarization wave) [dBZ], UZv (Unfiltered reflectivity factor vertical polarization wave) [dBZ].

Binary file version: Select the binary file version to use from the following:

- **v3:** Use Legacy format. See section 7.2 for detail.
- **v10:** See section 7.3 for detail.
- **v11:** See section 7.4 for detail.
  Note: v11 can only convert to HDF5.
  CF/Radial, NEXRAD, and UF are not supported at this time.



2.3.3. Radar site location



The items in this menu can be set during an observation.

Latitude [deg]: Sets the latitude of radar installation.

Longitude [deg]: Sets the longitude of radar installation.

Altitude [m]: Sets the radar installation altitude including the height above sea level.
(e.g., Height above sea level (elevation) + Building height + Radar stands height + radar height (0.5m) = Altitude [m])

Map data path: Sets the file of the background map for RainMap is saved. The RainMap program displays the map as a cylindrical projection layer.
Note: There is no map by default, therefore contact FEC support to create a map for it with providing the latitude/longitude information of the radar installed.

Map left top lat [deg]: The latitude of the top left corner of the “Map image” is set automatically.
Note: Do not change the setting.

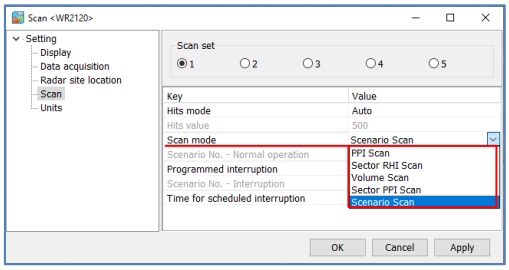
Map left top lon [deg]: The longitude of the top left corner of the “Map image” is set automatically.
Note: Do not change the setting.

Map right bottom lat [deg]: The latitude of the bottom right corner of the “Map Image” is set automatically.
Note: Do not change the setting.

Map right bottom lon [deg]: The longitude of the bottom right corner of the “Map Image” is set automatically.
Note: Do not change the setting.

External sensor: [ON] or [OFF] can be selected but leave in the [OFF] position.
Note: Keep this OFF, the default setting.

2.3.4. Scan



There are five scan patterns that can be customize and saved to the settings.
Note: This item is adjustable while observing.

However, it is necessary to click the [STBY] and [TX] button on the pull-down menu of [Radar operation] to reflect the changes to the scan setting.
(See section 2.5 for radar operation such as [STBY] and [TX])

Hits mode: Sets a sample value for caluculating Zh, Zdr, φdp, and ρhv. Recommendation is using the “Auto” mode.

- **Auto:** Adjusts the antenna rotation speed and PRF to appropriate values. The higher the hit value (lower rotation speed) the greater the accuracy.

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

For example, 10 rpm = 60 deg/sec

- **Manual:** Sets the value manually at [Hits value].

Hits value: Enter the value for the hits mode when [Hits mode] is selected to [Manual].
Note: It is possible that an excessive number of hits will increase the signal processing load and result in the loss of observational data. In that case, reduce the number of hits, or change to the Auto mode.

Scan mode: Select the scan mode for the antenna. A lower azimuth direction rotation speed gives higher accuracy. On the other hand, a fast rotation speed results in lower accuracy.

It is recommended to keep the rotation speed below 6.0 [rpm] to maintain observation accuracy. (See Table 2-8)

Table 2-1

Scan mode	Extension (V3 or V10)
PPI	ppi or ppix
Sector RHI	rhi or rhix
Volume	scn or scnx
Sector PPI	sppi or sppix
Scenario	According to the scan setting being executed

Table 2-2: 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	EL transition speed	0.5 to 6.0rpm
	AZ rotation speed	0.5 to 16.0rpm
Sector PPI	AZ rotation speed	0.5 to 16.0rpm

Note: The directional rotation speed can be set up to 16 rpm, but 10 rpm or less is recommended to maintain observation accuracy.

➢ PPI scan mode menu

[Plan Position Indicator scan]

Scans a continuous equiangular with 360-degree horizontal rotation at a single selectable elevation. Used to observe one set elevation continuously in a 360-degree radius.

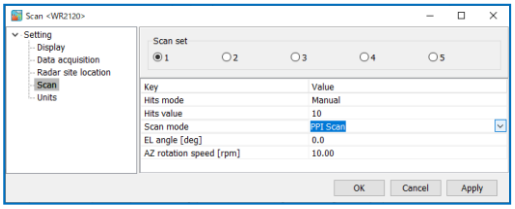
Example of settings: Observe 3.5 [deg] elevation angle at a rotational speed of 7.0 [rpm] in a 360-degree azimuth radius. (See Table 2-3)

EL angle [deg]: Sets the antenna's elevation angle during PPI mode.

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

Table 2-3

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



➢ Sector RHI scan mode menu

[Sector Range Height Indicator Scan]

Scans vertically (RHI) while moving horizontally, continuously within a preset azimuth and elevation range, generating a 3-dimensional rectangular solid angle. Horizontal data is not saved.

Continuously moves between the preset clockwise and counterclockwise azimuth and horizontal limits. (See Figure 2-2)

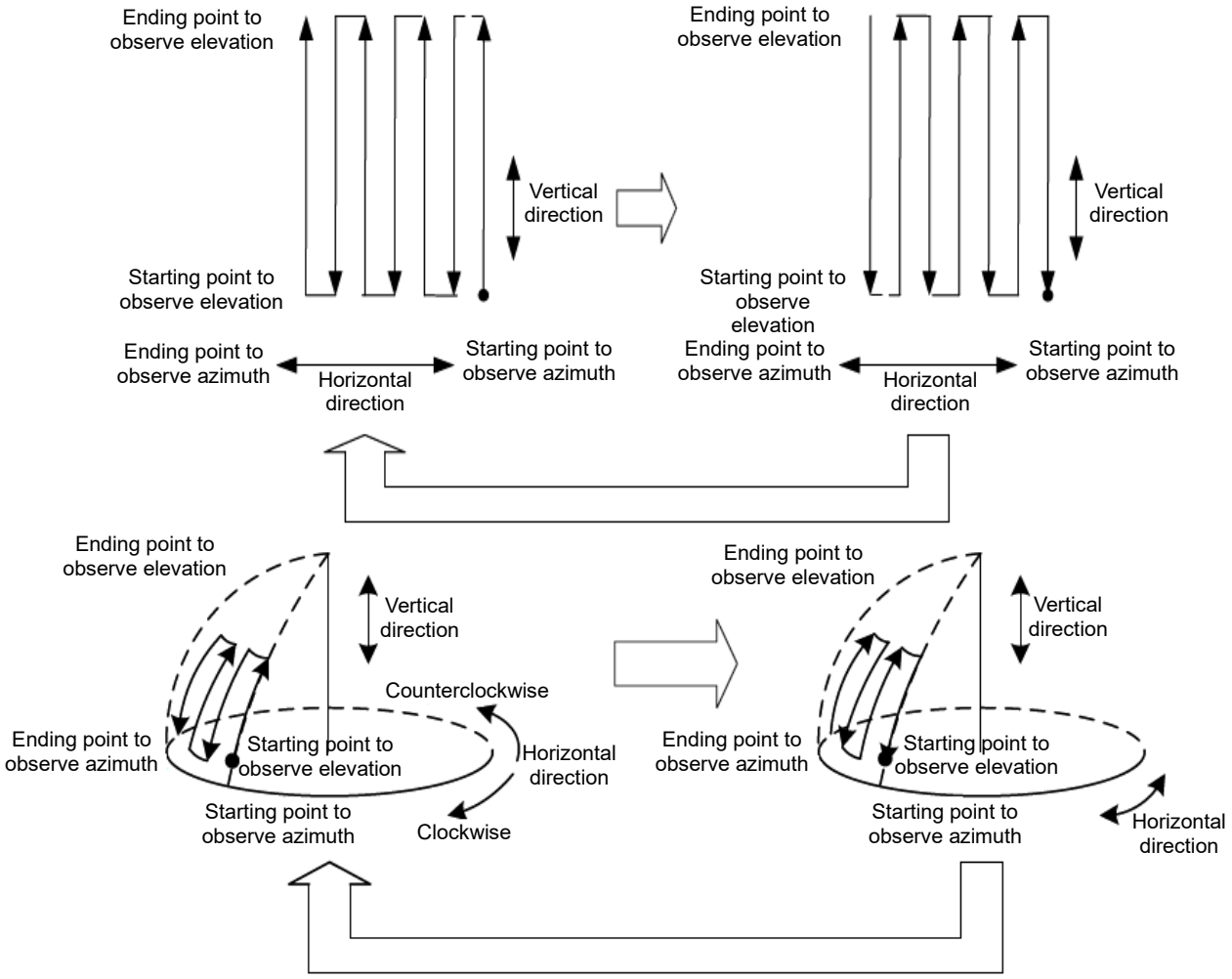


Figure 2-2: SRHI Scan mode

Example of settings: Enter the RainMap settings shown in Table 2-4 to observe with the parameters shown below:

- Range of azimuth angle: 30.0 to 60.0 deg.
- Azimuth step angle: 2.0 deg.
- Elevation angle: 3.5 to 22.0 deg.

Table 2-4

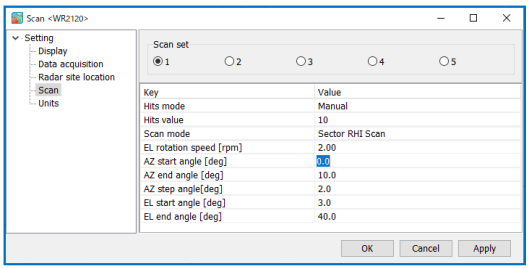
Key	Value
EL rotation speed [rpm]	2.0
AZ start angle [deg]	30.0
AZ end angle [deg]	60.0
AZ step angle [deg]	2.0
EL start angle [deg]	3.5
EL end angle [deg]	22.0

Note 1: The difference between the EL start angle and the end angle must be more than 0.1 [deg].
Note 2: A combination of 0 [deg] and 360 [deg] for AZ start angle and AZ end angle cannot be set.

EL rotation speed [rpm]: Sets the elevation speed of SRHI.

AZ start angle [deg]: Sets the azimuth start range.

AZ end angle [deg]: Sets the azimuth end range.



AZ step angle [deg]: Sets the number of antenna rotations to make while changing the azimuth angle.

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

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

➢ Volume scan mode menu

This mode activates PPI scan to change the elevation angle up to 32 steps, using the Volume Scan Period and RainMap time indication as reference. The scan starts from 0 seconds, which is an integral multiple of the Volume Scan Period, based on the time displayed in RainMap. For example, if the Volume Scan Period is 3 (20 / [h]), the scan start timing will be 00:00, 03:00, 06:00, and etcetera. All PPI scans for the configured elevation angle must be completed within the time of Volume Scan. Therefore, it is necessary to consider the number of elevation steps, observed rotation speed (rpm), movement speed in the elevation direction (rpm), and stabilization time after changing the elevation angle (fixed to 10 degrees) when setting the Volume Scan Period. (See Figure 2-3.)

Operation image of Volume scan:

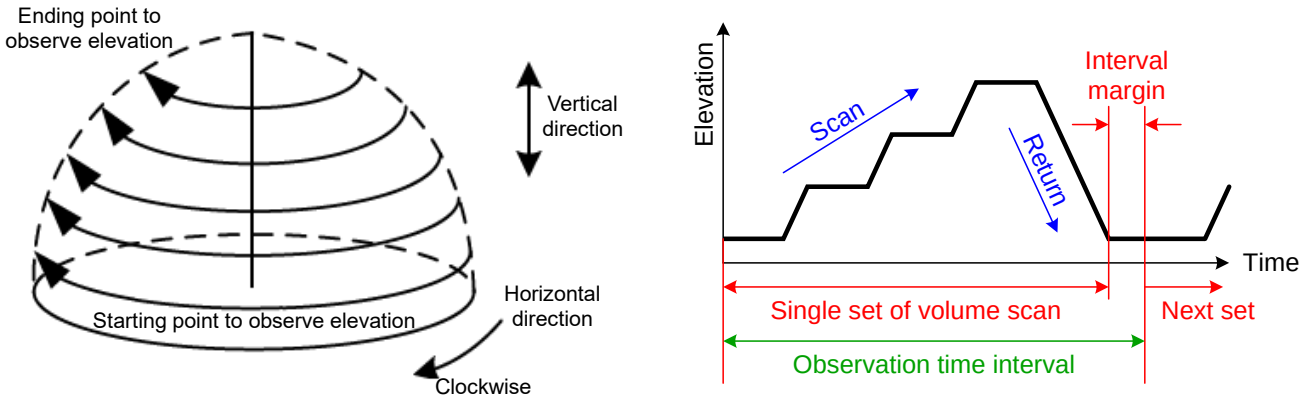


Figure 2-3: Volume Scan mode

Example of settings: When observing these six elevation angles (3.5 / 5.5 / 9.0 / 12.0 / 16.2 / 22.0 [deg]) every one minute, observation within a 58-second period can be completed by using the settings in Table 2-5. (Rotation set to 7.0 [rpm] in azimuth direction)

Table 2-5

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

Note 1: The ending time of the scenario is different if the elevation angle [deg] is different, even when using the same (0 to 5) elevation numbers.

Note 2: It is recommended to set the EL transition speed mode to "AUTO".

Bad example:
Below is the one bad example of volume scan setting.
it is not possible to observe six elevation angles by setting the volume scan period to 1 (60/[h]) with an azimuth rotation speed of 6.0 rpm (6 rotations per minute) that is because volume scan also requires an interval time to shift to the next elevation angle.

- Volume scan period: 1 (60/h)
- AZ rotation speed: 6.0 rpm << It must be 7.0 rpm or higher in this case.
- EL angle 0 to 5: Set 6 steps value

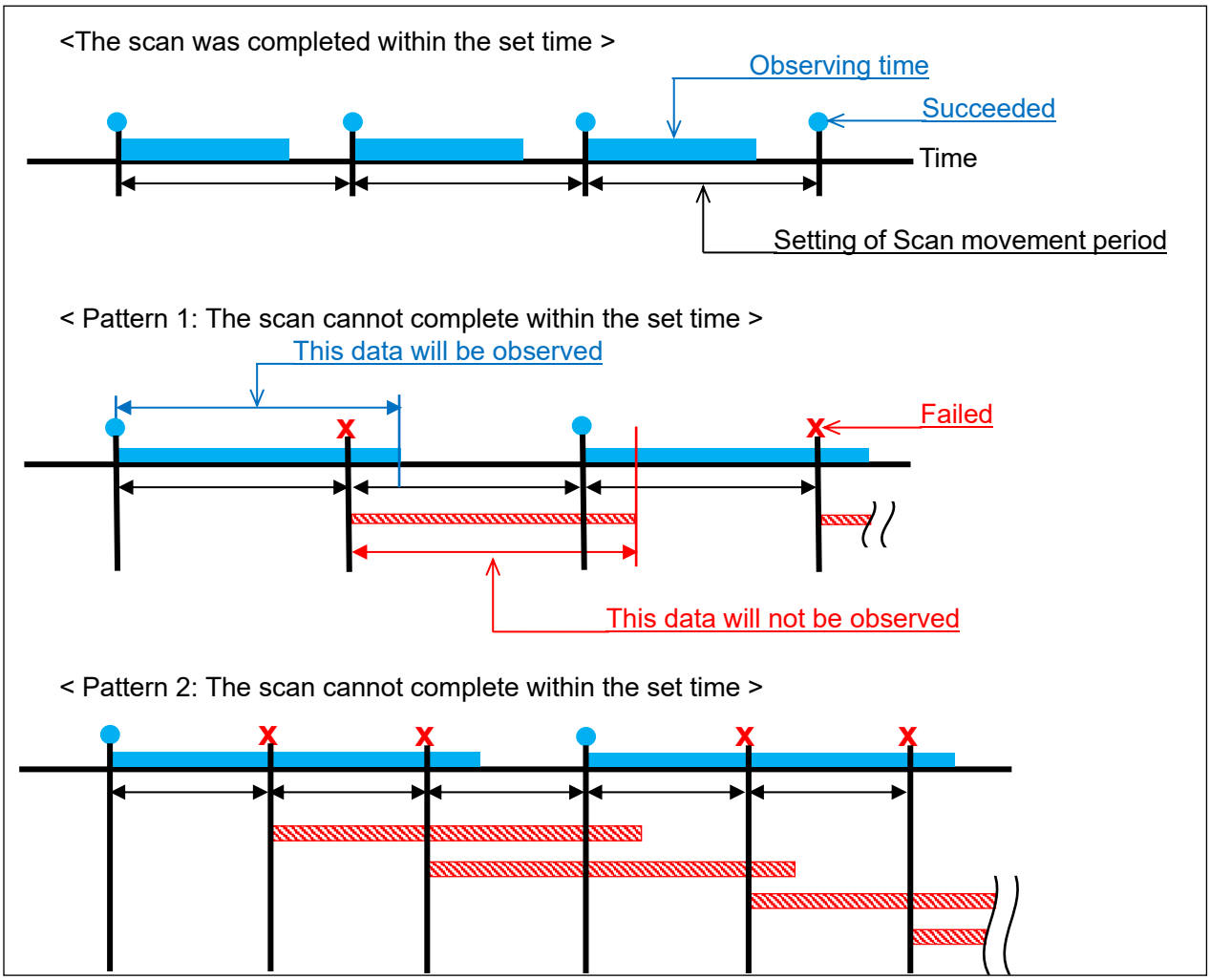


Figure 2-4: Image of observation timing

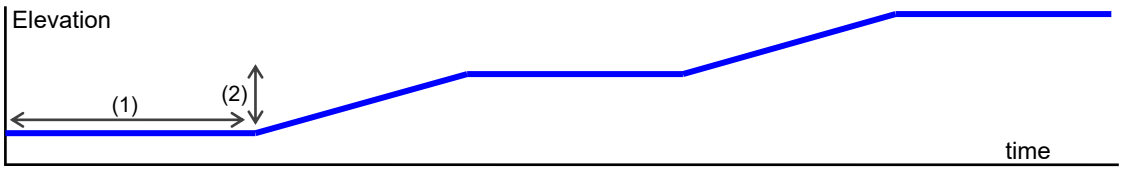
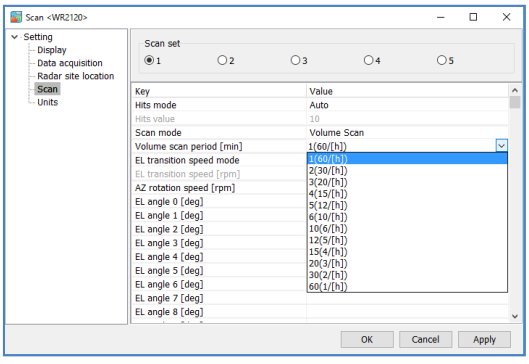


Figure 2-5: Image of elevation timing

(1) The elevation angle does not change and the rotation speed is set to the AZ rotation speed [rpm] during horizontal observation.
(2) The elevation angle changes during vertical movement according to the movement speed set by EL transmition speed[rpm].

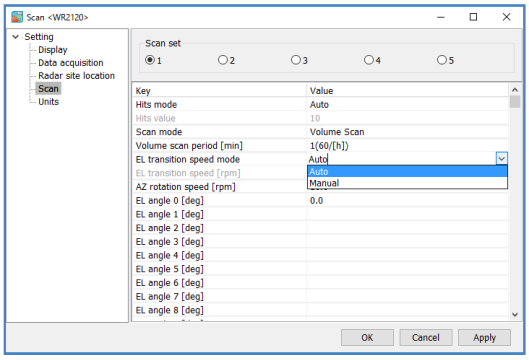
Volume scan period [min]: Select a volume scan move-ment period from:
1(60/[h]) / 2(30/[h]) / 3(20/[h]) / 4(15/[h]) / 5(12/[h]) / 6(10/[h]) / 10(6/[h]) / 12(5/[h]) / 15(4/[h]) / 20(3/[h]) / 30(2/[h]) / 60(1/[h])

For example, volume scan will activate every two minutes when [2(30/[h])] is selected. (It activates 30 times per hour; therefore, the measurement start time is 00, 02, 04, ..., 58 minutes.)



EL transition speed mode: Selects the radar elevation speed, [Auto] or [Manual].
Note: Select the [Auto] mode in normal operation.

- **Auto:** RainMap adjusts the speed of the radar elevation automatically.
- **Manual:** Set the speed manually.

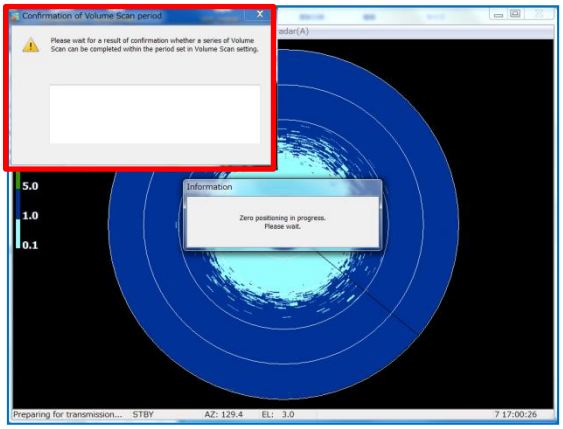


EL transition speed [rpm] (Manual setting): Sets an elevation direction rotation speed.

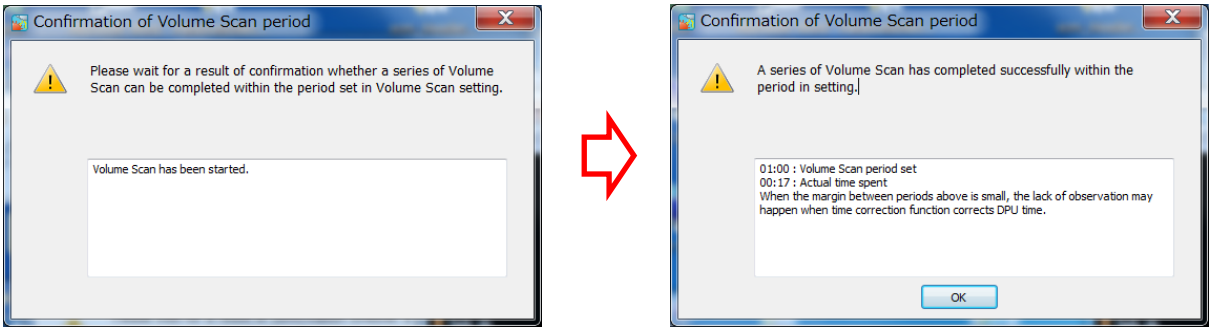
AZ rotation speed [rpm]: Sets the volume azimuth rotation speed.

EL angle 0 – 31 [deg]: Sets each elevation variation, up to 32 different values. The values are automatically sorted in ascending order.

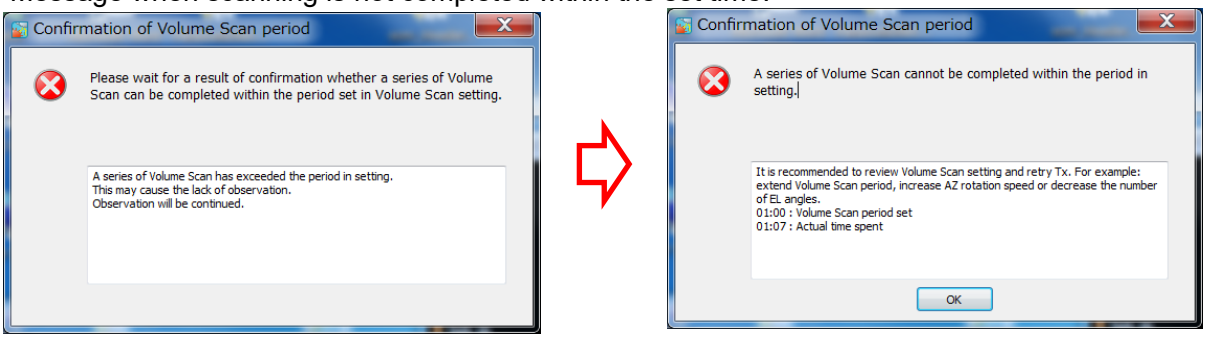
Status of volume scan screen: When it starts an observation after changing the settings, the scan time is displayed first, and then the last set time interval and the actual time required are displayed.



Message when scanning is completed within the set time:



Message when scanning is not completed within the set time:



➢ Sector PPI scan mode menu

[Sector Plan Position Indicator Scan]

Up to 32 elevation angles can be set, and horizontal scans are repeated in the specified azimuth angle range while changing the elevation angle to observe the rain area in the specified range. (See Figure 2-6)

Example of setting: The RainMap settings are shown in Table 2-6 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.

Table 2-6

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

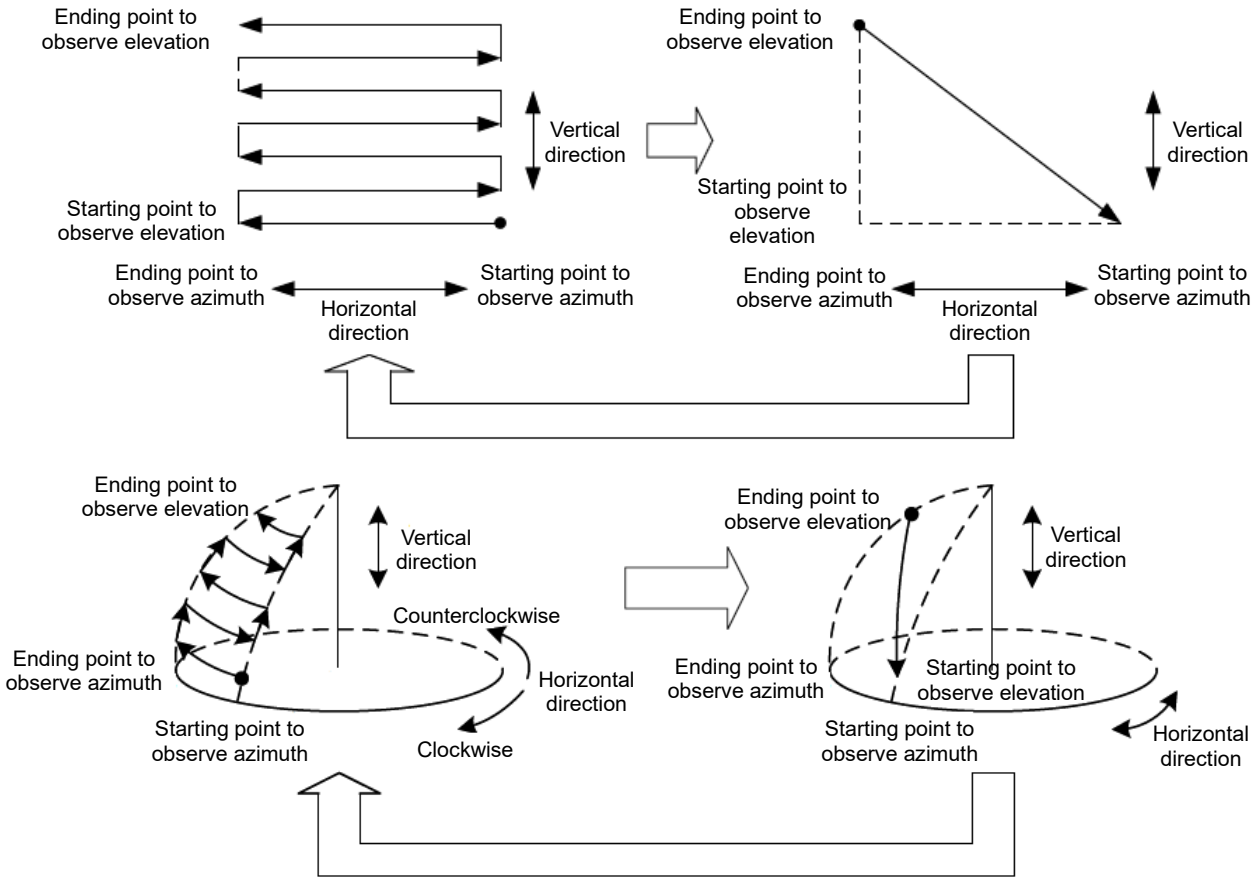
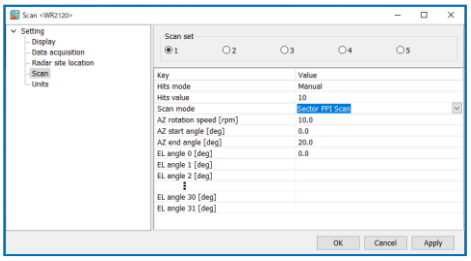


Figure 2-6: Sector PPI Scan mode

Note 1: Elevation movement is fixed at 6.0 rpm.
Note 2: A combination of 0 [deg] and 360 [deg] for AZ start and AZ end angle cannot be set.
Note 3: The difference between the AZ start and the AZ end angle must be more than 0.1 [deg].

AZ rotation speed [rpm]: Sets the azimuth rotation speed.



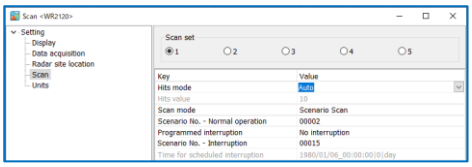
AZ start angle [deg]: Sets the azimuth start angle.

AZ end angle [deg]: Sets the azimuth end angle.

EL angle 0 – 31 [deg]: Sets each elevation variation, up to 32 different values. It values are sorted in ascending order.

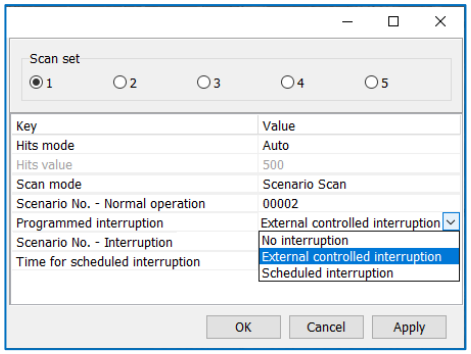
➢ Scenario scan mode menu:

Refer to the “Scenario scan operators manual” for details.



Scenario No. – Normal operation: Selects the scenario number to be performed during normal operation.

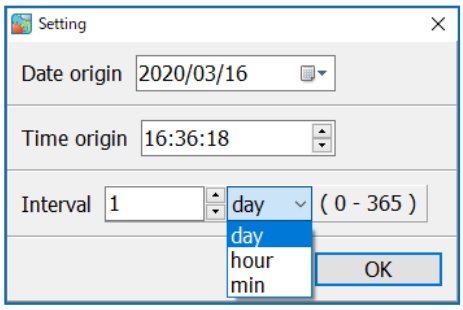
Programmed interruption: Select the type of interruption.



- **No interruption:** Sets no interruption.
- **External controlled interruption:** Rewrite "interrupt.txt" in the RainMap folder to start/end interrupts at any time.
- **Scheduled iterruption:** Use the [Time for scheduled interruption] to set the time at which the interrupt is to start, and to start the interrupt when the set time is reached.

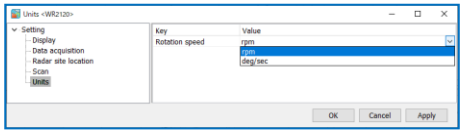
Scenario No. –Interruption: Selects the scenario number to use for the interruption.

Time for scheduled interruption: Selects the interrupt time interval used for schedule interruption.



2.3.5. Units

Rotation speed: Select the unit (rpm or deg / sec) for displaying the rotation speed



Note: Radar cannot control radar with a resolution of 1 deg/sec; to use units of deg/sec, enter multiples of 6 deg/sec.

2.4. Advanced Setting

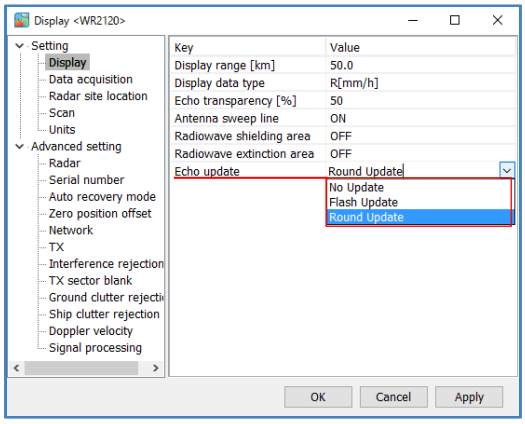
Press [Ctrl] + [Alt] + click [Setting] simultaneously to open the [Advanced setting] menu. The [Advanced setting] menu cannot be opened when the radar is transmitting. Click [STBY] or [Stop radar] to stop observation, then open the menu.

2.4.1. Setting

1) Display

Echo update: Selects how to update radar echoes.

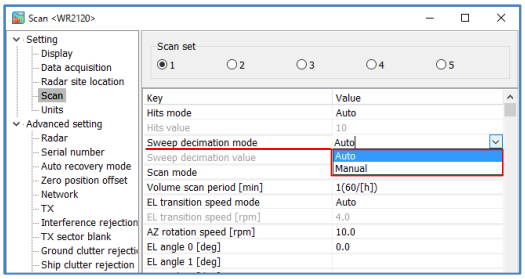
- **No Update:** Radar echo will not show on the screen. This setting can help reduce traffic volume at the DPU when using remote connection.
- **Flash Update:** Radar echoes are updated after one full antenna rotation.
- **Round Update** (Default setting): Continuously update the radar echoes in real-time.



2) Scan

Sweep decimation mode: Select either “Auto” or “Manual” mode in sweep decimation. It is strongly recommended using in “Auto” mode.

- **Auto:** This mode is to adjust the sweep decimation automatically and appropriately from the antenna rotation speed and PRF.



[Conditional expression]
Rotation speed ≦ 2 rpm: 0.25 deg / sweep (1 round about 1440 sweep)
2 rpm< Rotation speed ≦ 10 rpm: 0.5 deg /sweep (1 round about 720 sweep)

- **Manual:** Selects the sweep decimation interval manually.

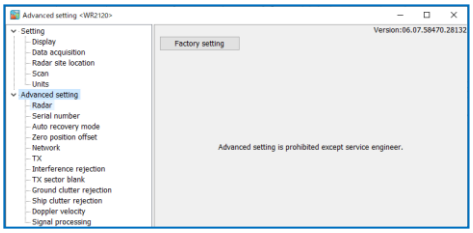
Sweep decimation value: Enter a value of sweep decimation when the sweep decimation mode is [Manual].

Note: The number of sweeps (the number of data) per scan changes depending on the sweep decimation value. Increasing the value reduces the number of data and decreasing the value increases the amount of data. If the sweep decimation value is too small, radar signal processing may slow, and the radar may not operate normally.

2.4.2. Advanced setting

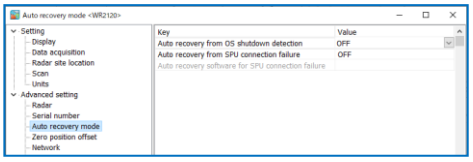
[Factory setting] in the Advanced setting menu is for manufacturer use only.

1) **Radar: Indicate only for [Factory setting].**



2) **Serial number (Manufacturer use only)**
Serial number: The serial number of the radar.
Product number: The product number of the radar.
Product name: The product name of the radar.

3) **Auto recovery mode**
Auto recovery from OS shutdown detection:
- **ON:** RainMap automatically restores to its pre-shutdown state when the OS (DPU) was unintentionally restarted.
- **OFF:** Disables auto recovery.

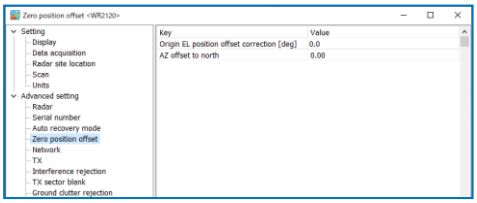


Example 1: Shutdown occurs during TRX: TRX state is restored after restarting.
Example 2: Shutdown occurs while TRX is stopped: TRX stop state is restored after restarting.
Note: TRX may start automatically when the DPU is powered, and the auto recovery setting is ON (Radar waves are emitted regardless of who turns on the power.). Some countries only permit authorized persons to start TRX. Therefore, use caution when turning on this setting.

Auto recovery from SPU connection failure:
- **ON:** The file registered in “Auto recovery software for SPU connection failure” initiates recovery when the connection between RainMap and the SPU has failed several times and is not reconnected.
  Notice: The WR2120 does not support this function.
- **OFF:** Disables auto recovery.

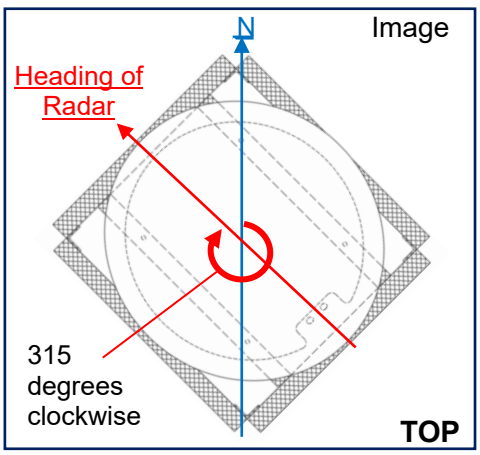
Auto recovery software for SPU connection failure: Unsupported function for WR2120.

4) **Zero position offset**
Origin EL position offset correction [deg]: Sets the tilt of the radar antenna to adjust the elevation origin horizontally.



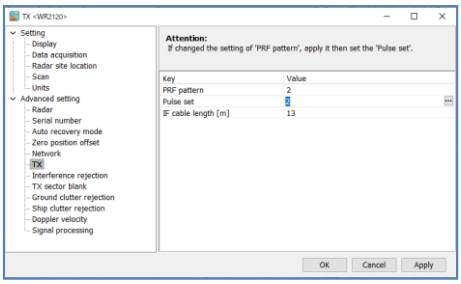
AZ offset to north: Sets the radar direction clockwise from the north.

Example: If the radar azimuth measurement is 315 degrees, then enter 315 in [Azimuth offset to north].



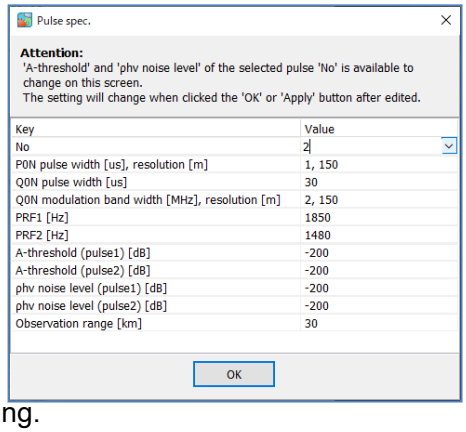
5) **Network: For manufacturer use.**

6) TX



PRF pattern: Selects the PRF pattern, from 1 to 3. (See Table 2-7. for details.), Then click [Apply] to apply the setting.

Note: If the PRF pattern is changed, the A-threshold value is not inherited. In this case, it is recommended to do the Renew A-threshold function again.



Pulse set: Click the […] button to select the pulse number pattern, from 1 to 8. A-threshold and ρhv noise level are automatically adjusted when Renew A-thresh-old function is performed (See section 2.8). A-threshold and ρhv noise level can be set manually, but ρhv noise level is recommended to use the Renew A-threshold function.

