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INTERFACE CONTROL DOCUMENT FOR THE SPG TO AWIPS CLASS 1 USER

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2620063

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Table of Contents

1 SCOPE

1.1 Identification

This document defines the interface connection between the TDWR Supplemental Product Generation Group (SPG) and a Class 1 User, or typically an AWIPS. SPG refers to the SPG equipment, 2830055, Pt 1 and Supplemental Product Generation Program CPCI-55, 2820086, Part 1.

1.2 System Overview

1.2.1 SPG

The SPG system is analogous to the RPG component of the WSR-88D system. However, the SPG receives base radar data from the FAA Terminal Doppler Weather Radar (also referred to herein as the TDWR). The TDWR SPG is used to gather weather information to be distributed to the National Weather Service (NWS), the Federal Aviation Administration (FAA), the Department of Defense (DOD), and the general public. The SPG is located at the NWS Weather Forecast Office and receives base data from the TDWR RDA through a wideband communication link. It is responsible for Base Data Ingest, Product Generation, Product Storage, Hydrometeorological Processing, Product Distribution, and Base Data Distribution.

1.2.2 Class 1 Users/AWIPS

The Class 1 user's systems may be located anywhere. They communicate with the SPG via LAN connection. These systems issue product requests to the SPG, receive the products from the SPG, and display the products to an operator.

1.3 Document Overview

This document defines the application layer interface between the SPG and Class 1 users/AWIPS. For this interface, this document identifies applicable standards and defines messages, product format and meaning of the packet codes. This ICD is not intended to serve as a document concerning the applicable standards. That is, the reader is assumed to be generally knowledgeable of the contents, terminology, etc., of the standards. Distribution of this document is unrestricted.

This document is organized in 3 sections and four appendices:
Section 1 provides information regarding the identification, scope, purpose and organization of this document.
Section 2 contains information about documentation relevant to this ICD, including applicable, and information documents.
Section 3 provides an overview of the application interface, operating procedures and message formats.

Appendix A contains a list of abbreviations, acronyms, and selected definitions.
Appendix B contains data transmission characteristics.
Appendix C contains product data compression using BZIP2.
Appendix D contains a description of the Generic Product Format.

2 REFERENCE DOCUMENTS

The SPG is a very proper subset of the NEXRAD Radar Product Generator (RPG) and is developed entirely using the RPG system infrastructure, applications layer interfaces, utilities and strictly implementing the RPG Interfaces with Class 1 and Class 2 users. Therefore, since the SPG to Class 1/AWIPS Interface is identical to the RPG to Class 1 User interface, this Interface Control Document (ICD) is largely a set of references to Interface Control Document for the RPG to Class 1 User, document 2620001K of the NEXRAD documentation suite.

2.1 Government Documents

2.1.1 Specifications

2830055, Pt 1	Prime Item Development Specification for SPG Equipment (B1, CI-55)
2810003	TDWR SPG System Specification
2820003B, Pt 1	Computer Program Development Specification for Supplemental Product Generation Program (SRS, CPCI-55)
2620070	Product Specification Interface Control Document
2620037	RPG X.25 Protocol Interface Control Document
2620041B	TCP/IP Interface Control Document
Source:	ROC Configuration Management 1313 Halley Circle Norman, Oklahoma 73069

2.2 Non-Government Documents

2.2.1 Industry Standards

Reference Number	**Title**
IEEE 754-1985	IEEE Standard for Binary Floating-Point Arithmetic
RFC 1832	XDR: External Data Representation Standard

3 APPLICATION LAYER

The SPG application layer interface provides Class 1 users or AWIPS with status messages and meteorological products.

3.1 SPG Message and Product Segmentation

SPG transport processing segments each application product larger than 10K bytes into 10K byte blocks of user data to be sent to the Network Layer. Therefore, the SPG application Message Header block is always required to correctly reassemble products larger than 10K bytes, regardless of the underlying network. [Note: 1K byte =1024 bytes].

3.2 Operating Procedures

Once the Class 1/AWIPS link is established and logically connected, application level message exchange may proceed. These messages consist of TDWR SPG system status messages transmitted to the user, requests for weather product data transmitted from the user to the SPG, and weather product data transmitted from the SPG to the Class 1 user/AWIPS. See RPG 2620037, or RPG TCP/IP, 2620041, for information on establishing the appropriate link.

3.2.1 Initial Messages

3.2.1.1 General Status Message

Upon connection, the first Product Data Level message transmitted by the SPG to a Class 1 user/AWIPS is the General Status Message. The General Status Message describes the state of the Radar Acquisition (RDA) data flow and the SPG. The SPG General Status Message contains no useful information on the equipment status of its RDA (TDWR) as no equipment status is transmitted from the TDWR. This data informs the Class 1 user/AWIPS about operational modes, the scan strategy and equipment status of the SPG, and communications status to the TDWR. Figure 3-17 provides a graphic representation of this message. Field identifiers are described (in halfword order) along with their respective units and range in this figure. As the state of the TDWR SPG system changes over the life of the communications session, the Class 1 user/AWIPS will be kept up to date by transmission of a new General Status Message.

3.2.2 Requesting Weather Products

Requesting Weather Product Data over a Class 1 user/AWIPS dedicated line is accomplished by the Class 1 user/AWIPS sending a Product Request Message as defined in Figure 3-4. It consists of one Message Header Block, followed by one or more Product Request Blocks. Any available product (except Free Text Message which may not appear on a routine product list) may be requested either on a one-time or routine basis.

3.2.2.1 Product Distribution and Availability

A Class 1 user/AWIPS may request any valid TDWR SPG product. These products may be requested for routine generation or as a one-time product request. All products may not be available to all users due to system degradation, system load shedding, or because of a hardware or software problem.

3.2.2.2 TDWR SPG Message Code Definitions

Table I shows the valid message codes for the TDWR SPG system. Note that product requests have a message code equal to the product code of the product being transmitted (16 to 299).

3.2.2.3 TDWR SPG Weather Product Code Definitions

Table III shows the valid product code for the TDWR SPG weather product to be transmitted to the user. Along with the product codes shown, the resolution, range, data level, and type of each product is shown.

3.2.2.4 Product Dependent Header Definitions

Table II shows the product dependent halfword definitions for the Product Request message (Figure 3-4). Table IV shows the fields that are product dependent for the Product Description Block in Figure 3-6. The products are shown in alphabetical order along with the corresponding message code, content of the product dependent parameter, the halfword location, units, range and accuracy.

3.2.2.5 Requesting One-Time Products

One-time product requests are requested one product per request message. The SPG will transmit the product as it becomes available, based on the parameters specified by the Product Request Block portion of the Product Request Message, and consider the request satisfied.

3.2.2.6 Requesting Routine Products

Routine product requests are requested as a list of products. This is up to a maximum of 31 for a Class 1 user, 50 for Class 99, and 160 for a Class 98 user. All AWIPS systems are classified as Class 98 although typically referred to as Class 1. There is no support for X.25 users, only TCP/IP via LAN connectivity. Routine product request lists have one Message Header Block with the "Number of Blocks" field set to the number-of-products-on-the-list + 1. The Message Header Block is then followed by a Product Request Block for each product on the routine product request list. The products on the routine list will then be sent automatically to the user, up to a maximum of once per volume scan, dependent upon the request parameters in the Product Request Block.

3.2.2.7 Request Response Message

If the SPG is unable to distribute a product to the user, or receives an invalid message, or request for an invalid product, the SPG will transmit a Request Response message as shown in Figure 3-18. This message describes the error condition, sequence number (if applicable) of the request that generated the response, and the product or message code of the message in question. All of the error conditions of this message nullify the product request for the reasons given in the message, with the exception of "Available Next Volume Scan" and "One-time Request Generation Process Faulted" errors, which inform the Class 1 user/AWIPS that the product will be sent in the next volume scan.

3.2.3 Alerting

WSR-88D RPG Alerting requirements are not required for the TDWR SPG.

3.2.4 External Data Message

External Data Messages are those importing meteorological or other scientific or mathematical information into the SPG from the Class 1 user/AWIPS. In all such messages, the message code will be set to 5 in the Message Header Block (Figure 3-2), though individual messages will vary in content and format. The specific type of external data message will be indicated by the setting of the Block ID in the body of the message block that follows. The format of the message is shown in Figure 3-23.

3.2.5 Bias Table Message

The Bias Table Message is not required for TDWR/SPG.

3.2.6 Other Messages

3.2.6.1 Product List Message

The Product List Message is not required for TDWR SPG.

3.2.6.2 Radar Coded Message

The Radar Coded Message (RCM) produced at a WSR-88D RPG, is not required of a TDWR SPG.

3.3 Message Description

3.3.1 Graphic Product Message

The SPG transmits products to the Class 1 User/AWIPS by using the Graphic Product message shown in Figure 3-6. The message consists of several blocks. Not all products require all blocks; however, the blocks are always transmitted in the order shown in Figure 3-6. One Header block and one Product Description block always precede the product. Products consist of one Product Symbology block (Block ID = 1), and zero or one of each of the Graphic Alphanumeric (Block ID = 2), and Tabular Alphanumeric blocks (Block ID = 3). The number of the last two blocks in each message used is product dependent.

3.3.1.1 Product Description Block

The Product Description block for product data transmission is shown in Figure 3-6 (sheets 2, 6, and 7). Many field identifiers in the Product Description block are product dependent and therefore change depending upon the product being transmitted. Refer to Table IV for the definitions of these fields and their corresponding products. The Products are listed by product name, in alphabetical order. As shown in Figure 3-6 (sheet 2), halfwords 55-60 contain offsets from the beginning of the message header (halfword 1) to the (-1) divider of each block indicated. If a product being transmitted does not require a block, or the data is not available, the offset to the block in question is set to zero. The first offset (halfword 55-56) is the offset to the Product Symbology block. The second offset (halfword 57-58) is the offset to the (-1) divider of the Graphic Alphanumeric block (Block ID = 2). The third offset is the offset to the Tabular Alphanumeric block (Block ID = 3).

Some products, by virtue of their size, require data compression. If a product is compressed, all product data following the Product Description block are compressed. Product dependent parameters defined within the Product Description block specify the compression method and size of the uncompressed product. The length of message in the Message Header block refers to the size of the compressed product. Refer to Table IV for Product Description block definitions for compressed products. Appendix D describes the data compression method.

3.3.1.2 Product Symbology Block

The Product Symbology block is block ID number 1 and is shown in Figure 3-6 (sheets 3 and 8). It is always numbered as 1. If it is available in a product, it will always follow the Product Description block. In general, this block contains display data packets that make up the geographic display of the product. These packets contain vectors, text and special character symbols, map data, radial data, raster data, precipitation data, vector arrow data, wind barb data, and special graphic symbols. The packet formats are defined in Figures 3-7 through 3-15c. The Symbology block may, depending upon the product, have multiple "layers" of packets. This is done in products that have both image type data, mixed with non-image type data. An example of this is a VAD Wind Profile product. It has wind profile graphics displayed as an image and alphanumeric data that is defined with text packets. The layers are started with the (-1) divider. The product dependent data identified in Table V is incorporated into the Product Symbology Block.

3.3.1.3 Graphic Alphanumeric Block

The Graphic Alphanumeric block is block ID number 2. It is the block in which display packets are defined to cause the storm related data to be displayed at the top of the geographic screen to amplify the corresponding graphic displayed symbology. The format of this block is shown graphically in Figure 3-6 (sheets 4 and 9). The only products for which this block is formatted are the following:

Product Code	Product Name
37-38	Composite Reflectivity
58	Storm Tracking Information
59	Hail Index
61	Tornado Vortex Signature
141	Mesocyclone Detection

The actual data within this block is a series of text packets that format the line data into 5 lines. The number of pages is data dependent. The text packet format used for the attributes is packet number 8 shown in Figure 3-8. Notice that I-start and J-start are defined as 1/4 km from the radar. The Graphic Attributes packets are not geographic, but are actual screen coordinates. Included in the text packet for each page of Attribute data is a series of vector packets to draw the grid lines. The vector packets used are shown in Figure 3-7. The product dependent data identified in Table VI is incorporated into the Graphic Alphanumeric Block.

3.3.1.4 Tabular Alphanumeric Block

The Tabular Alphanumeric block for product data transmission is Block ID number 3. The format of this block is shown graphically in Figure 3-6 (sheets 5 and 10). It is always numbered 3 even though it may not be the third block in the product. The following products have a paired-alphanumeric product that is encoded as Block 3 (Figure 3-6, sheet 7). The paired-alphanumeric product has a second Header and Product Description block as shown in the figure. The products that have Block ID 3 are as follows:

Product Code	Product Name	Block 3 Message Code
48	VAD Wind Profile	100
58	Storm Tracking Information	101
59	Hail Index	102
61	Tornado Vortex Signature	104
141	Mesocyclone Detection	141

The second header of the alphanumeric product is exactly the same as the header at the beginning of the message, except that the Message Code is as defined above. The Data portion of the alphanumeric product is ASCII text formatted into pages of 17 lines of 80-character data. Each page is separated by the (-1) divider. Alphanumeric products containing this block have it as the last block of the product message. The product dependent data identified in Table VII is incorporated into the Tabular Alphanumeric Block.

3.3.2 Stand-Alone Tabular Alphanumeric Product Message

Figure 3-16 defines the Stand-Alone Tabular Alphanumeric Product Message. This message is used for products that are completely alphanumeric, and are not paired as described in subsection 3.2.1.4. These products do not contain a symbology block. The Stand-Alone Tabular Alphanumeric Products are: Storm Structure (product 62), and Free Text Message (product 75). The format of the Product Description block is identical to that for the Graphic Product Message, except the first offset is to the (-1) divider shown in Figure 3-16. The product dependent data identified in Table VIII is incorporated into the Stand-Alone Tabular Alphanumeric Product Message.

3.3.3 Coordinate System

Three coordinate systems are supported for the expression of weather information:

Geographic Cartesian
Polar
Screen Cartesian

A Geographic Cartesian coordinate system with origin at the radar and positive directions of North (up), and East (right) are supported. The coordinate system has a range of ± 512 kilometers with 1/4-kilometer resolution. Specifically, I (right) and J (up) coordinates range from -2048 to +2048 with negative coordinates in two complement forms. Vectors are represented in this coordinate system.

A Polar coordinate system with origin at the radar and 0-degree radial North (up) is supported. The range coordinate covers from 0 to 460 kilometers with 1/4-kilometer resolution. The azimuth coordinate covers 0 to 360 degrees with 0.1-degree resolution. This resolution is necessary to achieve 0.1-degree resolution used system wide. Positive angles are clockwise. Specifically, theta coordinates range from 0 to 360 degrees. Images are represented in the Polar coordinate system. Each point in the display is represented by a display value.

A Screen Cartesian coordinate system with origin at the upper left corner and positive directions of X to the right and Y down are supported. The X coordinate ranges from 0 to 639 pixels and the Y-coordinate ranges from 0 to 511 pixels. X can be expressed in 10 bits and Y in 9 bits. The screen coordinate system is used to identify the location of text on the screen.

MSB	HALFWORD	LSB
MESSAGE	MESSAGE CODE	01
HEADER	DATE OF MESSAGE	02
BLOCK	TIME OF MESSAGE (MSW)	03
	TIME OF MESSAGE (LSW)	04
	LENGTH OF MESSAGE (MSW)	05
	LENGTH OF MESSAGE (LSW)	06
	SOURCE ID	07
	DESTINATION ID	08
	NUMBER OF BLOCKS	09

HALF WORD	FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
01	Message Code	INT*2	N/A	0 to +211	N/A	TDWR SPG Message Code defined in Table I
02	Date of Message	INT*2	Julian Date	1 to 32,767	1	Modified Julian Date at time of transmission (number of days since 1 January 1970, where 1=1 January 1970). To obtain actual Julian Date, add 2,440,586.5 to the modified date

03-04	Time of Message	INT*4	Seconds	0 to 86,399	1	Number of seconds after midnight, Greenwich Mean Time (GMT).
05-06	Length of Message	INT*4	N/A	18 to 502000	1	Number of bytes in message including header
07	Source ID	INT*2	N/A	3000 to 3045	1	Source (originators') ID of the sender
08	Destination ID	INT*2	N/A	0 to 999	1	Destination ID (receivers') for message transmission
09	Number Blocks	INT*2	N/A	1 to 160	1	Header Block plus the Product Description Blocks in message

Figure 3-3. Message Header

MSB	HALFWORD	LSB
	MESSAGE HEADER BLOCK (see Figure 3-3)	
PRODUCT	(-1) DIVIDER	10
REQUEST	LENGTH OF BLOCK	11
BLOCK	PRODUCT CODE	12
	FLAG BITS	13
	SEQUENCE NUMBER	14
	NUMBER OF PRODUCTS	15
	REQUEST INTERVAL	16
	VOLUME SCAN DATE	17
	VOL SCAN START TIME (MSW)	18
	VOL SCAN START TIME (LSW)	19
	PRODUCT DEPENDENT	20
	"	21
	"	22
	"	23
	"	24
	"	25

Figure 3-4. Product Request Message (Sheet 1)

HALF WORD	**FIELDNAME**	**TYPE**	**UNITS**	**RANGE**	**PRECISION/ ACCURACY**	**REMARKS**
10	Block Divider	INT*2	N/A	-1	N/A	Value of -1 used to delineate the Header from the Product Description Block(s)
11	Length of Block	INT*2	N/A	32	1	Number of bytes in block, including block divider, in the Product Description Block

12	Product Code	INT*2	N/A	16 to 131	N/A	Internal TDWR SPG product code corresponding to a weather product in Table I
13	Flag Bits	INT*2	N/A	0,1/bit	N/A	Bit # Value Meaning 0 1 High Priority 0 0 Low Priority 1 1 Reserved (Bit 0=MSB)
14	Sequence Number	INT*2	N/A	1 to 32,767	1	Monotonically increase for tracking of request
15	Number of Products	INT*2	N/A	-1, 1 to 9	1	-1 for continuous (RPS) product transmission. 1 to 9 for one-time requests, when Volume Scan Start Time of Product (halfwords 18, 19) is = -1 (equivalent to PUP Repeat Count). NOTE: For RPS requests, the number of products requested is determined from the Number of Blocks fields of the Message Header.
16	Request Interval	INT*2	N/A	1 to 9	1	If Volume Scan Start Time of Product is >=0 or -2, then Request Interval is 1. If Volume Scan Start Time of Product is = -1, then the range is 1 to 9 and corresponds to the interval of the number of scans to send the product, where: 1 = every volume scan 2 = every other volume scan . . . 9 = every ninth volume scan
17	Volume Scan Date of Product*	INT*2	Julian Date	-2,0 to 32,767	1	Modified Julian date at beginning of volume scan
18-19	Volume Scan Start Time of Product*	INT*4	Seconds	-2 to 86,399	1	Seconds after Midnight (Greenwich Mean Time)** or -1 requests current product -2 requests latest available product**
20-25	Product Dependent	INT*2	N/A	N/A	N/A	See Table II

Figure 3-4. Product Request Message (Sheet 2)
*Volume scan date is only applicable for one-time product request to that have a time in the range [0-86399]. If a volume scan date and time are specified, it corresponds to the volume scan start date and time that is searched for that product.

