WSR-98D DOPPLER WEATHER RADAR

DESCRIPTION OF BASE DATA FORMAT

Version V005

Beijing Metstar Radar Company

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修订记录

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CHAPTER 1 INTRODUCTION

1.1 Purpose and Scope

The document describes the format of WSR-98D Base Data. It can be used as interface and technical reference for development work on Base Data.

1.3 Background and Rules

Readers who read this document are assumed to have basic knowledge on Computer Science and C/C++ language. Weather Radar theory and experiences are also required to better understand the materials.

Data types are based on 32-bit little end computer system, data types used are defined here.
- INT – 4 bytes integer
- SHORT – 2 bytes integer
- CHAR*N – N bytes characters
- FLOAT – 4 bytes float value, in format of IEEE754
- LONG – 8 bytes integer

1.4 Base Data Architecture

WSR-98D Base Data is formatted in many blocks, each block contains a group of information. For example, Site Configuration block (see Table 2-4) is used to provide information on radar site, like site latitude, longitude and height of antenna.

All blocks are divided into 2 main segments – Product Common Blocks, Radial Data Block.

The Product Common Blocks are a set of blocks shared by all of different types of products and Base Data. It provides user with information on radar site and task, etc. Details of Product Common Blocks are provided in Chapter 2.

The Radial Data Blocks keeps moments data of weather. Radial Data Block consists of 3 sub blocks, Radial Header Block, Moment Header Block and Moment Data Block. Details of Radial Data Blocks are provided in Chapter 3.

The architecture of Base Data is described in Figure 1-1.

<table>
<tr><td rowspan="6">Product Common Blocks</td><td>GENERIC HEADER (32 Bytes)</td></tr>
<tr><td>SITE CONFIGURATION (128 Bytes)</td></tr>
<tr><td>TASK CONFIGURATION (256 Bytes)</td></tr>
<tr><td>CUT #1 CONFIGURATION (256 Bytes)</td></tr>
<tr><td>…</td></tr>
<tr><td>CUT #N CONFIGURATION (256 Bytes)</td></tr>
<tr><td rowspan="8">Radial 1</td><td>RADIAL HEADER (64 Bytes)</td></tr>
<tr><td>MOMENT HEADER #1 (32 Bytes)</td></tr>
<tr><td>MOMENT DATA #1 (N Bytes)</td></tr>
<tr><td>MOMENT HEADER #2 (32 Bytes)</td></tr>
<tr><td>MOMENT DATA #2 (N Bytes)</td></tr>
<tr><td>…</td></tr>
<tr><td>MOMENT HEADER #N (32 Bytes)</td></tr>
<tr><td>MOMENT DATA #N (N Bytes)</td></tr>
<tr><td></td><td>…….</td></tr>
<tr><td>Radial N</td><td>... ...</td></tr>
</table>

Figure 1-1 Base Data Architecture

CHAPTER 2 PRODUCT COMMON HEADER

2.1 Introduction.

In order to illustrate meteorological products and base data, some common blocks are attached ahead of meteorological data. These common blocks provide detail information on radar site and task that generating raw data.

For most of WSR-98D meteorological products and Base Data, there all share these common blocks. Common blocks are described in Table 2-1.

Table 2-1 Product Common Blocks

BLOCK	BYTES	REMARKS
GENERIC HEADER	32	Generic Product Header, see Table 2-2
SITE CONFIG	128	Site Configuration, see Table 2-4
TASK CONFIG	256	Task Configuration, see Table 2-5
CUT CONFIG	256*N	Cut Configuration, see Table 2-6 For some tasks, more than 1 cut can be included.

2.2 Generic Header Block

Generic Header Block is the first block of all product, it is a general summary block contains the summary information of the following other blocks. Generic Header Block keeps information like version of product format and data type.

Generic Header Block is described in Table 2-2.

Table 2-2 Generic Header Block

NO	FIELD NAME	TYPE /BYTES	UNIT	RANGE	REMARKS
01	Magic Word	INT	N/A	0x4D545352	Magic word for product
02	Major Version	SHORT	N/A	0 to 65536	Major Version
03	Minor Version	SHORT	N/A	0 to 65536	Minor Version
04	Generic Type	INT	N/A	2	Type of data, see Table 2-3
05	Product Type	INT	N/A	1 to 100	Type of Product, not used for Base Data
06	Reserved	16 Bytes	N/A	N/A	Reserved

Table 2-3 Generic Data Type List

PRODUCT TYPE	Generic NAME	REMARKS
1	Base Data	Base Data
2	Product	Meteorological Product

2.3 Site Configuration Block

Site Configuration Block is the second block of product, it provides information on radar site. All parameters related to radar site should be included in this block.