- 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 PRF signal processing.
- PRF 2 [Hz]: Long cycle for dual PRF signal processing.
- A-threshold (pulse 1) [dB]: Rain cut-off value of P0N.
- A-threshold (pulse 2) [dB]: Rain cut-off value of Q0N.
- ρhv noise level (pulse1) [dB]: This value is used to calculate SNR and correct ρhv.
- ρhv noise level (pulse2) [dB]: This value is used to calculate SNR and correct ρhv.
- Observation range [km]: Observation range (radius)
  No.1 = 30km, No.2 = 30km, No.3 = 50km, No.4 = 70km, No.5 = 50km, No.6 = 30km, No.7 = 50km, No.8 = 70km

Note 1: See Table 2.7 for pulse specification values.
Note 2: A-threshold is used to eliminate background noise in the received signal.
Note 3: Select a pulse set number, then click the [OK] button to register any changes made.
Note 4: P0N: Unmodulated pulse sequence used for short-range observations.
Note 5: Q0N: Frequency modulation pulse sequence used for long-distance observation.

IF cable length [m]:
Sets the actual length of coaxial for IF (intermediate frequency) cable between Antenna Unit (ATU) and Signal Processing Unit (SPU). The actual length is the specified value plus 3m as the wiring length in the ATU / SPU. For example, if the specification is 10m, the setting value will be 13m.

Recommend values for pulse setting: Select the optimum setting for the location while considering all related trade-offs of all observation settings. For example, it is not possible to observe rain with high accuracy using a fast antenna rotation speed, or wide detection range, and high resolution. There is a trade-off between the length of the detection range and the value of PRF. 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, and etc. are described in the World Meteorological Organization's "*WMO GUIDE TO METEOROLOGICAL IN-STRUMENTS AND METHODS OF OBSERVATION (the CIMO Guide, WMO-No. 8) PART 2 OBSERVING SYSTEMS CHAPTER 7 Radar measurements.*" and "*Guide to Operational Weather Radar Best Practices (WMO-No. 1257) Volume IV Weather Radar Siting, Configuration, and Scan Strategies*" Refer to it when configuring the radar.
For some observational tradeoffs, select the setting which best fits the radar installation location, referring to 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]	[μs]	[km]	[μs]	[MHz]	[Hz]	[Hz]	[m]		
1-1	30	0.5	3.3	20	4	2000	1600	75	Low	High
1-2	30	1	4.8	30	2	2000	1600	150	Mid	High
1-3	50	1	6.3	40	2	1700	1360	150	Low	Mid
1-4	70	1	7.8	50	2	1300	1040	150	Low	Low
1-5	50	2	7.8	50	2	1600	1280	150/300 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	150/300 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	150/300 Mix*	Mid	Mid
3-6	30	2	4.8	30	1	1750	1400	300	High	High
3-7	50	2	6.3	40	1	1475	1180	300	Mid	Mid
3-8	70	2	7.8	50	1	1125	900	300	Mid	Low

Note 1: Pulse No. 3-2 means PRF pattern = 3 and Pulse set = 2 in RainMap TX setting.
Note 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.
Note 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 receive interference waves from other transmissions. However, there are cases when this interference influence can be reduced.
Note 4: Mix*: Short pulse is 300, and long pulse is 150. Since the distance resolution when recording data is set separately, it does not affect the recorded file.
Note 5: Non-modulation pulse is P0N, Modulation pulse is Q0N.

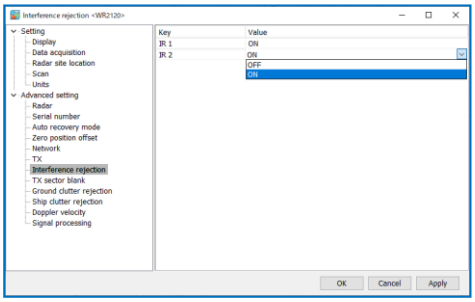
Sensitivity	Observation (approx.)	PRF1	Frequency	Doppler range
High	1mm/h	High	1700 to 2000Hz	±54.6 to ±64.2m/s
Middle	1.5mm/h	Middle	1300 to 1700Hz	±41.7 to ±54.6m/s
Low	2.5mm/h	Low	1100 to 1300Hz	±35.2 to ±41.7m/s

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

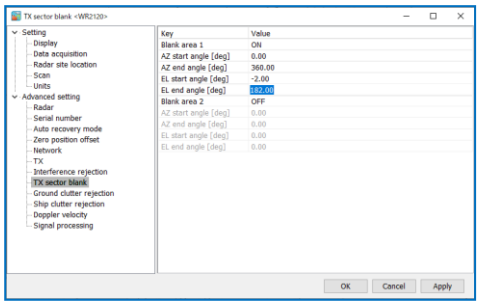
Many radar designs include an operator-selectable feature called the interference rejection (IR). The purpose of the IR is to reject or suppress interference into a radar receiver from co-channel transmissions from other radars. The IR is not effective against non-radar (communication-type) signals.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



IR 1, 2: Select [ON] to reject interference.
- IR1: Rejects the interference occurring before the matched filter (pulse compression).
- IR2: Rejects the interference occurring after the matched filter (pulse compression).

8) TX sector blank

Blank area 1 and 2: Select [ON] to activate the sector blank.



AZ start angle [deg]: Sets the azimuth start angle for the sector blank.

AZ end angle [deg]: Sets the azimuth end angle for the sector blank.

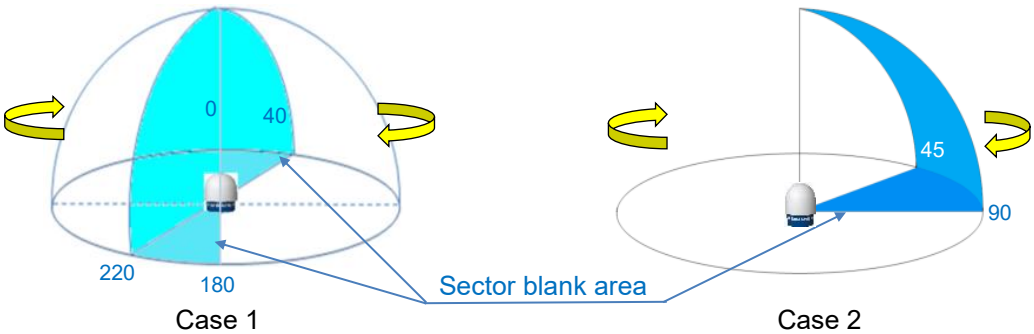
EL start angle [deg]: Sets the elevation start angle for the sector blank.

EL end angle [deg]: Sets the elevation end angle for the sector blank.

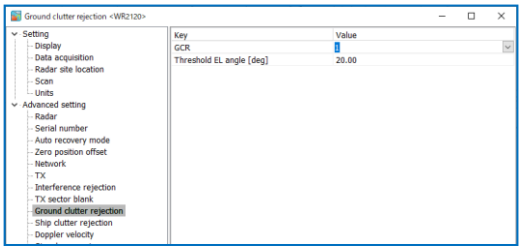
Note: The EL end angle can be set up to 182 degrees, but in that case, the sector blank must be set from -2 degrees to 90 degrees on the opposite side of 180 degrees from the start direction to the end direction.

Case 1: When the AZ start direction to end direction is 0 to 40 and the start elevation angle to end elevation angle is -2 to 182, transmission is stopped in both AZ directions 0 to 40 degrees and 180 degrees to 220 degrees.

Case 2: If the AZ start to end direction is 45 to 90 and the start to end elevation is -2 to 90, transmission is stopped only in the AZ direction of 45 to 90 degrees.



9) Ground clutter rejection

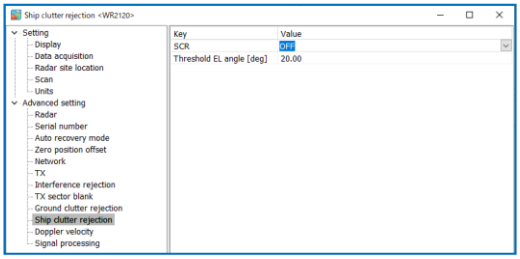


GCR: Select [OFF], [1], or [2] to specify whether to execute the ground clutter rejection process when the elevation angle being observed is lower than the threshold elevation angle.

- **OFF**: Disables ground clutter rejection.
- **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 Reference files (scr, scrx) and MTI process. (See section 2.8 of 4 for detail about reference data)

Threshold EL angle [deg]: Sets the threshold elevation angle. MTI processing is applied below the threshold elevation angle.

10) Ship clutter rejection

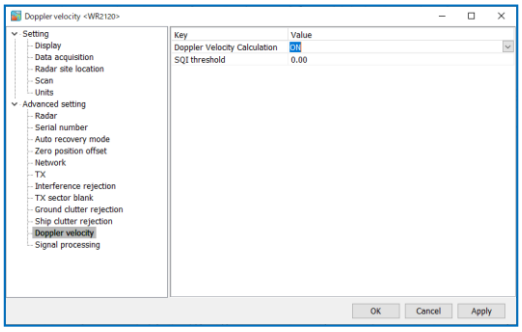


SCR: Select [OFF], [1], or [2] to specify whether to execute the ship clutter rejection process when the elevation angle being observed is lower than the threshold elevation angle.

- **OFF**: Disables ship clutter rejection.
- **ON**: Rejects the ship clutter based on the observation data

Threshold EL angle [deg]: Setup the threshold elevation angle. SCR processing is applied below the threshold elevation angle.

11) Doppler velocity

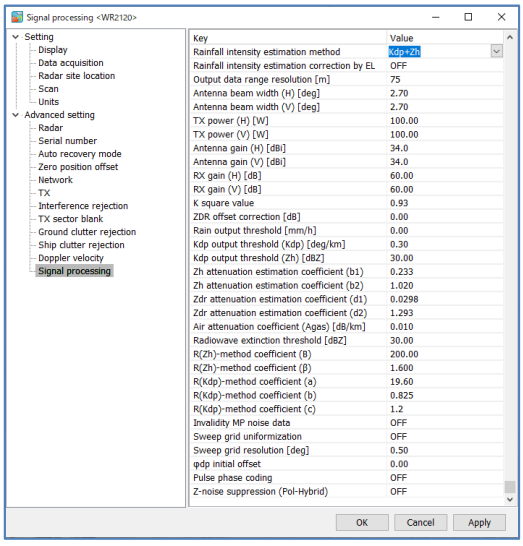


Doppler Velocity Calculation: Select [ON] to calculate the Doppler velocity.

SQI threshold: Set the SQI (Signal Quality Index) threshold (0.00 to 1.00). SQI is a quality indicator calculated from the correlation between a signal and its Doppler lag. If the SQI of each observation data point is below the threshold, the Doppler velocity and velocity range at that point are invalid.

.

12) Signal processing

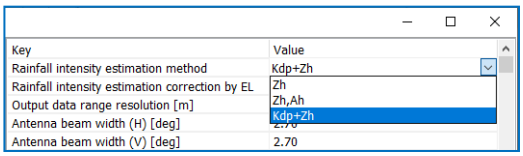


Rainfall intensity estimation method:
Selects a rainfall intensity estimation method. (See section 2.4.3)

- **Zh:** Calculates precipitation intensity based only on horizontal amplitude information.
- **Zh, Ah:** Calculates precipitation intensity based on Zh, which is corrected for precipitation attenuation by the Ah method.
- **Kdp+Zh:** Calculates rainfall intensity based on multi-parameters, amplitude, and phase.

Rainfall intensity estimation correction by EL: Select [ON] to correct the precipitation intensity estimation due to elevation angle changes.

Output data range resolution [m]:
Sets the range resolution of the data to output. If the value is 75 for example, the data is output every 75 m. It is recommended to set the same value as the range resolution of the pulse setting.



If the range resolution of the data to be output is smaller than the range resolution of the set pulse, the same value may be output even if the range is different.

Antenna beam width (H) [deg]: Half width of the main lobe horizontally polarized waves. (Do not change the setting.)

Antenna beam width (V) [deg]: Half width of the main lobe vertically polarized waves. (Do not change the setting.)

TX power (H) [W]: Sets the horizontally polarized waves power radiated from the antenna. (Do not change the setting. This setting does not affect the radar transmission output.)

TX power (V) [W]: Sets the vertically polarized waves power radiated from the antenna. (Do not change the setting. This setting does not affect the radar transmission output.)

Antenna gain (H) [dBi]: Sets the horizontally polarized waves gain of the antenna (based on the isotropic radiator). (Do not change the setting.)

Antenna gain (V) [dBi]: Sets the vertically polarized waves gain of the antenna (based on the isotropic radiator). (Do not change the setting.)

RX gain (H) [dB]: This is the gain of the entire horizontally polarized wave receiving system. (Do not change the setting. This setting does not affect the radar receive gain.)

RX gain (V) [dB]: This is the gain of the entire vertically polarized wave receiving system. (Do not change the setting. This setting does not affect the radar receive gain.)

K square value: A parameter proportional to raindrop's refractive index. The default value for rain is 0.93.

ZDR offset correction [dB]: Setts the Zdr offset value to revise amplitude deviation of horizontal and vertical.

Rain output threshold [mm/h]: The data threshold for precipitation intensity. Default setting is 0 mm / h. In this case, it can be observed even in light rain, but due to the difference in sensitivity between P0N and Q0N, the switching may be visible in the distance direction. To reduce this symptom, change the setting to 0.5 [mm / h] or thereabouts. To observe it in light rain, set to less than 0.5 [mm / h].

Kdp output threshold (Kdp) [deg/km]: If the value of Kdp is less than or equal to this threshold, Kdp [deg / km] is invalid. The default value is 0.3 [deg / km]. Values which are smaller than the default value are not recommended.

Kdp output threshold (Zh) [dBZ]: Sets Zh value of signal processing to calculate propagation phase difference rate of change Kdp[deg/km]. The default value is 30 [dBZ]. A setting lower than the default value is not recommended.

Zh attenuation estimation coefficient (b1) (b2): Sets the two types of signal processing coefficients (b1, b2) to calculate the rainfall attenuation for Zh.

Zdr attenuation estimation coefficient (d1) (d2): Sets the two types of signal processing coefficients (d1, d2) to calculate the rainfall attenuation for Zdr.
Air attenuation coefficient (AGAS) [dB/km]: Sets the coefficient to attenuate the air.

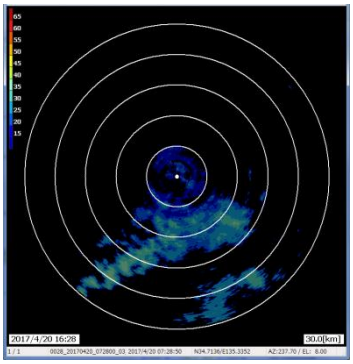
Radiowave extinction threshold [dBZ]: Sets a threshold value to judge whether radio waves have dissipated by comparing the value based on the precipitation attenuation value (Ah) and the propagation phase difference change rate (Kdp).

R (Zh)-method coefficient (B): Z-R relational expression: Z = BR ^ β
Here, Z [mm ^ 6 / m ^ 3] is the radar reflection factor, and R [mm / h] is the rainfall intensity. The default values for B and β for rain are 200 and 1.6, respectively. Enter the value of the coefficient "B".

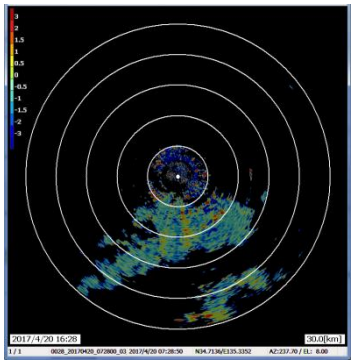
R (Zh)-method coefficient (β): Enter the value of the coefficient "β" (Beta).

R (Kdp)-method coefficient (a), (b), (c): a, b, and c are coefficients for calculating the rainfall intensity R (Kdp) [mm / h] using Kdp [deg / km]. Relational expression: Rain (Kdp) = c × a × Kdp^b

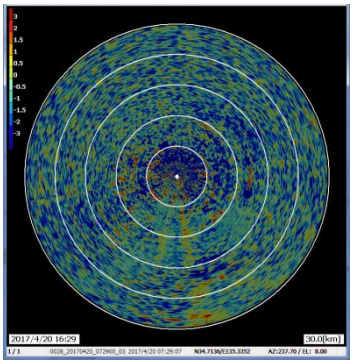
Invalidity MP Noise data: This function invalidates Zdr, ρhv, φdp, and Kdp when Zh is less than the A-threshold value. Select [ON] to disable multi-parameter noise.



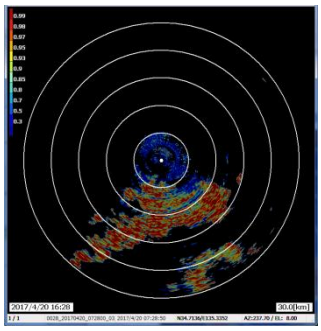
Zh



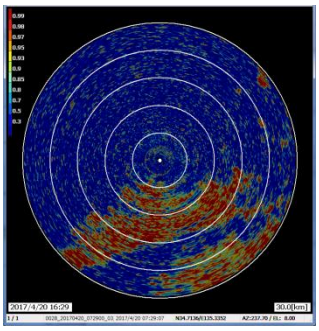
Zdr
Invalid MP Noise “ON”



Zdr
Invalid MP Noise “OFF”



ρhv
Invalid MP Noise “ON”



ρhv
Invalid MP Noise “OFF”

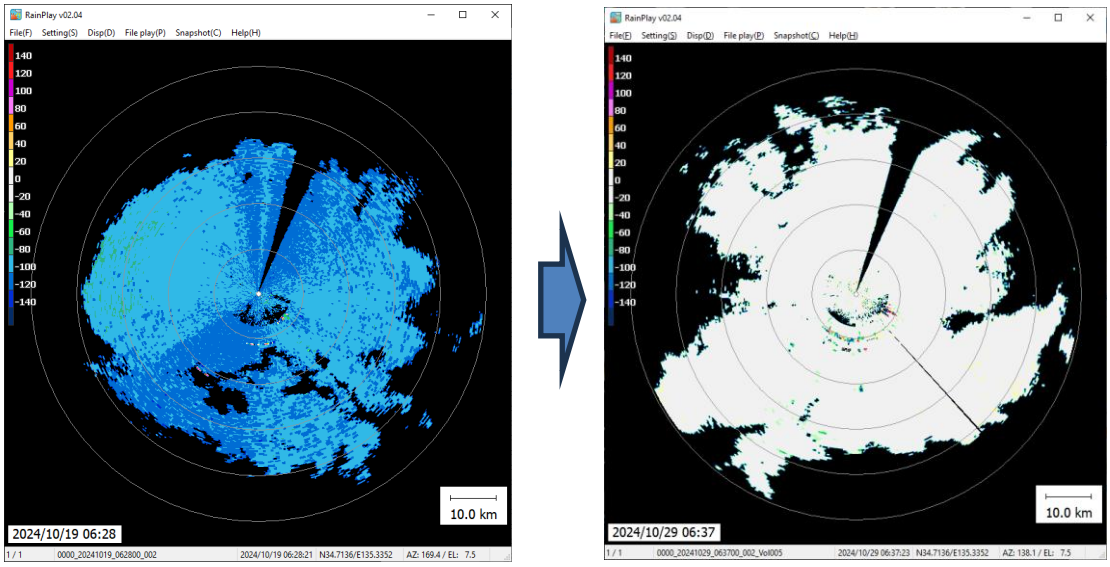
Note: Default value: Z = 200 R ^ 1.6 refers to Marshall-Palmer relation.
See the CIMO Guide to change the coefficient. Be aware of the possibility that rainfall error may increase.
(RM: Marshall, J. S., and W. McK. Palmer, 1948: The distribution of raindrops with size. J. Meteor., 5, 165–166.)

Sweep grid uniformization: Uniformizes the sweep interval of the observation data to be saved in the SCN files. For example, if this function is enabled for a PPI scan, the angular resolution in the azimuth direction will be constant.

Note: This function uses interpolation techniques to perform uniformization, which may result in angular errors; the worst-case error is 0.25 degrees.

Sweep grid resolution [deg]: Sets the resolution for [Sweep grid uniformization].

ϕdp initial offset: This function corrects the initial value of φdp (phase difference between H and V polarization). It is possible to adjust the value of φdp for precipitation echoes to around 0 deg. This change does not affect the calculation of Kdp.



Pulse phase coding: This function changes the phase of the pulse each time it is transmitted. The initial phase of the pulse will change randomly each time it is transmitted by selecting "random" with this function. The phase is restored during reception to match the phase change during transmission. Therefore, the phase of the first trip echo is received at the correct phase, and the phases of the second and more trip echoes are random. The W (Doppler Spectrum Width) of the second trip echoes will be wider, and the Doppler velocity will be random. Using this function makes it easier to identify higher-order trip echoes.

Z-noise suppression (Pol-Hybrid): This function increases the sensitivity of the received power by combining the H polarized and V polarized signals and suppressing noise components. When turned ON this function, set the A threshold (Pulse 1) [dB] and A Threshold (Pulse 2) [dB] in [Setting > Advanced Setting > TX > Pulse set] to low values within the range of 1 to 5 dB (recommended value is 4 dB). The effect of this function will not be seen unless lower the A-threshold value.

The calculation principles for Zh and Zv in this function are as follows:
First, the received power of normal H polarized waves is expressed by the following formula:

$$\hat{P}_h = \frac{1}{Hit}\sum_{i=1}^{Hit}|s_h(i) + n_h(i)|^2 = \langle|s_h + n_h|^2\rangle$$

Here, Hit is the number of pulse hits in the sample volume for which the received power is calculated, s_h is the complex signal of the target echo of the H polarization (unit: Volt), and n_h is the complex signal of the noise of the H polarization.

The received power of noise-suppressed H-polarized waves is expressed by the following formula:

$$\hat{P}_h(z - noize\ suppression) = |\langle(s_h + n_h) \times (s_v + n_v)^*\rangle| \sqrt{\frac{\langle|s_h + n_h|^2\rangle}{\langle|s_v + n_v|^2\rangle}}$$

Here, the asterisk (*) denotes the complex conjugate.
Similarly, the received power of noise-suppressed V-polarized waves is expressed by the following formula:

$$\hat{P}_v(z - noize\ suppression) = |\langle(s_h + n_h) \times (s_v + n_v)^*\rangle| \sqrt{\frac{\langle|s_v + n_v|^2\rangle}{\langle|s_h + n_h|^2\rangle}}$$

By calculating Zh and Zv using these received powers, noise-suppressed radar reflectivity factors can be obtained. This Zh is approximately equal to true Zh when the echo intensity is greater than the noise, but when the echo intensity is close to the noise level, it will not be

exact the true Zh but be mixed with some Zv. Therefore, the accuracy of the value is lost around the noise level, but it is useful because it can tell the presence or absence of echoes that were not observed near the noise level.
This function works on Zh, Zhc and Zv, but not on Zdr, Uzh, or UZv.

2.4.3. Precipitation estimates methods

Adjust the following parameters if the radar rainfall does not match the actual rainfall.

Zh method

1) Use standard equation, $\mathrm{Rain(Zh)} = \left(\frac{1}{\mathrm{B}}\right)^{\frac{1}{\beta}} \times 10^{\frac{\mathrm{Zh}}{10\times\beta}}$

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

2) The parameters “B” and “β” can be set from the [Advanced setting] menu. The default value of “B” is 200. “β” is 1.6. Zh unit is using dBZ.

Zh, Ah attenuation correction method

1) Calculate Zh_{corr} from Zh and Ah

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

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

2) The parameters b1, b2 and range direction data resolution Δr can set from the [Advanced setting] menu. The default values are 0.293, 1.101 and 0.1 [km], respectively.

3) Calculate rainfall intensity R from Zh_{corr} using same method of “Zh method” previously described.

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

Kdp+Zh method

1) Calculate 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] menu in RainMap.
(With elevation correction [OFF])

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

(With elevation correction [ON])

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

2) The parameters (a), (b), and (c) can set from advanced setting.
Default values are 19.6, 0.815, and 1.2, respectively.

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

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

3) The parameters $\mathrm{th(Kdp)}$ and $\mathrm{th(Zh)}$ can set from advanced setting.
Default values are 0.3 [deg/km], and 30 [dBZ], respectively.

2.5. Radar Operation



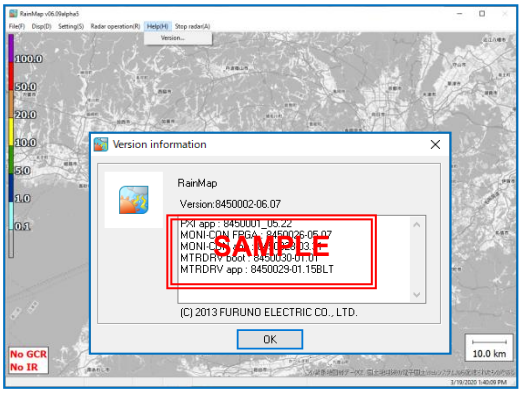
Connect: Connect the network between the DPU and the SPU.

Disconnect: Disconnect the network between the DPU and the SPU.

TX: Transmits, receives radar echoes, and rotates the antenna.

STBY: Stops transmission, stops receiving echoes, and stops rotating the antenna.

2.6. Help



Version: Shows the software version of the ATU and the SPU.
(RainMap, PXI App / MONI-CON FPGA / MONI-CON App / MTRDRV Boot / MTRDRV App)

Note: The radar must be connected to the network to show the version information.

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 radar adjustment menu in the menu bar. The radar must be connected by the RainMap show these items.

1) **Zero re-positioning**
   Forces the radar antenna to re-acquire the mechanical origin (zero point) direction. If an azimuth or elevation failure occurs, this function restores the origin position to normal.

2) **ATU/SPU reset**
   Force reboots the ATU and the SPU. Use only when error occurs during normal operations.

3) **Renew A-threshold**
   It measures the radar noise power and determines the denoising threshold and system noise level for each pulse according to the measured value. Click this menu item to start measurement and automatically stop upon completion of the measurement. A-threshold and phv noise level will be overwritten when this process is executed. This function is performed with the Z-noise suppression function disabled in order to obtain true noise. Please note that the A-threshold obtained by this function is the true noise threshold, the A-threshold for noise after Z noise suppression must be set manually.

   The threshold determinant formula is as follows:

$$Zh\ [\mathrm{dBZ}] = \begin{cases} C + 20\log_{10} r + P_r + 180, & \mathrm{A_Th} < C + P_r + 180 \\ C + P_r + 180, & \mathrm{A_Th} \geq C + P_r + 180 \end{cases}$$

   C: Radar constant (Refer the end of section 7.3 for deviation)
   r: Distance from radar [m]
   P_r: H-polarized wave reception power [dBm]
   That is, if the received signal does not exceed the A-threshold in the above determinant formula, $20\log_{10} r$ is not added to Zh, and Zh takes a very weak value. (-60 to -90 dBZ)

The V (Doppler velocity) and W (Doppler spectrum width) are processed using the following formula using a threshold value:

$$V\ [\mathrm{m/s}] = \begin{cases} V, & \mathrm{A_Th} < C + P_r + 180 \\ \text{Invalid value}, & \mathrm{A_Th} \geq C + P_r + 180 \end{cases}$$

$$W\ [\mathrm{m/s}] = \begin{cases} W, & \mathrm{A_Th} < C + P_r + 180 \\ \text{Invalid value}, & \mathrm{A_Th} \geq C + P_r + 180 \end{cases}$$

In addition, when [Invalidity MP Noise data] in section 2.4.2.12) is ON, Zdr, ρhv, φdp, and Kdp are also processed using thresholds:

$$Zdr\ [\mathrm{dB}] = \begin{cases} Zdr, & \mathrm{A_Th} < C + P_r + 180 \\ \text{Invalid value}, & \mathrm{A_Th} \geq C + P_r + 180 \end{cases}$$

$$\rho hv\ = \begin{cases} \rho hv, & \mathrm{A_Th} < C + P_r + 180 \\ \text{Invalid value}, & \mathrm{A_Th} \geq C + P_r + 180 \end{cases}$$

$$\varphi dp\ [\mathrm{deg}] = \begin{cases} \varphi dp, & \mathrm{A_Th} < C + P_r + 180 \\ \text{Invalid value}, & \mathrm{A_Th} \geq C + P_r + 180 \end{cases}$$

$$Kdp\ [\mathrm{deg/km}] = \begin{cases} Kdp, & \mathrm{A_Th} < C + P_r + 180 \\ \text{Invalid value}, & \mathrm{A_Th} \geq C + P_r + 180 \end{cases}$$

4) Auto ground clutter mapping

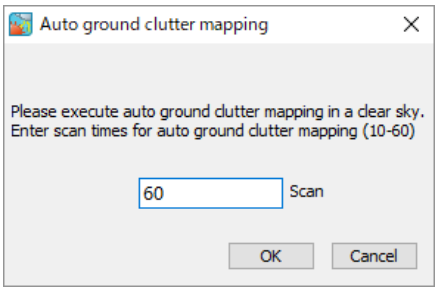
This function uses Volume Scan, and the time required for mapping and the elevation angle to be mapped depend on the Volume Scan settings. In addition, since the clutter observation result differs depending on the pulse setting, it is necessary to determine the pulse setting as well.

To obtain accurate ground clutter data, measurements should be taken on a day when there is no rainfall within the observation range (clouds are acceptable).

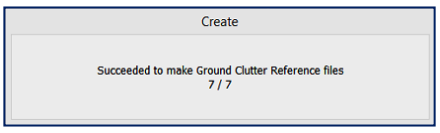
After deciding the pulse settings and Volume Scan settings to use for observation, click this menu to start the measurement. Automatically measures A maximum of 32 elevation angles (set in Volume Scan) are automatically measured, and the measurement stops after completion

(1) Sets the number of times to run the scenario, from 10 to 60. The larger the number the higher the accuracy.

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



(3) Ground clutter measurements are completed after the reference map (scr, scrx) has been created. After the measurement is completed (see the sample screen on the right), restart RainMap manually.

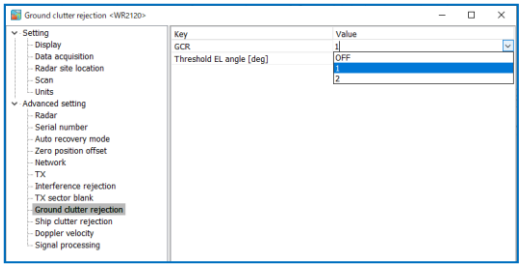


Data format of measured “scrx” file is the same as “scnx” file (“scr” is “scn”). Check the reference folder in RainPlay.
File directory: “Windows(C) > Users > Radar > Furuno > RainMap_RainPlay > Reference”

Auto ground clutter mapping duration =
Volume Scan Period x Number of Scenario execution + Data processing time

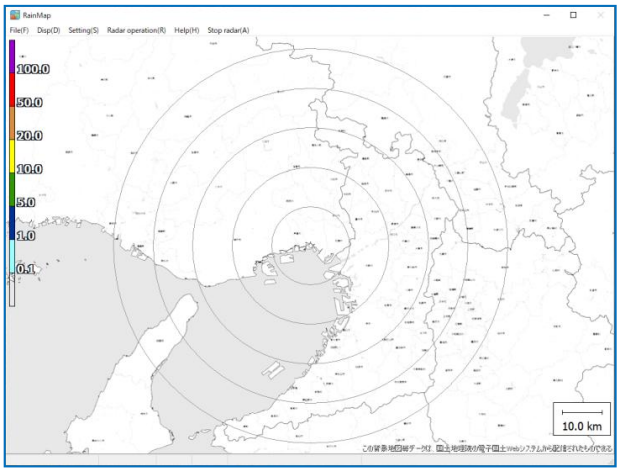
Execution example:
(1) Go to the “Scan” setting menu.
(2) Select the [Scan mode] to [Volume scan].
(3) Set the [Volume scan period [min] to [1(60/[h]) [min].
(4) Set the EL angle from 0 to 5 as follows: 3 deg, 6 deg, 9 deg, 12 deg, 15 deg, 20 deg.
(5) Set the [AZ rotation speed] to [10.00]. (It is recommended to set the rotation.)
(6) Select [Radar operation] from the menu bar, then select [Auto ground clutter mapping] in the pull-down menu to start operation.
(7) When pop-up message appears, set the scan measurements to the maximum value of 60. (With these settings, it takes 1 minute x 60 + time to process the mapping from the acquisition data. Set a maximum value to get the most accurate data)
(8) Click [OK] to start the ground clutter measurement.

Note 1: It may take time to start RainMap if there are many reference map files.
Note 2: The reference map created by "Auto ground clutter mapping" is applied only if "2" is selected in GCR.

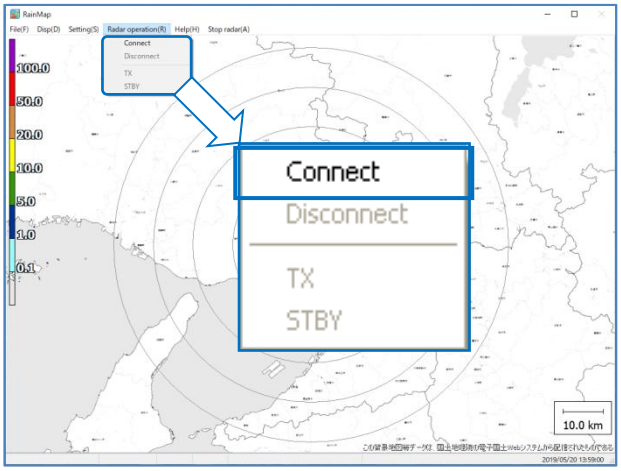


2.9. Operation Process

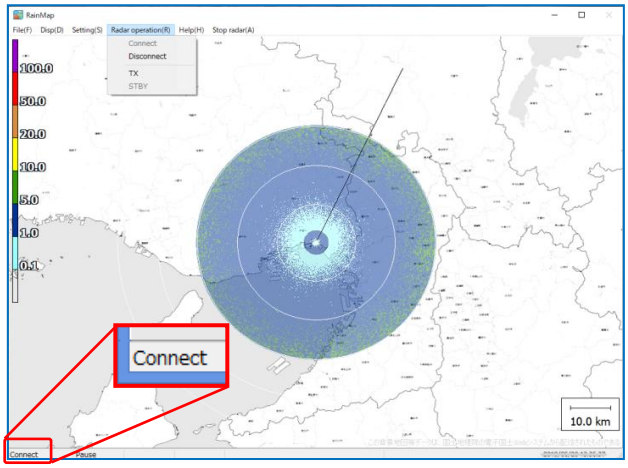
1) Start rainfall observation



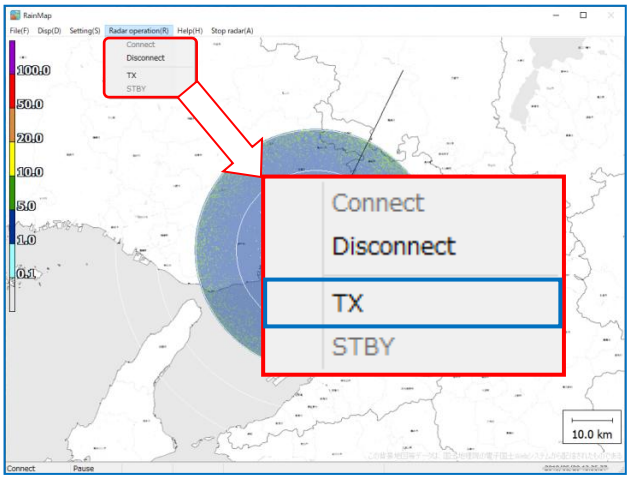
Set the observation parameters. (Pulse spec, Data acquisition, Scan mode, other)



Click [Radar from operation] and select [Connect] from drop-down menu



RainMap shows [Connect] at the bottom-left corner of the screen when the SPU and the DPU are connecting to one another and communicating

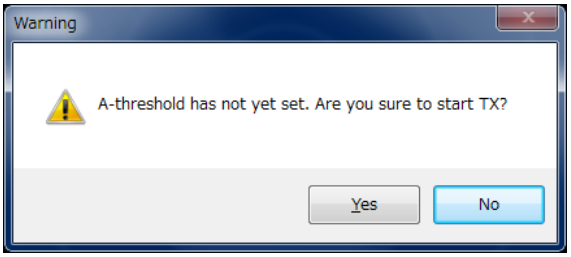


Select [Radar operation] and select [TX] from the drop-down menu.

A-threshold setup complete?

No

Yes



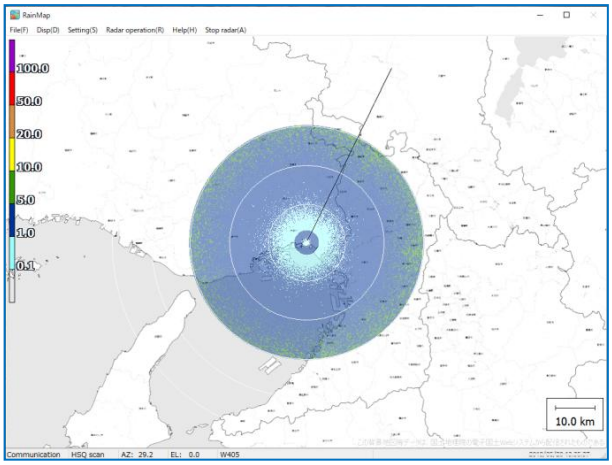
Note: This message will not display by default since the A threshold has already been set.

No



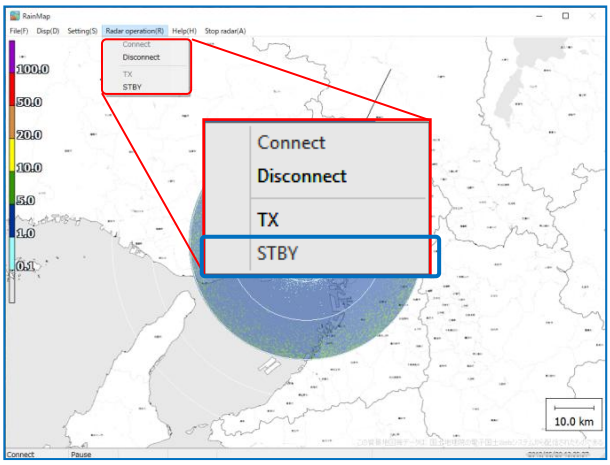
Yes



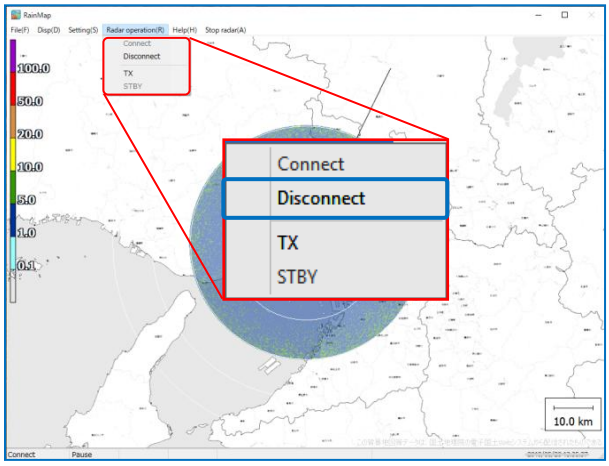


When start a radar observation, the observation information displays on the screen and the recorded data are saving into the data storage device.

2) Stop rainfall observation

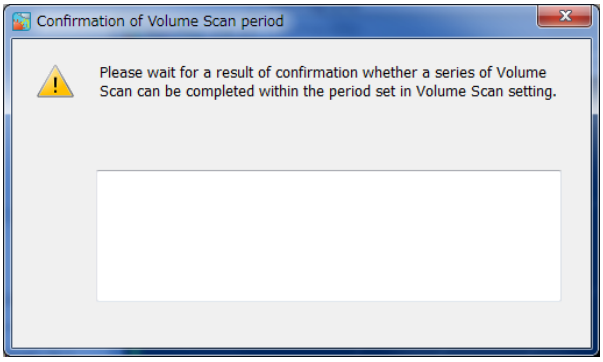


Select [Radar operation], then select [STBY] to stop the radar operation.