**For one-time product requests, if specifying the volume scan date and time or latest available and the product has elevation parameters then only the specific angle is allowed in the request. The feature described in Note 9 will result in a Request Response Message indicating Invalid Product Parameters.

Table I. TDWR SPG Message Code Definitions

MESSAGE CODE	**MESSAGE TYPE**	**FIGURE**
0,13	Product Request, Product Request Cancel	3-4
1	Spare	-
2	General Status	3-17
3	Request Response	3-18
4	Maximum Connection Time Disable Request	N/A
5	External Data Message	3-23
6	Spare	-
7	Reserved by RPG	-
8	Product List	3-21
9	Reserved by RPG	-
10	Spare	-
11	Sign-on Request Message (Class 2 WAN OTR	N/A
12	Users)	-
14	Spare	-
15	Spare	3-25
	Bias Table Message	
16 to 78	Products (See Table III for individual Product	
79 to 99	Codes)	
100 to 104	Reserved for WSR-88D Products	
105 to 111	Products (See Table III for individual Product	
112 to 131 132-134	Codes)	
135	Reserved for WSR-88D Products	
136 to 137	Products (See Table III for Individual Product	
138-140	Codes)	
	Reserved for future Product	
	Products (See Table III for Individual Product Codes)	
	Reserved for WSR-88D Products	
141-186	Products (See Table III for Individual Product Codes)	
188-299	Reserved for future Products	
Negative	Annotations have a negative message code equal in magnitude to that of the Product being annotated	

Table II. Product Dependent Halfword Definitions for Product Request Message

PRODUCT NAME	MSG CODE (s)	HALFWORD	CONTENT	UNITS	RANGE	ACCURACY/ PRECISION
Base Products	180, 182, 184, 186	•22	•Elevation Angle	•Degrees	•-1.0 to 60.0	•.1, Note 1, 9
Composite Reflectivity, Echo Tops, Vertically Integrated Liquid, Storm Tracking Information, Hail Index, Mesocyclone (MD), Digital Mesocyclone Detection (DMD)	37, 38, 41, 57, 58, 59, 61, 141, 149	•20	•Mini-volume number	•N/A	•1 or 2	•1
VAD	84	•22	•Altitude	•K Feet	•0 to 70	•1

Note 1. Scaled Integer.
Note 8. Minimum layer thickness is 1 K Feet
Note 9. Bits 0-12 (bit 0 is LSB) of halfword represents scaled elevation angle. For elevation angles > 0, the elevation angle is denoted degrees*10. For elevation angles > 0, the angle is denoted 3600 + degrees*10.

Bits 13-15 have special meaning. If bits 13-15 are not set, bits 0-12 denote elevation angle as described above. Bit 15 is reserved for future use and should never be set. If bit 14 is set (bits 15 and 13 not set) and bits 0-12 not set, then all elevation angles of the volume coverage pattern are requested. If bit 14 is set (bits 15 and 13 not set), bits 0-12 may be used to denote elevation angle as described above. In this case, all elevation angles of the volume coverage pattern matching the specified elevation angle are requested. If bit 13 is set (bits 15 and 14 not set), then all elevation angles at or below the angle specified by bits 0-12 are requested. If bit 13 and 14 are set (bit 15 is not set), then 0-12 specifies an elevation cut number. The lowest numbers of cuts (specified by the cut number) are requested.

If the elevation parameter specifies multiple requests, each request counts against the maximum product count specified for the requester. This check is only done when the request is first received at the SPG.

Table III. Message Codes for Products

CODE	NTR	PRODUCT NAME	RESOLUTION	RANGE	DATA LEVEL	MESSAGE FORMAT
186	1	Base Reflectivity	.16 x 1 Nmi x Deg	225	256	Radial Image
180	1	Base Reflectivity	.08 x 1 Nmi x Deg	48	256	Radial Image
181		Spare				
182	2	Base Velocity	.08 x 1 Nmi x Deg	48	256	Radial Image
184	3	Base Spectrum Width	.08 x 1 Nmi x Deg	48	256	Radial Image
16-30		Reserved by WSR-88D				
31		Reserved by WSR-88D				
33		Reserved by WSR-88D				
34		Reserved by WSR-88D				
37	6	Composite Reflectivity	.54 x .54 Nmi x Nmi	124 (note2)	16	Raster Image/Non-geographic Alpha

38	6	Composite Reflectivity	2.2 x 2.2 Nmi x Nmi	248 (note2)	16	Raster Image/Non-geographic Alpha
39		Spare				
40		Spare				
41	8	Echo Tops	2.2 x 2.2 Nmi x Nmi	124 (note 2)	16	Raster Image
42		Spare				
43		Reserved by WSR-88D				
44		Reserved by WSR-88D				
45		Reserved by WSR-88D				
46		Reserved by WSR-88D				
47		Reserved by WSR-88D				
48	12	VAD Wind Profile	5 Knots	N/A	5	Non-geographic Alphanumeric
49		Spare				
50		Reserved by WSR-88D				
51		Reserved by WSR-88D				
52		Spare				
53		Spare				
54		----------Reserved----------				
55		Reserved by WSR-88D				
56		Reserved by WSR-88D				
57	17	Vertically Integrated Liquid	2.2 x 2.2 Nmi x Nmi	124 (note 2)	16	Raster Image
58	18	Storm Tracking Information	N/A	48	N/A	Geographic and Non-geographic Alpha
59	19	Hail Index	N/A	48	N/A	Geographic and Non-geographic Alpha
60		Reserved by WSR-88D				
61	21	Tornado Vortex Signature	N/A	48	N/A	Geographic and Non-geographic Alphanumeric
62	22	Storm Structure	N/A	48	N/A	Alphanumeric
63		Reserved by WSR-88D				
64		Reserved by WSR-88D				
65		Reserved by WSR-88D				
66		Reserved by WSR-88D				
67		Reserved by WSR-88D				
68		Spare				
69		Spare				
70		Spare				
71		Spare				
72		Spare				
73		Reserved by WSR-88D				
74		Reserved by WSR-88D				

75	27	Free Text Message	N/A	N/A	N/A	Alphanumeric
76			----------Reserved for internal PUP use ----------			
78-82		Reserved by WSR-88D				
83		Spare				
84-90		Reserved by WSR-88D				
91-92		Reserved for internal PUP and RPG Use				
93		Reserved by WSR-88D				
94		Reserved by WSR-88D				
95		Reserved by WSR-88D				
96		Reserved by WSR-88D				
97		Reserved by WSR-88D				
98		Reserved by WSR-88D				
99		Reserved by WSR-88D				
100		Site Adaptable parameters for VAD Wind Profile (Product 48)				
101		Storm Track Alphanumeric Block				
102		Hail Index Alphanumeric Block				
103		Reserved by WSR-88D				
104		TVS Alphanumeric Block				
105		Reserved by WSR-88D				
106		Spare				
107-110		Reserved by WSR-88D				
111		Reserved by WSR-88D				
112-131		Reserved for Future Products				
132		Reserved by WSR-88D				
133		Reserved by WSR-88D				
134		Reserved by WSR-88D				
135		Reserved by WSR-88D				
136		Reserved by WSR-88D				
138		Reserved by WSR-88D				
139		Reserved by WSR-88D				
140		Reserved by WSR-88D				
141	20	Mesocyclone Detection	N/A	48	N/A	Geographic and Non-geographic Alpha
143		Reserved by WSR-88D				
144		Reserved by WSR-88D				
145		Reserved by WSR-88D				
146		Reserved by WSR-88D				
147		Reserved by WSR-88D				

149	20	Digital Mesocyclone Detection	N/A	48	N/A	Generic Data Format
150		Reserved by WSR-88D				
151		Reserved by WSR-88D				
152		Archive III Status Product				Generic Data Format
153-160		Reserved for Future Products				
161-170		Reserved for Future Products				
171-179		Reserved for Future Products				
188-200		Reserved for Future Products				
201-210		Reserved for Future Products				
211-220		Reserved for Future Products				
221-230		Reserved for Future Products				
231-240		Reserved for Future Products				
241-250		Reserved for Future Products				
251-260		Reserved for Future Products				
261-270		Reserved for Future Products				
271-280		Reserved for Future Products				
281-290		Reserved for Future Products				
291-296		Reserved for Internal RPG Use.				
297-299		Reserved for Internal RPG use				

Note: For all message codes for products: Units is N/A, Range is 0 to value shown and Accuracy/Precision is 1.1
Note 2: TDWR SPG raster image products which share product codes with NEXRAD, are formatted to the same maximum range as WSR-88D products. However, data bins beyond 48 Nmi range will never contain data values.

MSB HALFWORD LSB
MESSAGE HEADER BLOCK (see Figure 3-3)
PRODUCT DESCRIPTION

BLOCK (1) (see Sheet 2, 6, 7)
PRODUCT SYMBOLOGY BLOCK (1) (see Sheet 3, 8)
GRAPHIC ALPHANUMERIC BLOCK (1) (see Sheet 4, 9)
TABULAR ALPHANUMERIC BLOCK (1) (see Sheet 5, 10)

Note 1: All blocks need not be used. Any blocks that are used must remain in the order shown above.
Figure 3-6. Graphic Product Message (Sheet 1)

MSB	HALFWORD	LSB
PRODUCT 10	(-1) BLOCK DIVIDER	
DESCRIPTION 11	LATITUDE OF RADAR (MSW)	
BLOCK 12	LATITUDE OF RADAR (LSW)	
13	LONGITUDE OF RADAR (MSW)	
14	LONGITUDE OF RADAR (LSW)	
15	HEIGHT OF RADAR	
16	PRODUCT CODE	
17	OPERATIONAL MODE	
18	VOLUME COVERAGE PATTERN	
19	SEQUENCE NUMBER	
20	VOLUME SCAN NUMBER	
21	SCAN DATE	
22	SCAN TIME (MSW)	
23	SCAN TIME (LSW)	
24	PRODUCT GENERATION DATE	
25	PROD GENERATION TIME (MSW)	
26	PROD GENERATION TIME (LSW)	
27	PRODUCT DEPENDENT (P1)	(SEE TABLE IV)
28	PRODUCT DEPENDENT (P2)	(SEE TABLE IV)
29	ELEVATION NUMBER	
30	PRODUCT DEPENDENT (P3)	(SEE TABLE IV)
31	DATA LEVEL 1 THRESHOLD	(SEE NOTE, SHEET 11)
32	DATA LEVEL 2 THRESHOLD	
33	DATA LEVEL 3 THRESHOLD	
34	DATA LEVEL 4 THRESHOLD	
37	DATA LEVEL 7 THRESHOLD	

38	DATA LEVEL 8 THRESHOLD	
39	DATA LEVEL 9 THRESHOLD	
40	DATA LEVEL 10 THRESHOLD	
41	DATA LEVEL 11 THRESHOLD	
42	DATA LEVEL 12 THRESHOLD	
43	DATA LEVEL 13 THRESHOLD	
44	DATA LEVEL 14 THRESHOLD	(SEE NOTE, SHEET 11)
45	DATA LEVEL 15 THRESHOLD	
46	DATA LEVEL 16 THRESHOLD	
47	PRODUCT DEPENDENT (P4)	(SEE TABLE IV)
48	PRODUCT DEPENDENT (P5)	
49	PRODUCT DEPENDENT (P6)	
50	PRODUCT DEPENDENT (P7)	
51	PRODUCT DEPENDENT (P8)	
52	PRODUCT DEPENDENT (P9)	
53	PRODUCT DEPENDENT (P10)	
54	VERSION / SPOT BLANK	
55	OFFSET TO SYMBOLOGY (MSW)	
56	OFFSET TO SYMBOLOGY (LSW)	
57	OFFSET TO GRAPHIC (MSW)	
58	OFFSET TO GRAPHIC (LSW)	
59	OFFSET TO TABULAR (MSW)	
60	OFFSET TO TABULAR (LSW)	

Figure 3-6. Graphic Product Message (Sheet 2)

	MSB HALFWORD LSB	
PRODUCT	(-1) BLOCK DIVIDER	
SYMBOLOGY	BLOCK ID (1)	
BLOCK	LENGTH OF BLOCK (MSW)	
	LENGTH OF BLOCK (LSW)	
	NUMBER OF LAYERS	
	(-1) LAYER DIVIDER	
	LENGTH OF DATA LAYER (MSW)	
	LENGTH OF DATA LAYER (LSW)	
	DISPLAY DATA PACKETS	SEE FIGURES 3-7 THRU 3-14
	• • •	
	(-1) LAYER DIVIDER	
	LENGTH OF DATA LAYER (MSW)	
	LENGTH OF DATA LAYER (LSW)	

	DISPLAY DATA PACKETS	SEE FIGURES 3-7 THRU 3-14

Figure 3-6. Graphic Product Message (Sheet 3)

	MSB HALFWORD LSB
GRAPHIC	BLOCK DIVIDER (-1)
ALPHANUMERIC	BLOCK ID (2)
BLOCK	LENGTH OF BLOCK (MSW)
	LENGTH OF BLOCK (LSW)
	NUMBER OF PAGES
REPEAT FOR	PAGE NUMBER
EACH PAGE	LENGTH OF PAGE
	TEXT PACKET 1
	• • •
	TEXT PACKET N

Figure 3-6. Graphic Product Message (Sheet 4)

		MSB HALFWORD LSB	
	TABULAR	BLOCK DIVIDER (-1)	
	ALPHANUMERIC	BLOCK ID (3)	
	BLOCK	LENGTH OF BLOCK (MSW)	
		LENGTH OF BLOCK (LSW)	
		MESSAGE HEADER BLOCK (see Figure 3-3)	SECOND HEADER AND
		PRODUCT DESCRIPTION BLOCK	PRODUCT DESCRIPTION

		(see sheet 2)	BLOCK
		BLOCK DIVIDER (-1)	DATA FORMATTED
		NUMBER OF PAGES	AS ALPHANUMERIC
REPEAT	REPEAT	NUMBER OF CHARACTERS	PRODUCT MESSAGE
FOR EACH PAGE	FOR EACH LINE	CHARACTER DATA	
		END OF PAGE FLAG (-1)	

Figure 3-6. Graphic Product Message (Sheet 5)

HALF WORD	FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
10	Block Divider	INT*2	N/A	-1	N/A	Integer value of -1 used to delineate the header from the Product Description Block
11 - 12	Latitude of Radar	INT*4	Degrees	-90 to +90	0.001	North (+) or South (-) of the Equator
13 - 14	Longitude of Radar	INT*4	Degrees	-180 to +180	0.001	East (+) or West (-) of the Prime Meridian
15	Height of Radar	INT*2	Feet	-100 to +11000	1	Feet above mean sea level
16	Product Code	INT*2	N/A	16 to 299,	N/A	Internal TDWR SPG product code of weather product being transmitted (Refer to Table III)
17	Operational Mode	INT*2	N/A	0 to 2	N/A	2 = Precipitation/Severe Weather

18	Volume Coverage Pattern	INT*2	N/A	80 or 90	1	SPG volume coverage pattern for the scan strategy being used
19	Sequence Number	INT*2	N/A	-13, 0 to 32767	1	Sequence number of the request that generated the product (Refer to Figure 3-4). For products generated by an Alert Condition, sequence number = -13
20	Volume Scan Number	INT*2	N/A	1 to 80	1	Counter, recycles to one (1) every 80 volume scans
21	Scan Date (Note 4)	INT*2	Julian Date	1 to 32767	1	Modified Julian Date; integer number of days since 1 Jan 1970
22 - 23	Scan Time (Note 4)	INT*4	Seconds GMT	0 to 86399	1	Number of seconds after midnight, Greenwich Mean Time (GMT)
24	Generation Date of Product	INT*2	Julian Date	1 to 32767	1	Modified Julian Date as above
25 - 26	Generation Time of Product	INT*4	Seconds GMT	0 to 86399	1	Number of seconds after midnight, Greenwich Mean Time (GMT)
27 - 28	----------PRODUCT DEPENDENT AS PER TABLE IV----------					
29	Elevation Number	INT*2	N/A	0 to 22	1	Elevation number within volume scan for elevation based product 0 for volume-based products.
30 - 53	----------PRODUCT DEPENDENT AS PER TABLE IV----------(See Note 3)					
54	Version	INT*1	N/A	0 to 255	1	If the message is product data, the upper byte is the version number of the product. The

						original format of a product will be version 0. (Note 2)
54	Spot Blank	INT*1	N/A	0 to 1	1	If the message is product data, the lower byte is: 1 = Spot Blank ON 0 = Spot Blanking if OFF
55 - 56	Offset to Symbology	INT*4	Halfwords	0 to 400000	1	Number of halfwords from the top of message (message code field in header) to the -1 divider of each block listed. If the offset is zero (0), the block is not part of the product in question
57 - 58	Offset to Graphic	INT*4	Halfwords	0 to 400000	1	Same as above to Graphic Block (NOTE: For Product 62, this will point to the Cell Trend data)
59 - 60	Offset to Tabular	INT*4	Halfwords	0 to 400000	1	Same as above to Tabular Block

Figure 3-6. Graphic Product Message (Sheet 6)

Note 1. The Data Level threshold values used to define the color table of products, described in Table III, consist of up to 16 Data Levels. The exceptions to this are products 180, 182 and 186 that may have up to a maximum of 255 equally spaced data levels.