Site Code (No. 1 element in block) is the unique key of radar site, RPG and PUP can use this code to distinguish different radar sites.

Site Configuration Block is described in Table 2-4.

Table 2-4 Site Configuration Block

NO	FIELD NAME	TYPE /BYTES	UNIT	RANGE	REMARKS
01	Site Code	CHAR*8	N/A	ASCII	Site Code in characters
02	Site Name	CHAR*32	N/A	ASCII	Site Name or description in characters
03	Latitude	FLOAT	Degree	-90.0 to 90.0	Latitude of Radar Site
04	Longitude	FLOAT	Degree	-180.0 to 180.0	Longitude of Radar Site
05	Height	INT	Meters	0 to 65536	Height of antenna in meters
06	Ground	INT	Meters	0 to 65536	Height of ground in meters
07	Frequency	FLOAT	MHz	1.0 to 999,000.0	Radar operation frequency in MHz
08	Beam Width Hori	FLOAT	Degree	0.1 to 2.0	Antenna Beam Width Hori
09	Beam Width Vert	FLOAT	Degree	0.1 to 2.0	Antenna Beam Width Vert
10	Reserved	60 Bytes	N/A	N/A	

2.4 Task Configuration Block

Task Configuration Block provides information on radar scan task. Task can be PPI, RHI or Volume Coverage Pattern.

Task Configuration Block includes the general parameters or data of a task, for detail parameters of elevation or azimuth cut, the Cut Configuration Blocks provides more descriptions in detail.

For most tasks, more than 1 Cut is included, in which case more than 1 Cut Configuration Blocks are followed. Parameter Cut Number (No. 4 element in block) is the number of cut followed.

Task Configuration Block is described in Table 2-5.

Table 2-5 Task Configuration Block

NO	FIELD NAME	TYPE	UNIT	RANGE	REMARKS
01	Task Name	CHAR*32	N/A	ASCII	Name of the Task Configuration
02	Task Description	CHAR*128	N/A	ASCII	Description of Task
03	Polarization Type	INT	N/A	1 to 4	Polarization Type: 1 - Horizontal 2 - Vertical 3 - Simultaneously 4 - Alternation
04	Scan Type	INT	N/A	1 to 3	Volume Scan Type 0 - PPI Volume Scan 1- Single PPI 2 - Single RHI 3 -Single Sector 4 – Sector Volume Scan 5 – RHI Volume Scan 6 – Manual Scan
05	Pulse Width	INT	Nanoseconds	1 to 10000	Pulse Width
06	Volume Start Time	INT	Seconds	UTC	Start time of volume scan
07	Cut Number	INT	N/A	1 to 256	Number of Elevation or Azimuth cuts in the task
08	Horizontal Noise	FLOAT	dBm	-100.0 to 0.0	Noise level of horizontal channel
09	Vertical Noise	FLOAT	dBm	-100.0 to 0.0	Noise level of vertical channel
10	Horizontal Calibration	FLOAT	dB	0.0 to 200.0	System Reflectivity Calibration Const for horizontal channel.
11	Vertical Calibration	FLOAT	dB	0.0 to 200.0	System Reflectivity Calibration Const for vertical channel.
12	Horizontal Noise	FLOAT	dB	0.0 to 800.0	System Reflectivity

	Temperature				Calibration Const for horizontal channel.
13	Vertical Noise Temperature	FLOAT	dB	0.0 to 800.0	System Reflectivity Calibration Const for vertical channel.
14	Zdr Calibration	FLOAT	dB	-10.0 to 10.0	Reflectivity calibration difference of horizontal and vertical channel
15	Phase Calibration	FLOAT	Degree	-180.0 to 180.0	Phase calibration difference of horizontal and vertical channel
16	LDR Calibration	FLOAT	dB	-60 to 0	LDR calibration difference of horizontal and vertical channel
17	Reserved	40 Bytes	N/A	N/A	

2.5 Cut Configuration Block

Cut Configuration Block provides information of a specified cut in task.

For most tasks, more than 1 cut may be included. The parameter "Cut Number" in Task Configuration block decides the number of cuts in the task. When there are many cuts in one task, cut configuration are stored in disk one by one follow the order of antenna scanning.

Cut Configuration Block is described in Table 2-6.