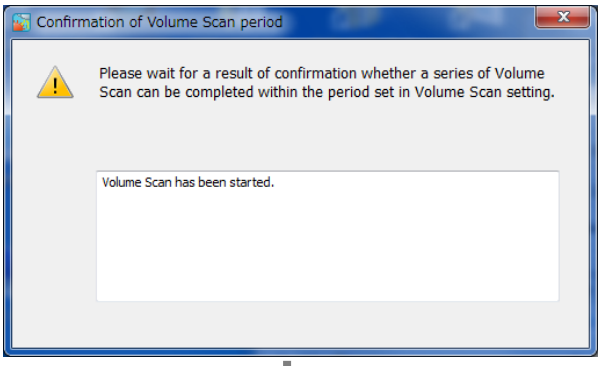
Select [Radar operation], then select [Disconnect] to disconnect

3) Volume scan observation



Start Volume Scan following the procedure in 1)

Note: This pop-up window appears only when the scan setting has changed.

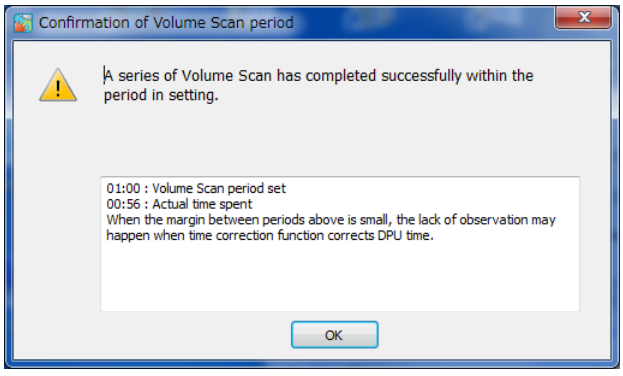


Start measuring the scan time

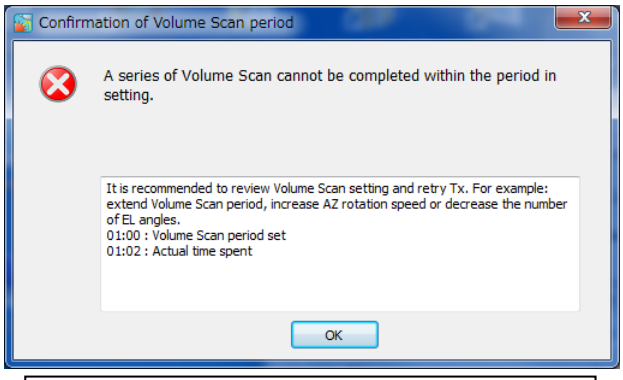
Was the scan completed within the Volume Scan cycle?

Yes

No



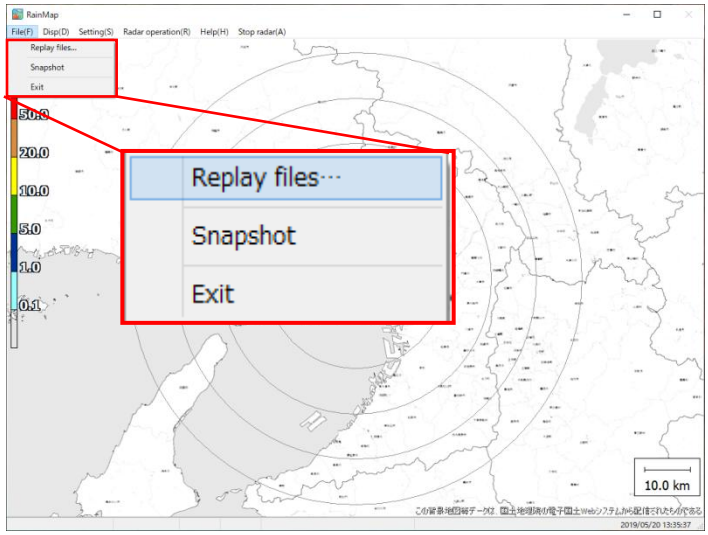
Volume scan was completed successfully.



Volume scan failed.
Check the setting and re-observe.

2.10. Observation Data Confirmation

1) Start playing the observation data



Click [File] from the menu bar, then select [Replay files···.]

Go to chapter 4

2) Scale label

The signal level of the displayed image is showing in 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 the label on the screen is determined by the available space on the left side of the screen.

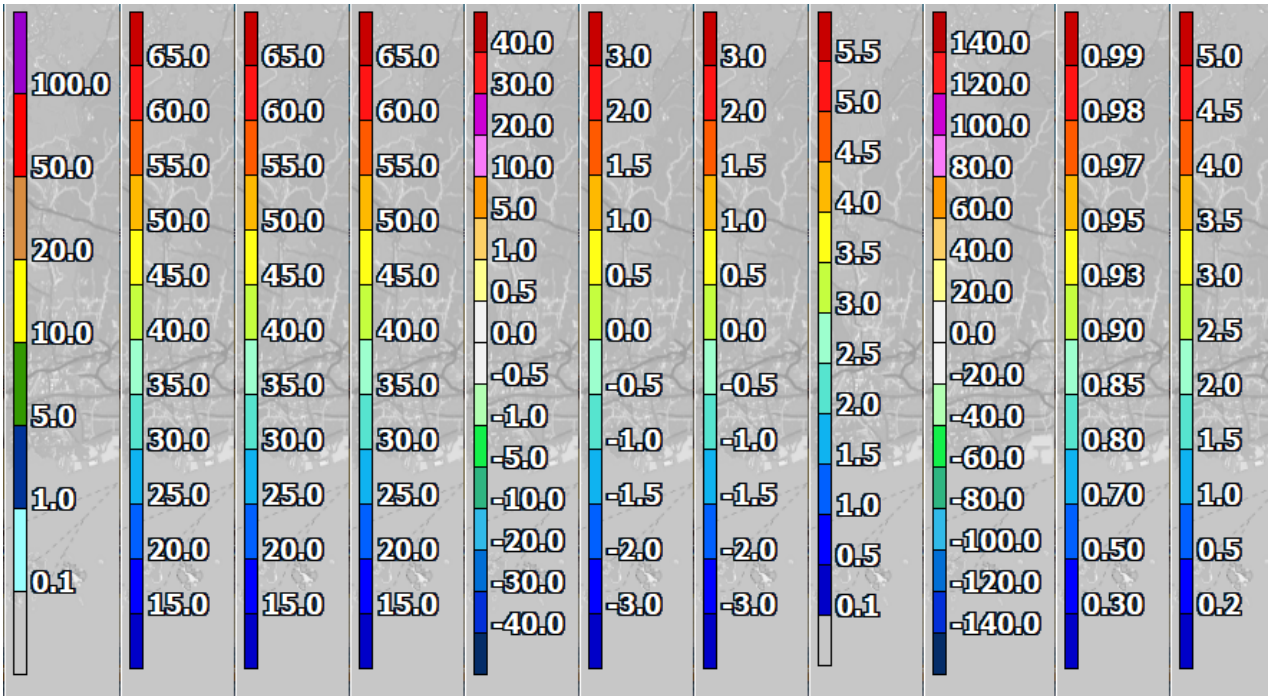


Figure 2-7: Scale label indication

3. RainMap SETTING TABLE

This chapter provides an overview to the RainMap settings.

3.1. Basic Setting

Click [Setting] to show the [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] / ϕdp[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
		Scale label		Default / Type1
	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] / ϕdp[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] / φdp[deg] / phv / W[m/s] / Quality
		Binary file version		v3 / v10
	Radar site location	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]
		External sensor		OFF / ON
	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 / Scenario Scan
		PPI Scan	EL angle [deg]	-2.0 - 90.0 [0.1]
			AZ rotation speed [rpm]	0.50 - 16.00 [0.01]
		Sector RHI Scan	EL rotation speed [rpm]	0.50 - 6.00 [0.01]
			AZ start angle [deg]	0.0 - 360.0 [0.1]
			AZ end angle [deg]	0.0 - 360.0 [0.1]
			AZ step angle [deg]	0.0 - 360.0 [0.1]
			EL start angle [deg]	-2.0. - 182.0 [0.1]
			EL end angle [deg]	-2.0. - 182.0 [0.1]
		Volume Scan	Volume scan period [min]	1(60/[h]) / 2(30/[h]) / 3(20/[h]) / 4(15/[h]) / 5(12/[h]) / 6(10/[h]) / 10(6/[h]) / 12(5/[h]) / 15(4/[h]) / 20(3/[h]) / 30(2/[h]) / 60(1/[h])
			EL transition speed mode	Auto / Manual
			EL transition speed [rpm]	0.5 - 6.0 [0.1]
			AZ rotation speed [rpm]	0.5 - 16.0 [0.1]
			EL angle 0【deg】	-2.0 - 90.0 [0.1]
			↓	↓
			EL angle 31【deg】	-2.0 - 90.0 [0.1]
		Sector PPI Scan	AZ rotation speed [rpm]	0.5 - 16.0 [0.1]
			AZ start angle [deg]	0.0 - 360.0 [0.1]
			AZ end angle [deg]	0.0 - 360.0 [0.1]
			EL angle 0【deg】	-2.0 - 90.0 [0.1]
			↓	↓
			EL angle 31【deg】	-2.0 - 90.0 [0.1]
		Scenario Scan	Scenario No. - Normal operation	00001 - 00030
			Programmed interruption	No interruption / External controlled interruption / Scheduled interruption
			Scenario No. - Interruption	-
			Time for scheduled interruption	Date origin / Time origin / Interval (day / hour / min)
	Units	Rotation speed		rpm / deg/sec

3.2. Advanced Setting

Press [Alt]+[Ctrl] keys + clicked [Setting] menu simultaneously to show the [Advanced setting] menu.

Setting	Display	Echo update		No Update / Flash Update / Round Update
	Scan	Sweep decimation mode		Auto / Manual
		Sweep decimation value		1 - 200 [1]
Advanced setting	Radar	-		-
	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]		-3.0 - 90.0 [0.1]
		AZ offset to north		0.00 - 360.00 [0.01]
	Network	-		-
	TX	PRF pattern		1 - 3 [1]
		Pulse set / No		1 - 8
		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]	
		IF cable length [m]		1 - 23 [1]
	Interference rejection	IR 1		OFF / ON
		IR 2		OFF / ON
	TX sector blank	Blank area 1		OFF / ON
		AZ start angle [deg]		0.00 - 360.00 [0.01]
		AZ end angle [deg]		0.00 - 360.00 [0.01]
		EL start angle [deg]		-2.00 - 182.00 [0.01]
		EZ end angle [deg]		-2.00 - 182.00 [0.01]
		Blank area 2		OFF / ON
		AZ start angle [deg]		0.00 - 360.00 [0.01]
		AZ end angle [deg]		0.00 - 360.00 [0.01]
		EL start angle [deg]		-2.00 - 182.00 [0.01]
		EZ end angle [deg]		-2.00 - 182.00 [0.01]
	Ground clutter rejection	GCR		OFF / 1 / 2
		Threshold EL angle [deg]		-2.00 - 90.00 [0.01]
	Ship clutter rejection	SCR		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
		Sweep grid uniformization		OFF / ON
		Sweep grid resolution [deg]		0.50 / 0.60 / 0.75 / 1.00 / 1.50 / 3.00
		φdp initial offset		-180.00 ~ 180.00
		Pulse phase coding		OFF / Random
		Z-noise suppression (Pol-Hybrid)		OFF / ON

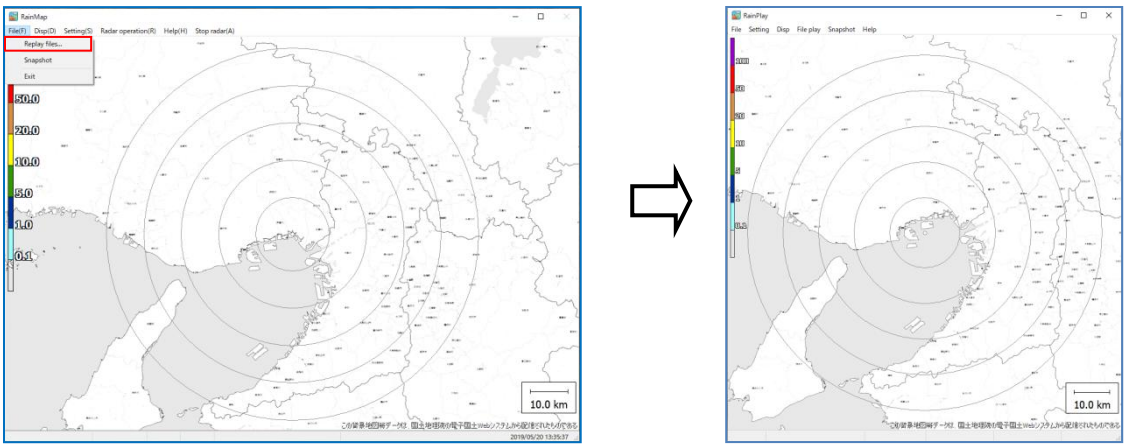
3.3. Data Backup

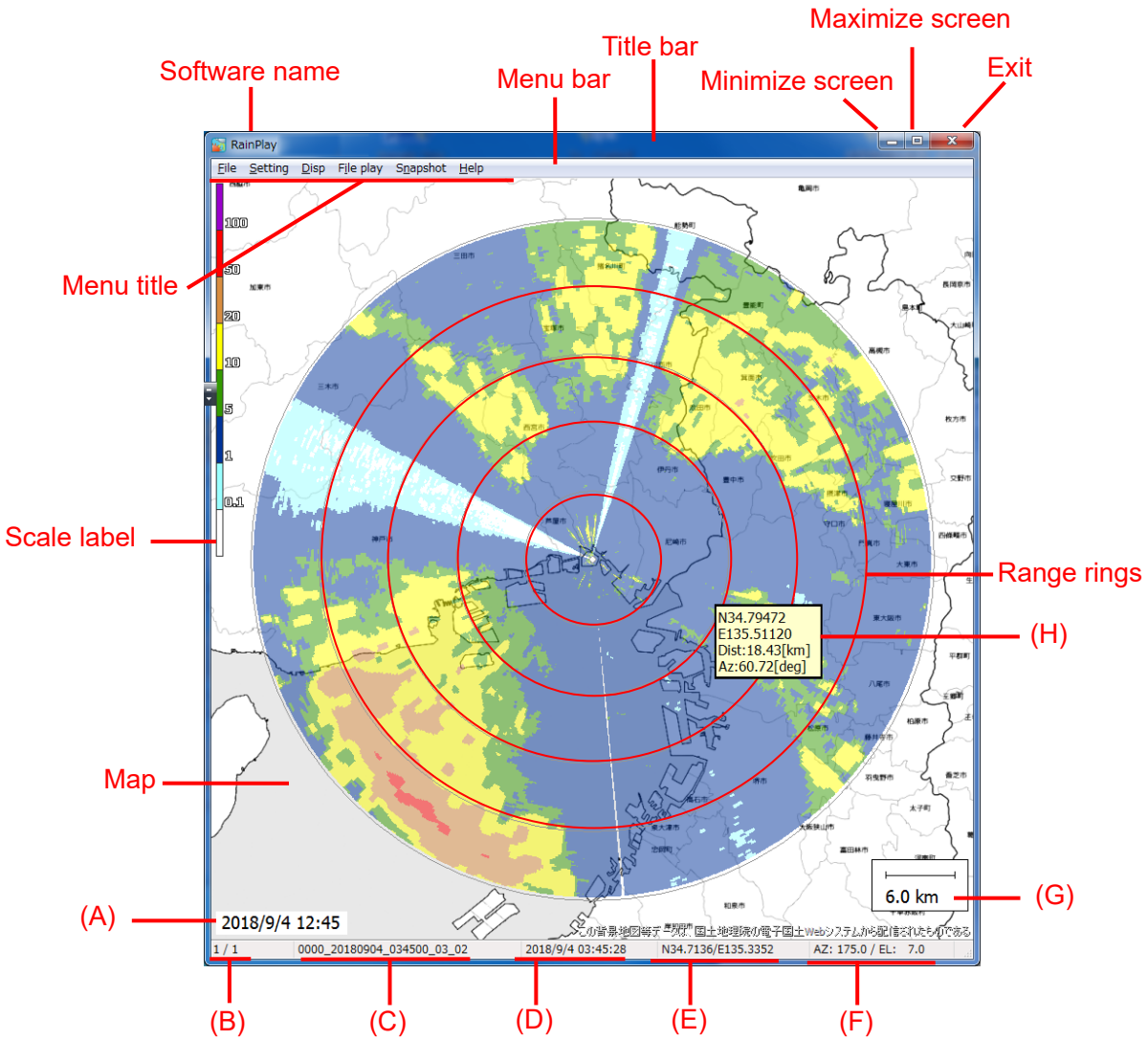
Because there is no guarantee of data integrity (including observation data, output file, and etc.), back up the data to external hard disk drives.

FURUNO will assume no responsibility for the damages, data integrity, repair, or any other damages resulting from data loss. For how to back up system, see [DPU Backup and Restore] in APPX.2.6.

4. RainPlay OPERATION

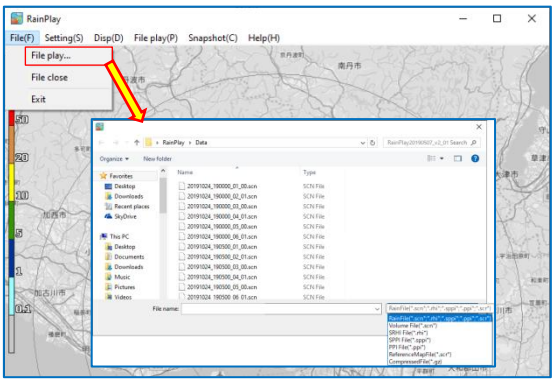
To start the RainPlay software, select [Replay files] from the [File] menu on RainMap.
RainPlay can also be started with the RainPlay.exe file in the RainMap_RainPlay folder.
File directory: “Windows(C) > Users > Radar > Furuno > RainMap_RainPlay > RainPlay.exe”





(A) Computer acquired date/time (local time)
(B) Playing file/display number
(C) The name of playing file
(D) Acquired date/time (UTC)
(E) Radar location
(F) Position of radar azimuth/elevation angle
(G) Range scale-bar.
(H) Shows the following information in a pop-up window by continuously pressing the mouse left button. (Latitude, longitude, distance from center, and azimuth)

4.1. File

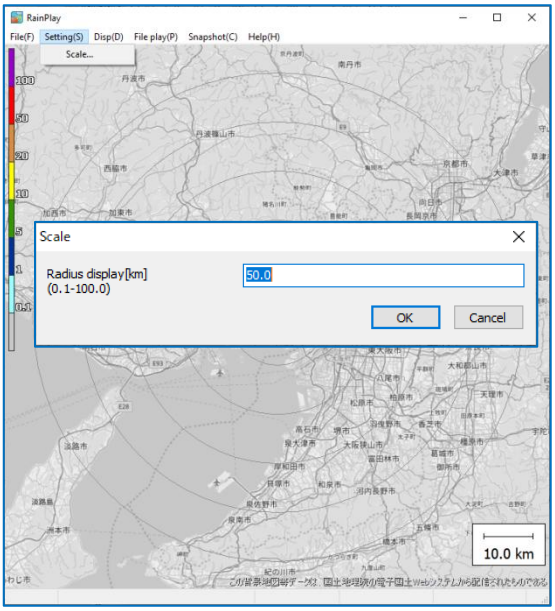


1) **File play:**
   Select binary data (scn, rhi, and etc.) files to play in a slide show.
   (See chapter 7 for information about file format)

2) **File close:** Close the opened binary data file.

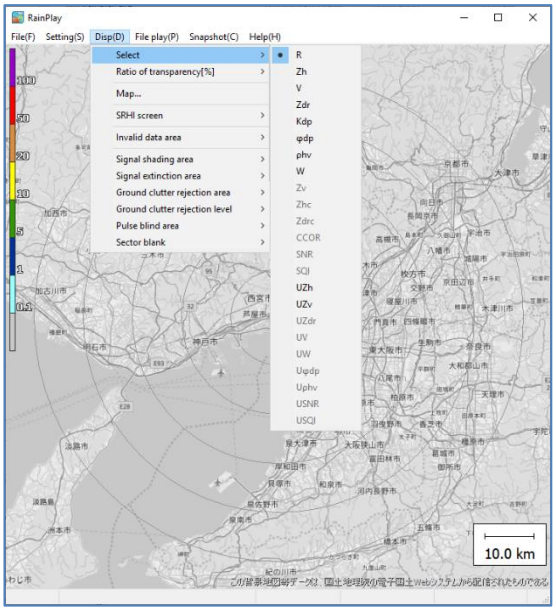
3) **Exit:** Quits the RainPlay software.

4.2. Setting



1) **Scale:** Set the display range (radius display [km]) in the [Scale] pop-up window.

4.3. Disp



1) **Select:** Select a data type to display.
   - **R:** Rainfall intensity
   - **Zh:** Reflectivity factor of horizontal polarization wave
   - **V:** Doppler velocity
   - **Zdr:** Differential reflectivity
   - **Kdp:** Specific differential phase
   - **φdp:** Differential phase (cross polarization)
   - **ρhv:** Correlation coefficient between Zh and Zv
   - **W:** Doppler spectrum width
   - **Zv:** Reflectivity factor of vertical polarization wave
   - **Zhc:** Rain attenuation corrected Zh
   - **Zdrc:** Rain attenuation corrected Zdr
   - **CCOR:** Clutter correction
   - **SNR:** Signal noise ratio
   - **SQI:** Signal quality index)
   - **UZh:** Unfiltered reflectivity factor of horizontal polarization wave
   - **UZv:** Unfiltered reflectivity factor of vertical polarization wave

   Note: UZdr, UV, UW, Uφdp. Uphv, USNR and USQI are currently unimplemented (reserved parameters).

2) **Ratio of transparency [%]:** Sets the display transparency of the observation data.

3) **Map:** Selects the background image map file (*.bmp, *.png) to show.

4) **SRHI screen:**
   - **90 degrees screen:** SRHI echo is displayed in the range of -2 to 90 degrees on the sub screen.
   - **180 degrees screen:** SRHI echo is displayed in the range of -2 to 182 degrees on the sub screen.

5) **Invalid data area:** Shows or hides the invalid data area.

6) **Signal shading area:** Shows or hides the signal shielding area.
   OFF: Hidden, 1: Grayed out, 2: Transparent gray

7) **Signal extinction area:** Shows or hides the signal extinction area outside the heavy rain area.
   OFF: Hidden, 1: Grayed out, 2: Transparent gray

8) **Ground clutter rejection area:** Shows or hides the ground clutter rejection area.
   OFF: Hidden, 1: Grayed out, 2: Transparent gray

9) **Ground clutter rejection level:** Shows or hides the level of ground clutter rejection.
   All: Grays out all areas to which the clutter reference has been applied.
   0: Hidden
   1：0.1～1mm
   2：1～5mm
   3：5～10mm
   4：10～20mm
   5：20～50mm
   6：50～100mm
   7：100mm and more

10) **Pulse blind area:** Shows or hides the pulse blind area. (the unobservable area near the center of the observation area)
   OFF: Hidden, 1: Grayed out, 2: Transparent gray

11) **Sector blank:** Shows or hides the sector blank area.
   OFF: Hidden, 1: Grayed out, 2: Transparent gray

4.4. File Play

1) **Start:** Plays back the binary data.

2) **Stop:** Stops playback.

3) **Pause:** Pauses playback.

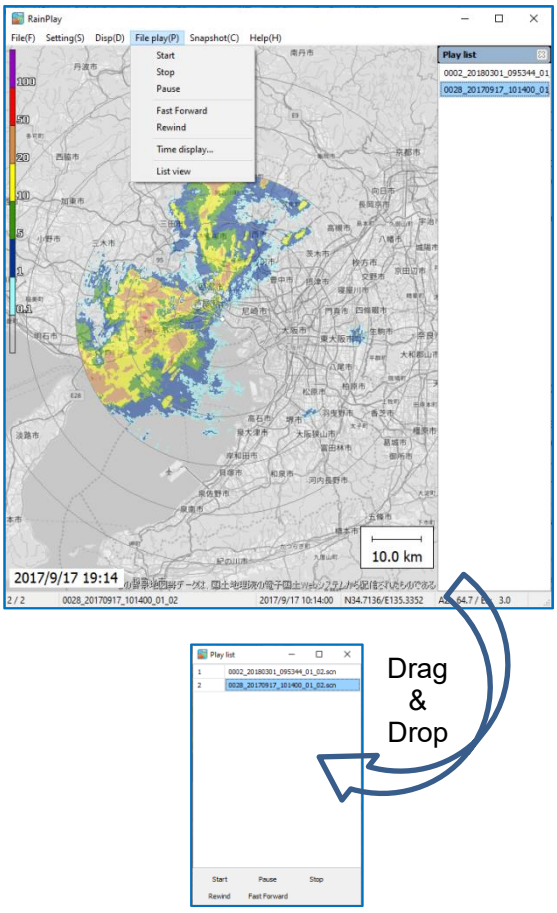
4) **Fast Forward:** Fast-forwards playback.

5) **Rewind:** Rewinds the data.

6) **Time display:** Sets a time display between 1,000 - 10,000 [ms]

7) **List view:** The [Play list] will be displayed on the right side of the screen. The list view can be separated from the RainPlay main screen but cannot be rejoined.

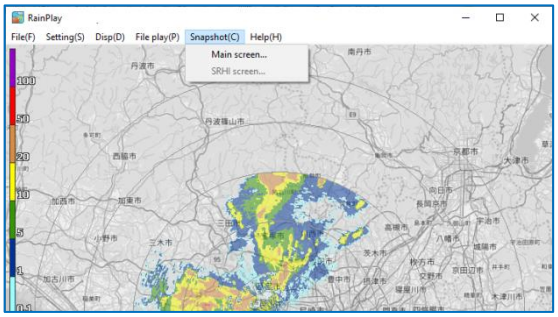
Note: All binary data will be played if put many data files into a play list at once.



4.5. Snapshot

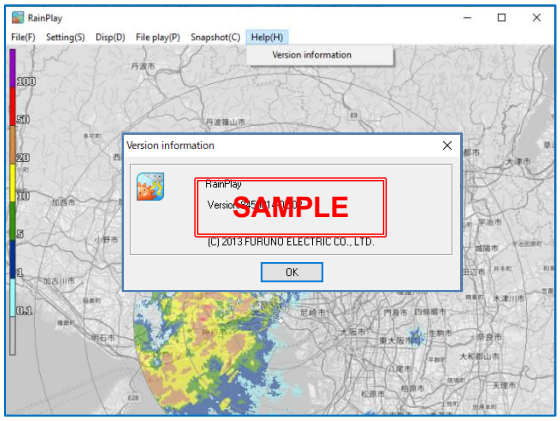
1) **Main screen:** Captures the main screen and selects where to save the screen image file (*.jpg).

2) **SRHI screen:** After displaying the [SRHI screen] from the [Disp] menu, select "SRHI screen" from the [Snapshot] menu, and select the destination folder for the image (*.jpg) of the displayed SRHI screen and save it.



4.6. Help

1) **Version information:** Shows the version information for this software.

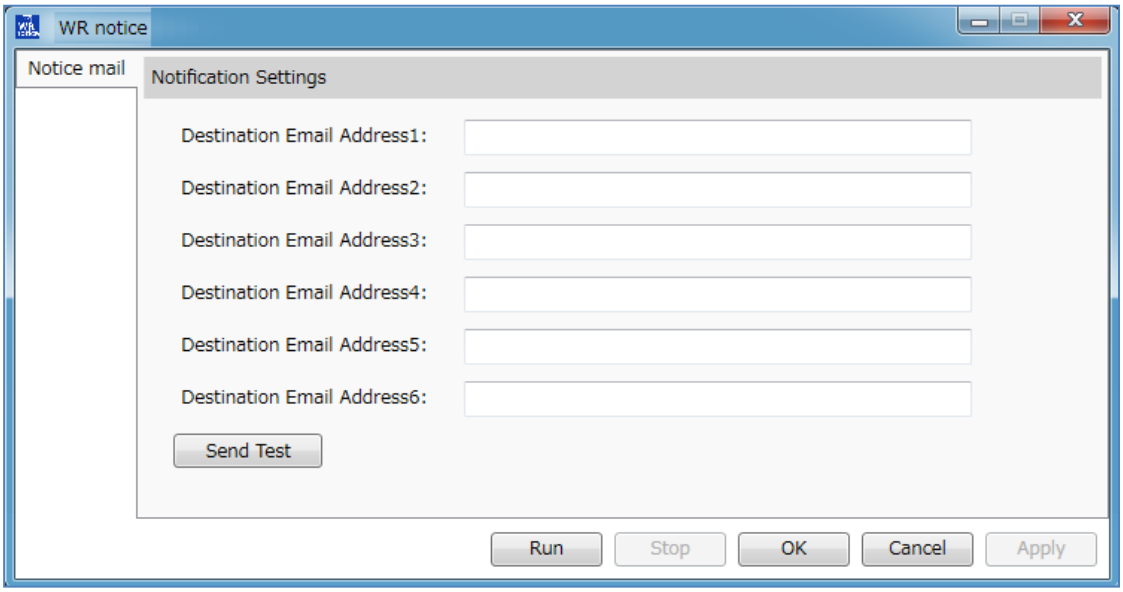


5. WR_TOOL

5.1. WR_notice

1) **Function:** WR_notice delivers a notice email with error code(s) to the specified email addresses when errors occur in the ATU/SPU. Further, WR_notice responds to alive monitoring email to notify whether the DPU is alive or not. WR_notice does not detect TX stopped. The DPU must be connected to the internet to use WR_notice.
Note: Register the email accounts that are to receive WR_notice, following the procedure below.

2) **Notification settings:** Click [WR_notice.exe] to start setting.
WR_notice starts in the background and the WR_notice icon ( ) appears in the taskbar. Set the email addresses that are to receive error information from WR_notice when an error occurs, in the [Notification Settings] tab. A maximum of six email destinations can be set. This list also works as the whitelist for the live monitoring email as well.
   (1) Click [Stop] if this software is running.
   (2) Add or delete email address from the list as necessary.
   (3) Click the [Apply] button to confirm the email addresses entered.
   (4) Click the [Send Test] and [Yes] buttons to receive the test email at the email addresses listed.



If the test was successful, the registered email addresses receive a test email from the address shown below.
****@wrnotice.furunosolutions.com
It may take a few minutes to receive the email, an example which is shown at right.
**** is a 4-digit radar product number which can be found in RainMap.

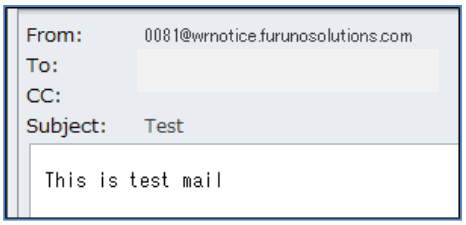


Figure 5-1: Sample of test mail

3) Run WR_notice:

(1) Setup on Startup.

Add a shortcut for [WR_notice] on the desktop. Copy the shortcut to Windows Startup to run WR_notice automatically every time the DPU boots.

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 the [WR_notice] shortcut on the desktop to open the WR_notice software.

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

The error code(s) will be sent to the email address. See section 8.3 for the error codes.

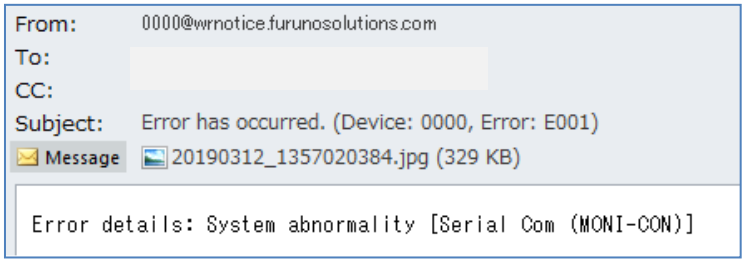


Figure 5-2**:** Sample of error email

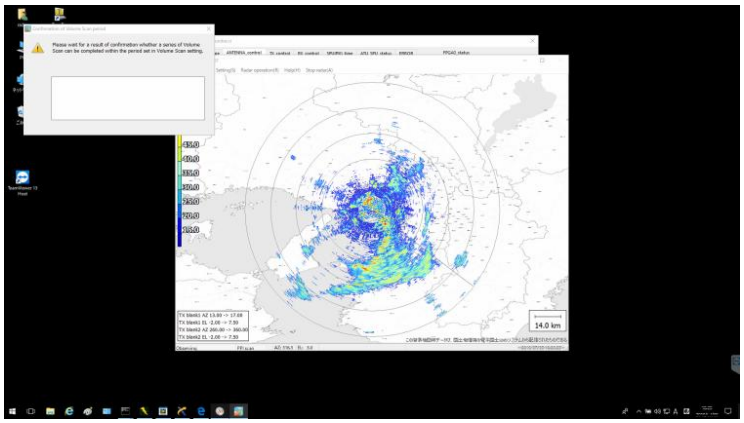


Figure 5-3: Sample of DPU screen capture attached in the error email

4) Alive monitoring email

WR_notice will respond to the email from the email which address is listed in “Destination Email.

When send an email with the subject “WR alive” to XXXX@wrnotice.furunosolution.com, WR_notice will respond “I’m alive” within minutes of sending the alive monitoring email.

It will not respond in case as below:

- WR_notice did not startup.
- The email did not send with the correct address or subject.
- Email sent from an email address not registered in WR_notice.

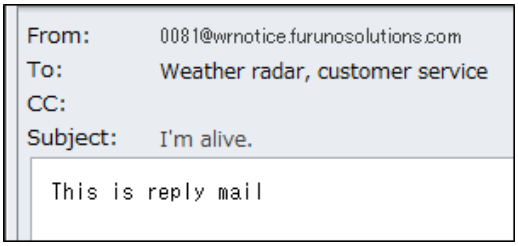


Figure 5-4: Sample of alive email

Note 1: XXXX is the product number, and it appears in the menu item [Radar const. info.] in RainMap.

Note 2: Since the alive monitoring mail function relays the mail via the mail server used by FURUNO, it can be used only by users who have agreed to the WR_notice error information provision agreement.

5.2. WR_transfer

WR_Transfer consists of some batch files and programs, and providing the following functions:

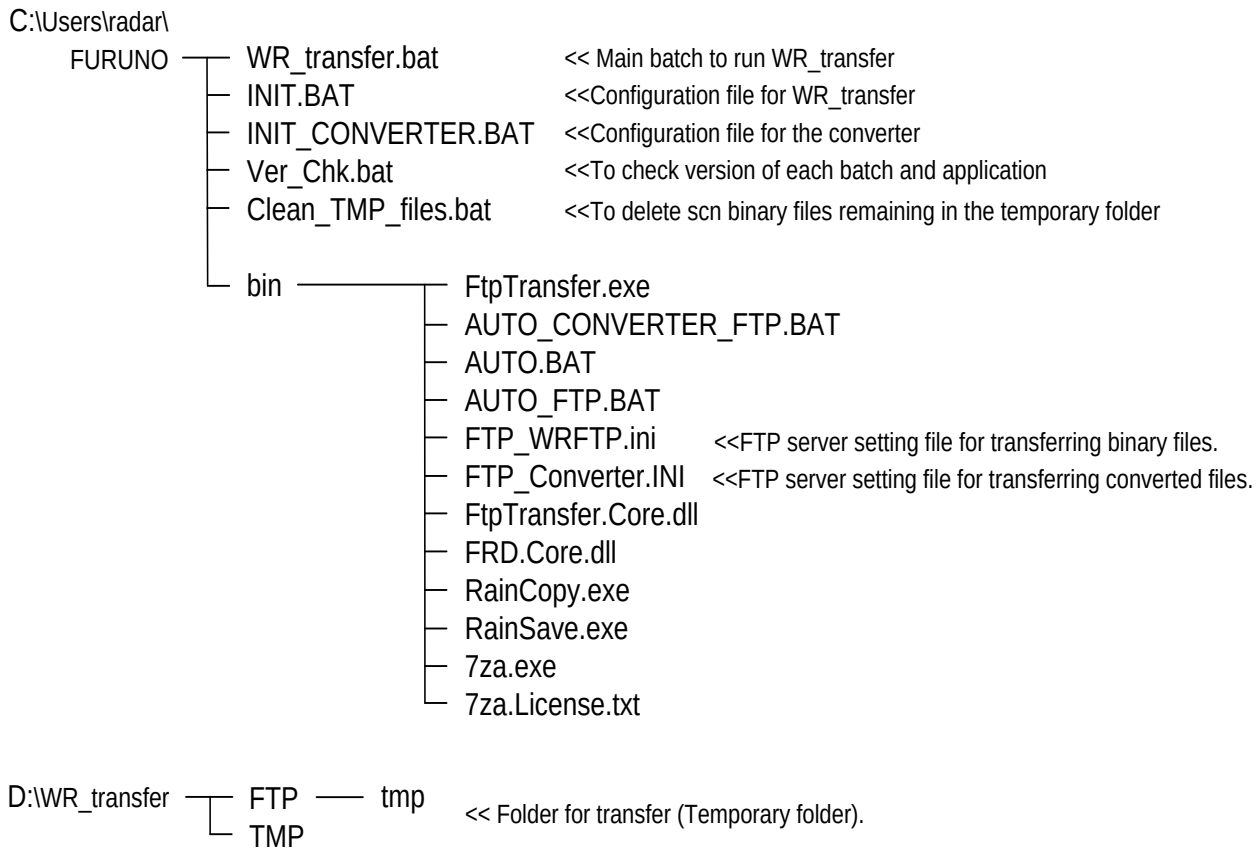
- Compress observed binary data.
- Transfer the compressed data using FTP.
- Convert data file format and transfer using FTP.

Compression is effective for conserving storage space. Simply, files are compressed and stored in a local storage. Users who want to observe files on their own server can use the FTP transfer feature to transfer files.
Users may also want to check and analyze their data using third-party software. The data conversion feature converts data into the following formats: NetCDF (CfRadial), NEXRAD level2, HDF5 (OPERA ODIM_H5), Universal Format (UF).

Note: Do not install any third-party software into the DPU because this can cause an out of system resource problem. Use only the pre-installed applications, which can be used with the application locker function in Windows. It is recommended to transfer the data to an external storage device and share the observation data with the software installed in a PC.

5.2.1. File configuration

WR_transfer consists of a batch file, an executable file, and a configuration file.
WR_transfer starts when WR_transfer.bat is executed.