For product 180 and 186, data level codes 0 and 1 correspond to "Below Threshold" and "Missing", respectively. Data level codes 2 through 255 denote data values starting from the minimum data value in even data increments. The threshold level fields are used to describe the 256 levels for product 94 as follows:

halfword 31 contains the minimum data value in dBZ * 10
halfword 32 contains the increment in dBZ * 10.
halfword 33 contains the number of levels (0 - 255)

For product 182, data levels codes 0 and 1 correspond to "Below Threshold" and "Range Folded", respectively. Data levels 2 through 255 denote data values starting from the minimum data value in even data increments. The threshold levels are used to describe the 256 levels for product 182 as follows:

halfword 31 contains the minimum data value in m/s*10
halfword 32 contains the increment in m/s*10
halfword 33 contains the number of levels (0 - 255)

Except for Products 180, 182, and 186 the Data Level Threshold halfwords are coded as follows:
If bit 0 (most significant bit) is set to one (1), then the least significant byte (bits 8-- 15) is interpreted as a code for:

0 = "BLANK"
1 = TH
2 = ND
3 = RF

If bits 1, 2, 3, 4, 5, 6 or 7 of the most significant byte are set to 1, then they are interpreted as a code for:
Bit 1 - If set the data field in the least significant byte is scaled by 100, to allow two decimal places of accuracy in some of the Threshold tables.
Bit 2 - If set the data field in the least significant byte is scaled by 20, to allow two decimal places of accuracy in some of the Threshold tables.
Bit 3 - If set the data field in the least significant byte is scaled by 10, to allow for one decimal place of accuracy in some of the threshold tables.

Bit 4 = ">"
Bit 5 = "<"
Bit 6 = "+"
Bit 7 = "-"

If bit 0 (most significant bit) is zero (0), then the low-order byte (bits 8 - 15) is a numeric value.
Example: A data level value of (Hex) 8401, (bit sequence 1000 0100 0000 0001) is interpreted as: < TH

Note 2. Products with Version Numbers

PRODUCT NAME	PRODUCT CODE	VERSION	REMARKS
Composite Reflectivity	37,38	1	Version 1 was introduced in WSR-88D Build 9. The only change is to the combined attributes table. The legacy MESO column data was replaced with data from the Mesocyclone Detection Algorithm (MDA). The MDA data in the table is the strength rank of the closest (within 20 km) MDA feature to the SCIT storm cell, or the word "NONE."
STI	58	1	
Hail Index	59	1	
Tornado Vortex Signature	61	1	
Digital Mesocyclone Detection	149	1	
Mesocyclone Detection	141	1	

Note 3. For products which are compressed, halfword 51 (P8) denotes the compression method:

halfword 51 contains 0 if no compression is applied

halfword 51 contains 1 if the data are compressed using bzip2 (refer to Appendix D for details)
And halfwords 52 (P9) and 53 (P10) denote the size of the uncompressed product, in bytes, excluding the sizes of the Message Header block and Product Description blocks:

halfword 52 contains size of uncompressed product (MSW), in bytes
halfword 53 contains size of uncompressed product (LSW), in bytes

If the product size less the product header and product description block is less than 1000 bytes, halfword 51 contains 0.
Note 4. TDWR SPG Product date & time stamps vary within a volume scan so that repeated elevations and mini-volume scan times can be distinguished. The TDWR SPG product time stamp rule set results in: a) The time stamp of mini-volume scan products (e.g., STI, HI, MD, TVS, CR) and aloft elevation base products are the same and generated every 3 minutes, b) The time interval between surface elevation base product scans is 1 minute; c) the time interval between products generated just once each 6 minute volume scan is 6 minutes.
Figure 3-6. Graphic Product Message (Sheet 7)
PRODUCT SYMBOLOGY BLOCK

FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Block Divider	INT*2	N/A	-1	N/A	Integer value of -1 used to delineate the Product Description from the Product Symbology Block
Block ID	INT*2	N/A	1	N/A	Constant value of 1 which identifies this block
Length of Block	INT*4	Bytes	1 to 400000	1	Length of block in bytes (includes preceding divider and block id)
Number of Layers	INT*2	N/A	1 to 18	1	Number of data layers contained in this block (see Note 2)
Layer Divider	INT*2	N/A	-1	N/A	Integer value of -1 used to delineate one data layer from another
Length of Data Layer	INT*4	N/A	1 to 400000	1	Length of data layer (in bytes) not including layer divider and length field
Display Data Packets	N/A	N/A	N/A	N/A	See Figures 3-7 through 3-14

Note 2. The various layers are different types of data formats. An example would be the combined moment product. One layer is reflectivity data in radial packets, another layer contains the vector

arrow packets that define the velocity and spectrum width data. The length of the layer does not include the divider or the length word.

Figure 3-6. Graphic Product Message (Sheet 8)

GRAPHIC ALPHANUMERIC BLOCK

FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Block Divider	INT*2	N/A	-1	N/A	Integer value of -1 used to delineate the Graphic Alphanumeric Block
Block ID	INT*2	N/A	2	N/A	Constant value of 2 which identifies this block
Length of Block	INT*4	Bytes	1 to 65535	1	Length of block in bytes (includes preceding divider and block id) from the divider to the end of message
Number of Pages	INT*2	N/A	1 to 48	1	Total number of pages
Page Number	INT*2	N/A	1 to 48	1	Current page number
Length of Page	INT*2	Bytes	4 to 1360	1	Number of bytes in Text Packet 1 through Text Packet N
Text Packet (N)	N/A	N/A	N/A	N/A	The format of these text packets are Packet Code 8, shown in Figure 3-8b, and Packet Code 10, shown in Figure 3-8

Figure 3-6. Graphic Product Message (Sheet 9)

TABULAR ALPHANUMERIC BLOCK (see Note 3)

FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Block Divider	INT*2	N/A	-1	N/A	Integer value of -1 used to delineate the Tabular Alphanumeric Block
Block ID	INT*2	N/A	3	N/A	Constant value of 3 which identifies this block
Length of Block	INT*4	Bytes	1 to 65535	1	Length of block in bytes from the divider to the end of message

---------- SECOND MESSAGE HEADER BLOCK ----------					
---------- SECOND PRODUCT DESCRIPTION BLOCK ----------					
Block Divider	INT*2	N/A	-1	N/A	Integer value of -1 used to delineate the data from the Product Description Block
Number of Pages	INT*2	N/A	1 to 48	1	Total number of pages
Number of Characters	INT*2	N/A	0 to 80	1	Number of characters in a line
Character Data	CHAR	8 Bit ASCII	ASCII Character Set	N/A	Characters are ASCII when the MSB is set to zero. When the MSB is set to one, the remaining 7 bits define the special symbol
End of Page Flag	INT*2	N/A	-1	N/A	Integer value of -1 to delineate the end of page

Note 3. Tabular Alphanumeric Block must be the last block in a product message. Maximum lines per page = 17. Alphanumeric Products containing SPG Site Adaptable Parameters must have the Site Adaptable Parameters formatted as the last page(s) of the Product.
Figure 3-6. Graphic Product Message (Sheet 10)

Table IV. Product Dependent Halfword Definition for Product Description Block

PRODUCT NAME	**MSG CODE**	**HWORD#**	**CONTENT**	**UNITS**	**RANGE**	**ACCUR/PREC**
Archive III Status Product	152	51	Compression Method	N/A	0 or 1	1
Archive III Status Product	152	52	Uncompressed Product Data Size (MSW)	Bytes	120 to 500000	1
Archive III Status Product	152	53	Uncompressed Product Data Size (LSW)			1
Base Reflectivity Data Array	180,186	30	Elevation Angle	Degree	-1.0 to +45.0	.1
Base Reflectivity Data Array	180,186	47	Max Reflectivity	dBZ	-30 to +80, (-33)	1, Note 6
Base Reflectivity Data Array	180,186	51	Compression Method	N/A	0 or 1	1

Base Reflectivity Data Array	180,186	52	Uncompressed Product Data Size (MSW)	Bytes	120 to 188000	1
Base Reflectivity Data Array	180,186	53	Uncompressed Product Data Size (LSW)			1
Base Spectrum Width	184	30	Elevation Angle	Degree	-1.0 to +45.0	.1, Note 1
Base Spectrum Width	184	47	Max Spectrum Width	Knots	0 to 19	1
Base Velocity Data Array	182	30	Elevation Angle	Degree	-1.0 to +45.0	.1, Note 1
Base Velocity Data Array	182	47	Max Neg. Velocity	Knots	-247 to 0	1
Base Velocity Data Array	182	48	Max Pos. Velocity	Knots	0 to 245	1
Base Velocity Data Array	182	51	Compression Method	N/A	0 or 1	1
Base Velocity Data Array	182	52	Uncompressed Product Data Size (MSW)	Bytes	120 to 372000	1
Base Velocity Data Array	182	53	Uncompressed Product Data Size (LSW)			1
Composite Reflectivity	37 - 38	27	Mini-Volume No.	N/A	1 or 2	1
Composite Reflectivity	37 - 38	47	Max Reflectivity	dBZ	-32 to +95, (-33)	1, Note 6
Composite Reflectivity	37 - 38	51	Cal. Constant (MSB)			
Composite Reflectivity	37 - 38	52	Cal Constant (LSB)	dB (Real*4)	-50.0 to +50.0, Note 14 -198.0 to +198.0, Note 15	N/A, Note 2
Digital Mesocyclone Detection	149	27	Mini-Volume No.	N/A	1 or 2	1
Digital Mesocyclone Detection	149	47	Adaptation Data setting for Minimum Reflectivity Threshold	dBZ	-25 to 35	1
Digital Mesocyclone Detection	149	51	Compression Method	N/A	0 or 1	1

Digital Mesocyclone Detection	149	52	Uncompressed Product Data Size (MSW)	Bytes	120 to 300000	1
Digital Mesocyclone Detection	149	53	Uncompressed Product Data Size (LSW)			1
Echo Tops Product	41	47	Max Echo	1000 Feet	0 to 70	1, Note 5
Echo Tops Product	41	27	Mini-Volume No.	N/A	1 or 2	1
Free Text Message	75	47	SPG ID Number	N/A	0 to 999	1
Hail Index	59	27	Mini-Volume No.	N/A	1 or 2	1
Mesocyclone Detection	141	27	Mini-Volume No.	N/A	1 or 2	1
Mesocyclone Detection	141	28	Adaptation Data setting for Overlap Display Filter	N/A	0 or 1	0 = overlap filter OFF 1 = overlap filter ON
Mesocyclone Detection	141	30	Adaptation Data setting for Minimum Display Filter Strength Rank	N/A	1 to 5	1
Mesocyclone Detection	141	47	Adaptation Data setting for Minimum Reflectivity Threshold	dBZ	-25 to 35	1
Storm Structure	62	--	--	--		
Storm Track	58	27	Mini-Volume No.	N/A	1 or 2	1
Storm Track	58	47	Total Number of Storms	N/A	0 to 100	1
TVS	61	27	Mini-Volume No.	N/A	1 or 2	1
TVS	61	47	Total Number of TVS	N/A	-25 to 25	1, Note 5
TVS	61	48	Total Number of ETVS	N/A	-25 to 25	1, Note 5
VAD Wind Profile	48	47	Max Speed (Horiz)	Knots	0 to 350	1, Note 5
VAD Wind Profile	48	48	Direct of Max Speed	Degree	0 to 359	1, Note 1 & 5
VAD Wind Profile	48	49	Alt of Max Speed	Feet/10	00.00 to 70.00	.01, Note 5

Velocity Az. Display	84	47	Wind Speed (Horiz)	Knots	0 to 350	1, Note 5
Velocity Az. Display	84	48	Wind Direct (Horiz)	Degree	0 to 359	1, Note 1 & 5
Velocity Az. Display	84	30	Wind Alt (Horiz)	1000 Feet	0 to 70	1
Velocity Az. Display	84	49	Elevation Angle	Degree	-1.0 to +45.0	.1, Note 1 & 5
Velocity Az. Display	84	50	Slant Range	Nmi	0.0 to 124.0	.1, Note 1 & 5
Velocity Az. Display	84	51	RMS Error	Knots	0 to 29	1, Note 5
Vertically Integ. Liq	57	27	Mini-Volume No.	N/A	1 or 2	1
Vertically Integ. Liq	57	47	Max VIL	Kg/Sq. meter	0 to 200	1

Note 1. Scaled Integer, precision column defines scaling.
Note 2. Real*4 represents one fullword (32 bits) of real data, where the values are in IEEE-754-1985 floating point representation.

Note 5.	Msg Code	Halfword	Description
Echo Tops Product	41	47	Value of zero altitude indicates "No Echoes Detected
VAD Wind Profile	48	49	Altitude value of -9999 indicates ("Wind Barbs") non-valid altitude, speed and direction which are displayed as blanks
Velocity Azimuth	84	47	Wind speed value of -9999 Display indicates non-valid speed and direction. Speed and direction are displayed as blanks
		50	Slant range value of -9999 indicates non-valid slant range and elevation angle. Values of slant range and elevation angle are displayed as blanks
		51	RMS value of -9999 indicates non-valid RMS. Value of RMS is displayed as blanks.
TVS	61	47	A negative value indicates that the Total Number of TVSs identified by the algorithm exceeded the Maximum number of TVSs in adaptation data. Those with the higher Low-level Delta Velocity were retained.
TVS	61	48	A negative value indicates that the Total Number of ETVSs identified by the algorithm exceeded the Maximum number of ETVSs in adaptation data. Those with the higher Low-level Delta Velocity were retained.

Note 6. Value enclosed in parentheses of range column is a code to indicate data is unavailable.
Note 11. Velocity Precision Code indicates the quantization of the base velocity data used to create this product. A value of 1 denotes 0.5 m/s and 2 denotes 1.0 m/s. Regardless of the value of this code, product 93 is formatted as if the precision is always 0.5 m/s.

Table V. Product Dependent Definition for Product Symbology Block

PRODUCT NAME	CONTENT	UNITS	RANGE	ACCURACY / PRECISION	REMARKS
VAD WIND PROFILE	Altitude	Kft	1 to 70	1	
	Volume Scan Start Time	N/A	Hours: 00 to 23 Minutes: 00 to 59	1	
VELOCITY AZIMUTH DISPLAY	Velocity	Kts	+/-200, +/-100, +/-80, +/-60, +/-40	1	
	Azimuth	Degrees	1 to 360	1	
	Best Fit Function in the form A_1+ VSIN(AZ + δ) Where: A = Harmonic Coefficient (Fourier #1) V = SQRT[CF2²+CF3²} with CF2 and CF3 corresponding to Harmonic Coefficient (Fourier #2 & #3) & = - Horizontal Wind Direction - 90°	 Kts Kts Degrees	 -39 to 39 0 to +247 0 to 359	 1 1 1	

Table VI. Product Dependent Definition for Graphic Alphanumeric Block

PRODUCT NAME	CONTENT	UNITS	RANGE	ACCURACY/ PRECISION	REMARKS
COMPOSITE REFLECTIVITY	Storm Cell ID	Alphanumeric	A0 through Z0, then A1 through Z1, then A2...Z9.	N/A	Thes sequence is recycled following Note 1
	Storm Position: Azimuth •Range	•Degrees nmi	0 to 360 0 to 248	•1 •1	Note 1
	Maximum Reflectivity	dBZ	0 to 95	1	Note 1
	Height of Maximum Reflectivity	Kft	0.0 to 70.0	0.1	Note 1
	Cell-Based VIL	kg/m²	0 to 120	1	Note 1

	Storm Top	Kft	0.00 to 70.00	0.1	If the storm top was identified at the highest elevation, the value is qualified with ">", Note 1
	Forecast Movement •Storm Direction •Storm Speed	•Alphanumeric or Degrees Kts	•New or 0 to 360 0 to 999	• 1 1	Newly identified storm cells are labeled "NEW". Note 1
	MDA Strength Rank	Alphanumeric	NONE, 1 to 25	1	
	TVS Feature Type	Alphanumeric	NONE, TVS or ETVS	N/A	If both a TVS and ETVS are associated with the same storm cell, then "TVS" will be displayed. Note 1
	Hail Characteristics •Probability of Hail (POH) •Probability of Severe Hail (POSH) Maximum Expected Hail Size	Alphanumeric or Percent Percent Inches	UNKNOWN or 0 to 100 0 to 100 0.00 and 0.50 to 4.00	 10 10 0.25	If the maximum expected hail size exceeds 4.0 inches, the hail size is labeled ">4.00". If the Probability of Hail and the Probability of Severe Hail are greater the 0% and the maximum expected hail size is less than 0.50 inches, the hail size is labeled "<0.50". If the Hail Characteristics cannot be determined, the Hail Characteristics are labeled "UNKNOWN". Note 1
ECHO TOPS	Status	Alphanumeric	No Echoes Detected	N/A	This status message will be sent only if the

					Echo Tops Grid is all zeroes.
HAIL INDEX	Storm Cell ID	Alphanumeric	A0 through Z0, then A1 through Z1, then A2...Z9	N/A	The sequence is recycled following Z9, (See Note 1)
	Storm Position • Azimuth • Range	Degrees •Nmi	•0 to 360 •0 to 248	• 1 1	•Note 1
	Hail Characteristics: Probability of Hail (POH)	Alphanumeric or Percent	UNKNOWN or 0 to 100	10	If maximum expected hail size exceeds 4.0 inches, the hail size is labeled ">4.00".
	Probability of • Severe Hail (POSH)	Percent	0 to 100	10	If the Probability of Severe hail is greater than 0% and the maximum expected hail size is less than 0.50 inches, the hail size is labeled "<0.50".
	•Maximum Expected Hail Size	Inches	0.00 and 0.50 to 4.00	0.25	If the Hail Characteristics cannot be determined, the Hail Characteristics are labeled "UNKNOWN" Note 1
	Hail Temperature Altitudes (MSL) • 0 Degree Celsius	Kft	0.0 to 70.0	.1	Note 1
	• -20 Degree Celsius	Kft	0.0 to 70.0	.1	
	Time of last change to Hail Temperature Altitude	N/A	Hours: 00 to 23 Minutes: 00 to 59	N/A	Note 1
	Date of last change to Hail Temperature Altitudes	N/A	Months: 01 to 12 Days: 01 to 31 Years: 00 to 99	N/A	Note 1

