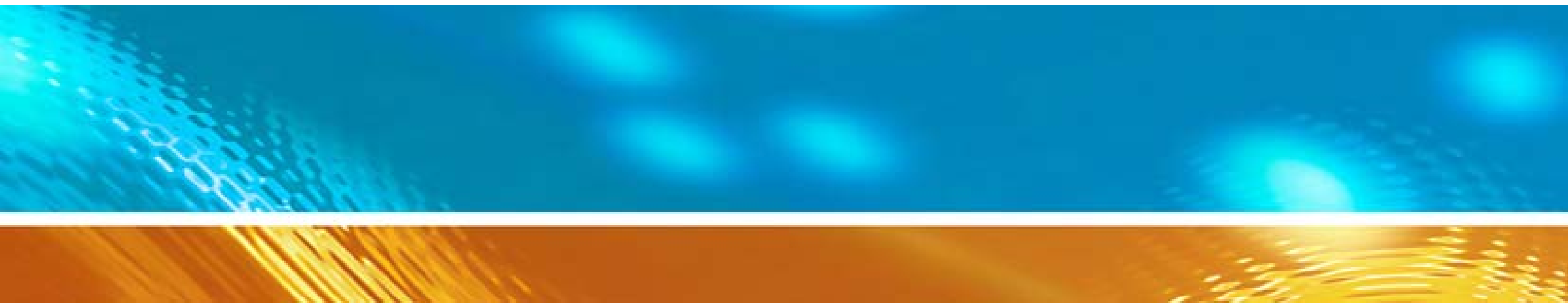
VAISALA

# PROGRAMMER'S MANUAL



IRIS

M211318EN-D

PUBLISHED BY

|  |  |  |
|---|---|---|
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# CHAPTER 1 GENERAL INFORMATION

The IRIS programming interface gives you access to the radar, antenna, and signal processing hardware, as well as the IRIS menus and utility software. This means that you can expand the capabilities of IRIS for any special purpose your site may require. For example:

- Create special-purpose products.
- Write applications that accept data generated by IRIS.
- Write new interfaces to IRIS.

## 1.1 About This Manual

Chapter 2, Introduction to IRIS Programming - describes where to find the IRIS source code libraries within the directory structure, and how to compile and link IRIS code.

Chapter 3, Custom Input and Output - shows how to define new IRIS products types, which can be accessed through the IRIS menus. This chapter contains an example program to help you get started.

Chapter 4, Data Formats - describes the data formats generated by IRIS products and used by the IRIS menus and utilities. Any application that you write must be able to understand the format of the data generated by IRIS.

Appendix A, Radar Control Protocol - describe the RCP transmit and receive formats.

Appendix B, Link Transmission Formats - describes the data formats for link outputs to AWS and HKO.

Appendix C, UF Format - dDescribes IRIS's implementation of the UF (Universal Format).

## 1.2 Version Information

**Table 1 Manual Revisions**

| Manual Code | Description |
|---|---|
| M211318EN-D | This manual. Fourth version. September 2014 |
| M211318EN-C | Previous manual. Third version. November 2013 |
| M211318EN-B | Previous manual. Second version. March 2013 |
| M211318EN-A | Previous manual. First version. |

## 1.3 Related Manuals

| Manual Code | Manual Name |
|---|---|
| M211315EN | IRIS and RDA Installation Manual |
| M211316EN | IRIS and RDA Utilities Manual |
| M211317EN | IRIS Radar User’s Manual |
| M211319EN | IRIS Product and Display Manual |
| M211320EN | RCP8 User's Manual |
| M211321EN | RVP8 User's Manual |
| M211452EN | IRIS and RDA Dual Polarization User’s Manual |

You can download the latest versions of the manuals from Vaisala product website, http://www.vaisala.com They can be read online using by Adobe® Reader®, which is installed with IRIS.

Vaisala encourages you to send your comments and/or corrections to:

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## 1.4 Documentation Conventions

Throughout the manual, important safety considerations are highlighted as follows:

| WARNING | Warning alerts you to a serious hazard. If you do not read and follow instructions very carefully at this point, there is a risk of injury or even death. |
|---|---|

| | |
|---|---|
| **CAUTION** | Caution warns you of a potential hazard. If you do not read and follow instructions carefully at this point, the product could be damaged or important data could be lost. |

| | |
|---|---|
| **NOTE** | Note highlights important information on using the product. |

The following conventions are used throughout this manual:

| | |
|---|---|
| $ | The dollar sign is used to show the operating |
| # | system prompt, the pound sign indicates the OS prompt for the root user. |

# CHAPTER 2
# INTRODUCTION TO IRIS PROGRAMMING

## 2.1 Directory Organization

IRIS source files, object modules, and library routines are placed in separate branches of the IRIS directory tree, as shown in Figure 1 on page 15.