5.2.2. Contents of bat file

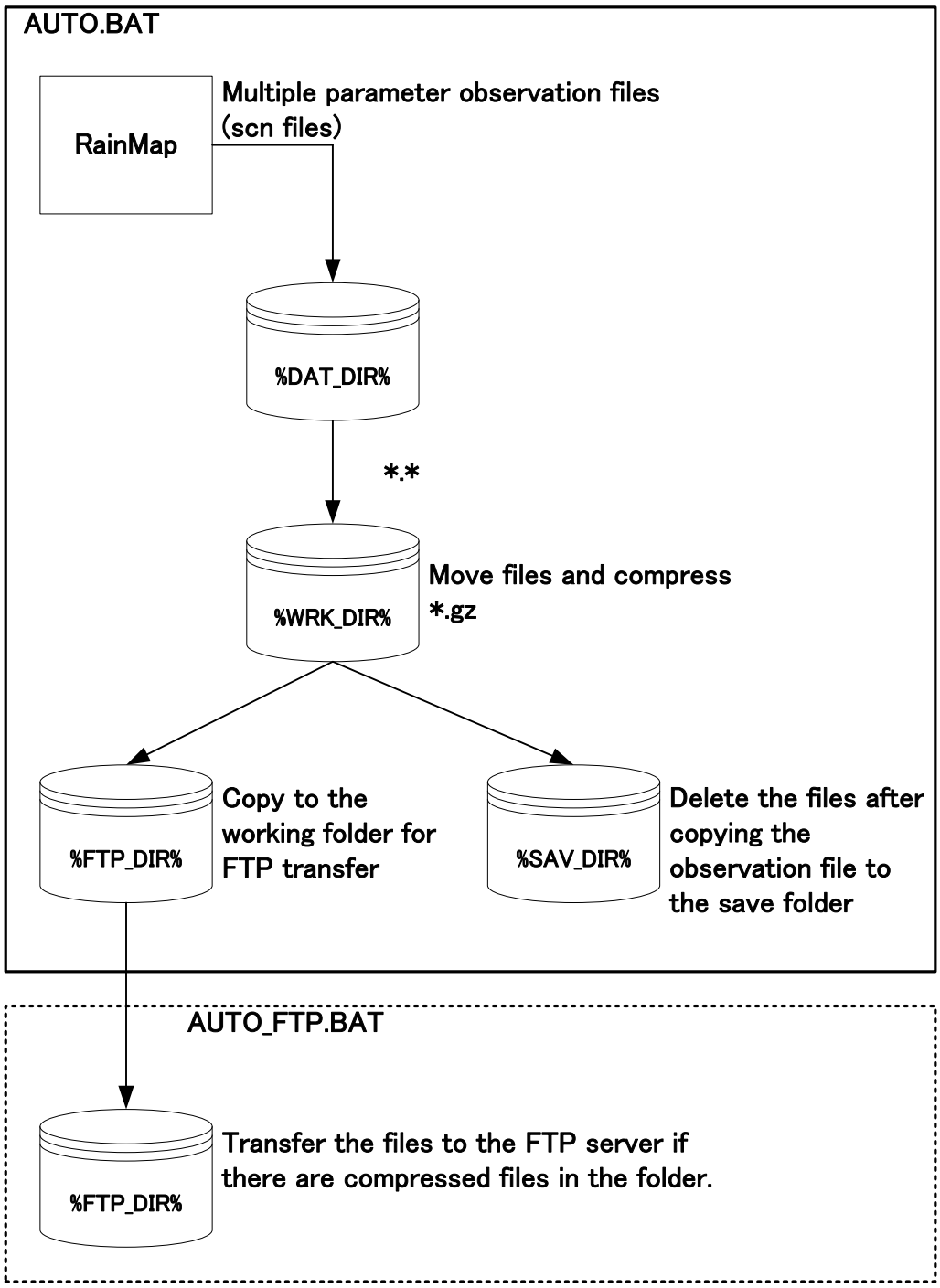


Figure 5-5: WR_transfer.bat processing contents

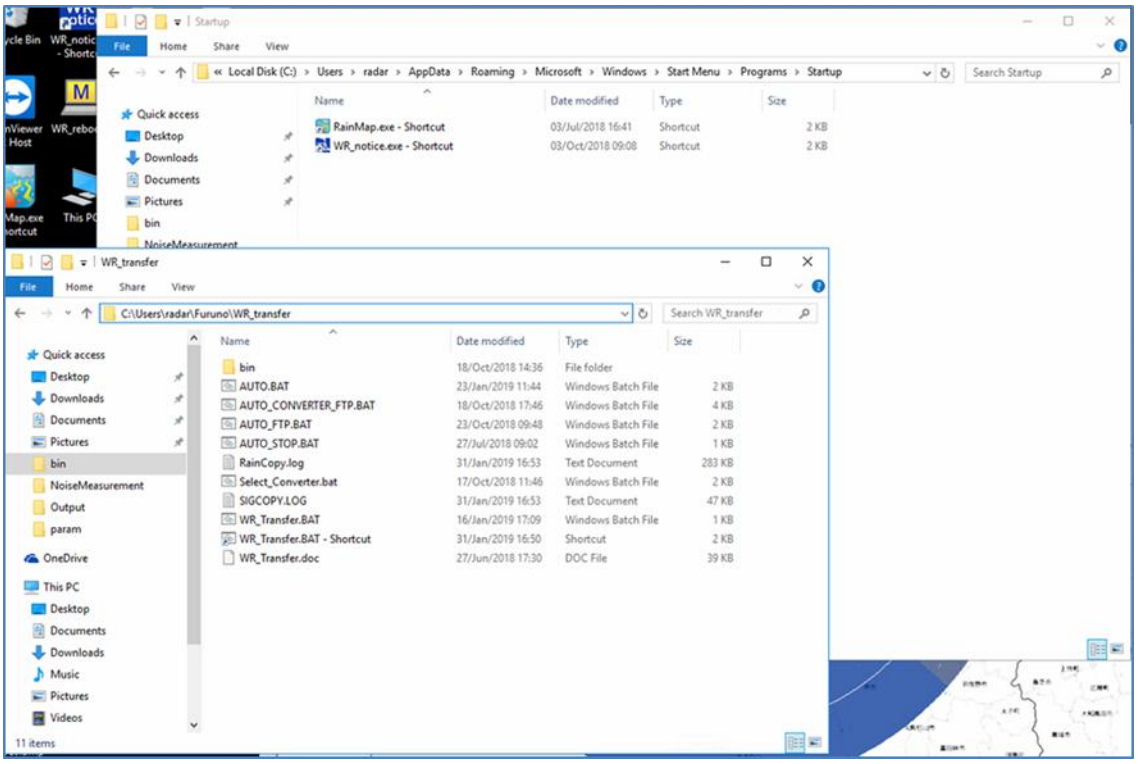


Figure 5-6: Copy the shortcut of WR_transfer.bat to the startup folder

I. Necessary Preparations

The following is required to use this software.

1) Create a folder to save the observation data in a drive other than C drive and set this in RainMap (the default setting is D: \ binary).
2) Create a destination folder to store the data on the target FTP server.

II. Setup on Startup

Add shortcut for WR_transfer.bat to Windows Startup to run WR_transfer.bat automatically every time the DPU boots:
Local Disk (C) > Users > radar > AppData > Roaming > Microsoft > Windows > Start Menu > Programs > Startup

III. Configuration Files

Two configurations' files are used.

- The first configuration file is named "INIT.BAT", a general configuration file that includes folder settings and a function switch. Open the text editor, then drag and drop the BAT file onto the editor and edit the file.

```
@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:\binary

@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
```

As shown above, the variables to be set are on lines 7 to 32 in the file.
Table 5-1 shows the description of each variable.

Table 5-1: Description of INIT.BAT

Variable	Description
DIR	Install folder of the WR_transfer Notice: Do not change from default value.
DAT_DIR	Data storing folder set by the RainMap
SAV_DIR	Compressed data storage folder If SAV_SW is enabled, the compressed SCN format data will be saved in the directory specified here.
WRK_DIR	Working folder for the WR_transfer
CNV_DIR	Working folder for File Converter
TRS_DIR	Remote folder on target FTP server. If FTP_SW is enabled, the compressed SCN format data will be saved in the remote directory specified here. If the FTP server uses a UNIX-like file path, enter the path in UNIX.
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) Refer 5.2.3 for more detail of data converter.

- The second configuration file is FTP_WRFTP.INI, which is in the WR_transfer \ bin \ folder. This file sets the IP address or name of the target FTP server, the default username, and the user password. Use FTP_WRFTP.INI if FTP_SW is enabled and FTP_Converter.INI if CNV_SW is enabled. Please note that the configuration file is different. See subsection 5.2.3 for how to set up FTP_Converter.INI.
  Setting of Passive Mode: Passive mode is “1” and Active mode is “0”.

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

IV. How the software runs

This software run as shown below:

1) Copy observed data from **DIR** to **WRK_DIR\TMP** and compress it.
   - Copy 10 minutes of observation data from the oldest file to WRK_DIR \ TMP in one process. This function provides a solution to transfer many files after recovery from failure of connection line or server.

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.

4) (CNV_SW: 1) Move the observation data (Binary) to the **Online Folder** of **CNV_DIR**
   - Converts the observation data (Binary) of CNV_DIR to the target format and compresses it.
   - Save the compressed data in the Archive Folder of CNV_DIR.
   - If FTP transfer is enabled, transfer compressed data from **Archive Folder** in **CNV_DIR** to the target server.

5.2.3. Data converter

I. Outlines

- SCNv11 only convert to HDF5. Please use SCNv10 to save binary data if necessary to convert to CF/radial, NEXRAD, or UF.
- 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.
- Data converter for NEXRAD Level 2 is installed in
  “C:\Users\radar\Furuno\SCN2NEXRAD_Converter\”.
  The executable file is SCN2NEXRAD_Converter.exe.
  Note that it does not support RHI mode.
- Data converter for UF is installed in
  “C:\Users\radar\Furuno\SCN2UF_Converter\”
  The executable file is SCN2UF_Converter.exe.
  Record item names correspondence between SCN and UF are shown in Table 5.2.
- The configuration file, config.txt is stored in each installation folder.

Table 5.2: Record item names correspondence between SCN and UF

SCN Observed data Name	UF Name
R (Rainfall intensity)	RA
Zh (Reflectivity factor of horizontal polarization wave)	DZ
V (Doppler velocity)	VR
Zdr (Differential reflectivity)	ZD
Kdp (Specific differential phase)	KD
ϕdp (Differential phase)	PH
ρhv (Correlation coefficient between Zh and Zv)	RH
W (Doppler spectrum width)	SW
Quality information "	QC

II. Enable the data converter

The data converters are launched and controlled by the batch files stored in the folder shown below: C:\Users\RADAR\FURUNO\WR_Transfer (%DIR%).

[INIT.BAT]

Set the CNV_SW value as "1" as described below to enable the data converter.

```
@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:\binary

@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]

- Launches and controls the data converters.
- Transfers the converted files to the FTP server.

The data flow for data converter

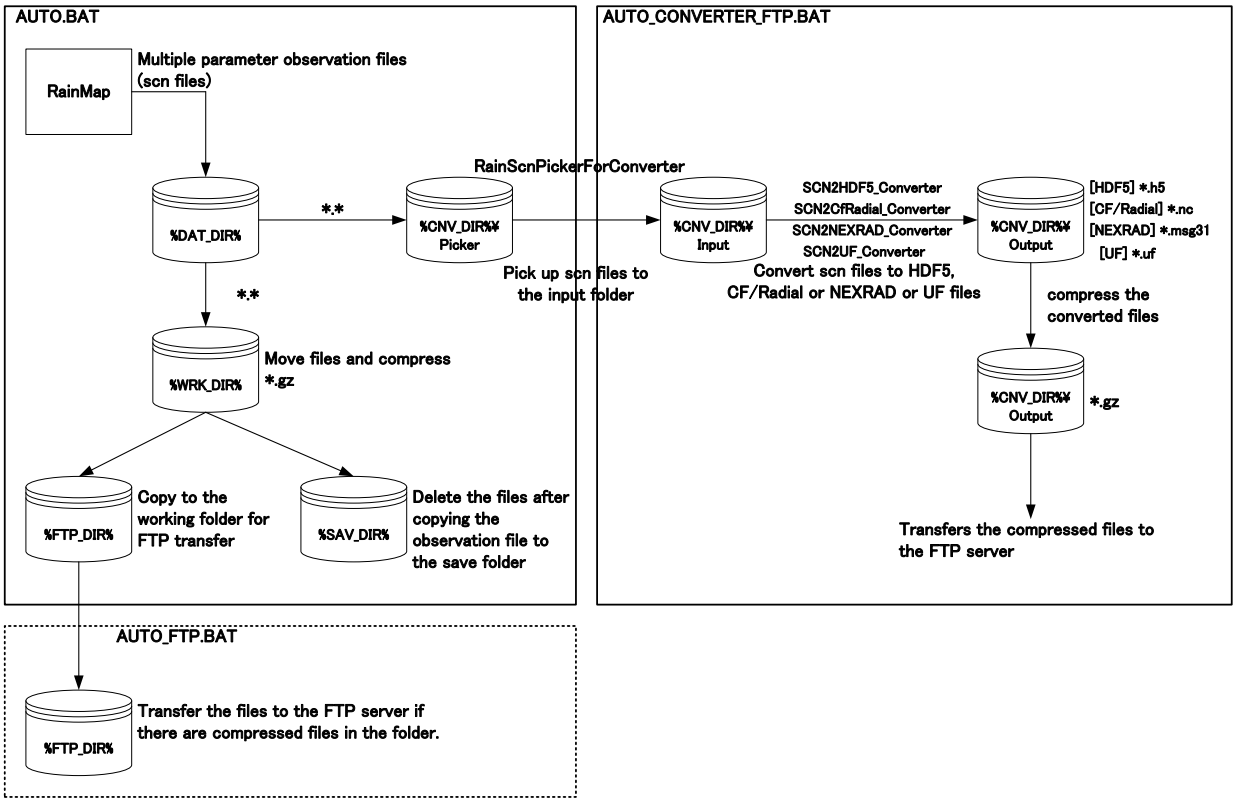


Figure 5.2: Data flow for data converter

III. Select a data converter to use

[INIT_CONVERTER.BAT]

Only one data converter can be used at one time. Set the DC_KIND value as shown below to select the data converter to use:

HDF: 1, CF/Radial: 2, NEXRAD: 3, UF:4

Note: SCNv11 only convert to HDF5. Please use SCNv10 to save binary data if necessary to convert to CF/radial, NEXRAD, or UF.

```
@rem Drive name for storage of converted files
SET HDD=D:

@rem Which data converter do you choose?
@rem HDF: 1, CF/Radial: 2, NEXRAD: 3,UF: 4
SET DC_KIND=1

@rem Folder name of the FTP-root
SET FTPOUT=/

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

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

Figure 5.3: Sample of INIT_CONVERTER.BAT

IV. Change the input/output folder name

[config.txt]

The input and output folders are stored in the installation folder of each data converter.

- Scn-files are input from the folder which is assigned as "OnlineFolder" in the configuration file (config.txt).
- Converted files are output to the folder which is assigned as "ArchiveFolder" in the configuration file (config.txt).
- To change the input and output folder name, change the value for "OnlineFolder" and "ArchiveFolder" to, for example, 'E:\Converter\input' and 'E:\Converter\output', respectively.
- From a performance point of view, we recommend that both folders be located on a separate drive (such as the D drive) and not on the system drive (C drive).

```
%%%
```

[INIT.BAT]

Set the CNV_DIR value to define the folder name for storing the converted files.

```
@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:\binary

@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
```

Figure 5.5: Sample of INIT.BAT

[INIT_CONVERTER.BAT]

Set the HDD value to define the drive name for storage of converted files.

```
@rem Drive name for storage of converted files
SET HDD=D:

@rem Which data converter do you choose?
@rem HDF: 1, CF/Radial: 2, NEXRAD: 3, UF: 4
SET DC_KIND=1

@rem Folder name of the FTP-root
SET FTPOUT=/

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

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

Figure 5.6: Sample of INIT_CONVERTER.BAT

V. ICAO radar identifier for NEXRAD Level2

For NEXRAD Level2, each radar is identified by four alphabet letters, which is called the ICAO radar identifier. To change the value of "ICAO", edit the ICAO line in the configuration file as shown below.

[config.txt]

“ICAO” is in the installation folder of NEXRAD Level2.
Before change> ICAO='NAME'
After change> for example, ICAO='FUSA'

```
%%%
```

VI. Output messages

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

The file names are SCN2HDF5_Converter.log, SCN2CfRadial_Converter.log, SCN2NEXRAD_Converter.log, and SCN2UF_Converter.log respectively.

STARTUP: Output in launching.

FINISHED: Output when each processing is finished normally.

ERROR: Output if any errors occur.

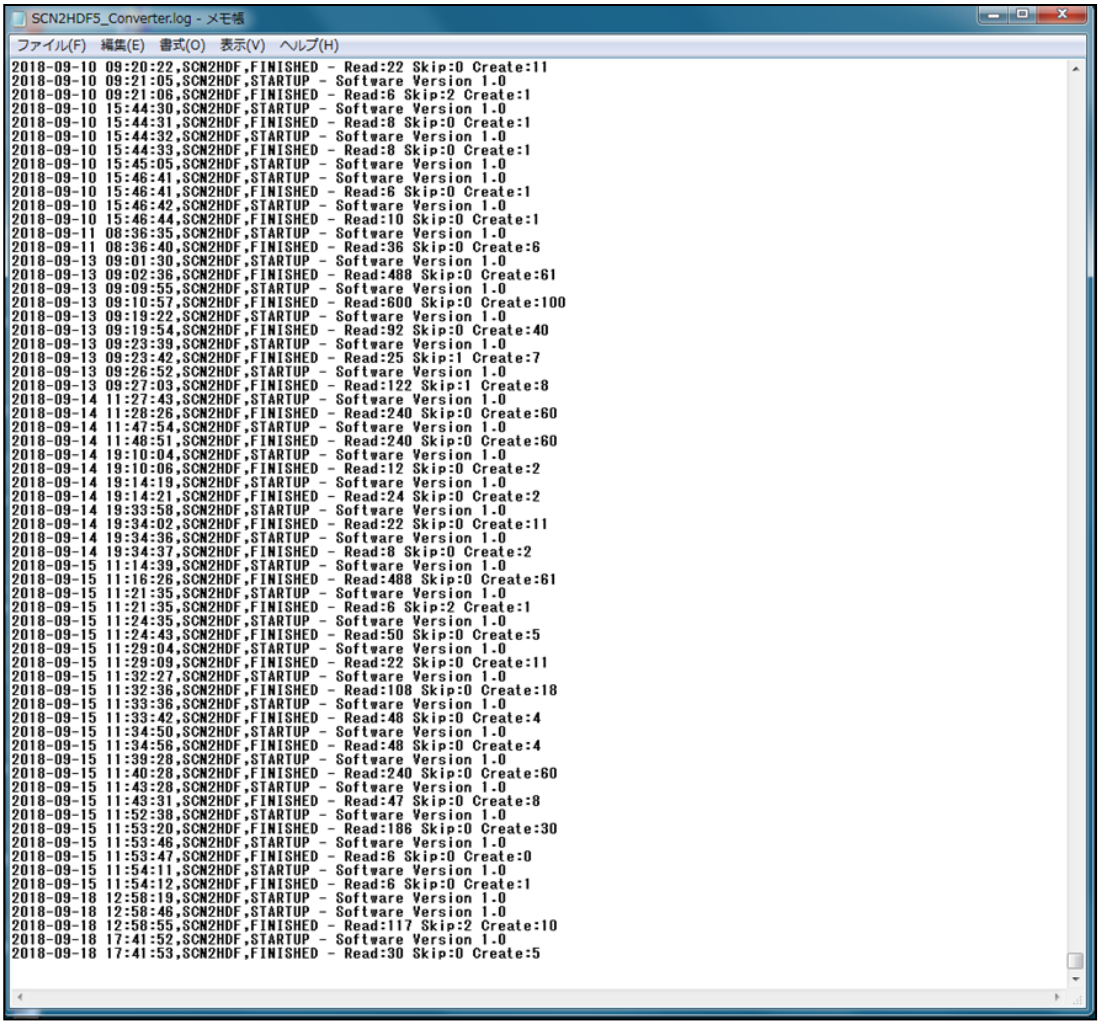


Figure 5.8: Sample of log file, SCN2HDF5_Converter.log

VII. Enable FTP transfer of converted files

[FTP_Converter.INI]

Setup FTP_Converter.INI in "%DIR%\bin\" folder.

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

Set the IP address or name of the target FTP server, given username, and password for the user. The Passive Mode can be used when its value is set as “1”. Set the folder names LOGDIR and ERRDIR, where the FTP-log and ERROR-log files are stored, respectively

[INIT_CONVERTER.BAT]

1) Edit the line indicated as 1) below to define the output folder on the FTP server.
   For example: SET FTPOUT=/

2) Edit the line indicated as 2) below to enable the FTP transfer.
   Before change> SET ENABLE_FTP=false
   After change> SET ENABLE_FTP=true

3) Edit the line indicated as 3) below to keep the converted files after FTP transfer.
   Before change> SET FTP_DEL=true
   After change> SET FTP_DEL=false

```
@rem Drive name for storage of converted files
SET HDD=D:

@rem Which data converter do you choose?
@rem HDF: 1, CF/Radial: 2, NEXRAD: 3
SET DC_KIND=1

1) @rem Folder name of the FTP-root
   SET FTPOUT=/

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

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

Figure 5.9: Sample of INIT_CONVERTER.BAT

5.2.4. Trouble shooting

1) If the compressed data storage or FTP transfer process does not work properly.

・Check if the batch files, AUTO.bat, and AUTO_FTP.bat are running as well.

Normally, the above two command-prompts are running. Only one command prompt is executed if FTP is not transferred (if FTP_SW is 0). Run WR_transfer.bat if the prompt is not running. If the AUTO.bat and AUTO_FTP.bat prompt screens still do not appear, then check that each SW is set to “1” in the INIT.BAT settings.

If the copy or FTP transfer process is not working properly, check whether the two batch files (AUTO.bat and AUTO_FTP.bat) are running. (Generally, two command prompts are running. Only one command prompt runs if FTP is not transferred). Check the contents of the operation if copying or FTP transfer is not occurring even though the two command prompts are running. However, since the contents of the processing are not shown at the command prompt in the default setting, it is impossible to know which command is not running. Therefore, make the following changes to show the processing contents at the command prompt to investigate the failure and correct the setting.
Before change: @echo off
After change: @rem @echo off

A .bat file can be checked and edited by dragging and dropping it onto the text editor. After rewriting the file, change the top line as shown in the figure below, then save the file.

```
@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 ###
```

```
@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

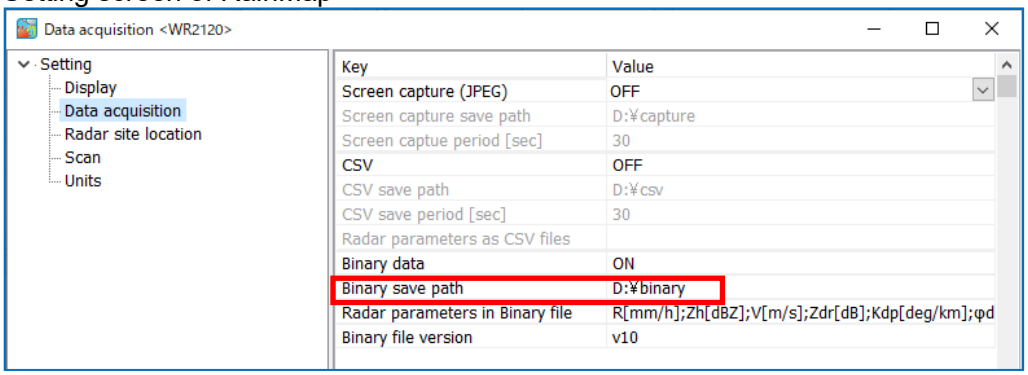
:SKIP00
@REM
************************************************************
@REM Does it received the BATCH stop
command？
@REM
************************************************************
if exist %DIR%\BATCH_STOP.BBB goto SKIP99
timeout 5
if not exist %FTP_DIR%\*.gz goto SKIP00

: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 ###
```

・Check that the following two paths match.

Setting screen of RainMap



Setting of INIT.BAT

```
@echo off
cmd /C REM //*************************************************************//
cmd /C REM // 2019 June 27th   Initialize file for WR_Transfer
cmd /C REM // for WR-2100/WR110/WR2120
cmd /C REM //*************************************************************//

@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: ¥binary

@REM Set data storing folder
```

2) If data converter does not work properly

・Check that the batch file of AUTO_CONVERTER_FTP.bat is running as well.

If the batch is not running (if the AUTO_CONVERTER_FTP.bat prompt screen does not appear), then exit the AUTO.bat and AUTO_FTP.bat prompts and then run WR_transfer.bat again. If the AUTO_CONVERTER_ FTP.bat prompt screen still does not appear, then check that the setting of INIT.BAT is “CNV_SW = 1”.

Setting of INIT.BAT

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

・Check that the CNV_DIR in INI.BAT, the folder setting in config.txt, and the drive path match with the HDD path in INIT_CONVERTER.BAT.

Setting of INIT_CONVERTER.BAT

```
@rem Drive name for storage of converted files
SET HDD=D:
```

[config.txt]（HDF5、CF/Radial、NEXRAD、and UF has each configuration file）

```
% 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 .nc output files
ArchiveFolder='D:¥Converter¥output';
```

[INI.BAT]

```
@REM   Set converter folder
SET CNV_DIR=D:¥Converter
```

・Check that the OnlineFolder and ArchiveFolder settings in the config.txt file for each converter is set to CNV_DIR \ input and CNV_DIR \ output in the INI.BAT settings, respectively.

config.txt（HDF5、CF/Radial、NEXRAD、and UF has each configuration file）

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

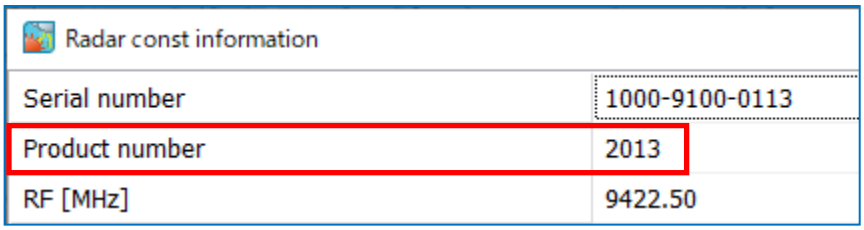
% Specify the Archive Folder meaning the output folder for the .nc output files
ArchiveFolder='D:¥Converter¥output';
```

[INI.BAT]

```
@REM   Set converter folder
SET CNV_DIR=D:¥Converter
```

・In the RainScnPickerForConverter.ini setting of RainScnPickerForConverter, check that the RADARNO setting matches the product number in [Radar const information] in RainMap.

[Radar const. information] in RainMap



RainScnPickerForConverter.ini