STORM TRACKING INFORMATION	Storm Cell ID	Alphanumeric	A0 through Z0, then A1 through Z1, then A2....Z9	N/A	The sequence is recycled following Z9. Note 1
	Storm Position •Azimuth •Range	• Degrees nmi	• 0 to 360 0 to 248	• 1 1	•Note 1
	Forecast Movement •Direction •Speed	•Alphanumeric or Degrees Kts	•NEW or 0 to 360 0.0 to 999	• 1 0.1	Newly identified storm cells are labeled "NEW" Note 1
	Forecast Error •Error •Mean	• nmi nmi	• 0.0 to 99.9 0.0 to 99.9	• 0.1 0.1	•Note 1
	Maximum Reflectivity	dBZ	0 to 95	1	Note 1
	Height of Maximum Reflectivity	Kft	0.0 to 70.0	0.1	Note 1
MESOCYCLONE DETECTION	Circulation ID	N/A	0 through 999	N/A	The sequence is recycled following 999
	Associated SCIT Storm ID	N/A	A0 through Z0, then A1 through Z1, then A2...Z9	N/A	Closest SCIT identified storm cell ID.
	Strength Rank	N/A	1 to 25	1	If the strength rank was computed by the Low-Top or Shallow method, an L or S will also be displayed.
	Low Level (base) Rotational Velocity	Kts	0 to 129	1	
	Position: • Azimuth • Range	Degrees • nmi	•0 to 360 •0 to 48	•1	•Base 2D feature component
	Height of Maximum Rotational Velocity (ARL)	Kft	0 to 33	1	
	Maximum Rotational Velocity	Kts	0 to 129	1	
	Base Height (ARL)	Kft	0 to 33	1	If the Base is on the lowest elevation scan or

					below 1km, then the height is preceded by a "<" in the display.
	Depth	Kft	0 to 33	1	If the Base is on the lowest elevation scan or below 1km, then the Depth is preceded by a ">" in the display.
TORNADO VORTEX SIGNATURE (TVS)	Feature Type	Alphanumeric	TVS or ETVS	N/A	
	Storm Cell ID	Alphanumeric	A0 through Z0, then A1 through Z1. then A2...Z9. "??" is displayed if the TVS feature is not associated with a storm cell.	N/A	The sequence is recycled following Z9
	TVS Feature Position: •Azimuth •Range	• •Degrees nmi	•0 to 359 0 to 48	• 1 1	
	Average Delta Velocity	kts	0 to 494	1	
	Low-level Delta Velocity	kts	0 to 494	1	
	Maximum Delta Velocity	kts	0 to 494	1	
	Base	kft	0.0 to 70.0	0.01	If the Base is on the lowest elevation scan, then it is preceded by a "<" in the display.
	Depth	kft	0 to 70	1	If the base or top is on the lowest or highest elevation scan, then the Depth is preceded by a "<" or ">" in the display, respectively

Note 1: "^" displayed when the attribute(s) is (are) updated to the current detection

Table VII. Product Dependent Definition for Tabular Alphanumeric Block

PRODUCT NAME	**CONTENT**	**UNITS**	**RANGE**	**ACCURACY/ PRECISION**	**REMARKS**
VAD WIND PROFILE	Site Adaptable Parameters	See Remarks	See Remarks	See Remarks	2820003 Pt 1, Table A-16 VAD
	ALT	100 ft	0 to 700	1	
	U	m/s	-127.0 to 126.0	0.1	
	V	m/s	-127.0 to 126.0	0.1	
	W	cm/s	-999.9 to 9999.9	0.1	
	DIR	degrees	0 to 360	1	
	SPD	knots	0 to 999	1	
	RMS	knots	0 to 30.0	0.1	
	DIV	10/s	-99.9999 to 999.9999	0.0001	
	SRNG	nm	0.0 to 124.00	0.01	
	ELEV	degrees	-1.0 to 45.0	0.1	
STORM TRACKING INFORMATION	Radar ID	N/A	0 to 999	1	
	Volume Scan Start Date	N/A	Months: 1 to 12 Days: 1 to 31 Years: 0 to 99	N/A	
	Volume Scan Start Time	N/A	Hours: 0 to 23 Minutes: 0 to 59 Seconds: 0 to 59	N/A	
	Number of Storm Cells	N/A	0 to 100	1	
	Average Storm Cell Motion •Speed	• kts	• 0 to 99	• 1	•Only on first page of Alphanumeric Product
	• Direction	degrees	0 to 360	1	
	Storm Cell ID	Alphanumeric	A0 through Z0, then A1 through Z1, then A2....Z9	N/A	The sequence is recycled following Z9 Note 1
	Current Position: •Azimuth	• Degrees	• 0 to 360	• 1	• Note 1
	•Range	•nmi	•0 to 24	•1	•
	Forecast Movement •Direction	• Alphanumeric or Degrees	• 0 to 359	• 1	• Note 1
	• Speed	Kts	0 to 999	1	
	Forecast Error	nmi	0.0 to 99.0	0.1	Note 1
	Mean Forecast Error	nmi	0.0 to 99.0	0.1	Note 1

	The Azimuth and Range Position for each forecast interval up to four forecast intervals	Alphanumeric or Degree Nmi	NO DATA or 0 to 360 0 to 248	1	Note 1
	Site Storm Cell Tracking/Forecast Position Adaptable Parameters	See Remarks	See Remarks	See Remarks	2820003, Pt 1, Table A-6 Storm Cell Tracking
TORNADO VORTEX SIGNATURE (TVS)	Radar ID	N/A	0 to 999	1	
	Volume Scan Start Date	N/A	Months: 1 to 12 Days: 1 to 31 Years: 0 to 99	N/A	
	Volume Scan Start Time	N/A	Hours: 0 to 23 Minutes: 0 to 59 Seconds: 0 to 59	N/A	
	Number of TVSs	N/A	0 to 25	1	If the TDA identified more than the (adaptable) maximum number of TVSs, then the number will be preceded by a ">"
	Number of ETVSs	N/A	0 to 25	1	If the TDA identified more than the (adaptable) maximum number of ETVSs, then the number will be preceded by a ">"
	Feature Type	Alphanumeric	TVS or ETVS	N/A	
	Feature ID	N/A	01 through 25	0/1	TVSs and ETVSs are numbered independently
	Storm Cell ID	Alphanumeric	A0 through Z0, then A1 through Z1, then A2....Z9, or ??	N/A	The sequence is recycled following Z9. "??" is displayed if the TVS or ETVS is not associated with a storm cell
	Position: •Azimuth	• Degrees	• 0 to 359	• 1	•
	Range	Nmi	0 to 48	1	

	Average Delta Velocity	kts	0 to 494	1	
	Low-level Delta Velocity	kts	0 to 494	1	
	Maximum Delta Velocity	kts	0 to 494	1	
	Height of the Maximum Delta Velocity	kft	0.0 to 70.0	0.1	
	Depth	kft	0.0 to 70.0	0.1	If the base or top is on the lowest or highest elevation scan, respectively then the Depth is preceded by a ">" in the display
	Base	kft	0 to 70	1	If the base is on the lowest elevation scan, then it is preceded by a "<" in the display
	Top	kft	0.0 to 70.0	.1	
	Maximum Shear	m/s/km (or E-3/sec)	0 to 999	1	
	Height of the Maximum Shear	kft	0.0 to 70.0	0.1	
	Site Adaptable Parameters	See Remarks	See Remarks	See Remarks	2820003, Pt 1, Table A-18 TDA
HAIL INDEX	Radar ID	N/A	0 to 999	1	
	Volume Scan Start Date	N/A	Months: 1 to 12 Days: 1 to 31 Years: 0 to 99	N/A	
	Volume Scan Start Time	N/A	Hours: 0 to 23 Minutes: 0 to 59 Seconds: 0 to 59	N/A	
	Number of Storm Cells	N/A	0 to 100	1	
	Storm Cell ID	Alphanumeric	A0 through Z0, then A1 through Z1, then A2...Z9	N/A	The sequence is recycled following Z9 Note 1
	Hail Characteristics Probability of Hail (POH) •Probability of Severe Hail (POSH) Maximum Expected	Alphanumeric Percent Percent Inches	UNKNOWN or 0 to 100 0 to 100 0.00 and 0.50 to 4.00	N/A	If the maximum expected hail size exceeds 4.00 inches, the hail size is labeled ">4.00". If the Probability of Hail and the Probability of

	Hail Size				Severe Hail are greater than 0% and the maximum expected hail size is less than 0.50 inches, the hail is labeled "<50.0". If the Hail Characteristics cannot be determined, the Hail Characteristics are labeled "UNKNOWN". Note 1
	Site Adaptable Parameters	See Remarks	See Remarks	See Remarks	2820003, Pt 1, Table A-8 Hail
MESOCYCLONE DETECTION	Radar ID	N/A	0 to 999	1	
	Volume Scan Start Date	N/A	Months: 1 to 12 Days: 1 to 31 Years: 0 to 99	N/A	
	Volume Scan Start Time	N/A	Hours: 0 to 23 Minutes: 0 to 59 Seconds: 0 to 59	N/A	
	Average Motion: • Direction • Speed	Degrees • Kts	• 0 to 360 • 0 to 129	•1 •1	•Average of all MDA detected circulations regardless of whether they meet minimum display thresholds.
	Circulation ID	N/A	0 through 999	N/A	The sequence is recycled following 999
	Position: • Azimuth • Range	Degrees •nmi	•0 to 360 •0 to 48	•1 •1	• Base 2D feature component
	Strength Rank	N/A	1 to 25	1	If the strength rank was computed by the Low-Top or Shallow method, an L or S will also be displayed.
	Associated SCIT Storm ID	N/A	A0 through Z0, then A1 through Z1, then A2...Z9	N/A	Closest SCIT identified storm cell ID.

	Low Level (base) Rotational Velocity	Kts	0 to 129	1	
	Low Level (base) Gate-to-Gate Velocity Difference	Kts	0 to 129	1	
	Base Height (ARL)	Kft	0 to 33	1	If the Base is on the lowest elevation scan or below 1km, then the height is preceded by a "<" in the display.
	Depth	Kft	0 to 33	1	If the Base is on the lowest elevation scan or below 1km, then the Depth is preceded by a ">" in the display.
	Storm Relative Depth Percentage	Percent	0 to 100	1	Based on the average depth of the ten SCIT identified storm cells having the highest cell based VIL.
	Maximum Rotational Velocity	Kts	0 to 129	1	
	Height of Maximum Rotational Velocity (ARL)	Kft	0 to 33	1	
	TVS	N/A	Y or N	N/A	Y if a TVS is detected within 2 km of Position
	Motion	deg/kts	0 to 360 deg 0 to 99 kts	1 deg 1 kt	Motion of this MDA detection or blanks if detection not tracked.
	Mesocyclone Strength Index	N/A	0 to 99999	1	See MDA AEL.

Note 1: Tabular Alphanumeric Block will display an adaptable number of storm cells**.**
Note 3: "^" displayed when the attribute(s) is (are) updated to the current detection.

MSB	HALFWORD No Value	LSB
	PACKET CODE (=6)	
	LENGTH OF DATA BLOCK (BYTES)	
	I STARTING POINT	1/4 Km or

	J STARTING POINT	Screen Coordinates
DATA	END I VECTOR NUMBER 1	
BLOCK	END J VECTOR NUMBER 1	
	END I VECTOR NUMBER 2	
	END J VECTOR NUMBER 2	
	•	
	•	

Figure 3-7 Linked Vector Packet - Packet Code 6 (Sheet 1)

MSB	Uniform Value	LSB
	PACKET CODE (=9)	
	LENGTH OF DATA BLOCK (BYTES)	
	VALUE (LEVEL) OF VECTOR	
	I STARTING POINT	1/4 Km
	J STARTING POINT	Screen Coordinates
DATA	END I VECTOR NUMBER 1	
BLOCK	END J VECTOR NUMBER 1	
	END I VECTOR NUMBER 2	
	END J VECTOR NUMBER 2	
	•	
	•	

Figure 3-7 Linked Vector Packet - Packet Code 9 (Sheet 2)
No Value

FIELDNAME	**TYPE**	**UNITS**	**RANGE**	**PRECISION/ ACCURACY**	**REMARKS**
Packet Code	INT*2	N/A	6	N/A	Packet Type 6
Length of Block	INT*2	Bytes	1 to 32767	1	Number of bytes in block not including self or packet code
I Starting Point	INT*2	Km/4 or Pixels	-2048 to +2047	1	I coordinate for vector starting point
J Starting Point	INT*2	Km/4 or Pixels	-2048 to +2047	1	J coordinate for vector starting point
End I Vector Number 1	INT*2	Km/4 or Pixels	-2048 to +2047	1	I coordinate for vector end point 1
End J Vector Number 1	INT*2	Km/4 or Pixels	-2048 to +2047	1	J coordinate for vector end point 1
End I Vector Number 2	INT*2	Km/4 or Pixels	-2048 to +2047	1	I coordinate for vector end point 2
End J Vector Number 2	INT*2	Km/4 or Pixels	-2048 to +2047	1	J coordinate for vector end point 2

Uniform Value

FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Packet Code	INT*2	N/A	9	N/A	Packet Type 9
Length of Block	INT*2	Bytes	1 to 32767	1	Number of bytes in block not including self or packet code
Value (Level) of Vector	INT*2	N/A	0 to 15	1	Color Level of Vector
I Starting Point	INT*2	Km/4 or Pixels	-2048 to +2047	1	I coordinate for vector starting point
J Starting Point	INT*2	Km/4 or Pixels	-2048 to +2047	1	J coordinate for vector starting point
End I Vector Number 1	INT*2	Km/4 or Pixels	-2048 to +2047	1	I coordinate for vector end point 1
End J Vector Number 1	INT*2	Km/4 or Pixels	-2048 to +2047	1	J coordinate for vector end point 1
End I Vector Number 2	INT*2	Km/4 or Pixels	-2048 to +2047	1	I coordinate for vector end point 2
End J Vector Number 2	INT*2	Km/4 or Pixels	-2048 to +2047	1	J coordinate for vector end point 2

Figure 3-7. Linked Vector Packet - Packet Code 9 (Sheet 3)

MSB	HALFWORD No Value	LSB
	PACKET CODE (=7)	
	LENGTH OF DATA BLOCK (BYTES)	

	BEGINNING I	VECTOR 1	1/4 KM
	BEGINNING J	VECTOR 1	OR
DATA	END I	VECTOR 1	SCREEN COORDINATES
BLOCK	END J	VECTOR 1	
	BEGINNING I	VECTOR 2	
	BEGINNING J	VECTOR 2	
	END I	VECTOR 2	
	END J	VECTOR 2	
	•	•	

Figure 3-8. Unlinked Vector Packet - Packet Code 7 (Sheet 1)

MSB	Uniform Value	LSB
	PACKET CODE (=10)	
	LENGTH OF DATA BLOCK (BYTES)	
	VALUE (LEVEL) OF VECTORS	

	BEGINNING I	VECTOR 1	1/4 KM
	BEGINNING J	VECTOR 1	OR
DATA	END I	VECTOR 1	SCREEN COORDINATES
BLOCK	END J	VECTOR 1	
	BEGINNING I	VECTOR 2	
	BEGINNING J	VECTOR 2	
	END I	VECTOR 2	
	END J	VECTOR 2	
	•	•	

Figure 3-8. Unlinked Vector Packet - Packet Code 10 (Sheet 2)
No Value

FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Packet Code	INT*2	N/A	7	N/A	Packet Type 7
Length of Block	INT*2	Bytes	1 to 32767	1	Number of bytes in block not including self or packet code
Begin I Vector 1	INT*2	Km/4 or Pixels	-2048 to +2047	1	I coordinate for vector starting point 1
Begin J Vector 1	INT*2	Km/4 or Pixels	-2048 to +2047	1	J coordinate for vector starting point 1
End 1 Vector 1	INT*2	Km/4 or Pixels	-2048 to +2047	1	I coordinate for vector end point 1
End J Vector 1	INT*2	Km/4 or Pixels	-2048 to +2047	1	J coordinate for vector end point 1
Begin I Vector 2	INT*2	Km/4 or Pixels	-2048 to +2047	1	I coordinate for vector starting point 2

Begin J Vector 2	INT*2	Km/4 or Pixels	-2048 to +2047	1	J coordinate for vector starting point 2
End I Vector 2	INT*2	Km/4 or Pixels	-2048 to +2047	1	I coordinate for vector end point 2
End J Vector 2	INT*2	Km/4 or Pixels	-2048 to +2047	1	J coordinate for vector end point 2

Figure 3-8. Unlinked Vector Packet - Packet Code 7 (Sheet 3)
Uniform Value

FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Packet Code	INT*2	N/A	10	N/A	Packet Type 10
Length of Block	INT*2	Bytes	1 to 32767	1	Number of bytes in block not including self or packet code
Value (Level) of Vector	INT*2	N/A	0 to 15	1	Color Level of Vector
Begin I Vector 1	INT*2	Km/4 or Pixels	-2048 to +2047	1	I coordinate for vector starting point 1
Begin J Vector 1	INT*2	Km/4 or Pixels	-2048 to +2047	1	J coordinate for vector starting point 1
End 1 Vector 1	INT*2	Km/4 or Pixels	-2048 to +2047	1	I coordinate for vector end point 1
End J Vector 1	INT*2	Km/4 or Pixels	-2048 to +2047	1	J coordinate for vector end point 1
Begin I Vector 2	INT*2	Km/4 or Pixels	-2048 to +2047	1	I coordinate for vector starting point 2
Begin J Vector 2	INT*2	Km/4 or Pixels	-2048 to +2047	1	J coordinate for vector starting point 2
End I Vector 2	INT*2	Km/4 or Pixels	-2048 to +2047	1	I coordinate for vector end point 2
End J Vector 2	INT*2	Km/4 or Pixels	-2048 to +2047	1	J coordinate for vector end point 2