Table 2-6 Cut Configuration Block

NO	FIELD NAME	TYPE	UNIT	RANGE	REMARKS
01	Process Mode	INT	N/A	1 to 2	Main processing mode of signal processing algorithm. 1 - PPP 2 - FFT
02	Wave Form	INT	N/A	1 to 7	WSR-88D defined wave form 0 – CS 1 – CD 2 – CDX 3 – Rx Test 4 – BATCH 5 – Dual PRF 6 – Random Phase 7 – SZ
03	PRF #1	FLOAT	Hz	1 to 3000	Pulse Repetition Frequency #1. For wave form Batch and Dual PRF mode, it's the high PRF, for other modes it's the only PRF.
04	PRF #2	FLOAT	Hz	1 to 3000	Pulse Repetition Frequency #2.

					For wave form Batch and Dual PRF mode, it's the low PRF, for other modes it's not used.
05	Unfold Mode	INT	N/A	1~4	Dual PRF mode 1 – Single PRF 2 – 3:2 mode 3 – 4:3 mode 4 – 5:4 mode
06	Azimuth	FLOAT	Degree	0.0 to 360.0	Azimuth degree for RHI scan mode,
07	Elevation	FLOAT	Degree	-10.0 to 360.0	Elevation degree for PPI scan mode,
08	Start Angle	FLOAT	Degree	-10.0 to 360.0	Start azimuth angle for PPI Sector mode. Start (High) Elevation for RHI mode.
09	End Angle	FLOAT	Degree	-10.0 to 360.0	Stop azimuth angle for PPI Sector mode. Stop (Low) Elevation for RHI mode.
10	Angular Resolution	FLOAT	Degree	0.0 to 10.0	Radial angular resolution for PPI scan.
11	Scan Speed	FLOAT	Deg/sec	0.0 to 36.0	Azimuth scan speed for PPI scan, Elevation scan speed for RHI mode.
12	Log Resolution	INT	Meter	1 to 5,000	Range bin resolution for surveillance data, reflectivity and ZDR, etc.
13	Doppler Resolution	INT	Meter	1 to 5,000	Range bin resolution for Doppler data, velocity and spectrum, etc.
14	Maximum Range	INT	Meter	1 to 500,000	Maximum range of scan
15	Maximum Range2	INT	Meter	1 to 500,000	Maximum range of scan
16	Start Range	INT	Meter	1 to 500,000	Start range of scan
17	Sample #1	INT	N/A	2 to 512	Pulse sampling number #1. For wave form Batch and Dual PRF mode, it's for high PRF, for other modes it's for only PRF.
18	Sample #2	INT	N/A	2 to 512	Pulse sampling number #2. For wave form Batch and Dual PRF mode, it's for low PRF, for other modes it's not used.
19	Phase Mode	INT	N/A	1 to 3	Phase modulation mode. 1 – Fixed Phase 2 – Random Phase 3 – SZ Phase

20	Atmospheric Loss	FLOAT	dB/km	0.0 to 10.0	two-way atmospheric attenuation factor
21	Nyquist Speed	FLOAT	m/s	0-100	
22	Moments Mask	LONG	N/A	0 to 127	Bit mask indicates which moments are involved in the scan. See Table 2-7
23	Moments Size Mask	LONG	N/A	0 to 0xFFFFFFFF	Bit mask indicates range length for moment data in Table 2-7. 0 for 1 byte, 1 for 2 bytes
24	Misc Filter Mask	INT	N/A	0 to 0xFFFF	Refer to Table 2-8
25	SQI Threshold	FLOAT	N/A	0.0 to 1.0	SQI Threshold for the scan
26	SIG Threshold	FLOAT	dB	0.0 to 20.0	SIG Threshold for the scan
27	CSR Threshold	FLOAT	dB	0.0 to 100.0	CSR Threshold for the scan
28	LOG Threshold	FLOAT	dB	0.0 to 20.0	LOG Threshold for the scan
29	CPA Threshold	FLOAT	N/A	0.0 to 100.0	CPA Threshold for the scan
30	PMI Threshold	FLOAT	N/A	0.0 to 1.0	PMI Threshold for the scan
31	Thresholds Reserved	8 Bytes	N/A	N/A	
32	dBT Mask	INT	N/A		Thresholds used for total reflectivity data. Bits mask start from “SQI Threshold”, take is as LSB.
33	dBZ Mask	INT	N/A		Thresholds used for reflectivity data. Bits mask start from “SQI Threshold”, take is as LSB.
34	Velocity Mask	INT	N/A		Thresholds used for velocity data. Bits mask start from “SQI Threshold”, take is as LSB.
35	Spectrum Width Mask	INT	N/A		Thresholds used for reflectivity data. Bits mask start from “SQI Threshold”, take is as LSB.
36	ZDR Mask	INT	N/A		Thresholds used for ZDR data. Bits mask start from “SQI Threshold”, take is as LSB.
37	Mask Reserved	12 Bytes	N/A	N/A	Reserved for mask
38	Scan Sync	INT	N/A	N/A	Reserved
39	Direction	INT	N/A	1,2	Antenna rotate direction, 1= clockwise, 2=counter clockwise
40	Ground Clutter Classifier Type	SHORT	N/A		1 - All data is passed 2 - No data is passed