```
RADARNO=2013
```

3) If the FTP transfer of the data converter does not work properly

・Check that the FTP transfer setting in INIT_CONVERTER.BAT is enabled

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

・Check that the FTP_Converter.INI is set correctly

Note: The configuration file for FTP transfer of the file converted by the data converter is not FTP_WRFTP.INI.

6. SHIELDING AREA DATA FILE FORMAT

The file format of shielding area uses a comma separated CSV file. The first row is the header, below it the parameters. The shielding area file name must be “Clip_RainMap.csv.

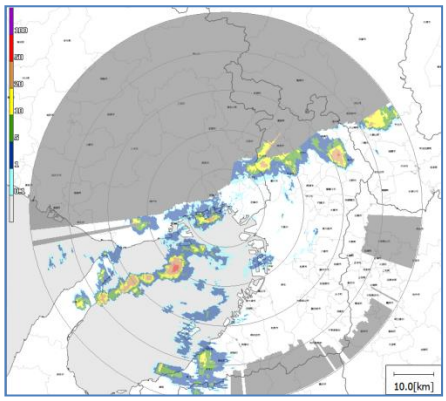


Figure 6-1:
Image of Radio wave shielding area

Header (reference and formula values):
Each column of header (red frame of column 1 to 4, row 1 in Figure 6-2 indicates an individual parameter for the shielding area file.
Column 1: Distance value (m) used for the shielding area range (distance) row cells calculation in a “CSV” file.
Column 2: Radar latitude in the “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 the “Clip_RainMap.csv” file must be entered as a decimal number. East longitude is positive and west longitude is negative.
Column 4: Radar altitude in meters.

Note: Latitude, longitude, and altitude must exactly match the values entered in the “Radar Site Location” settings in RainMap.

Parameter (values used in the shielding calculations):
The columns indicate the azimuth direction, and in the example of Figure 6-2, there are 720 columns defined in 0.5-degree increments. The rows indicate the individual distance (range) directions, and the shielding distance range is the distance resolution of the header multiplied by the number of rows. Enter the elevation angle value to be shielded in each cell (note that this is not the altitude). And enter the elevation angle in the range of -2 to 89 [degrees]. Beam width needs to be considered when generating a shielding area from a digital elevation map.

		Column								
		1	2	3	4	5	6	-	719	720
Row	1	100	34.741	135.354	10	Header				
	2								Parameter	
	3									
	4									
	5									
	6		20	20	20	20				
	7									
	8									
	-									
	500									
	501									

Latitude
Longitude
Height
Range resolution [m]
Distance Direction: 500 [m] = (6-1) x100
Azimuth Direction: 2 [deg] = 4 x 0.5
Shielding Elevation: 20 [deg]

Figure 6-2: csv file structure

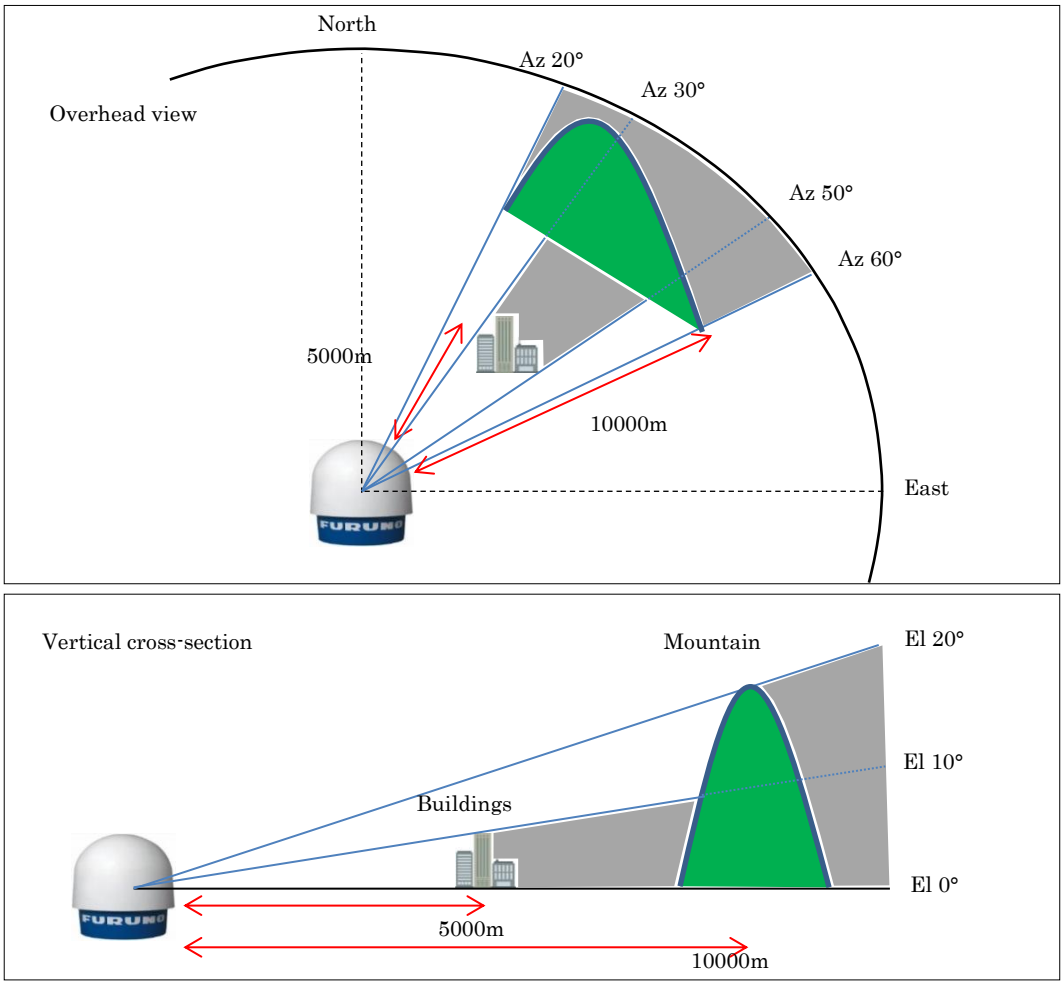


Figure 6-3: Example of radar view

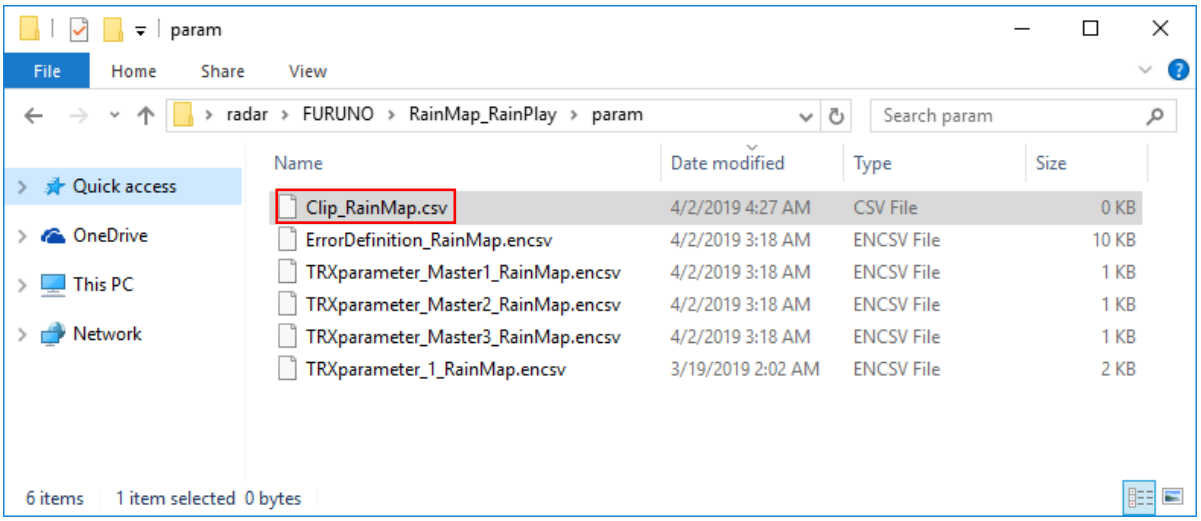
Create parameters (green frame) in Figure 6-4 to get the shielding shown in Figure 6-3. (Where the distance direction is approximately 100m.)

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

Figure 6-4: csv file for sample2

In Figure 6-3, a building exists within 30 to 50 degrees in the direction 5,000 m from the radar. The building shields radar elevations below 10 degrees. Therefore, in the CSV file, enter the elevation angle of 10 degrees in each distance cell (100 x 52 rows) up to 5,000 m and each azimuth cell (corresponding to columns 61 to 100) from 30 degrees to 50 degrees.
In addition, there are mountains within 20 to 60 degrees in the direction of 10,000 m from the radar. Mountains block radar elevations below 20 degrees. Therefore, in the CSV file, enter an elevation angle of 20 degrees in each distance cell (100 x 102 rows) up to 10,000 m and in each orientation cell (columns 41-120) from 20 degrees to 60 degrees.

Save the created "Clip_RainMap.csv" file to the "Param" folder in the "RainMap_RainPlay" folder. Restart RainMap.



7. OUTPUT DATA FORMAT

7.1. Data File Type 1 (csv)

1) Record unit

One observation parameter (Zh, V, W, and etc.) is stored in one CSV file.
The observation data that is set in the data acquisition item of RainMap saves a file in the folder in each setting cycle (example: 60 seconds).

2) Record file name

Outputs file extension: csv
Form: DATE_TIME_DATAKIND_ElevationAngle.csv (YYYYMMDD_HHMMSS_xx._###csv).
For example, output the rainfall intensity “01/10/2012 9:37:26” → "20121001_093726_Rain_000.csv".
This “time” is the local time set by the DPU.

Output data types are as shown below:

R: Rainfall intensity [mm/h]
Zh: Reflectivity factor (Horizontal) [dBZ]
V: Doppler velocity [m/s]
W: Doppler spectrum width [m/s]
Zdr: Differential reflectivity [dB]
Φdp: Differential phase (cross polarization) [deg]
Kdp: Specific differential phase [deg/km]
ρhv: Correlation coefficient between Zh and Zv

3) Data format (csv)

Row	Data	For example,
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 numbers
5	Data mark of the direction of distance (MAX 1028)	525 points
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)	0.00 deg.
9 to MAX	Range direction (r) [BIN] Data mark of the distance direction +7 (Variable length is depending on a number of antenna rotations)	row 532 (=525 point + 7row)

Table 7.1: Sample of CSV Output Data with explanation

2019/4/18 13:49	4 <- Log Date/Time(PC Time), Scan Mode																		
34.7136	<- Latitude [degree] (+:N, -:S)																		
135.3352	<- Longitude [degree] (+:E, -:W)																		
333	<- Total Sweep value (Max: 8192)																		
305	<- Data point of range direction (Max: 1028)																		
100	<- Resolution of range distance [m]																		
0	<- Azimuth offset value [degree]																		
351.08	352.13	353.23	354.29	355.39	<- Azimuth of every each sweep [degree] ->							0.79	1.85	2.99	4.04	5.14	6.2	7.29	8.35	9.45	10.55
0	0	0	0	0	<- Elevation of every each sweep [degree] ->							0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Direction of azimuth (θ) "Variable length"

Range (r) "Variable length"

[Scan Mode]
1: PPI, 2: -, 3: SectorRHI, 4: Volume, 5: Sector PPI

[Data Type] (xx)
R: Rainfall intensity [mm/h]
Zh: Reflectivity factor (Horizontal) [dBZ]
V: Doppler velocity [m/s]
W: Doppler spectrum width [m/s]
Zdr: Differential reflectivity [dB]
Φdp: Differential phase (cross polarization) [deg]
Kdp: Specific differential phase [deg/km]
phv: Correlation coefficient between Zh and Zv

Model of file name is Date_Time_DataType_ElevationAngle.csv(YYYYMMDD_HHMMSS_xx_###.csv)
E.g.) The case of output rainfall intensity occurred on 2019/04/18 13:49:00 would become

Table 7.2: Sample of Original CSV Output Data

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	2019/4/16 13:38	4																	
2	34.7136																		
3	135.3352																		
4	333																		
5	306																		
6	100																		
7	21.5																		
8	82.79	83.89	84.95	86.04	87.14	88.24	89.3	90.4	91.45	92.55	93.65	94.7	95.8	96.86	97.95	99.05	100.15	101.21	102.3
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10																			
11																			
12																			
13	0	0.6	1.5	0	0	1	0	1.2	0.4	0	0	0	1.1	2	1.1	0.7	0.3	0	0
14	0	0	1.3	0	0	0.9	1.5	1.2	0.6	0	0	1.7	1.5	1.3	1.2	0.8	0	1.1	0
15	0	0	0	2.1	1.1	1.4	0	1.8	0.5	0	1.3	2.8	2.9	1.7	2.6	0	0	2.4	0
16	1.6	1.9	1.3	1	0.7	0.9	0	2.1	0	1.1	0.5	3.5	0	1.4	2.7	0	0	2	0
17	0.7	0	1.7	0.4	0	1.9	1.1	0.5	0	1.9	0	2.2	0	0	2.9	1.9	2	1.9	1.2
18	0	0.4	1.3	0	0	0	0	1	0	1.8	0	1.9	0	2	2.7	2.1	0	3.9	3.6
19	2.5	1.3	0	0.9	5.4	4.4	2.1	0.7	0	0	0.2	0.3	1.5	0.6	2.4	1.6	3	2.3	1.2
20	2.2	0	0.9	3.6	2.9	3.2	1	0.6	0	1.1	0.3	1.5	0.5	1.4	0	0.8	0	1.2	0.3
21	1	0	0	0.9	1.1	2.5	3.9	1.2	0.8	1.9	0	1.4	1.5	1.3	1.4	0.5	0	0	0
22	0.8	0.6	0	1.1	0	1.6	0	1.6	1.5	1.8	0.4	2.5	1.2	0	0	0	1.3	0	0
23	1.7	1.7	1.3	2.6	4.2	2.9	0	2.2	1.6	3.1	1.5	3.1	2.8	2	1.6	1.6	1.8	0	0
24	1.6	1.6	1.7	6.2	6.6	2.7	1.2	0.5	0	2.9	1.5	1	1.4	1.6	1.6	0	0	3	1.7
25	2	1.3	1.3	1.4	1.1	2.7	1.7	1.1	1.5	5	3.8	1.3	0.4	0	0	0	1.9	2	0.6
26	0.9	2.5	2	0.6	0.8	2.8	3.2	4.2	5.3	5.3	6.4	3.5	1.6	0.6	0	0.7	1.6	0.2	0
27	0	1.6	1.5	0	1.9	5.2	2.1	3.1	5.5	5.3	5.2	3.7	4	3.6	1	1.3	0.5	0	0
28	0	3.6	2.2	2.2	1.5	0.7	0	1.5	2.6	5.2	5.5	5.8	4.9	3.5	3.8	1.3	2.4	2.6	1.8
29	0.7	2.4	0	0	1	0.7	0	0.3	0	3.7	2.7	3.3	1.9	1.2	1.1	0	2.2	4.3	2
30	1.1	2.1	1.5	0	0	0	1.1	0	0	3.8	2.3	1.2	0.8	0.6	0.6	0	2.2	4.3	3.9
31	1.1	2.5	2.6	0	0	0	1.1	0	0	3.9	1.8	2.7	3.3	2.1	1.6	2	0.6	0	2.1
32	1.9	2.7	0	0	0	0	1.4	2.5	3.1	6.2	5	4.4	4.6	5.7	4.4	4.6	3.5	2.4	2.7
33	0	3	1.4	0	0	0	0.1	1.4	4.5	1	4.6	4.2	3.7	2.4	5.7	2.6	3.2	2.6	0
34	1.4	2.8	1.1	0.3	0	0	0	0	2.1	1.1	2.4	1	2.2	0.8	2	3	3.2	2.3	1.7

7.2. Data File Type 2 [Binary v3] (legacy format)

1) Record unit

One scn file contains the observation parameters (Zh, V, W, and etc.) set in binary of data acquisition of RainMap in one scan unit (for example, one round of azimuth). The extension changes according to the scan format.

2) Record file name

xxxx_YYYYMMDD_hhmmss_##_**.scn:
scn: (Product number xxxx) + Scenario start (UTC yyyymmddhhmmss) + (Elevation number ##) + (Modulation method**)
Note 1: Elevation number is a starting elevation -> Sequence number from 01.
Note 2: Modulation method: 00: Pulse modulation, 01: Frequency modulation, 02: 00+01 (Alternate transmission)
For example, 0001_20130514_123400_01_00.scn

xxxx_YYYYMMDD_hhmmss_##_**.ppi:
ppi: (Product number xxxx) + Start acquisition (UTC yyyymmddhhmmss) + (01) + (Modulation method**)
Note: Modulation method: 00: Pulse modulation, 01: Frequency modulation, 02: 00+01 (Alternate transmission)
For example, 0001_20130514_123400_01_00. ppi

xxxx_YYYYMMDD_hhmmss_###.sppi:
sppi: (Product number xxxx) + Start scenario (UTC yyyymmddhhmmss) + (Elevation number ###)
Note: Elevation number is a starting elevation -> Sequence number from 000.
For example, 0001_20130514_123456_001.sppi

xxxx_YYYYMMDD_hhmmss_###.rhi:
rhi: (Product number xxxx) + Start scenario (UTC yyyymmddhhmmss) + (Azimuth number ###)
Note: Azimuth number is a starting azimuth -> an ending azimuth (or ending azimuth -> starting azimuth) with sequence number from 000.
For example, 0001_20130514_123456_001.rhi

For scenario scan:
The "TASKNAME" defined in the scenario is inserted in the record file name.
For example, 0001_20130514_123400_01_00_VOLUME1.scn (The "TASKNAME" is VOLUME1.)
For example, 0001_20130514_123400_01_00_PPI2.ppi (The "TASKNAME" is PPI2.)
For example, 0001_20130514_123456_001_SPPI3.sppi (The "TASKNAME" is SPPI3.)
For example, 0001_20130514_123456_001_SRHI4.rhi (The "TASKNAME" is SRHI4.)

All times listed in the file name are UTC times.

3) Data format

Binary format (Byte order: Little-endian)

Block	Item	Detail	Size [byte]	Off-set	Data type
Header	Size of header	80 [Byte] (*1)	2	2	unsigned short
	Version of data format	3	2	4	unsigned short
	DPU Log time: year	For example, 2013	2	6	unsigned short
	DPU Log time: month	For example, 05	2	8	unsigned short
	DPU Log time: day	For example, 15	2	10	unsigned short
	DPU Log time: hour	For example, 18	2	12	unsigned short
	DPU Log time: minute	For example, 30	2	14	unsigned short
	DPU Log time: second	For example, 00	2	16	unsigned short
	Latitude: degree	For example, 34 (N. Lat: +, S. Lat:-) Degrees from S0 deg to S1 deg are expressed -360 to -361 deg.	2	18	signed short
	Latitude: minute	For example, 44	2	20	unsigned short
	Latitude: second	For example, 59.999 (3 decimal places)	2	22	unsigned short
	Longitude: degree	For example, 135 (E. Lon: +, W. Lon.-) Degrees from W0 deg to W1 deg are expressed -360 to -361 deg.	2	24	signed short
	Longitude: minute	For example, 21	2	26	unsigned short
	Longitude: second	For example, 59.999 (3 decimal places)	2	28	unsigned short
	Antenna Altitude (Upper)	Range Upper: 0 to 65535	2	30	unsigned short
	Antenna Altitude (Lower)	Range lower: 0 to 9999 Altitude[cm]＝ (Upper) x 10000 + (Lower) For example, 123456[cm]＝12 x 10000 + 456	2	32	unsigned short
	Antenna rotation speed (Azimuth)	For example, 10.0 (1 decimal place of [rpm])	2	34	unsigned short
	PRF1	For example, 1600.0 (1 decimal place of [Hz])	2	36	unsigned short
	PRF2	For example, 2000.0 (1 decimal place of [Hz])	2	38	unsigned short
	Noise level (Pulse Modulation) - Horizontal polarization	For example, -62.00 (2 decimal places of [dBZ@1m])	2	40	signed short
	Noise level (Frequency Modulation) - Horizontal polarization	For example, -62.00 (2 decimal places of [dBZ@1m])	2	42	signed short
	Total number of sweeps: L	For example, 720 [qty]	2	44	unsigned short
	Number of range direction data: M	For example, 300 [qty]	2	46	unsigned short
	Resolution of range direction	For example, 100.00 (2 decimal places of [m])	2	48	unsigned short
	Constant radar: Mantissa (Horizontal polarization)	Range: -999999999 to 999999999	4	52	signed long
	Constant radar: Characteristic (Horizontal polarization)	Range: Characteristic: -32768 to 32767 Constant＝ (Mantissa) x 10^ (Characteristic) For example, 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) **Note:** This value is invalid for the single polarization.	4	58	signed long
	Constant radar: Characteristic (Vertical polarization)		2	60	signed short
	Azimuth Offset	For example, 200.00 ([deg] x 100) Offset value of North and radar direction of origin	2	62	unsigned short
	Record UTC time: year (*1)	For example, 2013	2	64	unsigned short
	Record UTC time: month (*1)	For example, 05	2	66	unsigned short
	Record UTC time: day (*1)	For example, 15	2	68	unsigned short
	Record UTC time: hour (*1)	For example, 09	2	70	unsigned short
	Record UTC time: minute (*1)	For example, 30	2	72	unsigned short
	Record UTC time: second (*1)	For example, 00	2	74	unsigned short
	Record item (*1)	For example, WR-2120: 33279 (dec) bit0: Rain, bit1: Zh, bit2: V, bit3: Zdr, bit4: Kdp, bit5: φdp, bit6: ρhv, bit7: W, bit8: quality information, bit9 to 14: reserved, bit15: 1 (fixed)	2	76	unsigned short
	Tx pulse blind area (*1)	For example, 7500 [m]	2	78	unsigned short
	Tx pulse specification (*1)	For example, 8	2	80	unsigned short
Angle information block	Angle information block size	6 [byte]	2	82	unsigned short
	Azimuth *Angle from initial position of ATU	Range: 0.00 to 359.99 (2 decimal places of [deg]) Initial position: 0 deg	2	84	unsigned short
	Elevation	Range: -2.00 to 182.00 (2 decimal places of [deg]) Horizontal: 0 deg, Elevation: +, Dip: -	2	86	signed short
Observed data block	Observed data size	For example, 5402 [byte]	2	88	unsigned short
	Rain (Rainfall intensity)	Range: 0 to 65535 Calculation formula N is a recording level. Rain[mm/h]= (N-32768)/100 Rain Range: -327.67 to 327.67 mm/h Resolution: 0.01 mm/h N=0 is invalid	2×M	-	unsigned short
	Zh (Reflectivity factor of horizontal polarization wave)	Range: 0 to 65535 Calculation formula N is a recording level. Zh[dBZ]= (N-32768)/100 Zh Range: -327.67 to 327.67 dBZ Resolution: 0.01 dBZ N=0 is invalid	2×M	-	unsigned short

Block	Item	Detail	Size [byte]	Off-set	Data type
Observed data block	V (Doppler velocity)	Range: 0 to 65535 Calculation formula N is a recording level. V[m/s]= (N-32768)/100 V Range: -327.67 to 327.67 m/s Resolution: 0.01 m/s N=0 is invalid	2×M	-	unsigned short
	Zdr (Differential reflectivity) (*1)	Calculation formula N is a recording level. Zdr[dB]= (N-32768)/100 Zdr Range: -327.67 to 327.67 dB Resolution: 0.01dB N=0 is invalid	2×M	*	unsigned short
	Kdp (Specific differential phase) (*1)	Calculation formula N is a recording level. Kdp[deg/km]= (N-32768)/100 Kdp Range: -327.67 to 327.67 deg/km Resolution: 0.01 deg/km N=0 is invalid	2×M	*	unsigned short
	φdp (Differential phase) (*1)	Calculation formula N is a recording level. φdp[deg]=360x(N-32768)/65535 φdp Range: -179.9972 to 179.9972 deg Resolution: 0.0055deg N=0 is invalid	2×M	*	unsigned short
	ρhv (Correlation coefficient between Zh and Zv) (*1) * Corrected by S/N	Calculation formula N is a recording level. ρhv [no unit] =2 x (N-1)/65534 ρhv Range:0.0 to 2.0 Resolution: 0.0000030 N=0 is invalid	2×M	*	unsigned short
	W (Doppler spectrum width)	Range: 0 – 65535 Calculation formula N is a recording level. W[m/s] = (N-1)/100 W Range: 0.00 to 655.34 m/s Resolution: 0.01 m/s N=0 is invalid	2×M	-	unsigned short
	Quality information (*1)	For example, 2 bit0: signal shielding bit1: signal extinction bit2: ground clutter reference bit3 to 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 to 7 shows additional) bit9 to 15: reserved	2×M	-	unsigned short

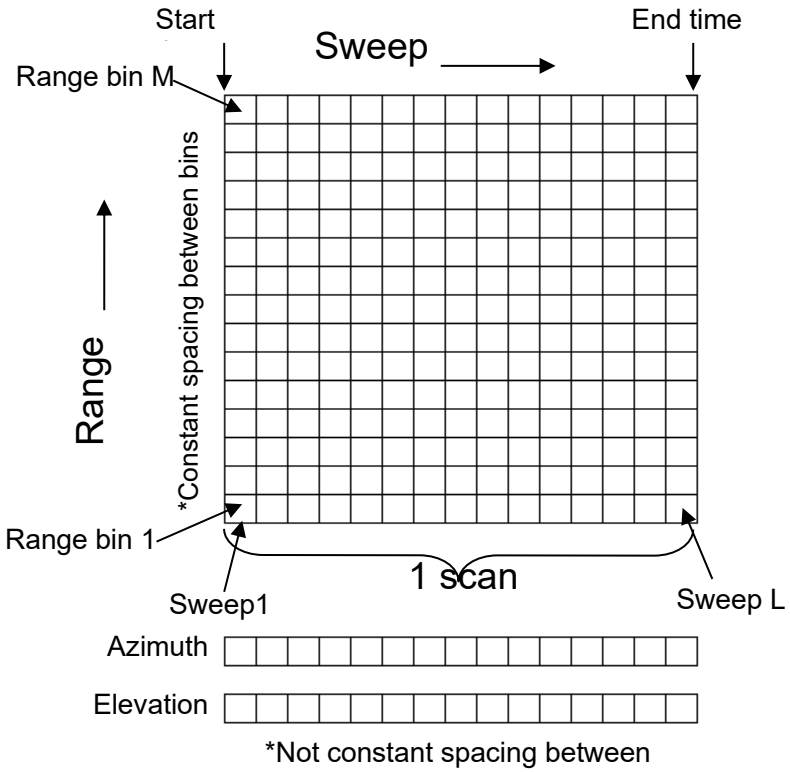
Block	Item	Detail	Size [byte]	Off-set	Data type
Angle information	Sweep 1	Angle Information 1			
Observed data	Sweep 1	Observed data R			
	・	・			
	Sweep 1	Observed data W			
	Sweep 1	Observed data Quality			
・	Sweep 2	Angle Information 2			
・	Sweep 2	Observed data R			
・	・	・			
・	・	・			
・	Sweep 2	Observed 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			

7.3. Data File Type 3 [Binary v10]

1） Record unit

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

2） Define of data dimensions



3） Record file name

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

For scenario scan: The “TASKNAME” defined in the scenario is inserted in the record file name. For example, 0001_20180910_183000_000_SCENARIO.scnx (The “TASKNAME” is SCENARIO.)

4） Data format

Binary format (Byte order: Little-endian).

Block	Item		Detail	Size [byte]	Off-set	Data type
Header	Size of header		156 [byte]	2	2	unsigned short
	Version of data format		10	2	4	unsigned short
	Scan start time (UTC)	Year	For example, 2018	2	6	unsigned short
		Month	For example, 09	1	7	unsigned char
		Day	For example, 10	1	8	unsigned char
		Hour	For example, 18	1	9	unsigned char
		Minute	For example, 30	1	10	unsigned char
		Second	For example, 00	1	11	unsigned char
		Spare	0	1	12	-
	Scan end time (UTC)	Year	For example, 2018	2	14	unsigned short
		Month	For example, 09	1	15	unsigned char
		Day	For example, 10	1	16	unsigned char
		Hour	For example, 18	1	17	unsigned char
		Minute	For example, 30	1	18	unsigned char
		Second	For example, 50	1	19	unsigned char
		Spare	0	1	20	-
	Time Zone (Include daylight-saving time)		For example, +9.00 (JST) For example, -6.00 (CST) For example, -5.00 (CDT) For example, +9.30 (ACST) For example, +8.45 (ACWST) (Two digits after the decimal point are multiplied by 100 and stored as an integer. The decimal part represents the minute)	2	22	signed short
	Product number		For example, 0000	2	24	unsigned short
	Model type		1: WR-50 2: WR-2100 3: WR110 4: WR2120	2	26	unsigned short
	Latitude		For example, 34.71360 (N. Lat: +, S. Lat:-) (Multiply [degree] by 100,000 and store as an integer) (Stored value: 3471360)	4	30	signed long
	Longitude		For example, 135.33520 (E. Lon: +, W. Lon.-) (Multiply [degree] by 100,000 and store as an integer)	4	34	signed long
	Antenna Altitude		For example, 10000 [cm]	4	38	signed long
	Azimuth Offset		For example, 200.00 (Multiply [degree] by 100 and store as an integer) (Offset value of North and radar direction of origin)	2	40	unsigned short
	TX frequency		For example, 9432.50 (Multiply [MHz] by 100 and store as an integer)	4	44	unsigned long
	Polarization mode		1: single-H 2: Simultaneous-dual	2	46	unsigned short
	Antenna gain H		For example, 34.0 (Multiply [dBi] by 10 and store as an integer)	2	48	unsigned short
	Antenna gain V		For example, 34.0 (Multiply [dBi] by 10 and store as an integer)	2	50	unsigned short
	Half-power beam width H		For example, 2.70 (Multiply [degree] by 100 and store as an integer)	2	52	unsigned short
	Half-power beam width V		For example, 2.70 (Multiply [degree] by 100 and store as an integer)	2	54	unsigned short

Block	Item	Detail	Size [byte]	Off-set	Data type
Header	TX power H (*6)	For example, 75.0 (Multiply [W] by 10 and store as an integer)	2	56	unsigned short
	TX power V (*6)	For example, 75.0 (Multiply [W] by 10 and store as an integer)	2	58	unsigned short
	Radar const. H (*4)	For example, -131.0 (Multiply [[m/mW] logarithmic dB] by 10 and store as an integer)	2	60	signed short
	Radar const. V (*4)	For example, -131.0 (Multiply [[m/mW] logarithmic dB] by 10 and store as an integer)	2	62	signed short
	Noise power H (Short pulse)	For example, -60.0 (Multiply [dBZ@1m] by 10 and store as an integer)	2	64	signed short
	Noise power H (Long pulse)	For example, -75.0 (Multiply [dBZ@1m] by 10 and store as an integer)	2	66	signed short
	Threshold power (Short pulse)	For example, -56.0 (Multiply [dBZ@1m] by 10 and store as an integer)	2	68	signed short
	Threshold power (Long pulse)	For example, -71.0 (Multiply [dBZ@1m] by 10 and store as an integer)	2	70	signed short
	Tx pulse specification	For example, 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	For example, 2000.0 (Multiply [Hz] by 10 and store as an integer)	2	76	unsigned short
	PRF2	For example, 1600.0 (Multiply [Hz] by 10 and store as an integer)	2	78	unsigned short
	PRF3	For example, 1400.0 (Multiply [Hz] by 10 and store as an integer)	2	80	unsigned short
	Nyquist velocity (*5)	For example, 64.2 (Multiply [m/s] by 10 and store as an integer)	2	82	unsigned short
	Sample number	For example, 64 (Number of samples used for making the 1 sweep data)	2	84	unsigned short
	Tx pulse blind length	For example, 300 [m]	2	86	unsigned short
	Short pulse width	For example, 1.00 (Multiply [μs] by 100 and store as an integer)	2	88	unsigned short
	Short pulse modulation bandwidth	For example, 0.00 (Multiply [MHz] by 100 and store as an integer)	2	90	unsigned short
	Long pulse width	For example, 30.00 (Multiply [μs] by 100 and store as an integer)	2	92	unsigned short
	Long pulse modulation bandwidth	For example, 2.00 (Multiply [MHz] by 100 and store as an integer)	2	94	unsigned short
	Pulse switch point	For example, 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)	For example, 7.5 (Multiply [rpm] by 10 and store as an integer)	2	100	unsigned short
	Number of sweep direction data: L	For example, 720 [qty]	2	102	unsigned short
	Number of range direction data: M	For example, 300 [qty]	2	104	unsigned short
	Resolution of range direction	For example, 100 [m]	2	106	unsigned short
	Current scan number	For example, 0 [st, nd, rd, th] (Starting from 0)	2	108	unsigned short
	Total number of scans comprising the volume	For example, 6 *Only Volume scan, SPPI scan (Starting from 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”		For example, 200.0 (Multiply by 10 and store as an integer) (Stored value: 2000))	2	114	unsigned short
	Z-R coefficient “β”		For example, 1.60 (Multiply by 100 and store as an integer)	2	116	unsigned short
	Kdp-R coefficient “a”		For example, 19.60 (Multiply by 100 and store as an integer)	2	118	unsigned short
	Kdp-R coefficient “b”		For example, 0.825 (Multiply by 1000 and store as an integer)	2	120	unsigned short
	Kdp-R coefficient “c”		For example, 1.20 (Multiply by 100 and store as an integer)	2	122	unsigned short
	Zh attenuation correction method		1. none 2. Kr 3. Kdp	2	124	unsigned short
	Zh attenuation correction coefficient “b1”		For example, 0.233 (Multiply by 1000 and store as an integer)	2	126	unsigned short
	Zh attenuation correction coefficient “b2”		For example, 1.020 (Multiply by 1000 and store as an integer)	2	128	unsigned short
	Zdr attenuation correction coefficient “d1”		For example, 0.0298 (Multiply by 10000 and store as an integer)	2	130	unsigned short
	Zdr attenuation correction coefficient “d2”		For example, 1.293 (Multiply by 1000 and store as an integer)	2	132	unsigned short
	Air attenuation (one way)		For example, 0.010 (Multiply [dB/km] by 1000 and store as an integer)	2	134	unsigned short
	Output threshold of Rain		For example, 0.5 (Multiply [mm/h] by 10 and store as an integer)	2	136	unsigned short
	Record item (*1)		For example, 33279 bit0: R, bit1: Zh, bit2: V, bit3: Zdr, bit4: Kdp, bit5: φdp, bit6: ρhv, bit7: W, bit8: Quality information, bit9 to 14: reserved, bit15: 1 (fixed)	2	138	unsigned short
	Signal Processing Flag (*3)		For example, 7 bit0: GCR(MTI) bit1: GCR(Ref) bit2: SCR	2	140	unsigned short
	Used clutter reference file (*2)	Year	For example, 2017 If GCR(Ref) is off, value is 0.	2	142	unsigned short
		Month	For example, 12	1	143	unsigned char
		Day	For example, 31	1	144	unsigned char
		Hour	For example, 23	1	145	unsigned char
		Minute	For example, 59	1	146	unsigned char
		Second	For example, 00	1	147	unsigned char
		Spare	0	1	148	-
	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: 0.00 to 359.99 (Multiply [deg] by 100 and store as an integer) (Initial position: 0 deg)	2	160	unsigned short
	Elevation		Range: -2.00 to 182.00 (Multiply [deg] by 100 and store as an integer) (Horizontal: 0deg, Elevation: +, Dip: -)	2	162	signed short

Block	Item	Detail	Size [byte]	Off-set	Data type
Observed data block	Observed data block size	For example, 16796 [byte]	2	164	unsigned short
	R (Rainfall intensity)	Calculation formula N is a stored value. R[mm/h] = (N-32768)/100 R Range: -327.67 to 327.67 mm/h Resolution: 0.01 mm/h N = 0 is invalid	2×M	*	unsigned short
	Zh (Reflectivity factor of horizontal polarization wave) (*1)	Calculation formula N is a stored value. Zh[dBZ] = (N-32768)/100 Zh Range: -327.67 to 327.67 dBZ Resolution: 0.01 dBZ N = 0 is invalid	2×M	*	unsigned short
	V (Doppler velocity) (*1)	Calculation formula N is a stored value. V[m/s] = (N-32768)/100 V Range: -327.67 to 327.67 m/s Resolution: 0.01 m/s N = 0 is invalid	2×M	*	unsigned short
	Zdr (Differential reflectivity) (*1)	Calculation formula N is a stored value. Zdr[dB] = (N-32768)/100 Zdr Range: -327.67 to 327.67 dB Resolution: 0.01dB N = 0 is invalid	2×M	*	unsigned short
	Kdp (Specific differential phase) (*1)	Calculation formula N is a stored value. Kdp[deg/km] = (N-32768)/100 Kdp Range: -327.67 to 327.67 deg/km Resolution: 0.01 deg/km N = 0 is invalid	2×M	*	unsigned short
	φdp (Differential phase) (*1)	Calculation formula N is a stored value. φdp[deg] = 360x(N-32768)/65535 φdp Range: -179.9972 to 179.9972 deg Resolution: 0.0055 deg N = 0 is invalid	2×M	*	unsigned short
	ρhv (Correlation coefficient between Zh and Zv) (*1) * Corrected by S/N	Calculation formula N is a stored value. ρhv [no unit] = 2 x (N-1)/65534 ρhv Range:0.0 to 2.0 Resolution: 0.0000030 N = 0 is invalid	2×M	*	unsigned short
	W (Doppler spectrum width) (*1)	Calculation formula N is a recording level. W[m/s] = (N-1)/100 W Range: 0.00 to 655.34 m/s Resolution: 0.01 m/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 to 5: Ground clutter quantity 0: Less than 0.1 mm/h 1: More than 0.1 mm/h 2: More than 1.0 mm/h 3: More than 5.0 mm/h 4: More than 10.0 mm/h 5: More than 20.0 mm/h 6: More than 50.0 mm/h 7: More than 100.0 mm/h bit6: Pulse blind area bit7: Sector blank bit8 to 15: reserved	2×M	*	unsigned short
Angle information	Sweep 1	Angle Information 1			
Observed data	Sweep 1	Observed data R			
	・	・			
	Sweep 1	Observed data W			
	Sweep 1	Observed data Quality			
・	Sweep 2	Angle Information 2			
・	Sweep 2	Observed data R			
・	・	・			
・	・	・			
・	Sweep 2	Observed data W			
・	Sweep 2	Observed data Quality			
・	Sweep L	Angle Information L			
・	Sweep L	Observed data R			
・	・	・			
・	・	・			
・	Sweep L	Observed data W			
	Sweep L	Observed data Quality			

(*1) Only valid types are saved in the observed data block.
(*2) “YYYYMMDDhhmmss” of Clutter reference filename is stored.
(*3) GCR(MTI): Ground Clutter Rejection is using the “Moving Target Indicator”.
SCR : Ship Clutter Rejection.
GCR(Ref): Ground Clutter Rejection is using the 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_h : Vertical -3 dB antenna beamwidth [rad]
τ : Pulse width [μs]
G : Antenna gain [dBi]
$Loss$: Loss of system [dB]

This definition of the radar constant is based on the following radar equation.

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

r : Distance from the radar [m]
P_r : Received power [mW]
(*5) In Dual PRF case, Nyquist velocity is expanded by multi PRF method.
(*6) This value is antenna-end output power and contains the waveguide (TX chain) loss.

7.4. Data File Type 4 [Binary v11]

1） Record unit
Same as Data File Type 3 [Binary v10]

2） Define of data dimensions
Same as Data File Type 3 [Binary v10]

3） Record file name
Same as Data File Type 3 [Binary v10]

4） Data format
Binary format (Byte order: Little-endian).

Block	Item		Detail	Size [byte]	Off-set	Data type
Header	Size of header		156 [byte]	2	2	unsigned short
	Version of data format		11	2	4	unsigned short
	Scan start time (UTC)	Year	For example, 2018	2	6	unsigned short
		Month	For example, 09	1	7	unsigned char
		Day	For example, 10	1	8	unsigned char
		Hour	For example, 18	1	9	unsigned char
		Minute	For example, 30	1	10	unsigned char
		Second	For example, 00	1	11	unsigned char
		Spare	0	1	12	-
	Scan end time (UTC)	Year	For example, 2018	2	14	unsigned short
		Month	For example, 09	1	15	unsigned char
		Day	For example, 10	1	16	unsigned char
		Hour	For example, 18	1	17	unsigned char
		Minute	For example, 30	1	18	unsigned char
		Second	For example, 50	1	19	unsigned char
		Spare	0	1	20	-