Figure 3-8. Unlinked Vector Packet - Packet Code 10 (Sheet 4)

MSB	HALFWORD Write Text (No Value)	LSB
	PACKET CODE (=1)	
	LENGTH OF DATA BLOCK (BYTES)	
	I STARTING POINT	1/4 KM

DATA	J STARTING POINT	Screen Coordinates
BLOCK	CHARACTER 1	CHARACTER 2
	CHARACTER 3	CHARACTER 4
	•	•
	•	•
	CHARACTER N-1	CHARACTER N

Figure 3-8b. Text and Special Symbol Packets - Packet Code 1 (Sheet 1)

	MSB	HALFWORD Write Text (Uniform Value)	LSB	
	PACKET CODE (=8)			
	LENGTH OF DATA BLOCK (BYTES)			
	VALUE OF TEXT STRING			
	I START	1/4 KM		
DATA	J START	Screen Coordinates		
BLOCK	CHARACTER 1	CHARACTER 2		
	CHARACTER 3	CHARACTER 4		
	•	•		
	•	•		
	CHARACTER N-1	CHARACTER N		

Figure 3-8b. Text and Special Symbol Packets - Packet Code 8 (Sheet 2)

	MSB	HALFWORD Write Special Symbols (No Value)	LSB	
	PACKET CODE (=2)			
	LENGTH OF DATA BLOCK (BYTES)			

	I STARTING POINT	1/4 KM
DATA	J STARTING POINT	Screen Coordinates
BLOCK	CHARACTER 1	CHARACTER 2
	CHARACTER 3	CHARACTER 4
	•	•
	•	•
	CHARACTER N-1	CHARACTER N

Figure 3-8b. Text and Special Symbol Packets - Packet Code 2 (Sheet 3)

Write Text (No Value)

FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Packet Code	INT*2	N/A	1	N/A	Packet Type 1
Length of Block	INT*2	Bytes	1 to 32767	1	Number of bytes in block not including self or packet code
I Starting Point	INT*2	Km/4 or Pixels	-2408 to +2047	1	I coordinate for text starting point
J Starting Point	INT*2	Km/4 or Pixels	-2048 to +2047	1	J coordinate for text starting point
Character 1 to N	Char	8 bit ASCII	ASCII Character Set	N/A	Characters are ASCII

Write Text (Uniform Value)

FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Packet Code	INT*2	N/A	8	N/A	Packet Type 8
Length of Block	INT*2	Bytes	1 to 32767	1	Number of bytes in block not including self or packet code
Value (Level) of Text	INT*2	N/A	0 to 15	1	Color Level of text
I Starting Point	INT*2	Km/4 or Pixels	-2048 to +2047	1	I coordinate for text starting point
J Starting Point	INT*2	Km/4 or Pixels	-2048 to +2047	1	J coordinate for text starting point
Character 1 to N	Char	8 bit ASCII	ASCII Character Set	N/A	Characters are ASCII

Figure 3-8b. Text and Special Symbol Packets - Packet Code 1 (Sheet 4)

Write Special Symbols (No Value)

FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Packet Code	INT*2	N/A	2	N/A	Packet Type 2
Length of Block	INT*2	Bytes	1 to 32767	1	Number of bytes in block not including self or packet code
I Starting Point	INT*2	Km/4 or Pixels	-2048 to +2047	1	I coordinate for special symbol starting point (Note 1)
J Starting Point	INT*2	Km/4 or Pixels	-2048 to +2047	1	J coordinate for special symbol starting point (Note 1)
Character 1 to N	Char	8 bit ASCII	ASCII Character Set	N/A	Characters are ASCII

Note 1: I, J for special symbols are at the center of the symbol and at the upper left corner of the symbol for text.
Note 2: The special symbol characters in use are: !(21), "(22), #(23), $(24), %(25) to report past storm cell position, current storm cell position, forecast storm cell position, past MDA position, and forecast MDA position, respectively. Where, the number in parenthesis is the 8-bit hexadecimal value for the ASCII character. The appearance of the special symbols (e.g., filled circles, plus marks, X within a circle) is described in the Product Specification ICD (2620003), sections 18.3.2 and 20.3.2.

Figure 3-8b. Text and Special Symbol Packets - Packet Code 2 (Sheet 5)

	MSB		HALFWORD		LSB	
	A	F	1	F		PACKET CODE
		INDEX OF FIRST RANGE BIN				
		NUMBER OF RANGE BINS				
		I CENTER OF SWEEP				
		J CENTER OF SWEEP				
		SCALE FACTOR (230 / # OF RANGE BINS)				
		NUMBER OF RADIALS				
			NUMBER OF RLE HALFWORDS IN RADIAL			
REPEAT FOR		RADIAL START ANGLE				
EACH RADIAL		RADIAL ANGLE DELTA				
	RUN (0)		COLOR CODE (0)	RUN (1)		COLOR CODE (1)
	RUN (2)		COLOR CODE (2)	RUN (3)		COLOR CODE (3)
		• • •				
		• • •				
	RUN (N)	COLOR CODE (N)	0000	0000		

Figure 3-10. Radial Data Packet (16 Data Levels) - Packet Code AF1F (Sheet 1)
Sectors or "Windows" Products will use this format with sufficient data to fill the requested area.

FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Packet Code	INT*2	N/A	AF1F (Hex)	N/A	Packet Type X'AF1F'
Index of First Range Bin	INT*2	N/A	0 to 460	1	Location of first range bin
Number of Range Bins	INT*2	N/A	1 to 460	1	Number of range bins comprising a radial
I Center of Sweep	INT*2	Km/4	-2048 to +2047	1	I coordinate of center of sweep
J Center of Sweep	INT*2	Km/4	-2048 to +2047	1	J coordinate of center of sweep
Scale Factor	Scaled Integer	Pixels	.001 to 8.000	.001	Number of pixels per range bin
Number of Radials	INT*2	N/A	1 to 400	1	Total number of radials in products
Number of RLE Halfwords in Radial	INT*2	Halfword	1 to 230	1	Number of RLE (Run Length Encoded) 16-bit halfwords per radial
Radial Start Angle	Scaled Integer	Degrees	0.0 to 359.9	.1	Starting angle at which radial data was collected; Scan is always in Clockwise direction
Radial Angle Delta	Scaled Integer	Degrees	0.0 to 2.0	.1	Radial angle data
Run(0)	4 Bit INT	N/A	0 to 15	1	4-bit run code
Color Code(0)	4 Bit INT	N/A	0 to 15	1	4-bit color level

Figure 3-10. Radial Data Packet (16 Data Levels) - Packet Code AF1F (Sheet 2)

	MSB	HALFWORD	LSB	
B	A	0	F or 7	PACKET CODE
8	0	0	0	/ OP FLAGS
0	0	C	0	
I COORDINATE START				
J COORDINATE START				
X SCALE INT				
X SCALE FRACTIONAL				
Y SCALE INT				
Y SCALE FRACTIONAL				
NUMBER OF ROWS				
PACKING DESCRIPTOR				
NUMBER OF BYTES IN THIS ROW				

REPEAT FOR	RUN (0)	COLOR CODE (0)	RUN (1)	COLOR CODE (1)	
EACH ROW	RUN (2)	COLOR CODE (2)	RUN (3)	COLOR CODE (3)	
		• • •			
		• • •			
	RUN (N)	COLOR CODE (N)	0000	0000	

Figure 3-11. Raster Data Packet - Packet Codes BA0F and BA07 (Sheet 1)

FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Packet Code	INT*2	N/A	BA0F (Hex) or BA07 (Hex)	N/A	Packet Type X 'BA0F" or X'BA07'
Packet Code	INT*2	N/A	8000 (Hex)	N/A	Packet Type X'8000'
Packet Code	INT*2	N/A	00C0 (Hex)	N/A	Packet Type X'00C0'
I Coordinate Start	INT*2	Km/4	-2048 to +2047	1	Starting location of data
J Coordinate Start	INT*2	Km/4	-2048 to +2047	1	Starting location of data
X Scale INT	INT*2	N/A	1 to 67	1	Scaling factor for grid
X Scale Fractional	N/A	N/A	N/A	N/A	Reserved for internal PUP use
Y Scale INT	INT*2	N/A	1 to 67	1	Scaling factor for grid
Y Scale Fractional	N/A	N/A	N/A	N/A	Reserved for internal PUP use
Number of Rows	INT*2	N/A	1 to 464	1	Number of rows in layer
Packing Descriptor	INT*2	N/A	2	N/A	Defines packing format 2
Number of Bytes in this Row	INT*2	Bytes	2 to 920	1	Number of bytes in this row not including self
Run(0)	4 Bit INT	N/A	0 to 15	1	4-bit run code
Color Code(0)	4 Bit INT	N/A	0 to 15	1	4-bit color level

Figure 3-11. Raster Data Packet - Packet Codes BA0F and BA07 (Sheet 2)

	MSB	HALFWORD	LSB	
		PACKET CODE (=17)		
	SPARE			
	SPARE			
	NUMBER OF LFM BOXES IN ROW			
	NUMBER OF ROWS			
REPEAT FOR		NUMBER OF BYTES IN ROW		
EACH ROW	RUN (0)		LEVEL (01)	
	RUN (1)		LEVEL (1)	

	• • •	• • •
	RUN (N)	LEVEL (N)

Figure 3-11a. Digital Precipitation Data Array Packet - Packet Code 17 (Sheet 1)

FIELDNAME	**TYPE**	**UNITS**	**RANGE**	**PRECISION/ ACCURACY**	**REMARKS**
Packet Code	INT*2	N/A	17	N/A	Packet Type 17
Spares	N/A	N/A	N/A	N/A	
Number of LFM Boxes in Row	INT*2	N/A	131	1	Number of boxes in each row
Number of Rows	INT*2	N/A	131	1	Total number of rows
Number of Bytes in Row	INT*2	N/A	2 to 262	1	Number of bytes in this row
Run(0)	1 Byte	N/A	0 to 255	1	8-bit run code
Level(0)	1 Byte	N/A	0 to 255	1	8-bit data level code. See Note 1 of Figure 3-6

Figure 3-11a. Digital Precipitation Data Array Packet - Packet Code 17 (Sheet 2)

	MSB	HALFWORD	LSB	
		PACKET CODE (=18)		
		SPARE		
		SPARE		
		NUMBER OF LFM BOXES IN ROW		
		NUMBER OF ROWS		
REPEAT FOR		NUMBER OF BYTES IN ROW		
EACH ROW	RUN (0)	LEVEL (0)	RUN (1)	LEVEL (1)
	RUN (2)	LEVEL (2)	RUN (3)	LEVEL (3)
		• • •		
		• • •		
	RUN (N)	LEVEL (N)	0000	0000

Figure 3-11b. Precipitation Rate Data Array Packet - Packet Code 18 (Sheet 1)

FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Packet Code	INT*2	N/A	18	N/A	Packet Type 18
Spares	N/A	N/A	N/A	N/A	
Number of LFM Boxes in Row	INT*2	N/A	13	1	Number of boxes in each row

Number of Rows	INT*2	N/A	13	1	Total number of rows
Number of Byes in Row	INT*2	N/A	2 to 14	1	Number of bytes in this row
Run(0)	4-Bit INT	N/A	0 to 15	1	4-bit run code
Level(0)	4-Bit INT	N/A	0 to 15	1	4-bit data level code

Figure 3-11b. Precipitation Rate Data Array Packet - Packet Code 18 (Sheet 2)

	MSB	HALFWORD	LSB	
		PACKET CODE (=16)		
		INDEX OF FIRST RANGE BIN		
		NUMBER OF RANGE BINS		
		I CENTER OF SWEEP		
		J CENTER OF SWEEP		
		RANGE SCALE FACTOR		
		NUMBER OF RADIALS		
		NUMBER OF BYTES IN RADIAL		
		RADIAL START ANGLE		
REPEAT		RADIAL DELTA ANGLE		
FOR		LEVEL (0)		LEVEL (1)
EACH		LEVEL (2)		LEVEL (3)
RADIAL		•		•
		•		•
		LEVEL (N-1)		LEVEL (N)

Figure 3-11c. Digital Radial Data Array Packet - Packet Code 16 (Sheet 1)

FIELDNAME	**TYPE**	**UNITS**	**RANGE**	**PRECISION/ ACCURACY**	**REMARKS**
Packet Code	INT*2	N/A	16	N/A	Packet Type 16
Index of First Range Bin	INT*2	N/A	0 to 230	1	Location of first range bin
Number of Range Bins	INT*2	N/A	0 to 920	1	Number of range bins comprising a radial
I Center of Sweep	INT*2	Km/4	-2048 to +2047	1	I coordinate of center of sweep
J Center of Sweep	INT*2	Km/4	-2048 to +2047	1	J coordinate of center of sweep
Range Scale Factor	Scaled Integer	N/A	.001 to 1.000	.001	Cosine of elevation angle for elevation based products. For volume based products the value 1.00.

Number of Radials	INT*2	N/A	1 to 400	1	Total number of radials in product (Note 1)
Number of Bytes in Radial	INT*2	N/A	1 to 920	1	Number of bytes of 8-bit data level values per radial
Radial Start Angle	Scaled Integer	Degrees	0.0 to 359.9	.1	Starting angle at which radial data was collected; Scan is always clockwise
Radial Delta Angle	Scaled Integer	Degrees	0.0 to 2.0	.1	Delta angle from previous radial
Level (0)	1 Byte	N/A	0 to 255	1	8-bit data level code. (See Note 1 of Figure 3-6)

Note 1: The SPG clips radials to 70 kft. This could result in an odd number of bins in radial. However, the radial will always be on a halfword boundary, so the number of bytes in a radial may be number of bins in a radial + 1.

Figure 3-11c. Digital Radial Data Array Packet - Packet Code 16 (Sheet 2)

	MSB	HALFWORD	LSB	
			PACKET CODE (=4)	
			LENGTH OF DATA BLOCK (BYTES)	
		REPEAT	VALUE	
DATA		FOR	X COORDINATE	
BLOCK		EACH	Y COORDINATE	
		BARB	DIRECTION OF WIND	
			WIND SPEED	
			• • •	

FIELDNAME	**TYPE**	**UNITS**	**RANGE**	**PRECISION/ ACCURACY**	**REMARKS**
Packet Code	INT*2	N/A	4	N/A	Packet Type 4
Length of Block	INT*2	Bytes	1 to 32767	1	Number of bytes in block not including self or packet code
Value	INT*2	N/A	1 to 5	1	Color level of wind barb (reflects the RMS value associated with the computed velocity)
X Coordinate	INT*2	Km/4 or Pixels	-2048 to +2047	1	Coordinate where the value starts
Y Coordinate	INT*2	Km/4 or Pixels	-2048 to +2047	1	Coordinate where the value starts
Direction of Wind	INT*2	Degrees	0 to 359	1	Points into wind

Wind Speed	INT*2	Knots	0 to 195	1	Magnitude of wind

Figure 3-13. Wind Barb Data Packet - Packet Code 4

	MSB	HALFWORD	LSB
		PACKET CODE (=3 or 11)	
MESOCYCLONE		LENGTH OF BLOCK (BYTES)	
REPEAT FOR		I POSITION	
EACH SYMBOL		J POSITION	
		RADIUS OF MESOCYCLONE	

	MSB	HALFWORD	LSB
		PACKET CODE (=12 or 26)	
TVS or ETVS		LENGTH OF BLOCK (BYTES)	
REPEAT FOR		I POSITION	
EACH SYMBOL		J POSITION	

	MSB	HALFWORD	LSB
		PACKET CODE (=13)	
HAIL POSITIVE (FILLED)		LENGTH OF BLOCK (BYTES)	
REPEAT FOR		I POSITION	
EACH SYMBOL		J POSITION	

	MSB	HALFWORD	LSB
		PACKET CODE (=14)	
HAIL PROBABLE		LENGTH OF BLOCK (BYTES)	
REPEAT FOR		I POSITION	
EACH SYMBOL		J POSITION	

Figure 3-14. Special Graphic Symbol Packet - Packet Code 3 or 11, 12 or 26, 13 and 14 (Sheet 1)

	MSB	HALFWORD	LSB
		PACKET CODE (=15)	
STORM ID		LENGTH OF BLOCK (BYTES)	
REPEAT FOR		I POSITION	
EACH SYMBOL		J POSITION	
	CHARACTER 1	CHARACTER 2	

	MSB	HALFWORD	LSB
		PACKET CODE (=19)	
HDA HAIL		LENGTH OF BLOCK (BYTES)	
REPEAT FOR		I POSITION	
EACH SYMBOL		J POSITION	
		PROB. OF HAIL	
		PROB. OF SEVERE HAIL	
		MAX HAIL SIZE	

	MSB	HALFWORD	LSB
SCIT PAST/		PACKET CODE (=23 or 24)	

FORECAST DATA	LENGTH OF BLOCK (BYTES)
	DISPLAY DATA PACKETS
	• •

	MSB	HALFWORD	LSB
		PACKET CODE (=25)	
STI CIRCLE		LENGTH OF BLOCK (6 BYTES)	
		I POSITION	
		J POSITION	
		RADIUS OF CIRCLE	

Figure 3-14. Special Graphic Symbol Packet - Packet Codes 15, 19, 23, 24 and 25 (Sheet 2)

FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Packet Code	INT*2	N/A	3, 12 to 15, 19, 23 to 26	N/A	Packet Type (Note 1)
Length of Block	INT*2	Bytes	1 to 32767	1	Number of bytes in block not including self or packet code
I Position	INT*2	Km/4	-2048 to +2047	1	I starting coordinate
J Position	INT*2	Km/4	-2048 to +2047	1	J starting coordinate
Radius of Mesocyclone	INT*2	Km/4	-2048 to +2047	1	A radius of 0 indicates that no mesocyclone is present and I, J coordinates are set to 0,0.
Character 1	Char	8-bit ASCII	A to Z	N/A	First character of Storm ID
Character 2	Char	8-bit ASCII	0 to 9	N/A	Second character of Storm ID
Probability of Hail	INT*2	N/A	0 to 100, -999	10	Probability in Percent (Note 2)
Probability of Severe Hail	INT*2	N/A	0 to 100, -999	10	Probability in Percent (Note 2)
Max Hail Size	INT*2	Inches	0 to 4	1	Maximum expected hail size
Display Data Packet	INT*2	N/A	N/A	N/A	Past or forecast position data for a Single storm cell. Consists of packet code 2, (Figure 3-8b), packet code 6*(Figure 3-7) or packet code 25 (Figure 3-14)