					3 – Use Real Time GC Classifier 4 – use bypass map
41	Ground Clutter Filter Type	SHORT	N/A		0- none 1 -Adaptive FFT 4 - IIR
42	Ground Clutter Filter Notch Width	SHORT	m/s	0.1-10	Scaled by 10
43	Ground Clutter Filter Window	SHORT	N/A		-1-none 0 - rect 1- Hamming 2- Blackman 3- Adaptive
44	Twins	Char	N/A	1-32	Number of similar cut configurations ,reserved.
45	Spare	71 Bytes	N/A	N/A	

Table 2-7 Moments Type/Bit Mask Definition

BIT	MOMENT	REMARKS
1(LSB)	dBT	Total Reflectivity, without clutter removed
2	dBZ	Reflectivity after clutter removed
3	V	Mean Radial Velocity
4	W	Spectrum Width
5	SQI	Signal Quality Index
6	CPA	Clutter Phase Alignment
7	ZDR	Differential Reflectivity
8	LDR	Liner Differential Ratio
9	CC	Cross Correlation Coefficient
10	ΦDP	Differential Phase
11	KDP	Specific Differential Phase
12	CP	Clutter Probability
13	FLAG	Flag of RVP data
14	HCL	Hydro Class
15	CF	Clutter Flag
16	SNR	Signal Noise Ratio
32	Zc	Corrected Reflectivity
33	Vc	Corrected Mean Radial Velocity
34	Wc	Corrected Spectrum Width
35	ZDRc	Corrected Differential Reflectivity
others	Spared	

Table 2-8 Filters Bit Mask Definition

BIT	FILTER	REMARKS
0(LSB)	Interference Filter	Pulse interference filter Algorithm
1	Censor Filter	WSR-88D Censor filter
2	1D Surveillance Speckle	1 dimension (along radial) speckle filter algorithm for reflectivity

3	1D Doppler Speckle	1 dimension (along radial) speckle filter algorithm for Doppler data
4	2D Surveillance Speckle	2 dimension (3*3 Azimuth and Radial) speckle filter algorithm for reflectivity
5	2D Doppler Speckle	2 dimension (3*3 Azimuth and Radial) speckle filter algorithm for Doppler data
6~31	Spare	

CHAPTER 3 Base Data Radial Data

3.1 Basedata Radial Header Block

Table 3-1 Basedata Radial Header Block

NO	FIELD NAME	TYPE /BYTES	UNIT	RANGE	REMARKS
01	Radial State	INT	N/A	0 to 6	0= Cut Start 1=Intermediate Data 2=Cut End 3=Volume Start 4=Volume End
02	Spot Blank	INT	N/A	0 to 1	0=Normal 1=Spot Blank
03	Sequence Number	INT	N/A	1to 65536	Sequence Number
04	Radial Number	INT	N/A	1 to 400	Radial Number for each cut
05	Elevation Number	INT	N/A	1 to 50	Elevation Number
06	Azimuth	FLOAT	degree	0 to 360	Azimuth Angle
07	Elevation	FLOAT	degree	-10 to 90	Elevation Angle
08	Seconds	INT	second	N/A	Radial data time in second
09	microseconds	INT	Microsecond	N/A	Radial data time in microsecond (expect seconds)
10	Length of data	INT	bytes	1-	Length of data in this radial, this header is excluded.
11	Moment Number	INT	N/A	1-64	Moments available in this radial
12	Reserved	20 Bytes	N/A	N/A	Reserved

3.2 Base Data Moment Header Block

Table 3-2 Basedata Moment Header Block

NO	FIELD NAME	TYPE /BYTES	UNIT	RANGE	REMARKS
01	Data Type	INT	N/A	1 to 64	Moment data type, See Table 2-7
02	Scale	INT	N/A	0.0 to	Data coding scale Code = value*scale+offset

				32768.0	
03	Offset	INT	N/A	0 to 32768	Data coding offset Code = value*scale+offset
04	Bin Length	SHORT	Bytes	1 to 2	Bytes to save each bin of data
05	Flags	SHORT	N/A		Bit Mask of flags for data. Reserved now.
06	Length	INT	bytes		Length of data of current moment, this header is excluded.
07	Reserved	12 Bytes			