	Time Zone (Include daylight-saving time)		For example, +9.00 (JST) For example, -6.00 (CST) For example, -5.00 (CDT) For example, +9.30 (ACST) For example, +8.45 (ACWST) (Two digits after the decimal point are multiplied by 100 and stored as an integer. The decimal part represents the minute）	2	22	signed short
	Product number		For example, 0000	2	24	unsigned short
	Model type		1: WR-50 2: WR-2100 3: WR110 4: WR2120	2	26	unsigned short
	Latitude		For example, 34.71360 (N. Lat: +, S. Lat:-) (Multiply [degree] by 100,000 and store as an integer) (Stored value: 3471360)	4	30	signed long
	Longitude		For example, 135.33520 (E. Lon: +, W. Lon.-) (Multiply [degree] by 100,000 and store as an integer)	4	34	signed long
	Antenna Altitude		For example, 10000 [cm]	4	38	signed long

Block	Item	Detail	Size [byte]	Off-set	Data type
Header	Azimuth Offset	For example, 200.00 (Multiply [degree] by 100 and store as an integer) (Offset value of North and radar direction of origin)	2	40	unsigned short
	TX frequency	For example, 9432.50 (Multiply [MHz] by 100 and store as an integer)	4	44	unsigned long
	Polarization mode	1: single-H 2: Simultaneous-dual	2	46	unsigned short
	Antenna gain H	For example, 34.0 (Multiply [dBi] by 10 and store as an integer)	2	48	unsigned short
	Antenna gain V	For example, 34.0 (Multiply [dBi] by 10 and store as an integer)	2	50	unsigned short
	Half-power beam width H	For example, 2.70 (Multiply [degree] by 100 and store as an integer)	2	52	unsigned short
	Half-power beam width V	For example, 2.70 (Multiply [degree] by 100 and store as an integer)	2	54	unsigned short
	TX power H (*6)	For example, 75.0 (Multiply [W] by 10 and store as an integer)	2	56	unsigned short
	TX power V (*6)	For example, 75.0 (Multiply [W] by 10 and store as an integer)	2	58	unsigned short
	Radar const. H (*4)	For example, -131.0 (Multiply [[m / mW] logarithmic dB] by 10 and store as an integer)	2	60	signed short
	Radar const. V (*4)	For example, -131.0 (Multiply [[m / mW] logarithmic dB] by 10 and store as an integer)	2	62	signed short
	Noise power H (Short pulse)	For example, -60.0 (Multiply [dBZ@1m] by 10 and store as an integer)	2	64	signed short
	Noise power H (Long pulse)	For example, -75.0 (Multiply [dBZ@1m] by 10 and store as an integer)	2	66	signed short
	Threshold power (Short pulse)	For example, -56.0 (Multiply [dBZ@1m] by 10 and store as an integer)	2	68	signed short
	Threshold power (Long pulse)	For example, -71.0 (Multiply [dBZ@1m] by 10 and store as an integer)	2	70	signed short
	Tx pulse specification	For example, 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	For example, 2000.0 (Multiply [Hz] by 10 and store as an integer)	2	76	unsigned short
	PRF2	For example, 1600.0 (Multiply [Hz] by 10 and store as an integer)	2	78	unsigned short
	PRF3	For example, 1400.0 (Multiply [Hz] by 10 and store as an integer)	2	80	unsigned short
	Nyquist velocity (*5)	For example, 64.2 (Multiply [m/s] by 10 and store as an integer)	2	82	unsigned short
	Sample number	For example, 64 (Number of samples used for making the 1 sweep data)	2	84	unsigned short
	Tx pulse blind length	For example, 300 [m]	2	86	unsigned short
	Short pulse width	For example, 1.00 (Multiply [μs] by 100 and store as an integer)	2	88	unsigned short
	Short pulse modulation bandwidth	For example, 0.00 (Multiply [MHz] by 100 and store as an integer)	2	90	unsigned short
	Long pulse width	For example, 30.00 (Multiply [μs] by 100 and store as an integer)	2	92	unsigned short

Block	Item	Detail	Size [byte]	Off-set	Data type
Header	Long pulse modulation bandwidth	For example, 2.00 (Multiply [MHz] by 100 and store as an integer)	2	94	unsigned short
	Pulse switch point	For example, 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)	For example, 7.5 (Multiply [rpm] by 10 and store as an integer)	2	100	unsigned short
	Number of sweep direction data: L	For example, 720 [qty]	2	102	unsigned short
	Number of range direction data: M	For example, 300 [qty]	2	104	unsigned short
	Resolution of range direction	For example, 100 [m]	2	106	unsigned short
	Current scan number	For example, 0 [st, nd, rd, th] (Starting from 0)	2	108	unsigned short
	Total number of scans comprising the volume	For example, 6 *Only Volume scan, SPPI scan (Starting from 1)	2	110	unsigned short
	Rainfall intensity estimation method	1: Zh 2: Zh, Kr 3: Zh, Ah 4: Kdp + Zh	2	112	unsigned short
	Z-R coefficient “B”	For example, 200.0 (Multiply by 10 and store as an integer) (Stored value: 2000))	2	114	unsigned short
	Z-R coefficient “β”	For example, 1.60 (Multiply by 100 and store as an integer)	2	116	unsigned short
	Kdp-R coefficient “a”	For example, 19.60 (Multiply by 100 and store as an integer)	2	118	unsigned short
	Kdp-R coefficient “b”	For example, 0.825 (Multiply by 1000 and store as an integer)	2	120	unsigned short
	Kdp-R coefficient “c”	For example, 1.20 (Multiply by 100 and store as an integer)	2	122	unsigned short
	Zh attenuation correction method	1. none 2. Kr 3. Kdp	2	124	unsigned short
	Zh attenuation correction coefficient “b1”	For example, 0.233 (Multiply by 1000 and store as an integer)	2	126	unsigned short
	Zh attenuation correction coefficient “b2”	For example, 1.020 (Multiply by 1000 and store as an integer)	2	128	unsigned short
	Zdr attenuation correction coefficient “d1”	For example, 0.0298 (Multiply by 10000 and store as an integer)	2	130	unsigned short
	Zdr attenuation correction coefficient “d2”	For example, 1.293 (Multiply by 1000 and store as an integer)	2	132	unsigned short
	Air attenuation (one way)	For example, 0.010 (Multiply [dB/km] by 1000 and store as an integer)	2	134	unsigned short
	Output threshold of Rain	For example, 0.5 (Multiply [mm/h] by 10 and store as an integer)	2	136	unsigned short
	Record item 1 (*1)	For example, 65535 bit0: R, bit1: Zh, bit2: V, bit3: Zdr, bit4: Kdp, bit5: φdp, bit6: ρhv, bit7: W, bit8: Quality information, bit9: Zv, bit10: Zhc, bit11: Zdrc, bit12: CCOR, bit13: SNR, bit14: SQI, bit15: 1 (fixed)	2	138	unsigned short

Block	Item		Detail	Size [byte]	Off-set	Data type
Header	Signal Processing Flag (*3)		For example, 7 bit0: GCR(MTI) bit1: GCR(Ref) bit2: SCR bit7: PPC (Pulse Phase Coding) bit8: ZNS (Z-Noise Suppression)	2	140	unsigned short
	Used clutter reference file (*2)	Year	For example, 2017 If GCR(Ref) is off, value is 0.	2	142	unsigned short
		Month	For example, 12	1	143	unsigned char
		Day	For example, 31	1	144	unsigned char
		Hour	For example, 23	1	145	unsigned char
		Minute	For example, 59	1	146	unsigned char
		Second	For example, 00	1	147	unsigned char
		Spare	0	1	148	-
	Record item 2		For example, 511 bit0: UZh, bit1: UZv, bit2: UZdr(reserved), bit3：UV(reserved), bit4: UW(reserved), bit5：Uφdp(reserved), bit6: Uρhv(reserved), bit7: USNR(reserved), bit8: USQI(reserved),bit9-bit15: reserved（0）	2	150	unsigned short
	Reserved Block		Reserved	6	156	-
Angle information block	Angle information block size		6 [byte]	2	158	unsigned short
	Azimuth (Angle from initial position of ATU)		Range: 0.00 to 359.99 (Multiply [deg] by 100 and store as an integer) (Initial position: 0 deg)	2	160	unsigned short
	Elevation		Range: -2.00 to 182.00 (Multiply [deg] by 100 and store as an integer) (Horizontal: 0deg, Elevation: +, Dip: -)	2	162	signed short
Observed data Block 1	Observed data block 1 size		For example, 16796 [byte]	2	164	unsigned short
	R (Rainfall intensity)		Calculation formula N is a stored value. R［mm/h] = (N-32768)/100 R Range: -327.67 to 327.67 mm/h Resolution: 0.01 mm/h N = 0 is invalid	2×M	*	unsigned short
	Zh (Reflectivity factor of horizontal polarization wave) (*1)		Calculation formula N is a stored value. Zh［dBZ] = (N-32768)/100 Zh Range: -327.67 to 327.67 dBZ Resolution: 0.01dBZ N = 0 is invalid	2×M	*	unsigned short
	V (Doppler velocity) (*1)		Calculation formula N is a stored value. V［m/s] = (N-32768)/100 V Range: -327.67 to 327.67 m/s Resolution: 0.01 m/s N = 0 is invalid	2×M	*	unsigned short
	Zdr (Differential reflectivity) (*1)		Calculation formula N is a stored value. Zdr [dB] = (N-32768)/100 Zdr Range: -327.67 to 327.67 dB Resolution: 0.01 dB N = 0 is invalid	2×M	*	unsigned short

Block	Item	Detail	Size [byte]	Off-set	Data type
Observed data Block 1	Kdp (Specific differential phase) (*1)	Calculation formula N is a stored value. Kdp［deg/km] = (N-32768)/100 Kdp Range: -327.67 to 327.67 deg/km Resolution: 0.01 deg/km N = 0 is invalid	2×M	*	unsigned short
	φdp (Differential phase) (*1)	Calculation formula N is a stored value. Φdp [deg] = 360x(N-32768)/65535 φdp Range: -179.9972 to 179.9972 deg Resolution: 0.0055 deg N = 0 is invalid	2×M	*	unsigned short
	ρhv (Correlation coefficient between Zh and Zv) (*1) * Corrected by S/N	Calculation formula N is a stored value. ρhv [no unit] = 2 x (N-1)/65534 ρhv Range:0.0 to 2.0 Resolution: 0.0000030 N = 0 is invalid	2×M	*	unsigned short
	W (Doppler spectrum width) (*1)	Calculation formula N is a recording level. W [m/s] = (N-1)/100 W Range: 0.00 to 655.34 m/s Resolution: 0.01 m/s N = 0 is invalid	2×M	*	unsigned short
	Quality information (*1)(*3)	bit0: Signal shading, bit1: Signal extinction, bit2: Clutter reference, bit3to5: Ground clutter quantity 0: Less than 0.1 mm/h 1: More than 0.1 mm/h 2: More than 1.0 mm/h 3: More than 5.0 mm/h 4: More than 10.0 mm/h 5: More than 20.0 mm/h 6: More than 50.0 mm/h 7: More than 100.0 mm/h bit6: Pulse blind area bit7: Sector blank bit8to15: reserved	2×M	*	unsigned short
	Zv (Reflectivity factor of vertical polarization wave) (*1)	Calculation formula N is a stored value. Zv［dBZ] = (N-32768)/100 Zv Range: -327.67 to 327.67 dBZ Resolution: 0.01 dBZ N = 0 is invalid	2×M	*	unsigned short
	Zh_corr (Rain attenuation correction reflectivity factor of vertical polarization wave) (*1)	Calculation formula N is a stored value. Zh_corr［dBZ] = (N-32768)/100 Zh_corr Range: -327.67 to 327.67 dBZ Resolution: 0.01 dBZ N = 0 is invalid	2×M	*	unsigned short
	Zdr_corr (Rain attenuation correction differential reflectivity) (*1)	Calculation formula N is a stored value. Zdr_corr [dB] = (N-32768)/100 Zdr_corr Range: -327.67 to 327.67 dB Resolution: 0.01 dB N = 0 is invalid	2×M	*	unsigned short

Block	Item	Detail	Size [byte]	Off-set	Data type
Observed data Block 1	CCOR (Clutter correction)	Calculation formula N is a stored value. CCOR[dB] = (N-32768)/100 CCOR Range: -327.67 to 327.67 dB Resolution: 0.01 dB N = 0 is invalid	2×M	*	unsigned short
	SNR (Signal noise ratio)	Calculation formula N is a stored value. SNR[dB] = (N-32768)/100 SNR Range: -327.67 to 327.67 dB Resolution: 0.01 dB N = 0 is invalid	2×M	*	unsigned short
	SQI (Signal quality index)	Calculation formula N is a stored value. SQI [no unit] = 2 x (N-1)/65534 SQI Range:0.0 to 2.0 Resolution: 0.0000030 N = 0 is invalid	2×M	*	unsigned short
Observed data Block 2 If the value of Record item 2 in the header is 0, this block does not exist.	Observed data block 2 size	For example, 18434 [byte]	2	*	unsigned short
	UZh (Unfiltered reflectivity factor of horizontal polarization wave) (*1)	Calculation formula N is a stored value. UZh[dBZ] = (N-32768)/100 UZh Range: -327.67 to 327.67 dBZ Resolution: 0.01 dBZ N = 0 is invalid	2×M	*	unsigned short
	UZv (Unfiltered reflectivity factor of vertical polarization wave) (*1)	Calculation formula N is a stored value. UZv[dBZ] = (N-32768)/100 UZv Range: -327.67 to 327.67 dBZ Resolution: 0.01 dBZ N = 0 is invalid	2×M	*	unsigned short
	UZdr (Unfiltered differential reflectivity) (Reserved parameter)	Calculation formula N is a stored value. UZdr [dB] = (N-32768)/100 UZdr Range: -327.67 to 327.67 dB Resolution: 0.01 dB N = 0 is invalid	2×M	*	unsigned short
	UV (Unfiltered doppler velocity) (Reserved parameter)	Calculation formula N is a stored value. UV[m/s] = (N-32768)/100 UV Range: -327.67 to 327.67 m/s Resolution: 0.01 m/s N = 0 is invalid	2×M	*	unsigned short
	UW (Unfiltered doppler spectrum width) (Reserved parameter)	Calculation formula N is a recording level. UW [m/s] = (N-1)/100 UW Range: 0.00 to 655.34 m/s Resolution: 0.01 m/s N = 0 is invalid	2×M	*	unsigned short
	Uφdp (Unfiltered differential phase) (Reserved parameter)	Calculation formula N is a stored value. Uφdp [deg] = 360x(N-32768)/65535 Uφdp Range: -179.9972 to 179.9972 deg Resolution: 0.0055 deg N = 0 is invalid	2×M	*	unsigned short

Block	Item	Detail	Size [byte]	Off-set	Data type
Observed data Block 2	Uphv (Unfiltered correlation coefficient between Zh and Zv) (Reserved parameter)	Calculation formula N is a stored value. Uphv [no unit] = 2 x (N-1)/65534 Uphv Range:0.0 to 2.0 Resolution: 0.0000030 N = 0 is invalid	2×M	*	unsigned short
	USNR (Unfiltered signal noise ratio) (Reserved parameter)	Calculation formula N is a stored value. USNR［dB] = (N-32768)/100 USNR Range: -327.67 to 327.67 dB Resolution: 0.01 dB N = 0 is invalid	2×M	*	unsigned short
	USQI (Unfiltered signal quality index) (Reserved parameter)	Calculation formula N is a stored value. USQI [no unit] = 2 x (N-1)/65534 USQI Range:0.0 to 2.0 Resolution: 0.0000030 N = 0 is invalid	2×M	*	unsigned short
Angle information	Sweep 1	Angle Information 1			
Observed data 1	Sweep 1	Observed data R			
	・	・			
	Sweep 1	Observed data SNR			
	Sweep 1	Observed data SQI			
Observed data 2	Sweep 1	Observed data UZh			
	Sweep 1	Observed data UZv			
Angle information	Sweep 2	Angle Information 2			
Observed data 1	Sweep 2	Observed data R			
	・	・			
	Sweep 2	Observed data SQI			
Observed data 2	Sweep 2	Observed data UZh			
	Sweep 2	Observed data UZv			
・	Sweep L	Angle Information L			
・	Sweep L	Observed data R			
・	・	・			
・	Sweep L	Observed data SQI			
・	Sweep L	Observed data UZh			
	Sweep L	Observed data UZv			

(*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 using the “Moving Target Indicator”.
SCR : Ship Clutter Rejection.
GCR(Ref): Ground Clutter Rejection is using the 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_h : Vertical -3 dB antenna beamwidth [rad]
τ : Pulse width [μs]
G : Antenna gain [dBi]
$Loss$: Loss of system [dB]

This definition of the radar constant is based on the following radar equation.

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

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

(*5) In Dual PRF case, Nyquist velocity is expanded by multi PRF method.
(*6) This value is antenna-end output power and contains the waveguide (TX chain) loss.

7.5. Data Size

Standard setting of single scan size (one complete azimuth rotation).
One file is generated in every 6 seconds.

- Data size per hour:
  5,189,916 byte x 3600 sec. / 6 sec. = approx. 2.9 GB (3,113,949,600)
- Data size at 30 days:
  3,113,949,600 byte x 30 days x 24 hrs. = approx. 2 TB

Header		Angle information		Observation data				Number of range direction data		Number of sweep direction data		Quantity of every scan
156	+	((6	+	2)	+	(18	x	For example, 400))	x	For example, 720	=	5,189,916 bytes

Note: The data capacity can be compressed approximately 50% to 70%. However, the compression ratio depends on weather conditions. Clear weather data can be compressed into a smaller file than active weather data. If the user needs 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 is saved in each file regardless of the individual checked fields, to ensure structured file information.

1) Sample setting

Azimuth scan speed: 5 rpm
Elevation angles: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 25, 30 and 40 degrees (13 angles)
Volume scan interval: 3 min.
Observation range 50km
Range resolution 150m
Binary format: SCNv10 (R, Zh, V, Zdr, Kdp, φdp, ρhv, W, Quality)

Required speed = 13 x 5,189,916 x 8 / (3 x 60) = 2.9 Mbps
Data size per hour =13 x 5,189,916 x 60 / 3 = 1.26 GB
Data size at 30 days = 13 x 5,189,916 x 60 x 24 x 30 / 3 = 905 GB

2) Worst setting

Azimuth scan speed: 10 rpm
Elevation angles: 2, 3, 4, 5, 6, 7, 8, 9 and degrees (9 angles)
Volume scan interval: 1 min.
Observation range 70km
Range resolution 75m
Binary format: SCNv11 (R, Zh, V, Zdr, Kdp, φdp, ρhv, W, Quality, Zv, Zh_corr, Zdr_corr, CCOR, SNR, SQI, UZ, UZv)

Required speed = 9 x 22,896,156 x 8 / 60 = 26.2 Mbps
Data size per hour =9 x 22,896,156 x 60 = 11.5 GB
Data size at 30 days = 9 x 22,896,156 x 60 x 24 x 30 = 8.1 TB

Important notice: If radar observations are performed in an environment where a large amount of data is generates due to data conversion and FTP transfers as described above, the lifespan of the DPU's SSD may be 2 years shorten. To prevent the SSD from becoming unusable after few years, please use the SSD status monitoring software.

3) 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.

To capture data accurately, it is necessary to scan hemisphere over the radar while changing its elevation angle as shown on Figure 7-1.

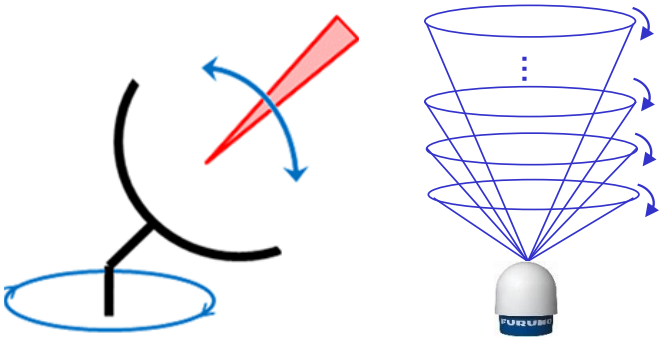


Figure 7-1: Basic volume scan

The WR2120 output the data files for each elevation angle. When using eight elevation angles, eight binary data files of several MB are generated for each file, and the file size depends on the data type to be saved and the distance resolution.

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.

8. MANTENANCE

8.1. Troubleshooting

STATE	CONTENT/PROCEDURE
Cannot turn the power on	1. Check if the power cable of the DPU has loosened. 2. Check the power plug of the DPU for damage. 3. Check the power cable of the DPU for damage. 4. Check that the breaker in the SPU is “ON”.
DPU has frozen or locked up	1. Press [Ctrl]+[Alt]+[Delete] simultaneously, select the application, then click [End Task] to force quit. Do the same to all applications if possible. Then, restart the DPU. 2. Press the reset button on the DPU or keep pressing the power button of the DPU for a few seconds to turn off the DPU. Then, push the power button of the DPU again. 3. Request service if the DPU freezes again.
Air conditioner of SPU is stopped	Request service.
The following failure(s) occurs: - No radar echo indication - SPU Failure - System Failure - Error code indication	1. Stop radar operation. Open the [Stop radar operation] menu on RainMap, then select [Stop motor]. Restart RainMap if normal operation cannot be restored. 2. [ATU/SPU reset] sends a reset command to the SPU, MONI-CON, motor driver, and itself to release from error. (See section 2.8) 3. If normal operation is not restored, turn OFF the switch of SPU and then turn it on again. (See section 1.6) 4. Request service and notify any error codes.
When launching RainPlay while observing RainMap with SRHI, the following error message appears: “Access violation at address XXX in module ‘ig9iod32.dll’. Read of address 00000000”.	The Intel graphic driver has stopped responding. Do the following to fix the problem. 1. Open the [Device Manager] of Windows. 2. Select [Display Adapter], then click the Intel Graphics driver name. 3. Select the [Driver] tab. 4. Click [Restore a driver] to roll back the driver selected.
Cannot connect SPU from RainMap	1. Start a command prompt at DPU, send “PING 192.168.210.200”, then check the PING response. If there is no PING response, turn OFF/ON the switch of SPU. (See section 1.6) 2. If the PING is not responded, connect the SPU directly to the DPU with a short LAN cable and see if they can connect to one another. (If it is difficult to connect directly with a short LAN, prepare a laptop with its IP-address 192.168.210.1, connect the SPU to the laptop with a short LAN cable, then send a PING from the laptop to the SPU. If the SPU responds, then connect DPU to the laptop and send a PING from the laptop to the DPU.) 3. If communication is established with a short LAN cable, there may be a problem with the LAN cable between the SPU and the DPU. If LAN between the SPU and the DPU was installed by the vendor, please contact the vendor for assistance.
Unstable communication between RainMap and SPU	Select [Stop motor] from the menu bar on RainMap. Start a command prompt at the DPU and send “PING 192.168.210.200 -l 65000 -n 10”. PING response results must be successful all 10 times, and the average round trip time must be less than 3 ms. If the PING result does not meet the above conditions, the LAN cable may be damaged. If the LAN between the SPU and the DPU was installed by the vendor, contact the vendor for assistance.

8.2. Log File Function

8.2.1. Error information log

Two types of error log files are created automatically and are saved into the following directory:
"Windows(C) > User > radar > AppData > Local > Furuno > RainMap >log"

1) RainMap_ErrorDisp.log
A maximum of 50 lines of error data is saved in this log file. When 50 lines are exceeded, additional error information overwrites older error line entries.

2) RainMap ErrorHist.log
All past error information is saved in this log file.

8.2.2. RainMap.log

1) Log file information
RainMap.log (Log file)

2) Limit of Log files
If there are more than 1,000 rows, the oldest rows will be overwritten.

3) Log file format
Save in "text" format.
For example,
[2014/06/17 10:35:06] SendParam,20140617_103506.dat
[2014/06/18 20:08:45] TRxStart,20140618_200845.dat

RainMap_ErrorDisp.log: Saves display detail failure information compiled from the 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	

8.3. 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]
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]
W801	System failure detected [Detected bad communication between DPU and SPU]
W802	Scenario scan failure detected [Scenario process time out]
W803	Scenario scan failure detected [Task process time out]
E804	System failure detected [Zero positioning failure]
E805	System failure detected [Invalid antenna direction data]
E806	System failure detected [Echo data not received from SPU]
E807	System failure detected [Non-existent pulse number is set in the scenario scan]

Note: The radar automatically stop operation when error occurs.

8.4. Life Expectancy of Major Parts

This radar has consumable parts, and the table below 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 before their expected expiration, to get the best performance and longest possible life from the equipment.

Part	Type	Estimated life expectancy
Antenna Unit		
MOTOR HORIZONTAL ASSY.	PKP264D28HASSY	10,000 hours
MOTOR VERTICAL ASSY.	PKP264D28VASSY	10,000 hours
HPA FAN CBL	WR2-CBL5	5 years
SP POWER SUPPLY ASSY.	AC6-2KHTN-00-XFN	5 years
Signal Processing Unit		
CHASSIS	781368-01	5 years
FAN	FM-11925P-D12-01	5 years
	FM-11938P-D12-01	5 years
Data Processing Unit		
DATA PROCESSING UNIT	WR110-DPU	5 years
AC ADAPTER	PW-120A2-1Y120G	5 years

Note 1: The table above shows the typical lifespan under normal conditions.

Note 2: When the radar is installed above 1,000 m, the life of the equipment becomes shorter due to deterioration of oil seal and the grease leakage. This is especially true with ball bearings in motors, fans, and spindles. For this reason, install the radar below 2,000m altitude.

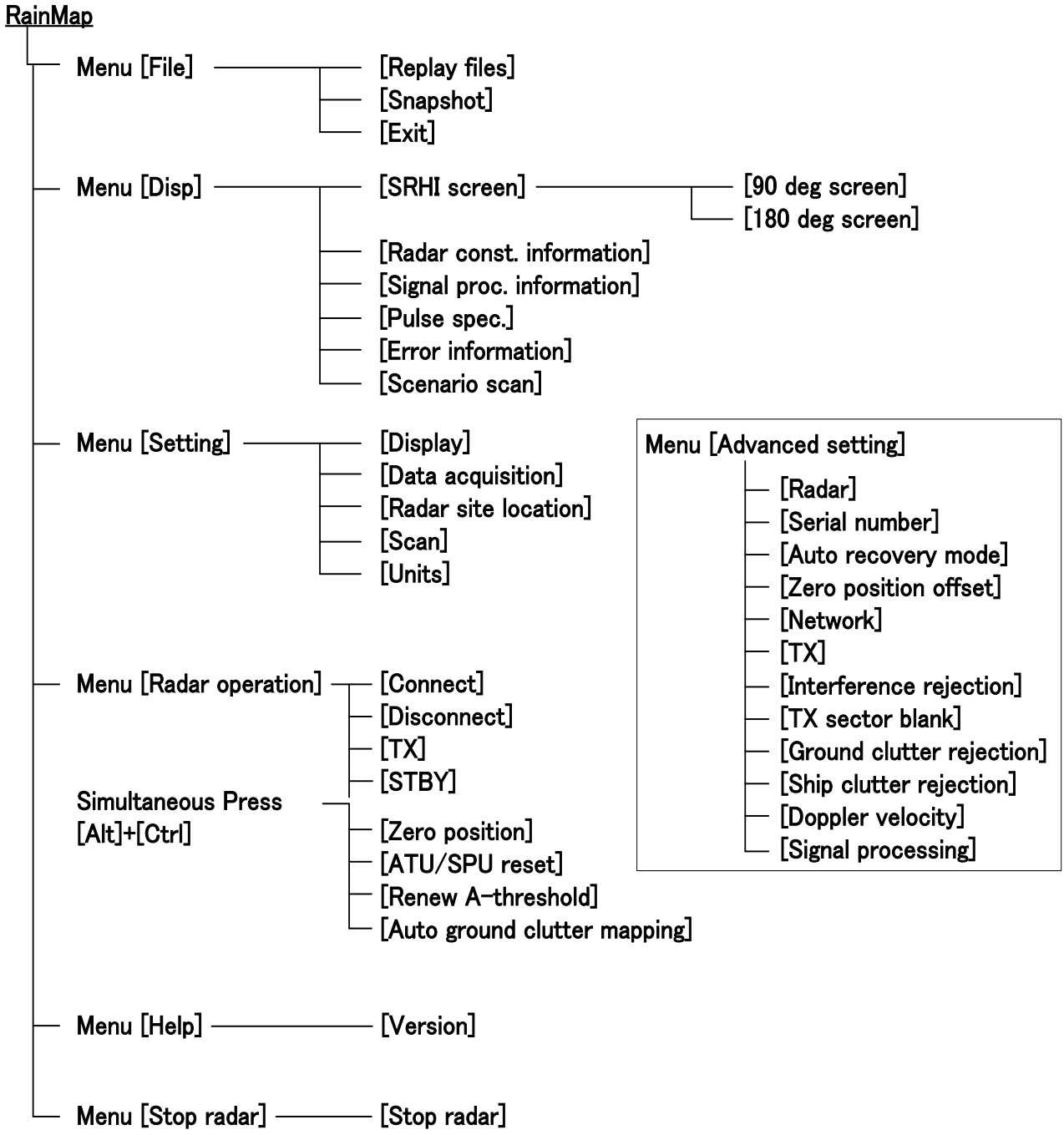
8.5. Preventative Maintenance

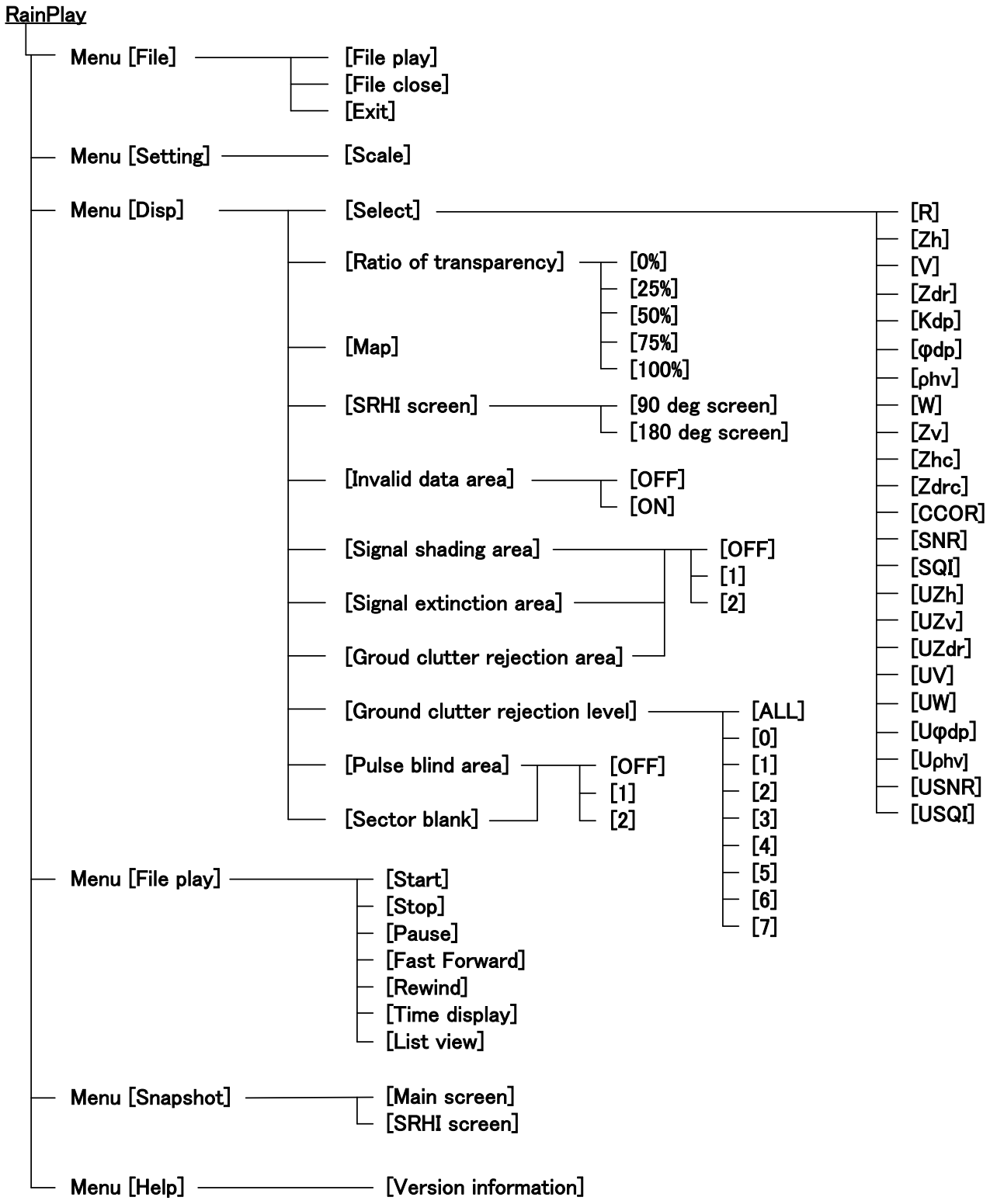
PERIOD	ITEM	CHECK POINT	REMEDY
When needed	Radar radome surface.	Sea salt, oil, etc. adhered to the surface?	Wipe off foreign material with a soft, wet cloth. The radome is constructed from FRP. Therefore, do not use gasoline, benzene, or a solvent like ketone for cleaning, as they may remove paint and markings.
After six months, or a strong wind, or a thunderbolt	Radar radome	Check for cracks.	Please contact to our trouble support after finished the waterproofing disposal.
After six months	Protective tube	Check for slack.	Remove slack.
Weekly	Error code in RainMap	Check for error messages	For error, stop the radar then reboot it. Next, restart RainMap. Call for service if normal operation cannot be restored.

*Before performing any maintenance, turn off the radar.

APPENDICES:

APPX.1. MENU TREE



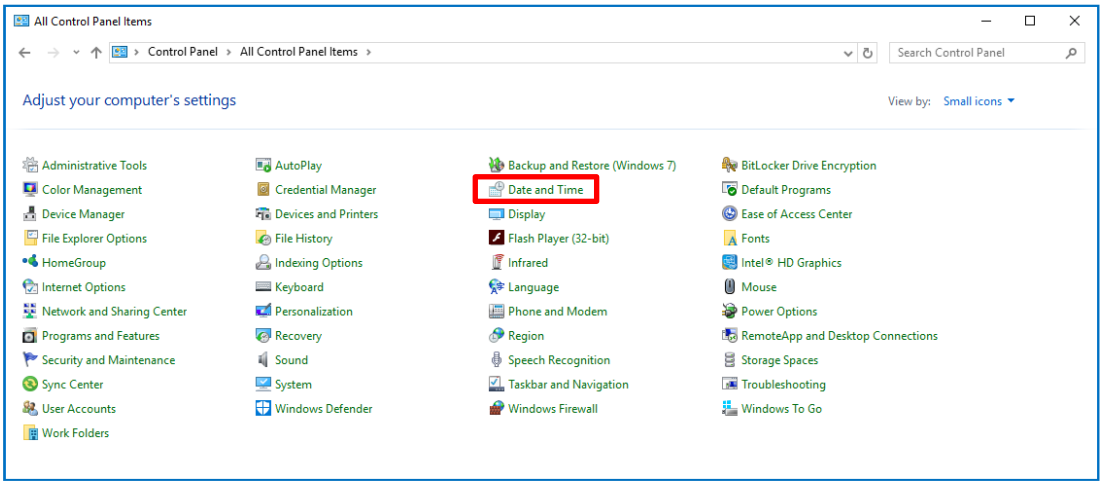

RainPlay
Menu [File]
[File play]
[File close]
[Exit]
Menu [Setting]
[Scale]
Menu [Disp]
[Select]
[R]
[Zh]
[V]
[Zdr]
[Kdp]
[φdp]
[ρhv]
[W]
[Zv]
[Zhc]
[Zdrc]
[CCOR]
[SNR]
[SQI]
[UZh]
[UZv]
[UZdr]
[UV]
[UW]
[Uφdp]
[Uρhv]
[USNR]
[USQI]
[Ratio of transparency]
[0%]
[25%]
[50%]
[75%]
[100%]
[Map]
[SRHI screen]
[90 deg screen]
[180 deg screen]
[Invalid data area]
[OFF]
[ON]
[Signal shading area]
[Signal extinction area]
[Groud clutter rejection area]
[OFF]
[1]
[2]
[Ground clutter rejection level]
[ALL]
[0]
[1]
[2]
[3]
[4]
[5]
[6]
[7]
[Pulse blind area]
[Sector blank]
[OFF]
[1]
[2]
Menu [File play]
[Start]
[Stop]
[Pause]
[Fast Forward]
[Rewind]
[Time display]
[List view]
Menu [Snapshot]
[Main screen]
[SRHI screen]
Menu [Help]
[Version information]

APPX.2. DPU SETTING

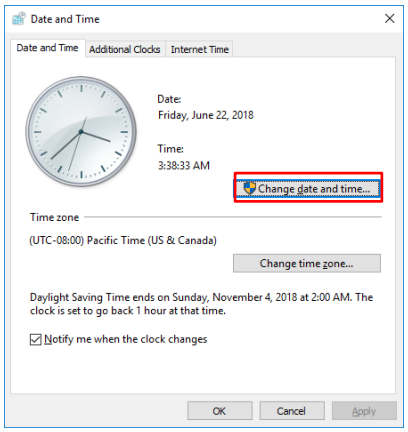
APPX.2.1. DPU Time Adjustment

The local time must be accurate to ensure strict adherence to the radar observation schedule and the time stamp of the data. If the address of the NTP server is set in the DPU, the time is automatically synchronized every 20 minutes.

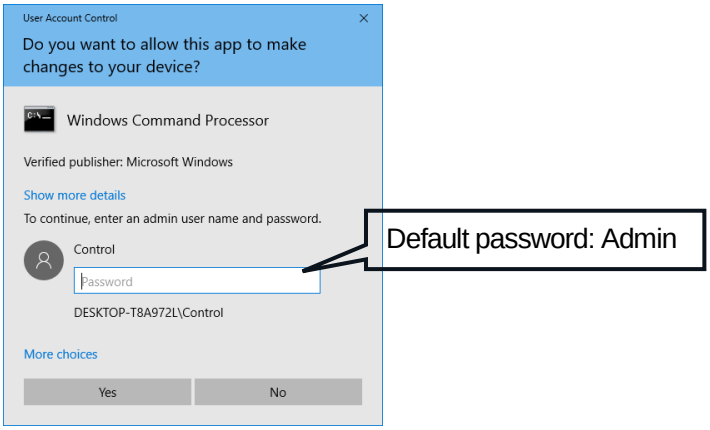
1) Open the control panel, then click the [Date and Time]



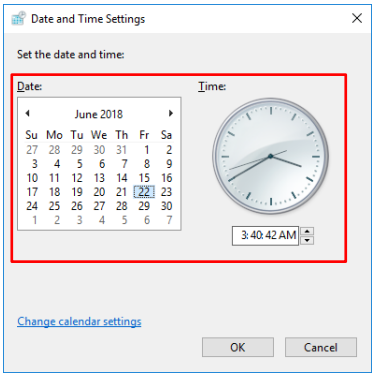
2) Click the [Change date and time] button.



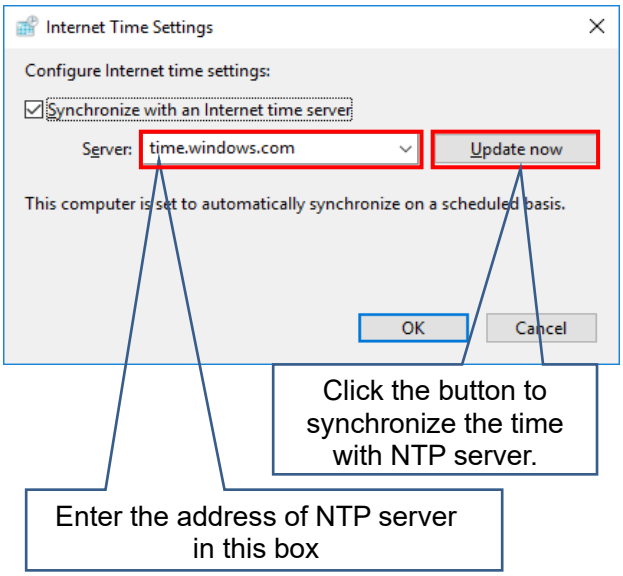
3) Enter the password for the Control account



3) To correct the time manually.



5) To correct the time by using internet time.



APPX.2.2. Precaution of Using DPU

“radar” account:

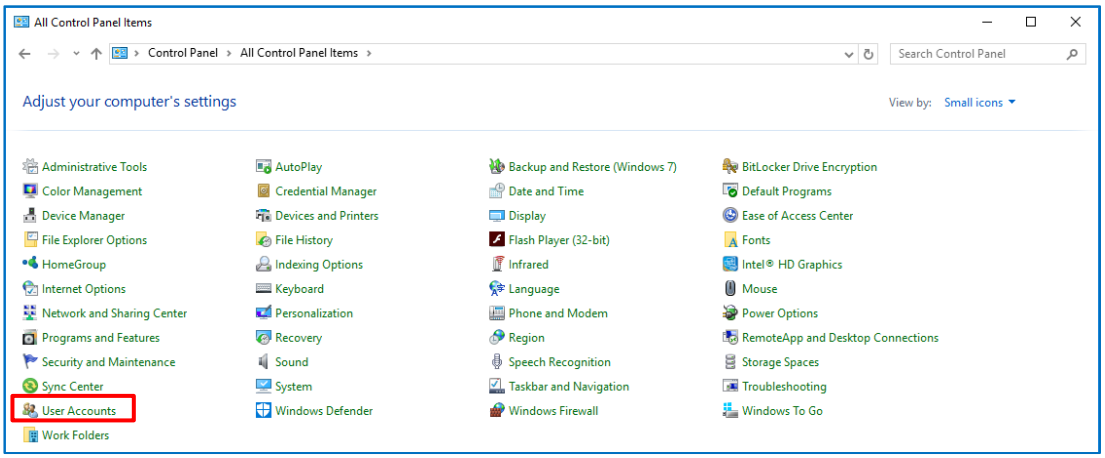
- Do not change the account name and the account password.
- Account password should be “radar”. (Changing the password disables the automatic logon function.)
- Do NOT give administrator rights to the radar account.
- Use this account to operate the weather radar.

“Control” account: This is the administrator account for the user. The user can perform operations that require administrator rights: however, this is not recommended. For security reasons, use this account only when necessary.
Change the default password.

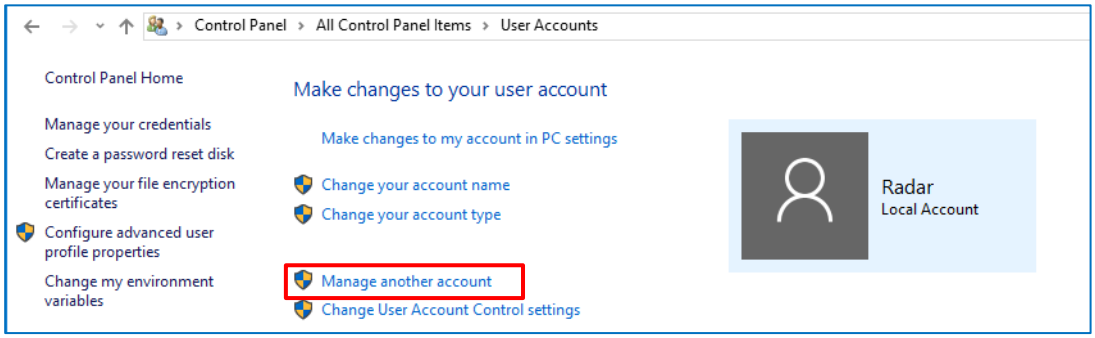
“Maintenance” account: This account is for manufacturer management. Do not change the account name and the account password.

APPX.2.3. DPU Account and Password Setting

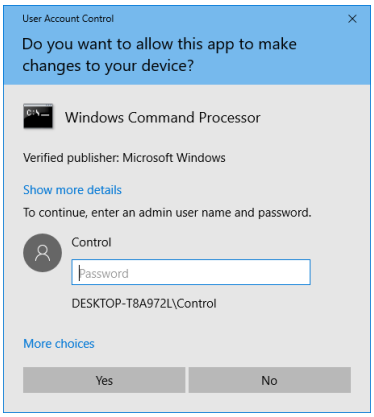
1) Open the control panel, then click [User Accounts].



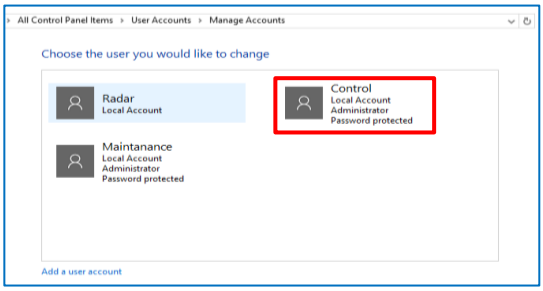
2) Click [Manage another account].



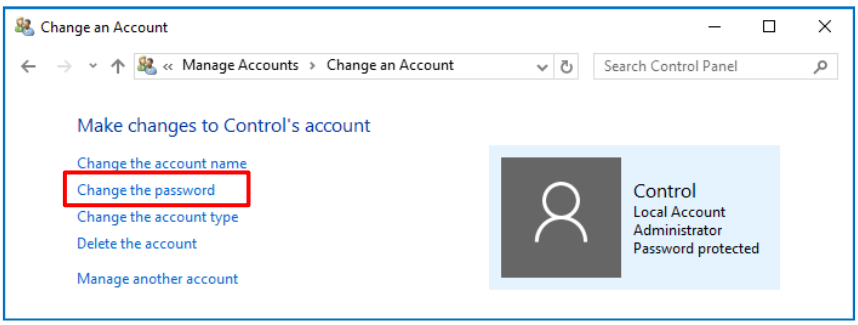
3) Enter the password for the Control account
Default password: Admin



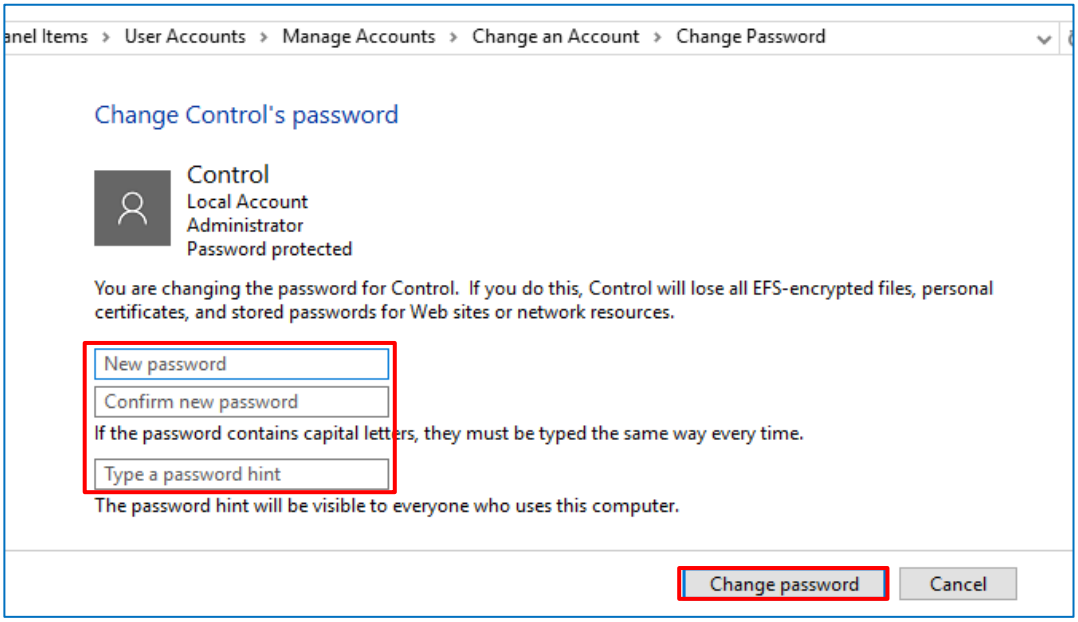
4) Click the account name [Control].
Note: Do not touch the [maintenance] account.



5) Click the [Change the password].



6) Enter new password, confirm new password, then enter a password hint. Click the [Change password] button. Store the password in a safe place.



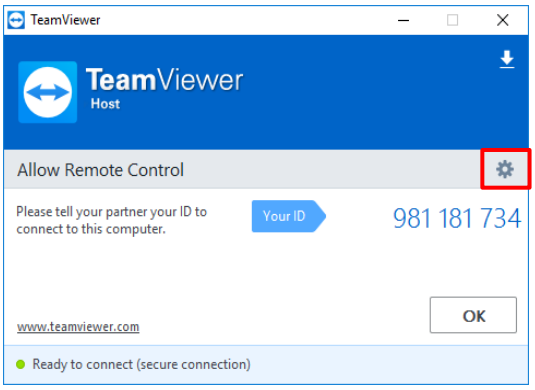
APPX.2.4. TeamViewer

The TeamViewer software allows remote control of the weather radar via the internet. If the security policy of the network to which the radar connects does not allow use of this software, uninstall the software. (See the Installation Manual for how to uninstall this software.)

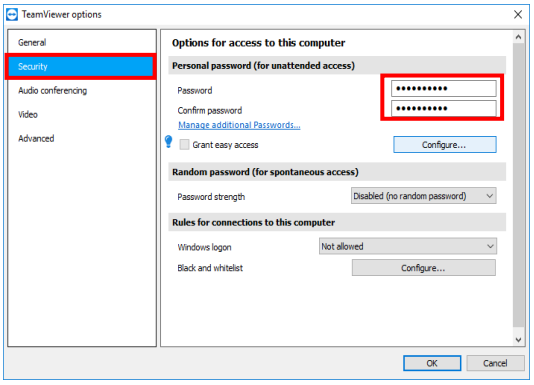
Security setting:

This section shows how to change the password for the TeamViewer. The default password is root. Change the password to reduce security risks.

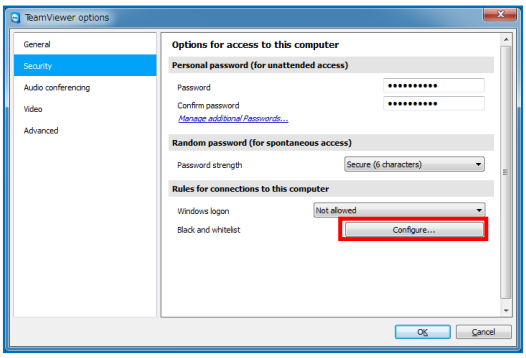
1) Open TeamViewer, then click the settings icon on the right side of the window.



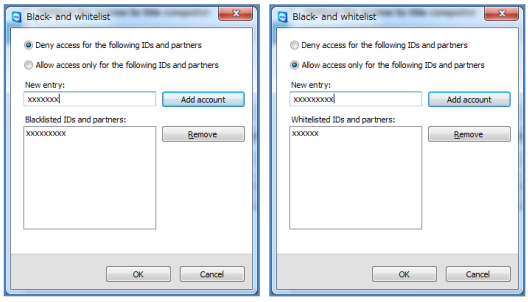
2) Click [Security] on the menu panel, enter a password, then confirm the password. Store the password in a safe place.



3) In [Rules for connections to this computer], click the [Configure] button to the right of [Black and whitelist].

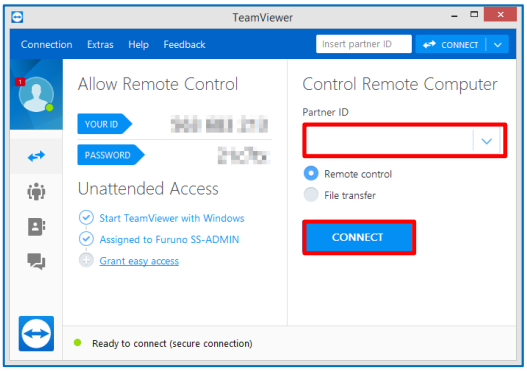


4) In the [Black and whitelist] window, if required, register any IDs on the list for [Deny access for the following IDs and partners] or [Allow access only for the following IDs and partners].
When adding account to the whitelist for [Allow access only for the following IDs and partners], it recommends entering the E-mail address that registered when signing up with TeamViewer instead of the ID for enhanced security.
Call FEC service for help and add FEC email address if necessary.



Remote control:

1) In [Partner ID], enter the ID of the host to access the host from a local PC. Click the [CONNECT] button.

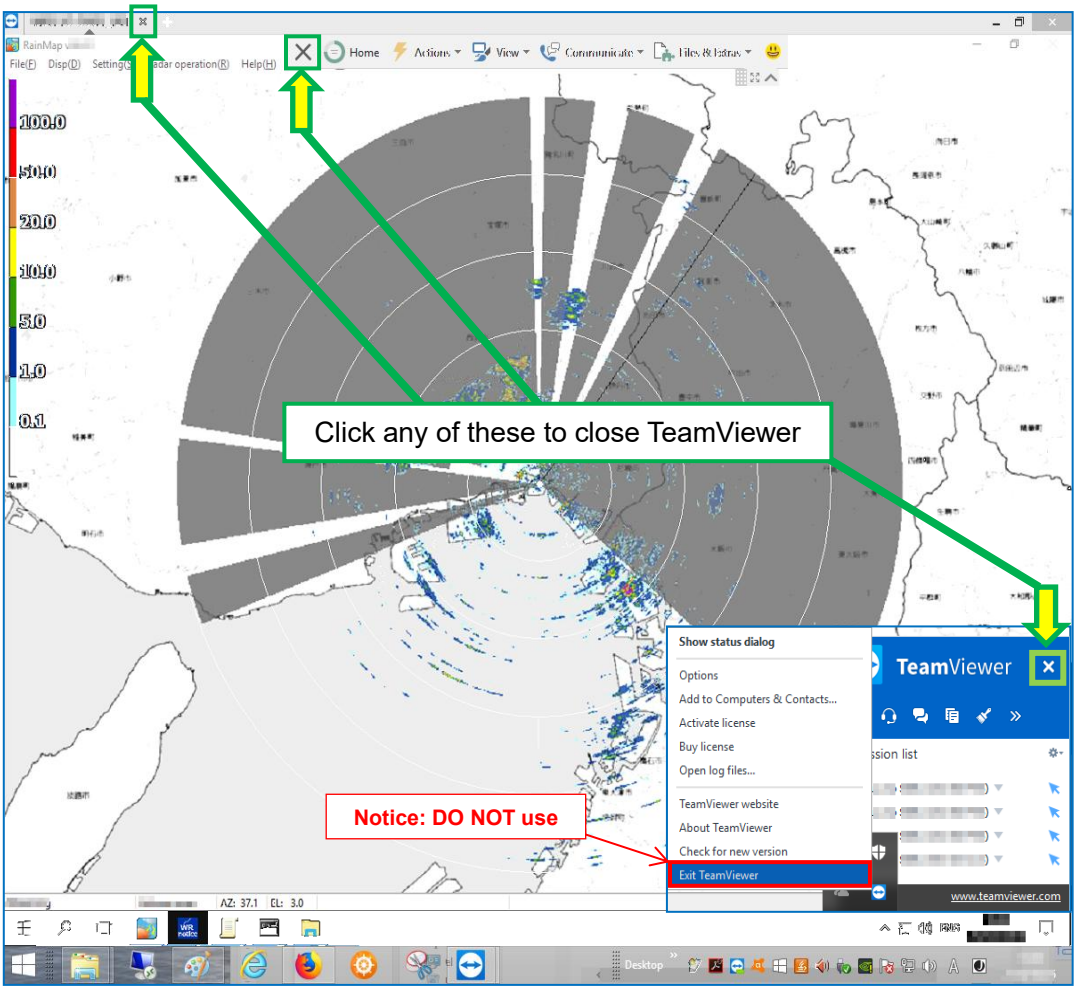


2) Enter the password that set on the host side when prompted for the password.

3) When the PC screen appears on the host PC, operate as using an ordinary PC.

4) Click the [X] button at any one of the three locations indicated in the figure below to disconnect from the host side.

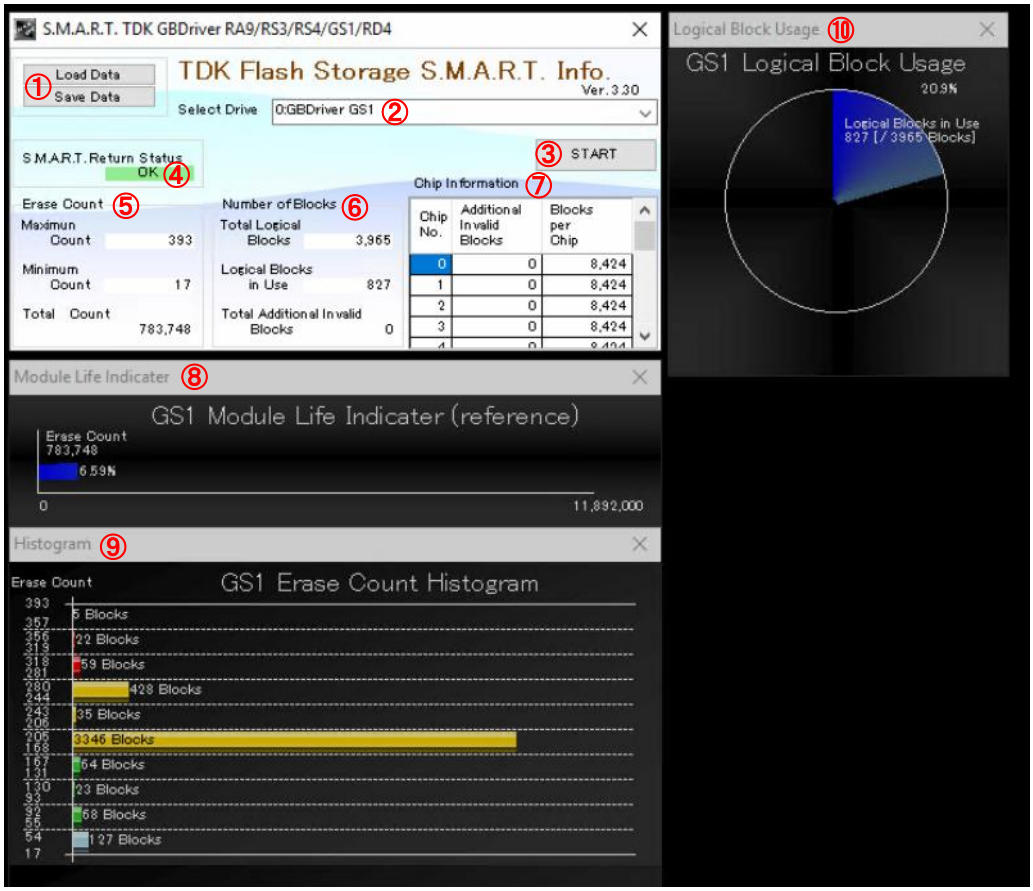