Radius of STI Circle	INT*2	Pixels	1 to 512	1	Radius of circle

Note 1. Packet code 23 for past position data, packet code 24 for forecast position data, and packet code 25 for current position. Packet code 12 is for TVS position data and packet code 26 is for ETVS position data.
Note 2.A value of -999 indicates that these cells are beyond the maximum range for algorithm processing.
Figure 3-14. Special Graphic Symbol Packet - Packet Codes 3, 12, 13, 14, 15, 19, 23, 24, 25 and 26 (Sheet 3)

	MSB	HALFWORD	LSB
		PACKET CODE (=20)	
		LENGTH OF BLOCK (BYTES)	
REPEAT FOR		I POSITION	
EACH SYMBOL		J POSITION	
		POINT FEATURE TYPE	
		POINT FEATURE ATTRIBUTE	

FIELDNAME	**TYPE**	**UNITS**	**RANGE**	**PRECISION/ ACCURACY**	**REMARKS**
Packet Code	INT*2	N/A	20	N/A	Packet Type (Note 1)
Length of Block	INT*2	Bytes	8 to 32760	1	Number of bytes in block not including self or packet code
I Position	INT*2	Km/4	-2048 to +2047	1	I starting coordinate
J Position	INT*2	Km/4	-2048 to +2047	1	J starting coordinate
Point Feature Type	INT*2	N/A	1 to 4, 5 to 8, 9-11	1	1 = reserved 2 = reserved 3 = reserved 4 = reserved 5 = TVS (extrapolated) 6 = ETVS (extrapolated) 7 = reserved 8 = reserved 9 = MDA Circulation with Strength Rank >= 5 AND with a Base Height <= 1 km ARL or with its Base on the lowest elevation angle. 10 = MDA Circulation with Strength Rank >= 5 AND with a Base Height > 1 km ARL

					AND that Base is not on the lowest elevation angle. 11 = MDA Circulation with Strength Rank < 5
Point Feature Attribute	INT*2	Type dependent, see remarks.	Type dependent, see remarks.	Type dependent, see remarks.	For feature types 1-4, 9, 10, 11, radius in km/4

Figure 3-14. Special Graphic Symbol Packet - Packet Code 20 (Sheet 4)

	MSB	HALFWORD	LSB
		PACKET CODE (=21)	
		LENGTH OF BLOCK (BYTES)	
	CELL ID C1	CELL ID C2	
		I POSITION	
		J POSITION	
REPEAT FOR		TREND CODE	
EACH TREND	# VOLUMES	LATEST VOL PTR	
CODE		VOL. 1 TREND DATA	
		• •	
		VOL N TREND DATA	

FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Packet Code	INT*2	N/A	21	N/A	Packet Type 21
Length of Block	INT*2	Bytes	12 to 198	1	Number of bytes to follow in this packet
Cell ID C1	8 bit ASCII	N/A	A to Z	N/A	First character of cell ID
Cell ID C2	8 bit ASCII	N/A	0 to 9	N/A	Second character of cell ID
I Position	INT*2	Km/8	-4096 to +4095	1	Cell I coordinate at latest Volume Scan
J Position	INT*2	Km/8	-4096 to +4095	1	Cell J coordinate at latest Volume Scan
Trend Code	INT*2	N/A	1 to 8	1	Indicates trend data type to follow: 1 = cell top 2 = cell base 3 = max. ref. hgt. 4 = prob. hail 5 = prob. svr. hail 6 = cell based VIL 7 = max. ref. 8 = centroid hgt.

Figure 3-15. Cell Trend Data Packet - Packet Code 21 (Sheet 1)

FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
# Volumes	INT*1	N/A	1 to 10	1	Number of volume scans of trend data for this trend code in the circular list
Latest Vol PTR	INT*1	N/A	1 to 10	1	Pointer to the latest volume scan in the circular list
Vol 1 Trend Data	INT*2	Note 1	Note 1	Note 1	Trend data for each scan in the circular list
•					
•					
•					
Vol N Trend Data					

TREND CODE	UNITS	SCALE FACTOR	SCALED RANGE	PRECISION	REMARKS
1	Feet	/100	0 to 1700	100 Feet	Note 2
2	Feet	/100	0 to 1700	100 Feet	Note 2
3	Feet	/100	0 to 700	100 Feet	
4	Percent	1	0 to 100	10 Percent	Note 3
5	Percent	1	0 to 100	10 Percent	Note 3
6	kg/m**2	1	0 to 100	1 kg/m**2	
7	dBZ	1	0 to 75	1 dBZ	
8	Feet	/100	0 to 700	100 Feet	

Note 1: The following defines the units, scale factor, range and precision for each trend code:
Note 2: If the value is over 700, then 1000 has been added to denote that the CELL TOP (BASE) was detected on the highest (lowest) elevation scan.
Note 3:Flag values of -999 denote that an UNKNOWN value (i.e. the cell is outside the maximum hail processing range).

Figure 3-15. Cell Trend Data Packet - Packet Code 21 (Sheet 2)

	PACKET CODE (=22)	
CELL TREND	LENGTH OF BLOCK (BYTES)	
VOLUME SCAN	# VOLUMES	LATEST VOL PTR
TIMES	VOL TIME 1	
	• •	
	VOL TIME N	

FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Packet Code	INT*2	N/A	22	N/A	Packet Type 22
Length of Block	INT*2	Bytes	4 to 22	1	Number of bytes to follow in this packet
# Volumes	INT*2	N/A	1 to 10	1	Number of cell trend volume scan times in the circular list
Latest Vol PTR	INT*2	N/A	1 to 10	1	pointer to the latest cell trend volume scan time in the circular list
Vol Time 1	INT*2	Minutes	0 to 1439	1	Circular list of cell trend volume scan times in minutes after midnight (seconds are truncated)
•					
•					
Vol Time N					

Figure 3-15a. Cell Trend Volume Scan Times - Packet Code 22

	PACKET CODE (=28, 29)
	RESERVED (=0)
GENERIC	LENGTH OF DATA (BYTES) (MSHW)
DATA	LENGTH OF DATA (BYTES) (LSHW)
PACKET	START OF SERIALIZED DATA
	SERIALIZED DATA HALFWORD 1
	• •
	SERIALIZED DATA HALFWORD N

FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Packet Code	INT*2	N/A	28 or 29	N/A	Packet Type 28 or Packet Type 29
Reserved	INT*2	N/A	0	N/A	See Note 1
Length of Serialized Data (MSHW)	INT*2	Bytes	0 to maximum 2-byte integer value	1	Number of bytes to follow in this packet (most significant halfword).
Length of Serialized Data (LSHW)	INT*2	Bytes	0 to maximum 2-byte integer value	1	Number of bytes to follow in this packet (least significant halfword).
Serialized Data	N/A	N/A	N/A	N/A	Serialized data returned from Generic Data Packet serializing function. See Note 2.

Note 1: Reserved for future use. Should be set to 0.
Note 2: The serialized data is encoded using External Data Representation (XDR). The XDR Standard is defined in Request For Comments (RFC) 1832. The deserialized data format is defined by Generic Product Format described in Appendix E.

Figure 3-15c Generic Data Packet - Packet Codes 28 and 29 (Sheet 1)

		MSB HALFWORD	LSB
			MESSAGE HEADER BLOCK (see Figure 3-3)
			PRODUCT DESCRIPTION BLOCK (see sheets 2, 6, & 7 of Figure 3-6)
			BLOCK DIVIDER (-1)
			NUMBER OF PAGES
REPEAT FOR	REPEAT FOR		NUMBER OF CHARACTERS
EACH PAGE	EACH LINE		CHARACTER DATA
			END OF PAGE FLAG (-1)

FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Block Divider	INT*2	N/A	-1	N/A	Integer value of -1, used to delineate this block from the header
Number of Pages	INT*2	N/A	1 to 48	1	Total number of page
Number of Characters	INT*2	N/A	0 to 80	1	Number of characters in line
Character Data to N	Char	8 bit ASCII	ASCII Character Set	N/A	Characters are ASCII
End of Page Flag	INT*2	N/A	-1	N/A	Integer value of -1, to delineate end of page

Figure 3-16. Stand-Alone Tabular Alphanumeric Product Message

Table VIII. Product Dependent Definition for Stand-Alone Tabular Alphanumeric Block

PRODUCT NAME	CONTENT	UNITS	RANGE	ACCURACY/ PRECISION	REMARKS
STORM STRUCTURE	Radar ID	N/A	0 to 999	N/A	
	Volume Scan Start Date	N/A	Months: 1 to 12 Days: 1 to 31 Years: 0 to 99	N/A	
	Volume Scan Start Time	N/A	Hours: 0 to 23 Minutes: 0 to 59	N/A	

			Seconds: 0 to 59		
	Number of Storms Cells	N/A	0 to 100	1	
	Storm Cell ID	Alphanumeric	A0 through Z0, then A1 through Z1, then A2 ...Z9	N/A	The sequence is recycled following Z9 Note 1
	Storm Positions: •Azimuth •Range	•Degree •nmi	•0 to 360 •0 to 248	•1 •1	• Note 1
	Storm Base	Kft	0.0 to 70.0	0.1	If the storm base was identified at the lowest elevation, the value is qualified with "<". Note 1
	Storm Top	Kft	0.0 to 70.0	0.1	If the storm top was identified at the highest elevation, the value is qualified with ">". Note 1
	Cell Based VIL	kg/m^2	0 to 120	1	Note 1
	Maximum Reflectivity	dBZ	0 to 95	1	Note 1
	Height of Maximum Reflectivity	Kft	0.0 to 70.0	0.1	Note 1
	Site Adaptable Parameters	See Remarks	See Remarks	See Remarks	See Table LXVIII, Site Adaptation Data in Radar Product Generation Program, 2820003, Pt 1.
FREE TEXT MESSAGE	Message Text	ASCII	All ASCII Characters	N/A	

MSB	HALFWORD LSB
	MESSAGE HEADER BLOCK (see Figure 3-3)
GENERAL 10 STATUS BLOCK	(-1) BLOCK DIVIDER
11	LENGTH OF BLOCK
12	MODE OF OPERATION
13	RDA OPERABILITY STATUS
14	VOLUME COVERAGE PATTERN

15	NUMBER OF ELEVATION CUTS
16 17 • • 35	ELEVATION 1 ELEVATION 2 • • ELEVATION 20
36	RDA STATUS
37	RDA ALARMS
38	DATA TRANSMISSION ENABLE
39	SPG OPERABILITY STATUS
40	SPG ALARMS
41	SPG STATUS
42	SPG NARROWBAND STATUS
43	REFLECT. CALIB. CORR.
44	PRODUCT AVAILABILITY
45	SPARE
46	SPARE
47	SPARE
48	RDA BUILD NUMBER
49	RDA CHANNEL NUMBER
50	RESERVED
51	RESERVED
52	BUILD VERSION
53	ELEVATION 21
54	..
55	..
56	..
57	ELEVATION 25
58	SPARE
.	
.	
100	SPARE

Figure 3-17. General Status Message (Sheet 1)

HALF WORD	FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
10	Block Divider	INT*2	N/A	-1	N/A	Integer -1, block divider
11	Length of Block	INT*2	Bytes	82	1	Number of bytes to follow
12	Mode of Operation	INT*2	N/A	0 to 2	N/A	Where: 0 = reserved 1 = reserved 2 = Precipitation/Severe Weather Mode
13	RDA Operability Status	Integer	N/A	0,1/Bit	Bit 15=LSB	Where:
					Bit 15=1	Reserved
					Bit 14=1	Online

					Bit 13=1	Maintenance Action Required
					Bit 12=1	Maintenance Action Mandatory
					Bit 11=1	Commanded Shutdown
					Bit 10=1	Inoperable
					Bit 9	Spare
					Bit 8=1	Wideband Disconnect
					Bits 7-0	Spare
					Bits 15-10, 8=0	Indeterminate: if all bits are zero, then the SPG determines the status
14	Volume Coverage Pattern	INT*2	N/A	1 to 767	1	RDA Volume Coverage Pattern for the scan strategy being used
15	Number of Elevation Cuts	INT*2	N/A	1 to 25	1	Maximum elevation cuts = 25
16 . . .	Elevation 1	Scaled Integer	Degrees	-1.0 to +45.0	.1	Elevation angle elevation 1
35	Elevation 20	Scaled Integer	Degrees	-1.0 +60.0	.1	Elevation angle for elevation 20. NOTE: If the number of elevation cuts N, is less than 20, then elevations N+1 through 20 are zeros
36	RDA Status	Integer	N/A	0,1/Bit	Bit 15=LSB	Where:
					Bit 15	Spare
					Bit 14=1	Reserved
					Bit 13=1	Reserved
					Bit 12=1	Reserved
					Bit 11=1	Operate
					Bit 10=1	Spare
					Bit 9=1	Reserved
					Bit 8-0	Spares
					Bits 14-9=0	Indeterminate; if all bits are zero, then the SPG cannot determine the status
37	RDA Alarms	Integer	N/A	0,1/Bit, Note 1	Bit 15=LSB	Where:
					Bit 15=1	Indeterminate; the SPG cannot determine the alarms present
					Bit 14=1	Reserved
					Bit 13=1	Reserved
					Bit 12=1	Reserved
					Bit 11=1	Reserved
					Bit 10=1	Reserved
					Bit 9=1	Reserved
					Bit 8=1	Spare
					Bit 7=1	Spare

					Bits 6-0	Spares
					Bits 15-7=0	No Alarms; if all bits are zero, then there are no alarms present
38	Data Transmission Enabled	Integer	N/A	0,1/Bit	Bit 15=LSB	Where:
					Bit 15=1	Spare
					Bit 14=1	None
					Bit 13=1	Reflectivity
					Bit 12=1	Velocity
					Bit 11=1	Spectrum Width
					Bits 10-0	Spares
39	SPG Operability Status	Integer	N/A	0,1/Bit	Bit 15=LSB	Where:
					Bit 15=1	Loadshed
					Bit 14=1	On-line
					Bit 13=1	Maintenance Action Required
					Bit 12=1	Maintenance Action Mandatory
					Bit 11=1	Commanded Shutdown
					Bits 10 to 0	Spares
40	SPG Alarms	Integer		N/A	Bit 15=LSB	Where:
					Bit 15=1	No Alarms
					Bit 14=1	Spare
					Bit 13=1	Spare
					Bit 12=1	SPG Control Task Failure
					Bit 11=1	Data Base Failure
					Bit 10=1	Spare
					Bit 9=1	SPG Input Buffer Loadshed (Wideband)
					Bit 8=1	Spare
					Bit 7=1	Product Storage Loadshed
					Bit 6=1	BDDS User Failure
					Bit 5=1	Spare
					Bit 4=1	Reserved
					Bit 3=1	Reserved
					Bit 2=1	Reserved
					Bit 1=1	Task Failure
					Bit 0=1	Media Failure
41	SPG Status	Integer	N/A	0,1/Bit	Bit 15=LSB	Where:
					Bit 15=1	Restart
					Bit 14=1	Operate
					Bit 13=1	Standby
					Bit 12=1	Spare
					Bit 11=1	Test Mode
					Bit 10-0	Spares
42	SPG Narrowband Status	Integer	N/A	0,1/Bit	Bit 15=LSB	Where:
					Bit 15=1	Commanded Disconnect

					Bit 14=1	Narrowband Loadshed
					Bit 13-0	Spares
43	Reflectivity Calibration Correction	Fixed Point, Scaled Integer	db/4	-792 to +792 (-198 dB to +198 dB)	.25/ 1	Reflectivity Calibration Correction (difference from adaptation data)
44	Product Availability	Integer	N/A	0,1/Bit	Bit 15=LSB Bit 15=1 Bit 14=1 Bit 13=1	Where: Product Availability Degraded Availability Not Available
45-47						
48	RDA Build Number	Fixed Point, Scaled Integer	N/A	0 to 999, Note 2	N/A	RDA major and minor build version information
49	RDA Channel Number	Integer	N/A	0,1,2	N/A	0 = Normal 1 = Reserved 2 = Reserved
50-51	Reserved					Halfword 50 & 51 are applicable to dial-up (Class II, Class IV, and Class V [RFC]) user only
52	Build Version	Scaled Integer	N/A	10 to 32767		SPG Build Version
53	Elevation 21	Scaled Integer	Degrees	-1.0 to +45.0	.1	Elevation angle for Elevation 21.
54 55 56	. . .					
57	Elevation 25	Scaled Integer	Degrees	-1.0 to +45.0	.1	Elevation angle for Elevation 25. NOTE: If number of elevation cuts N is less than 25, then elevations N+1 through 25 are zeros.
58-100	Spare	N/A	N/A	N/A	N/A	

Note 1: RDA Alarms reflect the controlling channel.
Note 2: For Legacy RDA systems, this value will be 0.

Figure 3-17. General Status Message (Sheet 2)

	MSB	HALFWORD	LSB
		MESSAGE HEADER BLOCK (see Figure 3-3)	
10		BLOCK DIVIDER (-1)	
REQUEST 11 RESPONSE		LENGTH OF BLOCK	
BLOCK 12		ERROR CODE (MSW)	
13		(LSW)	
14		SEQUENCE NUMBER	

15	PRODUCT/MESSAGE CODE
16	ELEVATION ANGLE
17	VOLUME SCAN DATE
18-19	VOLUME SCAN START TIME
20-24	SPARES (7 HALFWORDS)

Figure 3-18. Request Response Message (Sheet 1)

HALF WORD	FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
10	Block Divider	INT*2	N/A	-1	N/A	Integer -1, Block Divider
11	Length of Block	INT*2	Bytes	26	1	Number of bytes to follow
12-13	Error Code	Integer	N/A	0,1/Bit	Bit 31=LSB	Where:
					Bit 0=1	No Such Message Code
					Bit 1=1	No Such Product Code
					Bit 2=1	Product Not Generated (Not Available in Data Base)
					Bit 3=1	One-Time Request Generation Process Faulted
					Bit 4=1	Narrowband Loadshed
					Bit 5=1	Illegal Request
					Bit 6=1	SPG Memory Loadshed
					Bit 7=1	SPG CPU Loadshed (Note 1)
					Bit 8=1	Unavailability of Slots (Real-Time, Replay or Customized)
					Bit 9=1	Failure (Task Failed)
					Bit 10=1	Unavailable (Task Not Loaded Upon Startup)
					Bit 11=1	Available Next Volume Scan
					Bit 12=1	Moment Disabled
					Bit 13	Bit 13 is Reserved and Not Applicable to Associated PUPS
					Bit 14	Spare
					Bit 15	Aborted Volume Scan (Note 2)
					Bit 16	Invalid Product Parameters
					Bit 17	Product Not Generated (Data Sequence Error) Note 3
					Bit 18	Task Failure (Self-Terminated)
					Bits 19-31	Spares
14	Sequence Number	INT*2	N/A	-13, 0 to 32767	1	Sequence number of request that caused response
15	Product/Message Code	INT*2	N/A	-16 to -299, 16 to 299	N/A	Product/Message code as defined in Table I, that caused response
16	Elevation Angle	Scaled Integer	Degrees	-1.0 to +60.0	.1	Elevation angle of radar for requested product
17	Volume Scan Date	INT*2	Julian Date	1 to 32767	1	Modified Julian Date; integer number of days since Jan. 1, 1970

18-19	Volume Scan Start Time	INT*4	Seconds GMT	0 to 86399	1	Number of seconds after midnight, Greenwich Mean Time (GMT)
20-24	Spares					

Note 1: The SPG has not implemented the CPU Loadshed functionality that will generate an alarm.
Note 2: The following conditions will cause ABORTED VOLUME SCAN: Unexpected Start of Volume Scan.
Note 3: Product Not Generated (Data Sequence Error) is caused when VCP number changes unexpectedly, Azimuth Tolerance Exceeded in the initial elevation cut of volume, RDA Elevation Number Changes Unexpectedly, or Start of Elevation Y Expected, But Start Of Elevation received. In addition, any sequence error encountered during task processing …e.g. the task is not processing radial messages fast enough and its input buffers are lost at the expense of new input buffers.

Figure 3-18. Request Response Message (Sheet 2)

MSB	HALFWORD LSB
	MESSAGE HEADER BLOCK (see Figure 3-3)
10	BLOCK DIVIDER (-1)
11	LENGTH OF BLOCK
REPEAT FOR 12	ALERT GROUP
EACH ALERT 13	ALERT CATEGORY
CATEGORY 14	NUMBER OF ALLOWABLE THRESHOLDS
(MAX = 41) 15 • • • 20	THRESHOLD 1 • • • THRESHOLD 6
21	PRODUCT ID

4 APPENDIX A. GLOSSARY

Acronym/ Abbreviation	Description
A	Address Sequence
ABM	Asynchronous Balanced Mode
ACCUM	Accumulation
ADAPT	Adaptation
ADM	Asynchronous Disconnect Mode
ALT	Altitude
ANSI	American National Standards Institute
ARO	Asynchronous Respond Opportunity
ASCII	American Standard Code for Information Interchange
AWIPS	Advanced Weather Interactive Processing System
AZ	Azimuth
BA	Balanced, Asynchronous Balanced Mode (Same as ABM)
Beg	Beginning
Bit	Binary Digit
Block	A related set of bytes containing control information or data. A block is a component of a message.
bps	Bits per second
C	Control Sequence
Cal	Calibration
CALIB	Calibration
CCITT	Consultative Committee International Telephone and Telegraph
Char	Character
CKT	Circuit
CLIN	Contract Line Item Number
Comp	Composite
Const	Constant
CPC	Computer Program Component
CPCI	Computer Program Configuration Item
CPU	Central Processor Unit
CRC	Cyclical Redundancy Checking
dBA	10 log (Rainfall Accumulation/mm)
dBZ	Reflectivity, in decibels
DCE	Data Circuit-Terminating Equipment
deg	Degree
Dig	Digital
Dir	Direction
DISC	Disconnect
DM	Disconnected Mode
DTE	Data Terminal Equipment
EIA	Electronic Industries Association
Err	Error
Ext	External
F or Flag	Flag Sequence
FCS	Frame Check Sequence
Flg	Flag

Frame	A segment of a bit stream bounded by a uniquely recognizable bit sequence and containing a specified number of bits or bytes of data.
FRMR	Frame Reject
GFS	General Format Specifier
GMT	Greenwich Mean Time
Halfword	Two bytes (16 bits)
Header	A set of bits or bytes contained in a bounded segment of information which provides a label or control information to the remaining contents of the segment.
Hgt	Height
Hword	Halfword (16 bits)
I	Information
ICD	Interface Control Document
ID	Identification
INT*2	One halfword of integer data in standard 2' s compliment format
INT*4	One fullword (32 bits) of integer data in standard 2's compliment format
Int	Integer
Integ	Integrated
Integer	Bit stream of 1s and 0s, represented as an integer number, not formatted in 2's compliment format (i.e., 32,768 integer code would represent setting the MSB of a halfword).
ISO	International Organization for Standardization
kg	Kilogram
km	Kilometer
kts	Knots
LAPB	Link Access Procedure, Balanced
LCG	Logical Channel Group
LDS	Logically Disconnected State
LFM	Limited Fine Mesh
Liq	Liquid
LSB	Least Significant Bit
LSW	Least Significant Word
MAX	Maximum
Message	The complete set of information transported from the source to the destination. A message may be a product, product request, data, data request, or TDWR SPG control information.
MSB	Most Significant Bit
Msg	Message
MSL	Mean Sea Level
MSW	Most Significant Word
NMI	Nautical Mile
N/A	Not Applicable
Neg	Negative
NEXRAD	Next Generation Weather Radar
Num	Number
NTR	NEXRAD Technical Requirements
OP	Operation
OS	Operating System

OSI	Open Systems Interconnection
PDB	Product Description Block
Pos	Positive
Prec	Precipitation
Prob	Probability
Product	A collection of information that is self contained and provides a complete representation of a graphical image or an alphanumeric message.
PUP	Principal User Processor Group
PVC	Permanent Virtual Circuit
RAD	Radial
RCM	Radar Coded Message
RDA	Radar Data Acquisition Group
Real*4	One fullword (32 bits) of real data, where the MSB is the Sign-bit, followed by a 7 bit Exponent and a 24 bit Mantissa
Reflect	Reflectivity
RES	Resolution
RFC	River Forecast Center
RLE	Run Length Encoded
RMS	Root Mean Square
RNR	Receiver Not Ready
RPG	Radar Product Generation Group
RPGOP	Radar Product Generator Operational Position
RR	Receiver Ready
SABM	Set Asynchronous Balanced Mode
Scaled Integer	Integer values with an assumed decimal point whose position is defined by the precision of the item
SCN	Specification Change Notice
Sec	Second
sq	Square
Spd	Speed
SPG	Supplemental Products Generator
SPR	Software Problem Report
SR	Signaling Rate Selector
SW	Spectrum Width
SWE	Snow Water Equivalent
SWP	Severe Weather Probability
TAB	Tabular
TDWR	Terminal Doppler Weather Radar
TM	Test Mode
Turb	Turbulence
UCP	Unit Control Position
UI	Unnumbered Frame
VAD	Velocity Azimuth Display
Var	Variation
Vel	Velocity
VIL	Vertically Integrated Liquid
Wd	Width

5 APPENDIX B. DATA TRANSMISSION CHARACTERISTICS

Table X. Application Data Sizes

Typical Maximum Application Data Size Estimates (Note 1)		
Product Code	**Mnemonic**	**Message Size All VCPs**
0	Prod. Req.	For RPS list =.05 x # of prod on list. For OTR = .05
2	GSM	.124
3	Request Resp.	.048
4	Max. Connect	.028
6	n/a	
7	n/a	
8	Prod. List	.026 + (.014 x # of prod on list)
9	n/a	
11	Sign On	.036
12	n/a	
13	Prod. Req. Cancel	.05
14	n/a	
NOTE 1: All product sizes are estimated maximum based on Build 4.0 testing and sizes are given in Kilobytes where (1 Kilobyte = 1024 bytes).		

Note: TDWR SPG Product Sizes in tables XII and XII were derived from the radar site TBWI and therefore elevation angles listed pertain to that site. VCP80 sizes are based on data from the evening of July 27, 2005 which included widespread severe storms containing damaging microbursts. VCP90 sizes are based on data from the afternoon of August 12, 2008 which consisted of widespread warm season clear air radar returns.

Table XI. TDWR VCP80 SPG Product Size

Product Code	**Product Mnemonic**	**Elevation**	**Min Size (Bytes)**	**Max Size (Bytes)**	**Average Size (Bytes)**	**Median Size (Bytes)**
180	DR	0.5	71322	104076	87475	90043
180	DR	1.0	56313	95115	77246	82107
180	DR	3.3	36574	90635	69190	71055
180	DR	6.6	30208	99033	71371	73695
180	DR	10.0	22918	92094	62499	62504
180	DR	13.4	20857	79418	55863	63210
180	DR	19.4	12832	59074	40411	48671
180	DR	28.1	8700	41852	29349	37104
180	DR	42.0	4893	32091	21093	27792
182	DV	0.5	61752	79659	73892	75199
182	DV	1.0	50389	68306	58108	56657
182	DV	3.3	34836	65854	52480	52857
182	DV	6.6	28542	72900	53597	52875
182	DV	10.0	22117	65269	47640	47595
182	DV	13.4	19439	56789	40748	43392
182	DV	19.4	12381	44298	29856	33095
182	DV	28.1	8650	34819	22277	25686
182	DV	42.0	4722	30605	15836	19015

184	SW	.05	54868	78596	70421	71454
184	SW	1.0	44486	65590	54826	53814
184	SW	3.3	44628	58476	51743	52048
184	SW	6.6	40312	59116	49187	48676
184	SW	10.0	35112	55206	45485	44160
184	SW	13.4	33760	50068	40562	38944
184	SW	19.4	23870	39038	29749	28342
184	SW	28.1	16938	29320	21376	19591
184	SW	42.0	11770	23540	15678	14741
186	DR	0.6	62175	113545	90167	92418
37	CR		20582	28892	25755	25784
38	CR		5130	9706	8383	8480
41	ET		1606	1920	1806	1806
48	VWP		5106	12396	10831	12215
57	VIL		1412	1802	1609	1596
58	STI		2970	15116	9986	10047
59	HI		3556	11124	8119	8323
61	TVS		2112	3028	2172	2112
62	SS		4926	9710	6959	6852
84	VAD		2008	6322	4689	5285
141	MD		120	1642	413	120
149	DMD		784	3416	1795	1821

Table XII. TDWR VCP90 SPG Product Size

Product Code	**Product Mnemonic**	**Elevation**	**Min Size (Bytes)**	**Max Size (Bytes)**	**Average Size (Bytes)**	**Median Size (Bytes)**
180	DR	0.5	59295	81896	69372	70174
180	DR	1.0	50070	67681	59404	61722
180	DR	3.3	27570	51896	42143	43687
180	DR	6.1	32660	42073	38126	40271
180	DR	11.0	27287	32508	30739	30793
180	DR	15.9	17916	22400	20561	20836
180	DR	20.8	14015	17870	16207	16406
180	DR	25.7	10932	14324	12871	13057
180	DR	30.6	8568	11668	10339	10522
180	DR	35.5	7032	9727	8552	8744
180	DR	40.4	5878	8611	7432	7579
180	DR	45.3	5543	7864	6886	7089
180	DR	50.2	5253	7492	6536	6722
180	DR	55.1	5308	7263	6366	6537
180	DR	60.0	6265	7991	7224	7337
182	DV	0.5	54764	76785	64827	66024
182	DV	1.0	42848	62852	54083	56129
182	DV	3.3	23999	44560	36398	37191
182	DV	6.1	29816	36793	33839	34982
182	DV	11.0	24515	28462	27043	26866
182	DV	15.9	16258	19416	18420	18373
182	DV	20.8	12787	15504	14445	14385

182	DV	25.7	10146	12421	11612	11584
182	DV	30.6	7955	9980	9285	9348
182	DV	35.5	6414	8316	7574	7636
182	DV	40.4	5380	7306	6565	6651
182	DV	45.3	5242	6609	6047	6112
182	DV	50.2	4906	6224	5706	5735
182	DV	55.1	4884	6060	5543	5576
182	DV	60.0	5521	6637	6173	6164
184	SW	0.5	66384	88760	80230	80930
184	SW	1.0	53088	72190	65268	68158
184	SW	3.3	37848	58978	50344	51864
184	SW	6.1	42322	48572	45362	45558
184	SW	11.0	36568	41218	39453	39836
184	SW	15.9	28012	31804	30434	30450
184	SW	20.8	22538	25778	24326	24272
184	SW	25.7	18646	21312	20166	20162
184	SW	30.6	15700	18424	17332	17412
184	SW	35.5	13610	16354	15149	15276
184	SW	40.4	12278	14872	13613	13693
184	SW	45.3	11524	13562	12580	12614
184	SW	50.2	10846	12666	11891	11928
184	SW	55.1	10480	12168	11350	11402
184	SW	60.0	11240	12474	11866	11856
186	DR	0.6	37727	51372	45812	46156
35	CR		16526	17600	17169	17202
36	CR		4536	4804	4695	4702
37	CR		16610	17896	17393	17502
38	CR		4570	4900	4762	4766
41	ET		1358	1498	1437	1440
48	VWP		8278	9094	8754	8962
57	VIL		1322	1362	1336	1338
58	STI		1362	1362	1362	1362
59	HI		1566	1566	1566	1566
61	TVS		2112	2112	2112	2112
62	SS		3574	3574	3574	3574
84	VAD		1810	3218	2427	2402
141	MD		120	120	120	120
149	DMD		780	780	780	780

6 APPENDIX C. PRODUCT DATA COMPRESSION USING BZIP2

In order to decompress products having been compressed using bzip2, the libbzip2 library, version 1.0.1 or higher, is required. The source code can be found at the official home page (URL): **<http://sources.redhat.com/bzip2**. This web site contains complete instructions on building the libbzip2 library on a wide range of computer architectures and operating systems. Detailed documentation of the various library functions is also provided.
Within libbzip2, the library function that should be used to decompress the data is:

```
BZ2_bzBuffToBuffDecompress( char *dest,
    unsigned intdestLen,
    char *source,
    unsigned intsourceLen,
    intsmall,
    int verbosity).
```

The destination buffer "dest" holds the decompressed product. The destination buffer size "destLen" must be at least as large as the sum of the Message Header block, Product Description block and the compressed product data size given by the Product Dependent Parameters (see Table IV). The source "source" points to the compressed product data immediately following the Product Description block. The source length "sourceLen" is the total product size (defined in the Message Header block), less the size of the Message Header and Product Description blocks. Depending on the architecture, "small" can either be 0 (normal case) or non-zero. By specifying a non-zero value for "small", the library requires less memory utilization at the expense of increased decompression time. The verbosity level can take on any value from 0 to 4 inclusive with higher values denoting greater verbosity.

After the product is decompressed, the products Message Header and Product Description blocks can be prepended to the decompressed product data.

7 APPENDIX D. GENERIC PRODUCT FORMAT

The Generic Product Format is designed to be a flexible, platform independent data format wherein the information describing the data is contained in the data itself. Information for each product that typically has been included in this interface control document such as the parameter's definition, type, range, precision and scaling, is encoded in the data structures defined in this appendix.

The first item within the deserialized data will be the Product Description data structure (for packet 28 data) or the External Data Description data structure (for packet 29 data). The Product Description data structure is defined in Figure D-1. The External Data Description data structure is defined in Figure D-1b. Additional product data is determined by the values of "Parameter List" and "Component List". The Parameter List is defined in Figure D-2. The possible Component List data structures are defined in Figures D-3 through D-11.

The following conventions will be used for describing data structure element types:

Byte/Char	One byte (8 bits)
INT*2	2 byte, signed integer data
INT*4	4 byte, signed integer data
UINT*4	4 byte, unsigned integer data
REAL*4	4 byte, floating point data adhering to IEEE-754-1985 standard
String	NULL (0) terminated array of ASCII coded characters, each character occupying 1 byte
Pointer	Contains the address of a data item. Size is architecture dependent.

NAME
DESCRIPTION
CODE
TYPE
GENERATION TIME
RADAR NAME
RADAR LATITUDE
RADAR LONGITUDE
RADAR HEIGHT
VOLUME SCAN START TIME
ELEVATION SCAN START TIME
ELEVATION ANGLE
VOLUME SCAN NUMBER
OPERATIONAL MODE
VOLUME COVERAGE PATTERN
ELEVATION NUMBER
SPARE
SPARE
NUMBER OF PARAMETERS
PARAMETER LIST
NUMBER OF COMPONENTS
COMPONENT LIST

Figure D-1. Product Description Data Structure (Sheet 1)

FIELD NAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Name	String	N/A	N/A	N/A	Product name
Description	String	N/A	N/A	N/A	Product description (may contain version information)
Code	INT*4	N/A	See Table I	N/A	Product code
Type	INT*4	N/A	1 to 7	1/1	1=Volume, 2=Elevation, 3=Time, 4=On Demand, 5=On Request, 6=Radial, 7=External
Generation Time	UINT*4	Seconds	0 to 4294967295	1/0.5	Product generation time. See Note 1.
Radar Name	String	N/A	N/A	N/A	Null or empty string indicates the radar name is not applicable
Radar Latitude	REAL*4	Degrees	-90.0 to +90.0	N/A	Only applicable if radar name specified.
Radar Longitude	REAL*4	Degrees	-180.0 to +180.0	N/A	Only applicable if radar name specified.
Radar Height	REAL*4	Meters	30 to 3350	N/A	Meters above mean sea level.
Volume Scan Start Time	UINT*4	Seconds	0 to 4294967295	1/0.5	Volume scan start time. See Note 1.
Elevation Scan Start Time	UINT*4	Seconds	0 to 4294967295	1/0.5	Used only if type is equal to 2. See Note 1.
Elevation Angle	REAL*4	Degrees	-1.0 to +45.0	N/A	Angle of elevation scan
Volume Scan Number	INT*4	N/A	1 to 80	N/A	Counter, recycles to 1 after 80 volume scans.
Operational Mode	INT*2	N/A	1 to 3	N/A	1=Test, 2=Clear Air, 3=Precipitation
Volume Coverage Pattern	INT*2	N/A	0 to 999	N/A	Volume coverage pattern (VCP) number
Elevation Number	INT*2	N/A	1 to 20	N/A	Elevation number within the VCP.