Note: Do not click [Exit TeamViewer] from the menu that appears when right-click the TeamViewer icon on the host's taskbar. This is because TeamViewer at the site will be disconnected, and remote operation will not be possible.



APPX.2.5. SSD Condition Monitoring Software SMART GBD

SMART (Self-Monitoring & Analysis Reporting Technology) software performs self-diagnostic the status and lifespan of the SSD installed in the DPU.

1) Run SMART_GBD.exe from the following folder (administrator privileges are required).
   C:\Program Files (x86)\SMART_GBDv330
2) Select target drive in drive selection box from the [Select Drive].
3) Push [START] button to start collecting SMART data and check the SSD condition.



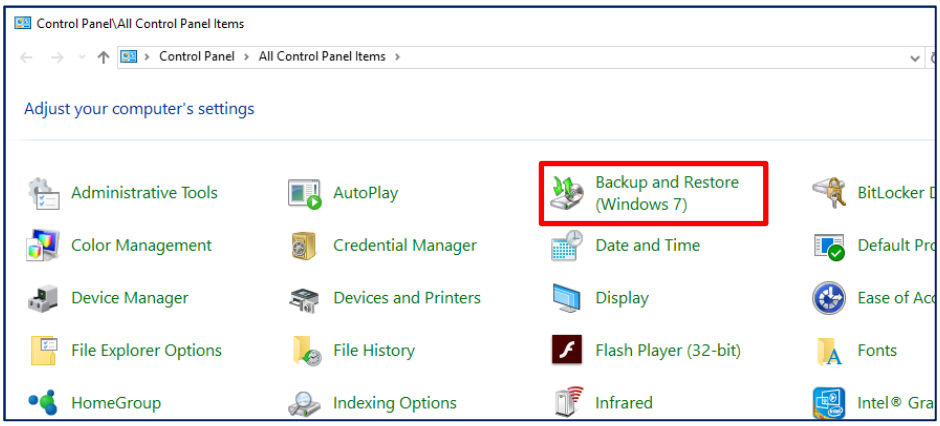
(1) [Load Data] & [Save Data] is the button to save/load data.
(2) [Select Drive] selects the drive to get SMART information.
(3) [START] is the button to get SMART return status and read data.
(4) [S.M.A.R.T. RETURN STATUS] indicates the drive status return as OK/NG. (NG includes warning status)
(5) [Erase Count] indicates the following below.
Maximum/Minimum: The program (erase) count in the block with the highest/lowest program (erase) count (CF/SSD).
Total Count: The total program (erase) count for all blocks (in a 10-level histogram) (CF/SSD).
(6) [Number of Blocks] indicates the number of total logical blocks (block units that can be written or erased simultaneously), the number of logical blocks in use, and bad blocks.
(7) [Chip information] indicates the NAND flash memory information (units and blocks used)
(8) [Module life indicator] indicates percentage (reference value) of SSD lifespan *This may differ from the actual time when the product becomes unusable (The current number of erases (usage rate) is shown as a percentage of the number of erases that can be used for all logical blocks. The lifespan can be predicted using the following formula based on the percentage increase after a certain period of use in a real usage environment).
(9) [Histogram] indicates the block erase count histogram. Only available to see it from detailed information mode. The total program (erase) count for all blocks in a 10-level histogram.
(10) [Logical Block Usage] indicates the usage rate of all logical blocks in a pie chart.

APPX.2.6. DPU Backup and Restore

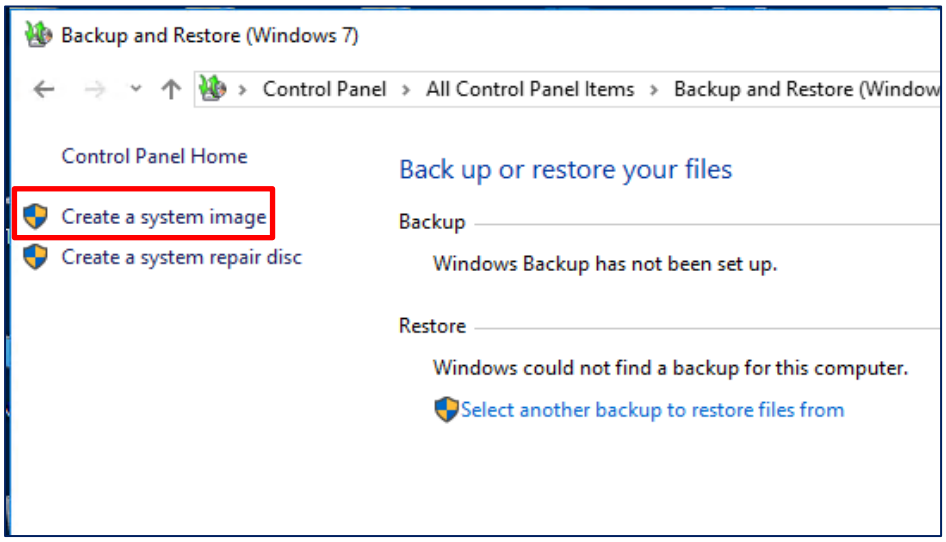
It is recommended that a backup of the system drive be made when the radar installation is complete, and the system is in a stable operating state.
Note: A backup image of the factory settings is stored on the D drive. (Applies to DPU shipped after April 2023)

1) How to make system backup

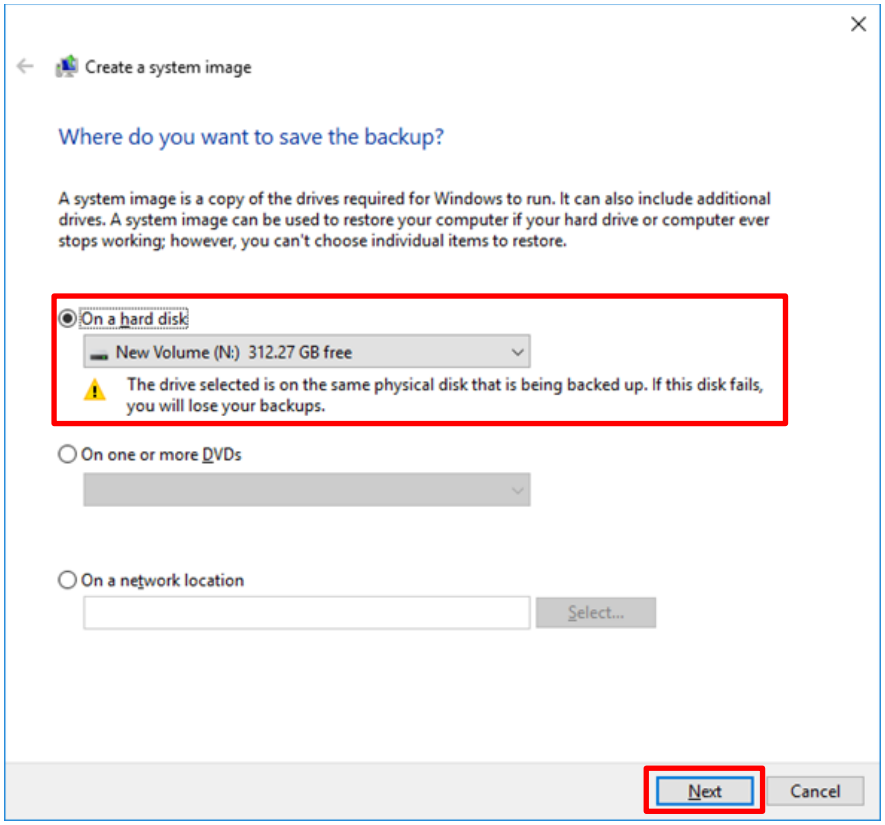
(1) Close all applications before starting the backup.
(2) Open the Control Panel, then select [Backup and Restore (Windows X*)]
*: X= Windows OS number.



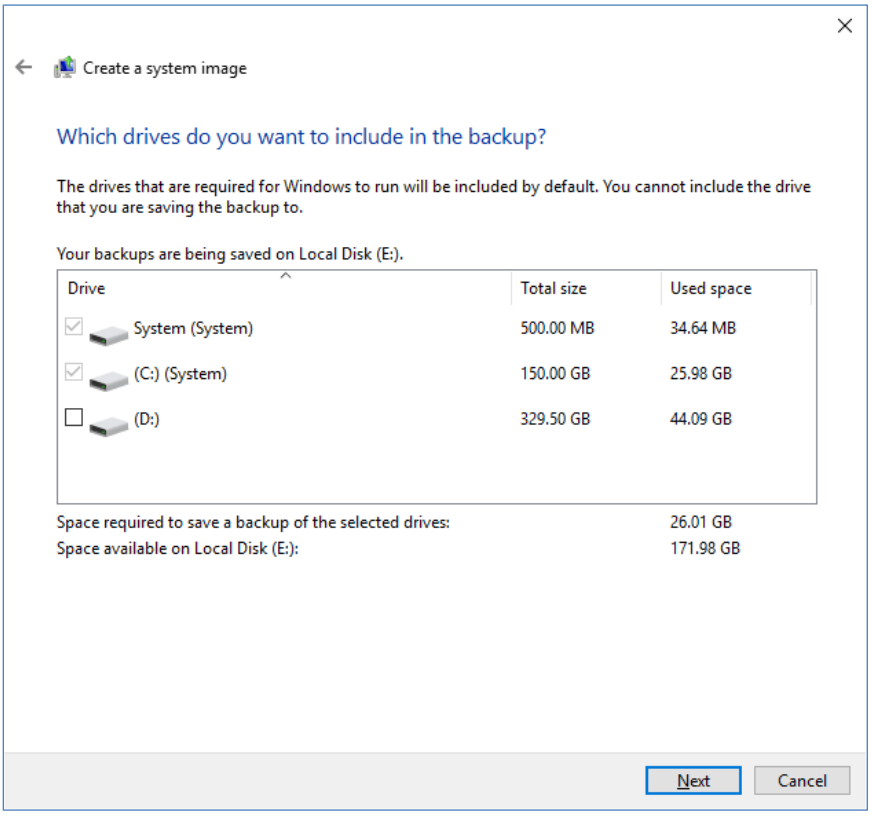
(3) Select [Create a system image]. Enter the password for the Control user, as asked for administrator rights.



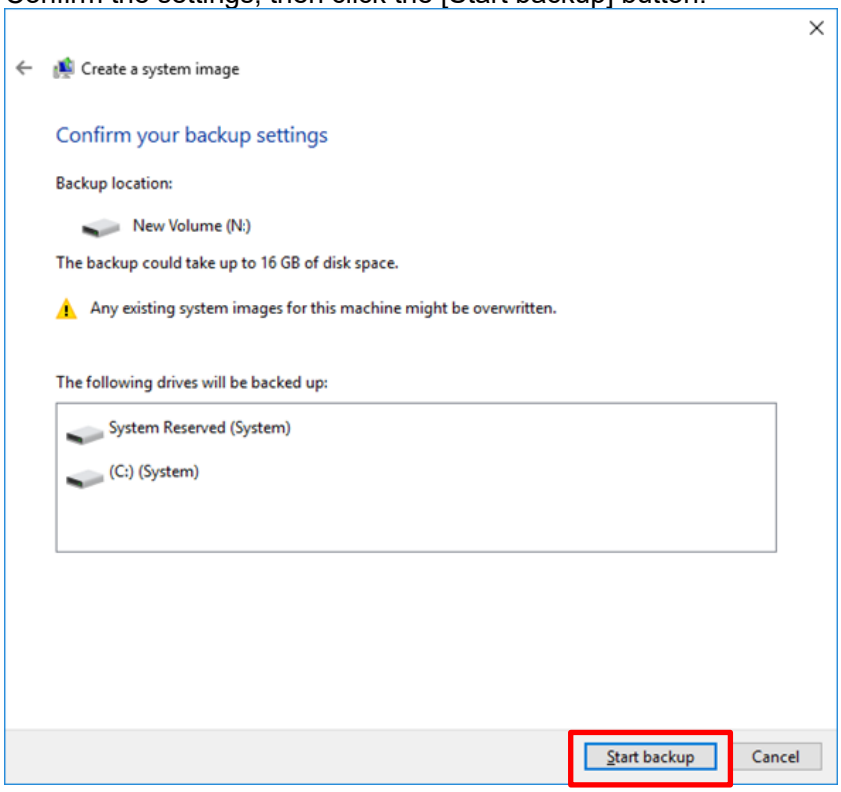
(4) Select the media or location (HDD, DVD, network) where to save the backup.
Note 1: USB HDDs can be used but not USB flash drives.
Note 2: The USB HDD must be scanned for viruses before connecting it to the DPU to insure it is virus free.
Note 3: If a backup already exists on the selected drive, the previous backup will be overwritten. If a factory backup exists on drive D, do not overwrite it.



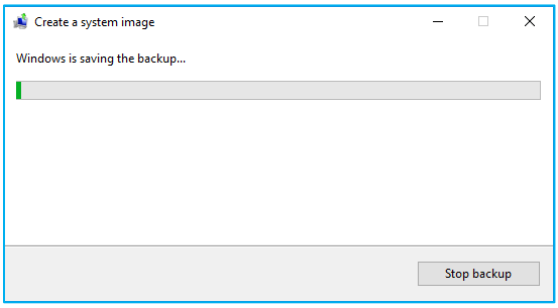
(5) Select the drive to back up except D drive because it may erase some data on the D drive when restore.



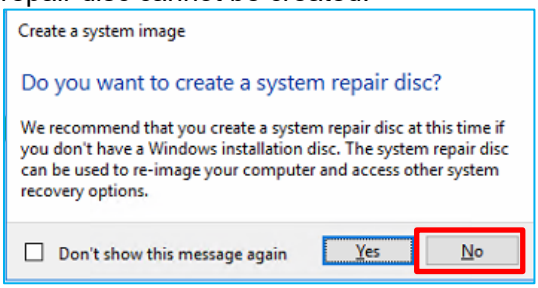
(6) Confirm the settings, then click the [Start backup] button.



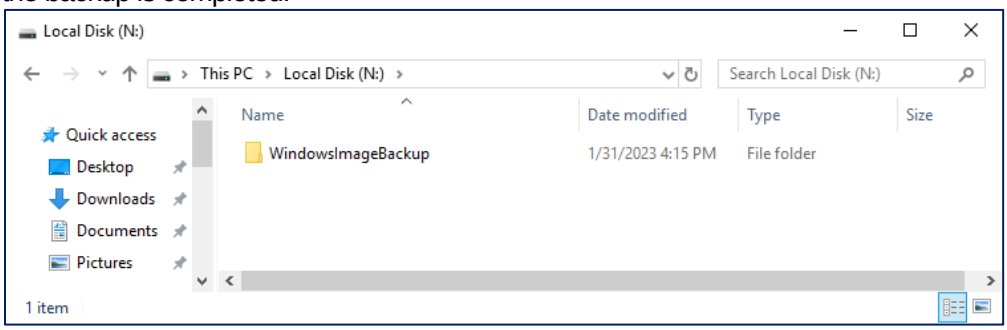
(7) Wait tens of minutes to several hours for the backup to completed.



(8) When the backup is completed, it will ask to create a system repair disk.
Select "No" here; DPU does not have a CD/DVD drive and therefore a system repair disc cannot be created.



(9) Confirm that the [WindowsImageBackup] folder is saved on the destination drive when the backup is completed.

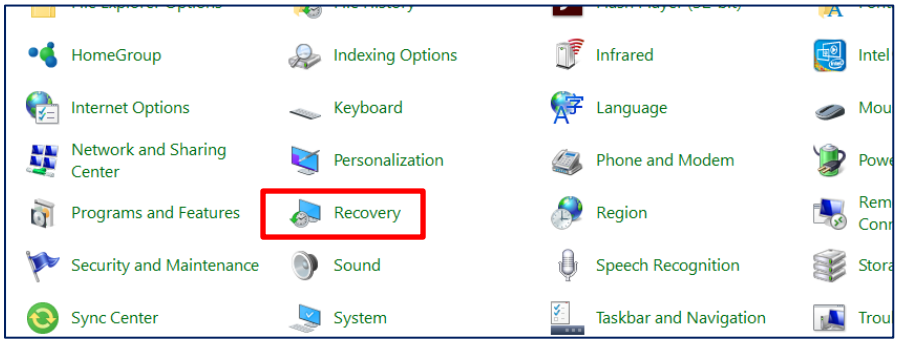


2) How to create a Windows Recovery Media (USB).

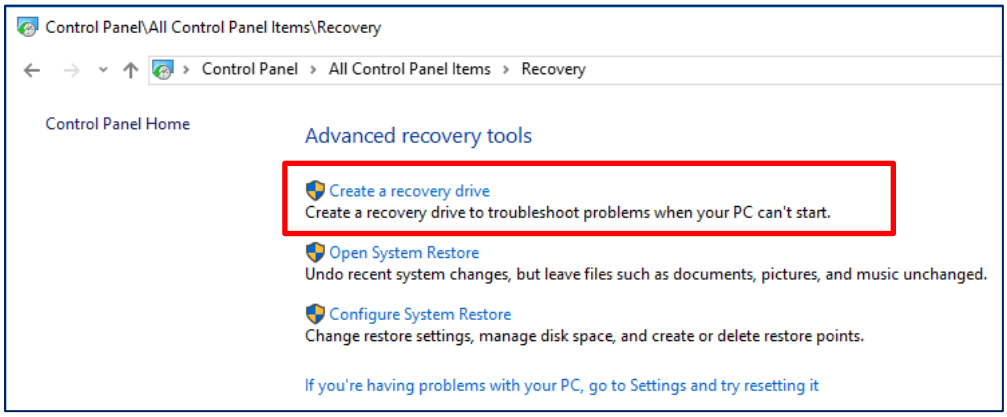
The Windows Recovery Media is necessary to restore the system from a backup. Since the DPU does not have a CD/DVD drive, create the recovery media using a USB flash media.

Note: The USB flash media must be formatted and scanned for viruses before connecting it to the DPU to insure it is virus free.

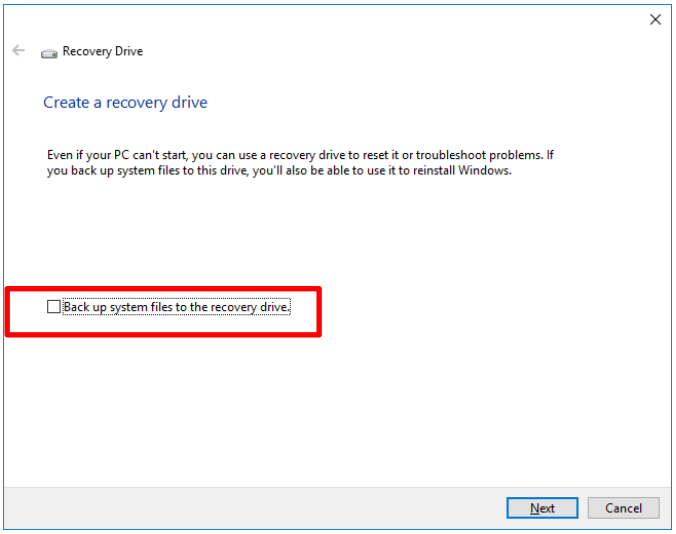
(1) Open the Control Panel, then select [Recovery].



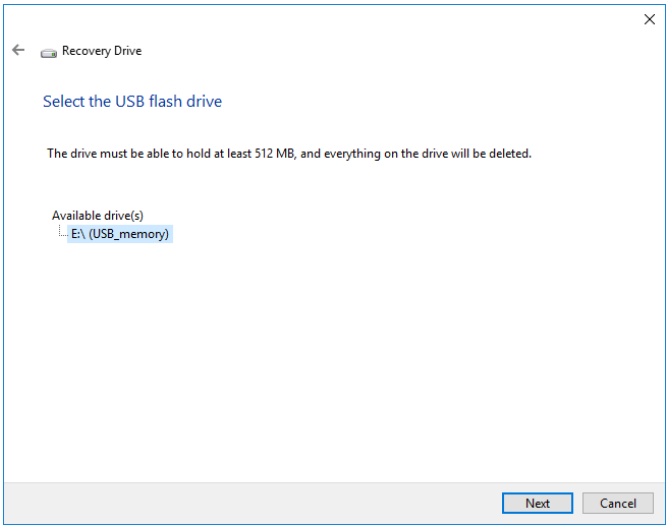
(2) Select [Create a recovery drive]. Enter the password for the Control user, as asked for administrative rights.



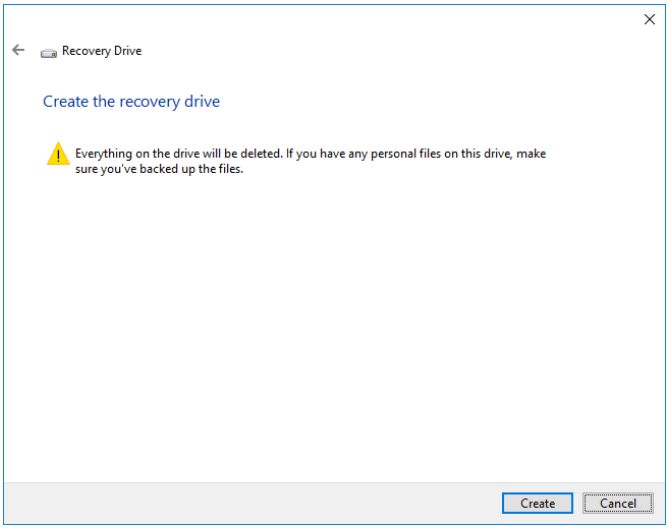
(3) Uncheck the [Back up system files to the recovery drive.]. The recovery drive cannot be created if this item is checked.



(4) Confirm that the USB flash media inserted in the DPU is listed as an available drive, then click the [Next] button.
Note: If the USB flash media is not recognized here, try another USB flash media



(5) Click the [Create] button to create the recovery media. Wait a few minutes for completion.



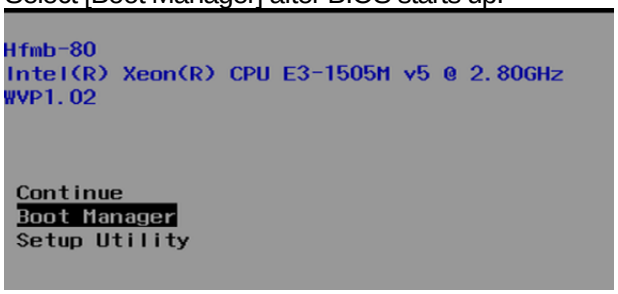
3) How to restore from backup

Note: Restoration from a backup must be done with care. Failure to restore from a backup may render the system unusable.

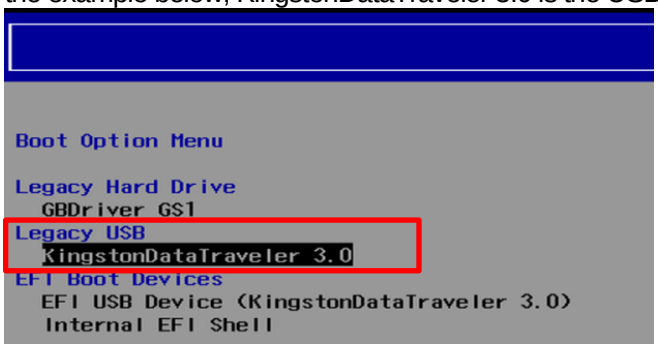
Insert the "Windows Recovery Media (USB)" or the USB-HDD with the backup saved into the DPU. (If restoring from drive D on DPU, USB-HDD is not required)

(1) Start the DPU while pressing the F2 key on the keyboard.

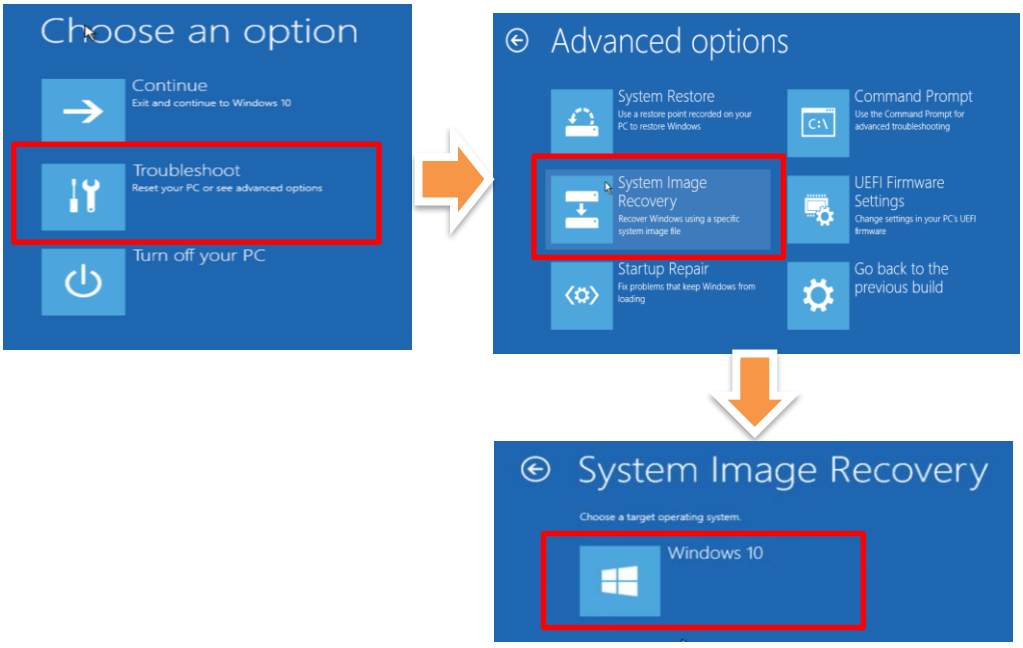
(2) Select [Boot Manager] after BIOS starts up.



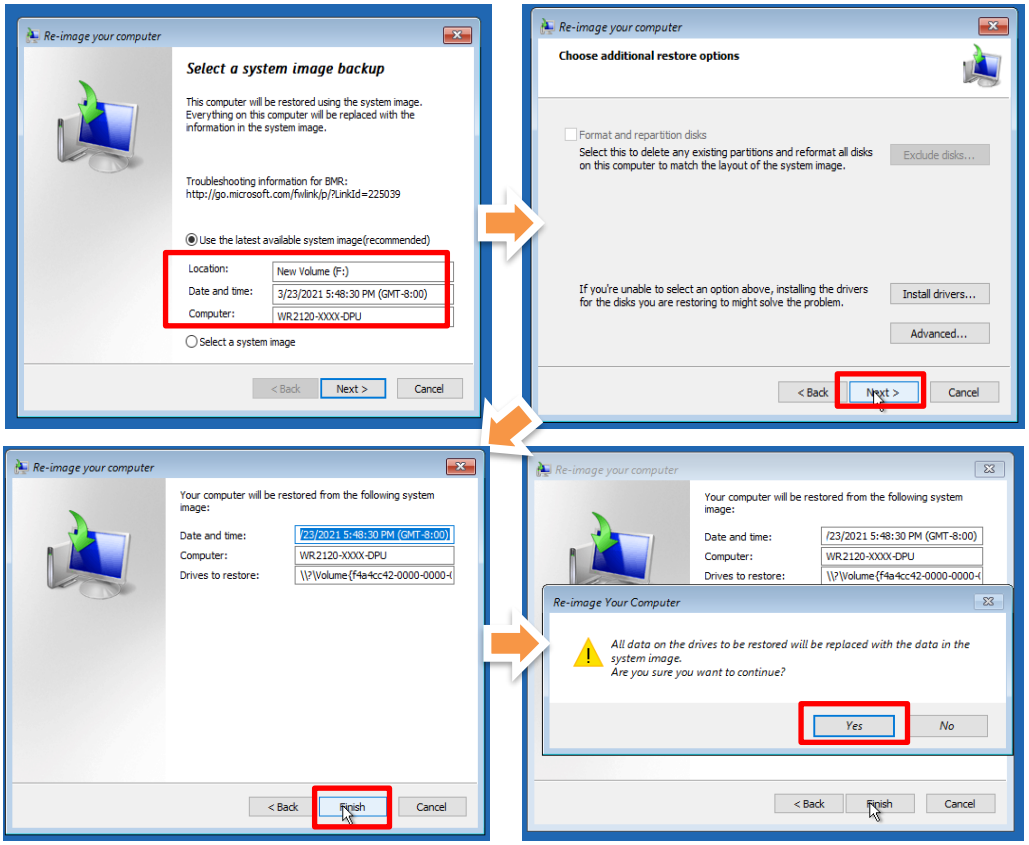
(3) At [Legacy USB], select the USB media (recovery media) that connected to the DPU. (In the example below, KingstonDataTraveler 3.0 is the USB media)



(4) Windows RE boot from the USB media. Select the options shown in the figure below.



(5) Confirm the system image of the backup wish to restore is selected.



(6) Remove the USB media (and USB-HDD) when the restoration is complete.

APPX.3. RADIO REGULATORY INFORMATION

USA-Federal Communications Commission (FCC)

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

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

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

Caution: Exposure to Radio Frequency Radiation.

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

This equipment should be installed and operated keeping the radiator at least 9.1 m or more away from person's body.

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

APPX.4. TRADEMARK INFORMATON

Microsoft and Windows are registered trademarks of Microsoft Corporation in the United States and other countries.

Silverlight is a trademark of Microsoft Corporation in the United States and other countries.

LabVIEW, National Instruments, NI and NI FlexRIO are trademarks of National Instruments Corporation.

APPX.5. DECLARATION OF CONFORMITY

Bulgarian (BG)	С настоящото Furuno Electric Co., Ltd. декларира, че гореспоменат тип радиосъоръжение е в съответствие с Директива 2014/53/ЕС, SI 2017/1206. Цялостният текст на ЕС/UK декларацията за съответствие може да се намери на следния интернет адрес:
Spanish (ES)	Por la presente, Furuno Electric Co., Ltd. declara que el tipo de equipo radioeléctrico arriba mencionado es conforme con la Directiva 2014/53/UE, SI 2017/1206. El texto completo de la declaración de conformidad de la EU/UK está disponible en la siguiente dirección Internet:
Czech (CS)	Tímto Furuno Electric Co., Ltd. prohlašuje, že výše zmíněné typ rádiového zařízení je v souladu se směrnicí 2014/53/EU, SI 2017/1206. Úplné znění EU/SK prohlášení o shodě je k dispozici na této internetové adrese:
Danish (DA)	Hermed erklærer Furuno Electric Co., Ltd., at ovennævnte radioudstyr er i overensstemmelse med direktiv 2014/53/EU, SI 2017/1206. EU/UK-overensstemmelseserklæringens fulde tekst kan findes på følgende internetadresse:
German (DE)	Hiermit erklärt die Furuno Electric Co., Ltd., dass der oben genannte Funkanlagentyp der Richtlinie 2014/53/EU, SI 2017/1206 entspricht. Der vollständige Text der EU/UK-Konformitätserklärung ist unter der folgenden Internetadresse verfügbar:
Estonian (ET)	Käesolevaga deklareerib Furuno Electric Co., Ltd., et ülalmainitud raadioseadme tüüp vastab direktiivi 2014/53/EL, SI 2017/1206 nõuetele. EL/GB vastavusdeklaratsiooni täielik tekst on kättesaadav järgmisel internetiaadressil:
Greek (EL)	Με την παρούσα η Furuno Electric Co., Ltd., δηλώνει ότι ο προαναφερθέντας ραδιοεξοπλισμός πληροί την οδηγία 2014/53/ΕΕ, SI 2017/1206. Το πλήρες κείμενο της δήλωσης συμμόρφωσης ΕΕ/UK διατίθεται στην ακόλουθη ιστοσελίδα στο διαδίκτυο:
English (EN)	Hereby, Furuno Electric Co., Ltd. declares that the above-mentioned radio equipment type is in compliance with Directive 2014/53/EU, SI 2017/1206. The full text of the EU/UK declaration of conformity is available at the following internet address:
French (FR)	Le soussigné, Furuno Electric Co., Ltd., déclare que l'équipement radioélectrique du type mentionné ci-dessus est conforme à la directive 2014/53/UE, SI 2017/1206. Le texte complet de la déclaration UE/RU de conformité est disponible à l'adresse internet suivante:
Croatian (HR)	Furuno Electric Co., Ltd. ovime izjavljuje da je gore rečeno radijska oprema tipa u skladu s Direktivom 2014/53/EU, SI 2017/1206. Cjeloviti tekst EU/UK izjave o sukladnosti dostupan je na sljedećoj internetskoj adresi:
Italian (IT)	Il fabbricante, Furuno Electric Co., Ltd., dichiara che il tipo di apparecchiatura radio menzionato sopra è conforme alla direttiva 2014/53/UE, SI 2017/1206. Il testo completo della dichiarazione di conformità UE/RU è disponibile al seguente indirizzo Internet:
Latvian (LV)	Ar šo Furuno Electric Co., Ltd. deklarē, ka augstāk minēts radioiekārta atbilst Direktīvai 2014/53/ES, SI 2017/1206. Pilns ES/AK atbilstības deklarācijas teksts ir pieejams šādā interneta vietnē:

Lithuanian (LT)	Aš, Furuno Electric Co., Ltd., patvirtinu, kad pirmiau minėta radijo įrenginių tipas atitinka Direktyvą 2014/53/ES, SI 2017/1206. Visas ES/JK atitikties deklaracijos tekstas prieinamas šiuo interneto adresu:
Hungarian (HU)	Furuno Electric Co., Ltd. igazolja, hogy fent említett típusú rádióberendezés megfelel a 2014/53/EU, SI 2017/1206 irányelvnek. Az EU/EK-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, SI 2017/1206. It-test kollu tad-dikjarazzjoni ta' konformità tal-UE/RU 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, SI 2017/1206. De volledige tekst van de EU/VK-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, SI 2017/1206. Pełny tekst deklaracji zgodności UE/UK 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, SI 2017/1206. O texto integral da declaração de conformidade da EU/UK está disponível no seguinte endereço de Internet:
Romanian (RO)	Prin prezenta, Furuno Electric Co., Ltd. declară că echipamentul radio menționat mai sus este în conformitate cu Directiva 2014/53/UE, SI 2017/1206. Textul integral al declarației de conformitate UE/RU este disponibil la următoarea adresă internet:
Slovak (SK)	Furuno Electric Co., Ltd. týmto vyhlasuje, že vyššie spomínané rádiové zariadenie typu je v súlade so smernicou 2014/53/EÚ, SI 2017/1206. Úplné EÚ/SK vyhlásenie o zhode je k dispozícii na tejto internetovej adrese:
Slovenian (SL)	Furuno Electric Co., Ltd. potrjuje, da je zgoraj omenjeno tip radijske opreme skladen z Direktivo 2014/53/EU, SI 2017/1206. Celotno besedilo izjave EU/ZK 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, SI 2017/1206 mukainen. EU/UK-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, SI 2017/1206. Den fullständiga texten till EU/Storbritannien-försäkran om överensstämmelse finns på följande webbadress:

Online Resource

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

APPX.6. BRITISH STANDARD

This British Standard is the UK implementation of EN 62368-1:2014, incorporating corrigendum May 2015. It is derived from IEC 62368-1:2014, incorporating corrigendum February 2015. It supersedes BS EN 60065:2014 and BS EN 60950-1:2006+A2:2013 which will be withdrawn on 20 June 2019.

The use of certain substances in electrical and electronic equipment is restricted within the EU (Directive 2011/65/EU).

Special national condition: National characteristic or practice that cannot be changed even over a long period, For example, climatic conditions, electrical earthing conditions.

4.7.3 United Kingdom

To the end of the subclause the following is added:
The torque test is performed using a socket-outlet complying with BS 1363, and the plug part shall be assessed to the relevant clauses of BS 1363. Also see Annex G.4.2 of this annex

G.4.2 United Kingdom

To the end of the subclause the following is added:
The plug part of direct plug-in equipment shall be assessed to BS 1363: Part 1, 12.1, 12.2, 12.3, 12.9, 12.11, 12.12, 12.13, 12.16, and 12.17, except that the test of 12.17 is performed at not less than 125 °C. Where the metal earth pin is replaced by an Insulated Shutter Opening Device (ISOD), the requirements of clauses 22.2 and 23 also apply.

G.7.1 United Kingdom

To the first paragraph the following is added:
Equipment which is fitted with a flexible cable or cord and is designed to be connected to a mains socket conforming to BS 1363 by means of that flexible cable or cord shall be fitted with a ‘standard plug’ in accordance with the Plugs and Sockets etc. (Safety). Regulations 1994, Statutory Instrument 1994 No. 1768, unless exempted by those regulations.

Note: "Standard plug" is defined in SI 1768:1994 and essentially means an approved plug conforming to BS 1363 or an approved conversion plug.

APPX.7. WINDOWS 10 IOT ENTERPRISE SOFTWARE LICENSE TERMS

MICROSOFT SOFTWARE LICENSE TERMS
WINDOWS 10 IOT ENTERPRISE & MOBILE (ALL EDITIONS)

IF YOU LIVE IN (OR IF YOUR PRINCIPAL PLACE OF BUSINESS IS IN) THE UNITED STATES, PLEASE READ THE BINDING ARBITRATION CLAUSE AND CLASS ACTION WAIVER IN SECTION 8. IT AFFECTS HOW DISPUTES ARE RESOLVED.

Thank you for choosing Microsoft!

Depending on how you obtained the Windows software, this is a license agreement between (i) you and the device manufacturer or software installer that distributes the software with your device; or (ii) you and Microsoft Corporation (or, based on where you live or if a business where your principal place of business is located, one of its affiliates) if you acquired the software from a retailer. Microsoft is the device manufacturer for devices produced by Microsoft or one of its affiliates, and Microsoft is the retailer if you acquired the software directly from Microsoft.

This agreement describes your rights and the conditions upon which you may use the Windows software. You should review the entire agreement, including any supplemental license terms that accompany the software and any linked terms, because all of the terms are important and together create this agreement that applies to you. You can review linked terms by pasting the (aka.ms/) link into a browser window.

By accepting this agreement or using the software, you agree to all of these terms, and consent to the transmission of certain information during activation and during your use of the software as per the privacy statement described in Section 3. If you do not accept and comply with these terms, you may not use the software or its features. You may contact the device manufacturer or installer, or your retailer if you purchased the software directly, to determine its return policy and return the software or device for a refund or credit under that policy. You must comply with that policy, which might require you to return the software with the entire device on which the software is installed for a refund or credit, if any.

1. Overview

a. Applicability.

This agreement applies to the Windows software that is preinstalled on your device, or acquired from a retailer and installed by you, the media on which you received the software (if any), any fonts, icons, images or sound files included with the software, and also any Microsoft updates, upgrades, supplements or services for the software, unless other terms come with them. It also applies to Windows apps developed by Microsoft that provide functionality such as mail, calendar, contacts, music, and news that are included with, and are a part of Windows. If this agreement contains terms regarding a feature or service not available on your device, then those terms do not apply.

b. Additional terms.

Depending on your device's capabilities, how it is configured, and how you use it, additional Microsoft and third-party terms may apply to your use of certain features, services, and apps.

(i) Some Windows apps provide an access point to, or rely on, online services, and the use of those services is sometimes governed by separate terms and privacy policies, such as the Microsoft Services Agreement at (aka.ms/msa). You can view these terms and policies by looking at the service terms of use or the app's settings, as applicable; please read them. The services may not be available in all regions.

(ii) The manufacturer or installer may also preinstall apps, which will be subject to separate license terms.

(iii) The software may include third party software such as Adobe Flash Player that is licensed under its own terms. You agree that your use of Adobe Flash Player is governed by the license terms for Adobe Systems Incorporated at (aka.ms/adobeflash). Adobe and Flash are either registered trademarks or trademarks of Adobe Systems Incorporated in the United States and/or other countries.

(iv) The software may include third party programs that are licensed to you under this agreement, or under their own terms. License terms, notices and acknowledgements, if any, for the third-party program can be view at (aka.ms/thirdpartynotices).

2. Installation and Use Rights

a. License

The software license is permanently assigned to the device with which you acquired the software. You may only use the software on that device.

b. Device

In this agreement, “device” means a physical hardware system) with an internal storage device capable of running the software. A hardware partition or blade is considered to be a device.

c. Restrictions

The manufacturer or installer and Microsoft reserve all rights (such as rights under intellectual property laws) not expressly granted in this agreement. For example, this license does not give you any right to, and you may not:

(i) use or virtualize features of the software separately.

(ii) publish, copy (other than the permitted backup copy), rent, lease, or lend the software.

(iii) transfer the software.

(iv) work around any technical restrictions or limitations in the software.

(v) use the software as server software, for commercial hosting, make the software available for simultaneous use by multiple users over a network, install the software on a server and allow users to access it remotely, or install the software on a device for use only by remote users.

(vi) reverse engineer, decompile, or disassemble the software, or attempt to do so, except and only to the extent that the foregoing restriction is (a) permitted by applicable law; (b) permitted by licensing terms governing the use of open source components that may be included with the software; or (c) required to debug changes to any libraries licensed under the GNU Lesser General Public License which are included with and linked to by the software; and

(vii) when using Internet-based features you may not use those features in any way that could interfere with anyone else’s use of them, or to try to gain access to or use any service, data, account, or network, in an unauthorized manner.

d. Multi use scenarios.

(i) Multiple versions. If when acquiring the software, you were provided with multiple versions (such as 32-bit and 64-bit versions), you may install and activate only one of those versions at a time.

(ii) Multiple or pooled connections. Hardware or software you use to multiplex or pool connections or reduce the number of devices or users that access or use the software, does not reduce the number of licenses you need. You may only use such hardware or software if you have a license for each instance of the software you are using.

(iii) Device connections. You may allow up to 20 other devices to access the software installed on the licensed device for the purpose of using the following software features: file services, print services, Internet information services, and Internet connection sharing and telephony services on the licensed device. The 20-connection limit applies to devices that access the software indirectly through “multiplexing” or other software or hardware that pools connections. You may allow any number of devices to access the software on the licensed device to synchronize data between devices. This section does not mean, however, that you have the right to install the software, or use the primary function of the software (other than the features listed in this section), on any of these other devices.

(iv) Remote access. Users may access the licensed device from another device using remote access technologies, but only on devices separately licensed to run the same or higher edition of this software.

(v) Remote assistance. You may use remote assistance technologies to share an active session without obtaining any additional licenses for the software. Remote assistance allows one user to connect directly to another user’s computer, usually to correct problems.

(vi) **POS application.** If the software is installed on a retail point of service device, you may use the software with a point of service application ("POS Application"). A POS Application is a software application which provides only the following functions: (i) process sales and service transactions, scan and track inventory, record and/or transmit customer information, and perform related management functions, and/or (ii) provide information directly and indirectly to customers about available products and services. You may use other programs with the software as long as the other programs: (i) directly support the manufacturer's specific use for the device, or (ii) provide system utilities, resource management, or anti-virus or similar protection. For clarification purposes, an automated teller machine ("ATM") is not a retail point of service device.

(vii) **Cloud Computing Devices.** If your device uses Internet browsing functionality to connect to and access cloud hosted applications: (i) no desktop functions may run locally on the device, and (ii) any files that result from the use of the desktop functions may not be permanently stored on the system. "Desktop functions," as used in this agreement, means a consumer or business task or process performed by a computer or computing device. This includes but is not limited to email, word processing, spreadsheets, database, scheduling, network, or internet browsing and personal finance.

(viii) **Desktop Functions**. If your system performs desktop functions, then you must ensure that they: (i) are only used to support the application, and (ii) operate only when used with the application.

e. Windows 10 IoT Enterprise Features for Development and Testing Only.

(1) Device Health Attestation.
You may only implement Device Health Attestation in a commercial use if you execute a Microsoft Windows IoT Core Services Agreement at: https://azure.microsoft.com/en-us/services/windows-10-iot-core/.

f. Specific Use. The manufacturer designed the licensed device for a specific use. You may only use the software for that use.

3. Privacy; Consent to Use of Data.

Your privacy is important to us. Some of the software features send or receive information when using those features. Many of these features can be switched off in the user interface, or you can choose not to use them. By accepting this agreement and using the software you agree that Microsoft may collect, use, and disclose the information as described in the Microsoft Privacy Statement available at (aka.ms/privacy), and as may be described in the user interface associated with the software features.

4. Authorized Software and Activation.

You are authorized to use this software only if you are properly licensed and the software has been properly activated with a genuine product key or by other authorized method. When you connect to the Internet while using the software, the software will automatically contact Microsoft or its affiliate to confirm the software is genuine and the license is associated with the licensed device. You can also activate the software manually by Internet or telephone. In either case, transmission of certain information will occur, and Internet, telephone and SMS service charges may apply. During activation (or reactivation that may be triggered by changes to your device's components), the software may determine that the installed instance of the software is counterfeit, improperly licensed or includes unauthorized changes. If activation fails, the software will attempt to repair itself by replacing any tampered Microsoft software with genuine Microsoft software. You may also receive reminders to obtain a proper license for the software. Successful activation does not confirm that the software is genuine or properly licensed. You may not bypass or circumvent activation. To help determine if your software is genuine and whether you are properly licensed, see (aka.ms/genuine). Certain updates, support, and other services might only be offered to users of genuine Microsoft software.

5. Updates.

You may obtain updates only from Microsoft or authorized sources, and Microsoft may need to update your system to provide you with those updates. The software periodically checks for system and app updates and may download and install them for you. To the extent automatic updates are enabled on your device; by accepting this agreement, you agree to receive these types of automatic updates without any additional notice.

6. Geographic and Export Restrictions.

If your software is restricted for use in a particular geographic region, then you may activate the software only in that region. You must also comply with all domestic and international export laws and regulations that apply to the software, which include restrictions on destinations, end users, and end use. For further information on geographic and export restrictions, visit (aka.ms/exporting).

7. Support and Refund Procedures.

For the software, contact the device manufacturer or installer for support options. See the support number provided with the software. For updates and supplements obtained directly from Microsoft, Microsoft may provide limited support services for properly licensed software as described at (aka.ms/mssupport). If you are seeking a refund, contact the manufacturer or installer to determine its refund policies. You must comply with those policies, which might require you to return the software with the entire device on which the software is installed for a refund.

8. Binding Arbitration and Class Action Waiver if You Live in (or if a Business Your Principal Place of Business is in) the United States.

We hope we never have a dispute, but if we do, you and we agree to try for 60 days to resolve it informally. If we cannot, you and we agree to binding individual arbitration before the American Arbitration Association ("AAA") under the Federal Arbitration Act ("FAA"), and not to sue in court in front of a judge or jury. Instead, a neutral arbitrator will decide, and the arbitrator's decision will be final except for a limited right of appeal under the FAA. Class action lawsuits, class-wide arbitrations, private attorney-general actions, and any other proceeding where someone acts in a representative capacity are not allowed. Nor is combining individual proceedings without the consent of all parties. "We," "our," and "us" includes Microsoft, the device manufacturer, and software installer.

a. Disputes covered—everything except IP. The term "dispute" is as broad as it can be. It includes any claim or controversy between you and the manufacturer or installer, or you and Microsoft, concerning the software, its price, or this agreement, under any legal theory including contract, warranty, tort, statute, or regulation, except disputes relating to the enforcement or validity of your, your licensors', our, or our licensors' intellectual property rights.