					Only used if type is equal to 2.
Spare	INT*2	N/A	N/A	N/A	Spare (reserved for future compression type)
Spare	INT*4	N/A	N/A	N/A	Spare (reserved for future decompressed size)
Number of Parameters	INT*4	N/A	0 to 1000	N/A	Number of product specific parameters
Parameter List	Pointer to Structure	N/A	N/A	N/A	See Note 2
Number of Components	INT*4	N/A	0 to 1000	N/A	Number of product specific components
Component List	Pointer to Structure	N/A	N/A	N/A	See Note 3

Figure D-1. Product Description Data Structure (Sheet 2)
Note 1. Specified in number of seconds elapsed since midnight GMT January 1, 1970 (Unix Time).
Note 2. Product Parameter data structure defined in Figure D-2.
Note 3. When the product contains multiple detected events, this is an array of pointers to Event Component data structures (see Figure D-10). A product can have any number of events. If there is only one event, this is an array of pointers, each of which points to one of the following product component structure types: Radial Component (Figure D-3), Grid Component (Figure D-5), Area Component (Figure D-6), Text Component (Figure D-8), or Table Component (Figure D-9). A product can have any number of components of mixed types.

NAME
DESCRIPTION
CODE
TYPE
GENERATION TIME
SPARE (MSW)
SPARE (LSW)
SPARE (MSW)
SPARE (LSW)
SPARE (MSW)
SPARE (LSW)
SPARE (MSW)
SPARE (LSW)
NUMBER OF PARAMETERS
PARAMETER LIST
NUMBER OF COMPONENTS
COMPONENT LIST

Figure D-1b. External Data Description Data Structure (Sheet 1)

FIELD NAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Name	String	N/A	N/A	N/A	Product name
Description	String	N/A	N/A	N/A	Product description (may contain version information)
Code	INT*4	N/A	See Table I	N/A	Product code
Type	INT*4	N/A	7	1/1	Product type = External
Generation Time	UINT*4	Seconds	0 to 4294967295	1/0.5	Product generation time. See Note 1.
Spare	INT*4	N/A	N/A	N/A	Spare
Spare	INT*4	N/A	N/A	N/A	Spare
Spare	INT*2	N/A	N/A	N/A	Spare
Spare	INT*2	N/A	N/A	N/A	Spare (reserved for future compression type)
Spare	INT*4	N/A	N/A	N/A	Spare (reserved for future decompressed size)
Number of Parameters	INT*4	N/A	0 to 1000	N/A	Number of product specific parameters
Parameter List	Pointer to Structure	N/A	N/A	N/A	See Note 2
Number of Components	INT*4	N/A	0 to 1000	N/A	Number of product specific components
Component List	Pointer to Structure	N/A	N/A	N/A	See Note 3

Figure D-1b. External Data Description Data Structure (Sheet 2)

Note 1. Specified in number of seconds elapsed since midnight GMT January 1, 1970 (Unix Time).

Note 2. Product Parameter data structure defined in Figure D-2.

Note 3. When the product contains multiple detected events, this is an array of pointers to Event Component data structures (see Figure D-10). A product can have any number of events. If there is only one event, this is an array of pointers, each of which points to one of the following product component structure types: Radial Component (Figure D-3), Grid Component (Figure D-5), Area Component (Figure D-6), Text Component (Figure D-8), or Table Component (Figure D-9). A product can have any number of components of mixed types.

PARAMETER ID
PARAMETER ATTRIBUTES

Figure D-2. Product Parameter Data Structure (Sheet 1)

FIELD NAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Parameter ID	String	N/A	N/A	N/A	Parameter identifier
Parameter Attributes	String	N/A	N/A	N/A	See Notes 1, 2.

Figure D-2. Product Parameter Data Structure (Sheet 2)

Note 1. Format description of the ASCII-text parameter attributes:

1. The attributes are represented by an ASCII string. The string consists of a number of sections terminated by ";", each of which specifies an applicable attribute. ";" after the last section is optional. Each section must be in the form of "attribute name = attribute description" where "attribute name" must be one of the following: "name", "type", "unit", "range", "value", "default", "accuracy", "description", "conversion" and "exception". The attribute name is case-insensitive. That is, for example, "name", "Name" and "NAME" are all valid and identical. "attribute description" is a character string that describes the value of the attribute as explained in the following.
2. Attribute description:

"name": The name of the parameter. An example is "name = 2D feature altitude".

"type": One of the following type names: "int", "short", "byte" (4-byte, 2-byte and 1-byte integer respectively), "bit" (1-bit data), "float", "double" (4-byte and 8-byte IEEE floating point numbers respectively), "string" (ASCII character string), "unit", "ushort" and "ubyte" (unsigned versions of int, short and byte). An example is "type = int". If type is not specified, "int" is assumed. The type name is case-insensitive.

"unit": The physical unit of the data value. Standard unit names are to be defined. Examples are "unit = meter" and "unit = percent".

"range": The set of all valid values for the parameter. The range can be specified with one of the following three formats:

a. Single interval specification defined by "[min, max]" where "min" and "max" are respectively the minimum and maximum values. "[" and "]" can be replaced by "(" and ")" respectively if the boundary is not inclusive. Unlimited boundary is specified by "-". Examples are "range = [1, 2]", "range = (1, 2]", "range = [1., -)", "range = [A, Z]" (character string type), and "range = (-, -)".

b. A list of valid values: { v1, v2, ...}. Examples are "range = {1, 2, 3}" and "range = {reflectivity, velocity, spectrum width}.

c. A named method that checks the range. The method name is enclosed by "<" and ">". The method must be described elsewhere.

"value" and "default": A value or a list of values separated by ",". Examples are "value = 1", "value = 1.0, 2., 3.0" and "value = Yes, No".

"accuracy": The accuracy of the data. [max_error] is used for the absolute maximum error and (max_error) for the relative maximum error.

"description": A text description of the data.

"conversion": The way to convert binary data stored externally. The conversion can be specified with one of the following formats:

a. Format [scale, offset] is used for scale-offset type of conversion: value = data * scale + offset. An example is "conversion = [2., 64.]".

b. Format {valueMap, data1, value1, data2, value2, ...} for data mapping conversions. Where "valueMap" is a reserved key word. "data1", "data2" ... are the data and "value1", "value2" ... are the values to convert to. An example is "conversion = {valueMap, 1, -5., 2, 0., 3, 50., 4, 100.}".

c. Format <method> is used for named conversion method. The method must be described elsewhere.
Elements of binary data array are assumed to be stored one after another in the local byte order for types other than "bit" and "string". For type "bit", we assume that the elements are stored in a byte array each of which holds 8 elements. The first bit element is stored in the left-most bit in the bytes. For type "string", elements are null-terminated strings and stored one after another with the null terminator.

"exception": A list of the exceptional data values and their meanings. An example is "exception = 0, below threshold, 1, missing data". Standard vocabulary for describing exceptional values needs to be established in the future.

3. When characters ";", "=" and "," are used for formatting purpose, characters "space", "tab" and "line return" surrounding them are insignificant. That is, for example, "name = short", "name=short" and "name =short" are all identical. Non-formatting use of ";" and "," are allowed if no ambiguity is introduced. In case of ambiguity, "\" can be used in front of characters ";" and "," to indicate that they are not interpreted as formatting characters. The part of "Attribute description" is case-sensitive except otherwise specified.

Note 2.

Component parameters are either definitive or descriptive. Definitive component parameters are required and predefined. Examples are:

The dimension size (number of grid points) for each dimension.

The location of the origin and the coordinate orientation for certain grids. For equally spaced grid, the step size for each dimension.

The altitude of a geo-area if the altitude is relevant.

The definitive component parameters must be predefined so the user of the product can interpret and display the data product-independently.

Descriptive component parameters, on the other hand, provide additional descriptions of the product component. Examples are the data field name, the intensity of the event, the forecast position and so on.

RADIAL COMPONENT TYPE (=1)
LATITUDE
LONGITUDE
NUMBER OF COMPONENT PARAMETERS
COMPONENT PARAMETER LIST
NUMBER OF RADIALS
RADIAL DATA

Figure D-3. Radial Component Data Structure (Sheet 1)

FIELD NAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Radial Component Type	INT*4	N/A	1	N/A	Radial component type
Latitude	REAL*4	Degrees	-90.0 to +90.0	N/A	Latitude location of center of radar elevation sweep
Longitude	REAL*4	Degrees	-180.0 to +180.0	N/A	Longitude location of center of radar elevation sweep
Number of Component Parameters	INT*4	N/A	1 to 1000	N/A	Number of component parameters
Component Parameter List	Pointer to Structure	N/A	N/A	N/A	See Figure D-2
Number of Radials	INT*4	N/A	0 to 800	N/A	Number of radials in a radar elevation sweep
Radial Data	Pointer to Structure	N/A	N/A	N/A	See Figure D-4

Figure D-3. Radial Component Data Structure (Sheet 2)

AZIMUTH
WIDTH
BIN SIZE
RANGE TO FIRST BIN
BIN VALUES

Figure D-4. Radial Information Data Structure (Sheet 1)

FIELD NAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Azimuth	REAL*4	Degrees	0.0 to 360.0	N/A	Azimuth of the center of the radial

Width	REAL*4	Degrees	0.0 to 2.0	N/A	Radial width or separation
Bin Size	REAL*4	Meters	0.0 to 1000.0	N/A	Range extent of each bin
Range to First Bin	REAL*4	Meters	1000.0 to 460000.0	N/A	Range to the center of the first bin
Bin Values	Structure	N/A	N/A	N/A	See Figure D-11

Figure D-4. Radial Information Data Structure (Sheet 2)

GRID COMPONENT TYPE (=2)
NUMBER OF DIMENSIONS
DIMENSIONS
GRID TYPE
NUMBER OF COMPONENT PARAMETERS
COMPONENT PARAMETER LIST
GRID DATA

Figure D-5. Grid Component Data Structure (Sheet 1)

FIELD NAME	**TYPE**	**UNITS**	**RANGE**	**PRECISION/ ACCURACY**	**REMARKS**
Grid Component Type	INT*4	N/A	2	N/A	Grid component type
Number of Dimensions	INT*4	N/A	1 to 4	N/A	Number of grid dimensions
Dimensions	Pointer to INT*4	N/A	N/A	N/A	Grid dimensions, ordered from fastest changing to slowest.
Grid Type	INT*4	N/A	1 to 4	N/A	1=Array, 2=Equally spaced, 3=Lat/Lon, 4=Polar
Number of Component Parameters	INT*4	N/A	1 to 1000	N/A	Number of component parameters
Component Parameter List	Pointer to Structure	N/A	N/A	N/A	See Figure D-2. See Note 1.
Grid Data	Structure	N/A	N/A	N/A	See Figure D-11.

Figure D-5. Grid Component Data Structure (Sheet 2)

Note 1. Grid origin and dimension sizes are defined by component parameters. For equally spaced dimensions, we use component parameters for specifying the step sizes. For each unequally spaced grid dimension, we use an additional 1-D grid component to specify the grid pointer locations in that

dimension.

AREA COMPONENT TYPE (=3)
NUMBER OF COMPONENT PARAMETERS
COMPONENT PARAMETER LIST
AREA TYPE
NUMBER OF POINTS
LIST OF POINTS

Figure D-6. Area Component Data Structure (Sheet 1)

FIELD NAME	**TYPE**	**UNITS**	**RANGE**	**PRECISION /ACCURACY**	**REMARKS**
Area Component Type	INT*4	N/A	3	N/A	Area component type
Number of Component Parameters	INT*4	N/A	1 to 1000	N/A	Number of component parameters
Component Parameter List	Pointer to Structure	N/A	N/A	N/A	See Figure D-2
Area Type	INT*4	N/A	1 to 131075	N/A	0x00001=Point (Lat/Lon), 0x00002=Area (Lat/Lon), 0x00003=Polyline (Lat/Lon), 0x10001=Point (X/Y), 0x10002=Area (X/Y), 0x10003=Polyline (X/Y), 0x20001=Point (Az/Ran), 0x20002=Area (Az/Ran), 0x20003=Polyline (Az/Ran)
Number of Points	INT*4	N/A	1 to 10000	N/A	Number of data points
List of Points	Pointer to Structure	N/A	N/A	N/A	See Figures D-7a, D-7b, and D-7c.

Figure D-6. Area Component Data Structure (Sheet 2)

LATITUDE
LONGITUDE

Figure D-7a. Geographic Location Data Structure (Sheet 1)

FIELD NAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Latitude	REAL*4	Degrees	-90.0 to +90.0	N/A	Latitude location of data point
Longitude	REAL*4	Degrees	-180.0 to +180.0	N/A	Longitude location of data point

Figure D-7a. Geographic Location Data Structure (Sheet 2)

X COORDINATE
Y COORDINATE

Figure D-7b. X/Y Location Data Structure (Sheet 1)

FIELD NAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
X Coordinate	REAL*4	km	N/A	N/A	X-coordinate of data point (See Note 1)
Y Coordinate	REAL*4	km	N/A	N/A	Y-coordinate of data point (See Note 1)

Figure D-7b. X/Y Location Data Structure (Sheet 2)

Note 1. The default unit for the X/Y location structure is kilometers (km). If a different unit is required, it must be specified in the component parameters.

AZIMUTH
RANGE

Figure D-7c. Az/Ran Location Data Structure (Sheet 1)

FIELD NAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Azimuth	REAL*4	Degrees	N/A	N/A	Azimuth of data point
Range	REAL*4	km	N/A	N/A	Range of data point (See Note 1)

Figure D-7c. Az/Ran Location Data Structure (Sheet 2)

Note 1. The default unit for range is kilometers. If a different unit is required, it must be specified in the component parameters.

TEXT COMPONENT TYPE (=4)
NUMBER OF COMPONENT PARAMETERS
COMPONENT PARAMETER LIST
TEXT

Figure D-8. Text Component Data Structure (Sheet 1)

FIELD NAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Text Component Type	INT*4	N/A	4	N/A	Text component type

Number of Component Parameters	INT*4	N/A	1 to 1000	N/A	Number of component parameters
Component Parameter List	Pointer to Structure	N/A	N/A	N/A	See Figure D-2
Text	String	N/A	N/A	N/A	ASCII string

Figure D-8. Text Component Data Structure (Sheet 2)

TABLE COMPONENT TYPE (=5)
NUMBER OF COMPONENT PARAMETERS
COMPONENT PARAMETER LIST
TITLE
NUMBER OF COLUMNS
NUMBER OF ROWS
COLUMN LABELS
ROW LABELS
ENTRIES

Figure D-9. Table Component Data Structure (Sheet 1)

FIELD NAME	**TYPE**	**UNITS**	**RANGE**	**PRECISION/ ACCURACY**	**REMARKS**
Table Component Type	INT*4	N/A	5	N/A	Table component type
Number of Component Parameters	INT*4	N/A	1 to 1000	N/A	Number of component parameters
Component Parameter List	Pointer to Structure	N/A	N/A	N/A	See Figure D-2
Title	String	N/A	N/A	N/A	ASCII string
Number of Columns	INT*2	N/A	1 to 32768	N/A	Number of columns in table
Number of Rows	INT*2	N/A	1 to 32768	N/A	Number of rows in table
Column Labels	Pointer to Structure	N/A	N/A	N/A	See Figure D-12.
Row Labels	Pointer to Structure	N/A	N/A	N/A	See Figure D-12.
Entries	Structure	N/A	N/A	N/A	See Figure D-12.

Figure D-9. Table Component Data Structure (Sheet 2)

EVENT COMPONENT TYPE (=6)
NUMBER OF EVENT PARAMETERS
EVENT PARAMETER LIST

NUMBER OF COMPONENTS
COMPONENT LIST

Figure D-10. Event Component Data Structure (Sheet 1)

FIELD NAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Event Component Type	INT*4	N/A	6	N/A	Event component type
Number of Event Parameters	INT*4	N/A	1 to 10000	N/A	Number of event parameters
Event Parameter List	Pointer to Structure	N/A	N/A	N/A	See Figure D-2.
Number of Components	INT*4	N/A	1 to 1000	N/A	Number of components
Component List	Pointer	N/A	N/A	N/A	See Note 1.

Figure D-10. Event Component Data Structure (Sheet 2)

Note 1. An array of pointers each of which points to one of the product component structures. An event can have any number of components of mixed types. Possible types are Radial Component (Figure D-3), Grid Component (Figure D-5), Area Component (Figure D-6), Text Component (Figure D-8), and Table Component (Figure D-9).

ATTRIBUTES
DATA

Figure D-11. Binary Data Data Structure (Sheet 1)

FIELD NAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Attributes	String	N/A	N/A	N/A	See Figure D-2 Note 1. Attribute "type" is required.
Data	Pointer	N/A	N/A	N/A	See Note 1.

Figure D-11. Binary Data Data Structure (Sheet 2)

Note 1. The data is fully described by "Attributes". The attributes are used to interpret the data.

For Grid Component data (see Figure D-5), the gridded data are stored as a 1-dimensional array with the index of the first dimension varying the fastest.

For Table Component data, "Entries" is an "Number of Rows" X "Number of Columns" array with the row index varying the fastest.

TEXT STRING

Figure D-12. String Data Structure (Sheet 1)

FIELD NAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Text String	String	N/A	N/A	N/A	ASCII coded characters terminated with a null character

Figure D-12. String Data Structure (Sheet 2)