b. Mail a Notice of Dispute first. If you have a dispute and our customer service representatives cannot resolve it, send a Notice of Dispute by U.S. Mail to the manufacturer or installer, ATTN: LEGAL DEPARTMENT. If your dispute is with Microsoft, mail it to Microsoft Corporation, ATTN: LCA ARBITRATION, One Microsoft Way, Redmond, WA 98052-6399. Tell us your name, address, how to contact you, what the problem is, and what you want. A form is available at (aka.ms/disputeform). We will do the same if we have a dispute with you. After 60 days, you or we may start an arbitration if the dispute is unresolved.

c. Small claims court option. Instead of mailing a Notice of Dispute, and if you meet the court's requirements, you may sue us in small claims court in your county of residence (or if a business your principal place of business) or our principal place of business–King County, Washington USA if your dispute is with Microsoft. We hope you will mail a Notice of Dispute and give us 60 days to try to work it out, but you do not have to before going to small claims court**.**

d. Arbitration procedure. The AAA will conduct any arbitration under its Commercial Arbitration Rules (or if you are an individual and use the software for personal or household use, or if the value of the dispute is $75,000 USD or less whether or not you are an individual or how you use the software, its Consumer Arbitration Rules). For more information, see (aka.ms/adr) or call 1-800-778-7879. To start an arbitration, submit the form available at (aka.ms/arbitration) to the AAA; mail a copy to the manufacturer or installer (or to Microsoft if your dispute is with Microsoft). In a dispute involving $25,000 USD or less, any hearing will be telephonic unless the arbitrator finds good cause to hold an in-person hearing instead. Any in-person hearing will take place in your county of residence (of if a business your principal place of business) or our principal place of business—King County, Washington if your dispute is with Microsoft. You choose. The arbitrator may award the same damages to you individually as a court could. The arbitrator may award declaratory or injunctive relief only to you individually to satisfy your individual claim.

e. Arbitration fees and payments.

(i) Disputes involving $75,000 USD or less. The manufacturer or installer (or Microsoft if your dispute is with Microsoft) will promptly reimburse your filing fees and pay the AAA's and arbitrator's fees and expenses. If you reject our last written settlement offer made before the arbitrator was appointed, your dispute goes all the way to an arbitrator's decision (called an "award"), and the arbitrator awards you more than this last written offer, the manufacturer or installer (or Microsoft if your dispute is with Microsoft) will: (1) pay the greater of the award or $1,000 USD; (2) pay your reasonable attorney's fees, if any; and (3) reimburse any expenses (including expert witness fees and costs) that your attorney reasonably accrues for investigating, preparing, and pursuing your claim in arbitration. The arbitrator will determine the amounts unless you and we agree on them.

(ii) Disputes involving more than $75,000 USD. The AAA rules will govern payment of filing fees and the AAA's and arbitrator's fees and expenses.

(iii) Disputes involving any amount. If you start an arbitration, we will not seek our AAA or arbitrator's fees and expenses, or your filing fees we reimbursed, unless the arbitrator finds the arbitration frivolous or brought for an improper purpose. If we start an arbitration we will pay all filing, AAA, and arbitrator's fees and expenses. We will not seek our attorney's fees or expenses from you in any arbitration. Fees and expenses are not counted in determining how much a dispute involves.

f. Must file within one year. You and we must file in small claims court or arbitration any claim or dispute (except intellectual property disputes — see Section 9.a.) within one year from when it first could be filed. Otherwise, it is permanently barred.

g. Severability. If the class action waiver is found to be illegal or unenforceable as to all or some parts of a dispute, those parts will not be arbitrated but will proceed in court, with the rest proceeding in arbitration. If any other provision of Section 9 is found to be illegal or unenforceable, that provision will be severed but the rest of Section 9 still applies.

h. Conflict with AAA rules. This agreement governs if it conflicts with the AAA's Commercial Arbitration Rules or Consumer Arbitration Rules.

i. Microsoft as party or third-party beneficiary. If Microsoft is the device manufacturer or if you acquired the software from a retailer, Microsoft is a party to this agreement. Otherwise, Microsoft is not a party but is a third-party beneficiary of your agreement with the manufacturer or installer to resolve disputes through informal negotiation and arbitration.

9. Governing Law.

The laws of the state or country where you live (or if a business where your principal place of business is located) govern all claims and disputes concerning the software, its price, or this agreement, including breach of contract claims and claims under state consumer protection laws, unfair competition laws, implied warranty laws, for unjust enrichment, and in tort, regardless of conflict of law principles. In the United States, the FAA governs all provisions relating to arbitration.

10. Consumer Rights, Regional Variations.

This agreement describes certain legal rights. You may have other rights, including consumer rights, under the laws of your state or country. You may also have rights with respect to the party from which you acquired the software. This agreement does not change those other rights if the laws of your state or country do not permit it to do so. For example, if you acquired the software in one of the below regions, or mandatory country law applies, then the following provisions apply to you:

a. Australia. References to "Limited Warranty" are references to the express warranty provided by Microsoft or the manufacturer or installer. This warranty is given in addition to other rights and remedies you may have under law, including your rights and remedies in accordance with the statutory guarantees under the Australian Consumer Law. In this section, "goods" refers to the software for which Microsoft or the manufacturer or installer provides the express warranty. Our goods come with guarantees that cannot be excluded under the Australian Consumer Law. You are entitled to a replacement or refund for a major failure and compensation for any other foreseeable loss or damage. You are also entitled to have the goods repaired or replaced if the goods fail to be of acceptable quality and the failure does not amount to a major failure.

b. Canada. You may stop receiving updates on your device by turning off Internet access. If and when you re-connect to the Internet, the software will resume checking for and installing updates.

c. European Union. The academic use restriction in Section 12.d(i) below does not apply in the jurisdictions listed on this site: (aka.ms/academicuse).

d. Germany and Austria.

(i) **Warranty.** The properly licensed software will perform substantially as described in any Microsoft materials that accompany the software. However, the manufacturer or installer, and Microsoft, give no contractual guarantee in relation to the licensed software.

(ii) Limitation of Liability. In case of intentional conduct, gross negligence, claims based on the Product Liability Act, as well as, in case of death or personal or physical injury, the manufacturer or installer, or Microsoft is liable according to the statutory law. Subject to the preceding sentence, the manufacturer or installer, or Microsoft will only be liable for slight negligence if the manufacturer or installer or Microsoft is in breach of such material contractual obligations, the fulfillment of which facilitate the due performance of this agreement, the breach of which would endanger the purpose of this agreement and the compliance with which a party may constantly trust in (so-called "cardinal obligations"). In other cases of slight negligence, the manufacturer, installer, or Microsoft will not be liable for slight negligence.

e. Other regions. See (aka.ms/variations) for a current list of regional variations.

11. Additional Notices.

a. Networks, data, and Internet usage. Some features of the software and services accessed through the software may require your device to access the Internet. Your access and usage (including charges) may be subject to the terms of your cellular or internet provider agreement. Certain features of the software may help you access the Internet more efficiently, but the software's usage calculations may be different from your service provider's measurements. You are always responsible for (i) understanding and complying with the terms of your own plans and agreements, and (ii) any issues arising from using or accessing networks, including public/open networks. You may use the software to connect to networks, and to share access information about those networks, only if you have permission to do so.

b. H.264/AVC and MPEG-4 visual standards and VC-1 video standards. The software may include H.264/MPEG-4 AVC and/or VC-1 decoding technology. MPEG LA, L.L.C. requires this notice:

> THIS PRODUCT IS LICENSED UNDER THE AVC, THE VC-1, AND THE MPEG-4 PART 2 VISUAL PATENT PORTFOLIO LICENSES FOR THE PERSONAL AND NON-COMMERCIAL USE OF A CONSUMER TO (i) ENCODE VIDEO IN COMPLIANCE WITH THE ABOVE STANDARDS ("VIDEO STANDARDS") AND/OR (ii) DECODE AVC, VC-1, AND MPEG-4 PART 2 VIDEO THAT WAS ENCODED BY A CONSUMER ENGAGED IN A PERSONAL AND NON-COMMERCIAL ACTIVITY AND/OR WAS OBTAINED FROM A VIDEO PROVIDER LICENSED TO PROVIDE SUCH VIDEO. NO LICENSE IS GRANTED OR SHALL BE IMPLIED FOR ANY OTHER USE. ADDITIONAL INFORMATION MAY BE OBTAINED FROM MPEG LA, L.L.C. SEE WWW.MPEGLA.COM.

c. Malware protection. Microsoft cares about protecting your device from malware. The software will turn on malware protection if other protection is not installed or has expired. To do so, other antimalware software will be disabled or may have to be removed.

12. Entire Agreement.

This agreement (together with the printed paper license terms or other terms accompanying any software supplements, updates, and services that are provided by the manufacturer or installer, or Microsoft, and that you use), and the terms contained in web links listed in this agreement, are the entire agreement for the software and any such supplements, updates, and services (unless the manufacturer or installer, or Microsoft, provides other terms with such supplements, updates, or services). You can review this agreement after your software is running by going to (aka.ms/useterms) or going to Settings - System - About within the software. You can also review the terms at any of the links in this agreement by typing the URLs into a browser address bar, and you agree to do so. You agree that you will read the terms before using the software or services, including any linked terms. You understand that by using the software and services, you ratify this agreement and the linked terms. There are also informational links in this agreement. The links containing notices and binding terms are:

- Windows 10 Privacy Statement (aka.ms/privacy)
- Microsoft Services Agreement (aka.ms/msa)

NO WARRANTY

THE SOFTWARE ON YOUR DEVICE (INCLUDING THE APPS) IS LICENSED “AS IS.” TO THE MAXIMUM EXTENT PERMITTED BY YOUR LOCAL LAWS, YOU BEAR THE ENTIRE RISK AS TO THE SOFTWARE’S QUALITY AND PERFORMANCE. SHOULD IT PROVE DEFECTIVE, YOU ASSUME THE ENTIRE COST OF ALL SERVICING OR REPAIR. NEITHER THE DEVICE MANUFACTURER NOR MICROSOFT GIVES ANY EXPRESS WARRANTIES, GUARANTEES, OR CONDITIONS FOR THE SOFTWARE. TO THE EXTENT PERMITTED UNDER YOUR LOCAL LAWS, THE MANUFACTURER AND MICROSOFT EXCLUDE ALL IMPLIED WARRANTIES AND CONDITIONS, INCLUDING THOSE OF MERCHANTABILITY, QUALITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT. YOU MAY HAVE ADDITIONAL CONSUMER RIGHTS OR STATUTORY GUARANTEES UNDER LOCAL LAWS THAT THESE TERMS CANNOT CHANGE.

IF YOUR LOCAL LAWS IMPOSE A WARRANTY, GUARANTEE, OR CONDITION EVEN THOUGH THIS AGREEMENT DOES NOT, ITS TERM IS LIMITED TO 90 DAYS FROM WHEN THE FIRST USER ACQUIRES THE SOFTWARE. IF THE MANUFACTURER OR MICROSOFT BREACHES SUCH A WARRANTY, GUARANTEE, OR CONDITION, YOUR SOLE REMEDY, AT THE MANUFACTURER’S OR MICROSOFT’S ELECTION, IS (I) REPAIR OR REPLACEMENT OF THE SOFTWARE AT NO CHARGE, OR (II) RETURN OF THE SOFTWARE (OR AT ITS ELECTION THE DEVICE ON WHICH THE SOFTWARE WAS INSTALLED) FOR A REFUND OF THE AMOUNT PAID, IF ANY. THESE ARE YOUR ONLY REMEDIES FOR BREACH OF A WARRANTY, GUARANTEE, OR CONDITION YOUR LOCAL LAWS IMPOSE.

TO THE EXTENT NOT PROHIBITED BY YOUR LOCAL LAWS, IF YOU HAVE ANY BASIS FOR RECOVERING DAMAGES, YOU CAN RECOVER FROM THE MANUFACTURER OR MICROSOFT ONLY DIRECT DAMAGES UP TO THE AMOUNT YOU PAID FOR THE SOFTWARE (OR UP TO $50 USD IF YOU ACQUIRED THE SOFTWARE FOR NO CHARGE). YOU WILL NOT, AND WAIVE ANY RIGHT TO, SEEK TO RECOVER ANY OTHER DAMAGES OR REMEDY, INCLUDING LOST PROFITS AND DIRECT, CONSEQUENTIAL, SPECIAL, INDIRECT, OR INCIDENTAL DAMAGES, UNDER ANY PART OF THIS AGREEMENT OR UNDER ANY THEORY. THIS LIMITATION APPLIES TO (I) ANYTHING RELATED TO THIS AGREEMENT, THE SOFTWARE (INCLUDING THE APPS), THE DEVICE, SERVICES, CORRUPTION OR LOSS OF DATA, FAILURE TO TRANSMIT OR RECEIVE DATA, CONTENT (INCLUDING CODE) ON THIRD PARTY INTERNET SITES OR THIRD PARTY PROGRAMS, AND (II) CLAIMS FOR BREACH OF CONTRACT, WARRANTY, GUARANTEE, OR CONDITION; STRICT LIABILITY, NEGLIGENCE, OR OTHER TORT; VIOLATION OF A STATUTE OR REGULATION; UNJUST ENRICHMENT; OR UNDER ANY OTHER THEORY.

THE DAMAGE EXCLUSIONS AND REMEDY LIMITATIONS IN THIS AGREEMENT APPLY EVEN IF YOU HAVE NO REMEDY (THE SOFTWARE IS LICENSED “AS IS”), IF REPAIR, REPLACEMENT, OR A REFUND (IF REQUIRED BY YOUR LOCAL LAW) DOES NOT FULLY COMPENSATE YOU FOR ANY LOSSES, IF THE MANUFACTURER OR MICROSOFT KNEW OR SHOULD HAVE KNOWN ABOUT THE POSSIBILITY OF THE DAMAGES, OR IF THE REMEDY FAILS OF ITS ESSENTIAL PURPOSE.

Check with your device manufacturer to determine if your device is covered by a warranty.

APPX.8. WINDOWS SDK LICENSE TERMS AND THIRD-PARTY SOFTWARE NOTICES

MICROSOFT SOFTWARE LICENSE TERMS

MICROSOFT WINDOWS SOFTWARE DEVELOPMENT KIT (SDK) FOR WINDOWS

These license terms are an agreement between Microsoft Corporation (or based on where you live, one of its affiliates) and you. Please read them. They apply to the software named above, which includes the media on which you received it, if any. The terms also apply to any Microsoft

- APIs (i.e., APIs included with the installation of the SDK or APIs accessed by installing extension packages or service to use with the SDK),
- updates,
- supplements,
- internet-based services, and
- support services

for this software, unless other terms accompany those items. If so, those terms apply.

By using the software, you accept these terms. If you do not accept them, do not use the software.

As described below, using some features also operates as your consent to the transmission of certain standard computer information for Internet-based services.

If you comply with these license terms, you have the rights below.

1. INSTALLATION AND USE RIGHTS.

a. You may install and use any number of copies of the software on your devices to design, develop and test your programs that run on a Microsoft operating system. Further, you may install, use and/or deploy via a network management system or as part of a desktop image, any number of copies of the software on computer devices within your internal corporate network to design, develop and test your programs that run on a Microsoft operating system. Each copy must be complete, including all copyright and trademark notices. You must require end users to agree to terms that protect the software as much as these license terms.

b. Utilities. The software contains certain components that are identified in the Utilities List located at http://go.microsoft.com/fwlink/?LinkId=524839. Depending on the specific edition of the software, the number of Utility files you receive with the software may not be equal to the number of Utilities listed in the Utilities List. Except as otherwise provided on the Utilities List for specific files, you may copy and install the Utilities you receive with the software on to other third party machines. These Utilities may only be used to debug and deploy your programs and databases you have developed with the software. You must delete all the Utilities installed onto a third party machine within the earlier of (i) when you have finished debugging or deploying your programs; or (ii) thirty (30) days after installation of the Utilities onto that machine. We may add additional files to this list from time to time.

c. Build Services and Enterprise Build Servers. You may install and use any number of copies of the software onto your build machines or servers, solely for the purpose of:

i. Compiling, building, verifying and archiving your programs;

ii. Creating and configuring build systems internal to your organization to support your internal build environment; or

iii. Enabling a service for third parties to design, develop and test programs or services that run on a Microsoft operating system.

d. Included Microsoft Programs. The software contains other Microsoft programs. The license terms with those programs apply to your use of them.

e. Third Party Notices. The software may include third party code that Microsoft, not the third party, licenses to you under this agreement. Notices, if any, for the third party code are included for your information only. Notices, if any, for this third party code are included with the software and may be located at http://aka.ms/thirdpartynotices.

2. ADDITIONAL LICENSING REQUIREMENTS AND/OR USE RIGHTS.

a. Distributable Code. The software contains code that you are permitted to distribute in programs you develop if you comply with the terms below.

i. Right to Use and Distribute. The code and test files listed below are "Distributable Code".

- REDIST.TXT Files. You may copy and distribute the object code form of code listed in REDIST.TXT files plus the files listed on the REDIST.TXT list located at http://go.microsoft.com/fwlink/?LinkId=524842. Depending on the specific edition of the software, the number of REDIST files you receive with the software may not be equal to the number of REDIST files listed in the REDIST.TXT List. We may add additional files to the list from time to time.
- Third Party Distribution. You may permit distributors of your programs to copy and distribute the Distributable Code as part of those programs.

ii. Distribution Requirements. For any Distributable Code you distribute, you must

- Add significant primary functionality to it in your programs;
- For any Distributable Code having a filename extension of .lib, distribute only the results of running such Distributable Code through a linker with your program;
- Distribute Distributable Code included in a setup program only as part of that setup program without modification;
- Require distributors and external end users to agree to terms that protect it at least as much as this agreement;
- For Distributable Code from the Windows Performance Toolkit portions of the software, distribute the unmodified software package as a whole with your programs, with the exception of the KernelTraceControl.dll and the WindowsPerformanceRecorderControl.dll which can be distributed with your programs;
- Display your valid copyright notice on your programs; and
- Indemnify, defend, and hold harmless Microsoft from any claims, including attorneys' fees, related to the distribution or use of your programs.

iii. Distribution Restrictions. You may not

- Alter any copyright, trademark or patent notice in the Distributable Code;
- Use Microsoft's trademarks in your programs' names or in a way that suggests your programs come from or are endorsed by Microsoft;
- Distribute partial copies of the Windows Performance Toolkit portion of the software package with the exception of the KernelTraceControl.dll and the WindowsPerformanceRecorderControl.dll which can be distributed with your programs;
- Distribute Distributable Code to run on a platform other than the Microsoft operating system platform;
- Include Distributable Code in malicious, deceptive or unlawful programs; or
- Modified or distribute the source code of any Distributable Code so that any part of it becomes subject to an Excluded License. And Excluded License is one that requires, as a condition of use, modification or distribution, that
  - The code be disclosed or distributed in source code form; or
  - Others have the right to modify it.

b. Additional Rights and Restrictions for Features made Available with the Software.

i. Windows App Requirements. If you intend to make your program available in the Windows Store, the program must comply with the Certification Requirements as defined and described in the App Developer Agreement, currently available at: https://msdn.microsoft.com/en-us/library/windows/apps/hh694058.aspx.

ii. Bing Maps. The software may include features that retrieve content such as maps, images and other data through the Bing Maps (or successor branded) application programming interface (the "Bing Maps API") to create reports displaying data on top of maps, aerial and hybrid imagery. If these features are included, you may use these features to create and view dynamic or static documents only in conjunction with and through methods and means of access integrated in the software. You may not otherwise copy, store, archive, or create a database of the entity information including business names, addresses and geocodes available through the Bing Maps API. You may not

use the Bing Maps API to provide sensor based guidance/routing, nor use any Road Traffic Data or Bird's Eye Imager (or associated metadata) even if available through the Bing Maps API for any purpose. Your use of the Bing Maps API and associated content is also subject to the additional terms and conditions at http://go.microsoft.com/fwlink/?LinkId=21969.

iii. **Additional Mapping APIs.** The software may include application programming interfaces that provide maps and other related mapping features and services that are not provided by Bing (the "Additional Mapping APIs"). These Additional Mapping APIs are subject to additional terms and conditions and may require payment of fees to Microsoft and/or third party providers based on the use or volume of use of such Additional Mapping APIs. These terms and conditions will be provided when you obtain any necessary license keys to use such Additional Mapping APIs or when you review or receive documentation related to the use of such Additional Mapping APIs.

iv. **Push Notifications.** The Microsoft Push Notification Service may not be used to send notifications that are mission critical or otherwise could affect matters of life or death, including without limitation critical notifications related to a medical device or condition. MICROSOFT EXPRESSLY DISCLAIMS ANY WARRANTIES THAT THE USE OF THE MICROSOFT PUSH NOTIFICATION SERVICE OR DELIVERY OF MICROSOFT PUSH NOTIFICATION SERVICE NOTIFICATIONS WILL BE UNINTERRUPTED, ERROR FREE, OR OTHERWISE GUARANTEED TO OCCUR ON A REAL-TIME BASIS.

v. **Speech namespace API.** Using speech recognition functionality via the Speech namespace APIs in a program requires the support of a speech recognition service. The service may require network connectivity at the time of recognition (e.g., when using a predefined grammar). In addition, the service may also collect speech-related data in order to provide and improve the service. The speech-related data may include, for example, information related to grammar size and string phrases in a grammar.

   Also, in order for a user to use speech recognition on the phone they must first accept certain terms of use. The terms of use notify the user that data related to their use of the speech recognition service will be collected and used to provide and improve the service. If a user does not accept the terms of use and speech recognition is attempted by the application, the operation will not work and an error will be returned to the application.

vi. **PlayReady Support.** The software may include the Windows Emulator, which contains Microsoft's PlayReady content access technology. Content owners use Microsoft PlayReady content access technology to protect their intellectual property, including copyrighted content. This software uses PlayReady technology to access PlayReady-protected content and/or WMDRM-protected content. Microsoft may decide to revoke the software's ability to consume PlayReady-protected content for reasons including but not limited to (i) if a breach or potential breach of PlayReady technology occurs, (ii) proactive robustness enhancement, and (iii) if Content owners require the revocation because the software fails to properly enforce restrictions on content usage. Revocation should not affect unprotected content or content protected by other content access technologies. Content owners may require you to upgrade PlayReady to access their content. If you decline an upgrade, you will not be able to access content that requires the upgrade and may not be able to install other operating system updates or upgrades.

vii. **Package Managers.** The software may include package managers, like NuGet, that give you the option to download other Microsoft and third party software packages to use with your application. Those packages are under their own licenses, and not this agreement. Microsoft does not distribute, license or provide any warranties for any of the third party packages.

viii. **Font Components.** While the software is running, you may use its fonts to display and print content. You may only embed fonts in content as permitted by the embedding restrictions in the fonts; and temporarily download them to a printer or other output device to help print content.

ix. **Notice about the H.264/AVD Visual Standard, and the VC-1 Video Standard.** This software may include H.264/MPEG-4 AVC and/or VD-1 decoding technology. MPEG LA, L.L.C. requires this notice:

   THIS PRODUCT IS LICENSED UNDER THE AVC AND THE VC-1 PATENT PORTFOLIO LICENSES FOR THE PERSONAL AND NON-COMMERCIAL USE OF A CONSUMER TO (i) ENCODE VIDEO IN COMPLIANCE WITH THE ABOVE STANDARDS ("VIDEO STANDARDS") AND/OR (ii) DECODE AVC, AND VC-1 VIDEO THAT WAS ENCODED BY A CONSUMER ENGAGED IN A PERSONAL AND NON-COMMERCIAL ACTIVITY AND/OR WAS OBTAINED FROM A VIDEO PROVIDER LICENSED TO PROVIDE SUCH VIDEO. NONE OF THE LICENSES EXTEND TO ANY OTHER PRODUCT REGARDLESS OF WHETHER SUCH PRODUCT IS INCLUDED WITH THIS SOFTWARE IN A SINGLE ARTICLE. NO LICENSE IS GRANTED OR SHALL BE IMPLIED FOR ANY OTHER USE. ADDITIONAL INFORMATION MAY BE OBTAINED FROM MPEG LA, L.L.C. SEE WWW.MPEGLA.COM.

   For clarification purposes, this notice does not limit or inhibit the use of the software for normal business uses that are personal to that business which do not include (i) redistribution of the software to third parties, or (ii) creation of content with the VIDEO STANDARDS compliant technologies for distribution to third parties.

3. **INTERNET-BASED SERVICES. Microsoft provides Internet-based services with the software. It may change or cancel them at any time.**

   a. **Consent for Internet-Based Services.** The software features described below and in the privacy statement at http://go.microsoft.com/fwlink/?LinkId=521839 connect to Microsoft or service provider computer systems over the Internet. In some cases, you will not receive a separate notice when they connect. In some cases, you may switch off these features or not use them as described in the applicable product documentation. By using these features, you consent to the transmission of this information. Microsoft does not use the information to identify or contact you.

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