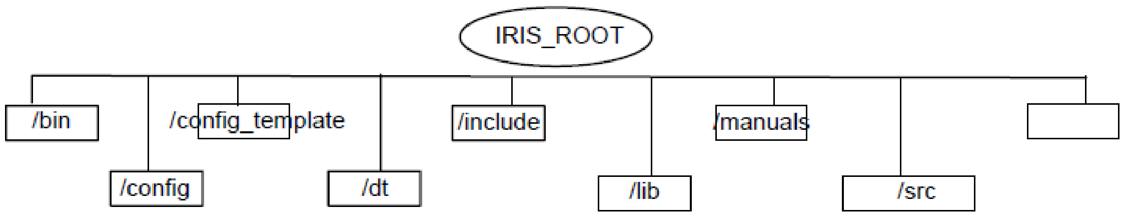


**Figure 1 IRIS Directory Tree**

`IRIS_ROOT` refers to the root directory for the IRIS system. It is often `/usr/sigmet; IRIS_ROOT` is defined as an environment variable. When referring to a file within the IRIS directory tree, this manual assumes `IRIS_ROOT` to be the root directory. All pathnames are relative to `IRIS_ROOT`, unless otherwise noted. All source code discussed here is placed in the /src directory.

Table 2 on page 16 gives a short description of the library routine subdirectories, Table 3 on page 16 lists the IRIS subdirectories, Table 4 on page 17 describes the utility subdirectories, and Table 5 on page 17 lists the Configuration subdirectories. All system wide header files are in the `${IRIS_ROOT}/include` directory, and all library .a files are in the

`${IRIS_ROOT}/lib` directory. In the tables below, the public source code is marked with a "*".

**Table 2 Contents of Library Subdirectories**

| Directory | Description |
|---|---|
| antenna* | Antenna driver library routines that control the radar and antenna. |
| audio* | Speech output library. |
| bxutils | GUI utilities library used by BxPro. |
| config* | Configuration subroutines that save and load setup files. |
| dpolatten | Dual polarization attenuation library. |
| dsp* | DSP driver routines that control the actions of the signal processor. |
| exthdr* | Extended header custom plugin library. |
| fileformats* | Library to read and write graphical formats like GIF. |
| hdf5* | Library to read and write HDF5 files (3rd party). |
| himath* | Math libraries for fft, polynomial, map projections, etc. |
| lib | Files with the `.a` extension are stored here. |
| link* | Link output file. |
| maps* | Read/write overlays, catchmets, terrain maps. |
| misc* | Miscellaneous libraries. |
| nordrad2* | Nordrad supplied API. |
| outlib* | Formats displayed images from IRIS products. |
| rtq* | Real-time display transmitter library. |
| share | Source code for shared memory routines that perform various operations, such as handling the ingest file directory, handling errors and other events, etc. |
| tvsubs* | High level Graphics display library routines. |
| user* | General-purpose routines. |
| uxsig | X-Windows support routines. |
| vtv* | Virtual TV routines that read and write IRIS graphical products to buffers in memory. |
| xsig* | X functions. |

**Table 3 Contents of IRIS Subdirectories**

| Directory | Description |
|---|---|
| archive | Source code for the archive process. |
| examiners* | Code for **rays** and **productx**. |
| ingest | Source code for the ingest process. |
| ingfio | Source code for the ingfio process. |
| input | The input pipe handler process. |
| network | Source code for the network process. |
| nordrad | Nordrad product receiver. |
| output* | Source code for the output process. |
| product | Source code for the product process. |
| reingest | Source code for the reingest process. |

**Table 3 Contents of IRIS Subdirectories (Continued)**

| Directory | Description |
|---|---|
| server | Source code for the IRIS server. |
| siris | Source code for the `siris` program. |
| sserver | Socket server used for IRIS/Web. |
| watchdog | Source code for the watchdog process. |
| window* | Source code for the X-window handler. |
| xuif | IRIS main menu program. |

**Table 4 Contents of Utilities Subdirectories**

| Directory | Description |
|---|---|
| adids* | ADIDS output pipe. |
| antenna* | AntExport, AntLog, antx, qant utilities. |
| archive2* | Archive2 input and output pipes. |
| asterix* | Asterix output pipe. |
| bufr* | BUFR input and output pipes. |
| custom* | Misc custom interface programs. |
| ewis* | EWIS output pipe. |
| examples* | Simple source code, including UPI routines. |
| grib1* | GRIB1 output pipe. |
| hdf5* | HDF5 input and output pipes. |
| mcidas* | McIDAS pipes. |
| nexrad* | Nexrad calibration utilities. |
| nordrad2* | NORDRAD2 relay programs. |
| pipes_in* | More input pipes. |
| pipes_out* | More output pipes. |
| rainbow* | Rainbow input pipe. |
| tdwr* | TDWR interface programs. |
| ualf* | UALF Lightning input relay programs. |
| uf* | UF input and output pipes. |

**Table 5 Contents of Configuration Subdirectories**

| Directory | Description |
|---|---|
| init | Fonts and initializing scripts. |
| menu | Menu configuration files. |
| overlay | Overlay definition files. |

## 2.2 Setting up the Development Environment

You may need to compile your own programs using IRIS headers, and which may link to IRIS libraries on occasion, for example:

- If you are writing your own code to read or write IRIS products using the IRIS data structures.
- If you are writing your own input or output pipe program to convert the data to another format.
- If you are writing your own code to interface to the RCP and RVP using our public APIs. This might be an offline diagnostic program, for example.
- When defining new product types using UPI.

First, be sure to install the source files, object modules, libraries, and emacs on your system. This is done by pushing these 4 buttons in the **install** program. See the instructions for your operating system in the *IRIS Installation Manual.*

**Setting up a developer source tree:**

Before you start writing new code, you need to set up directories to work in. Do this with the following commands in the operator account:

```
$ cd

$ mkdir sigmet_src

$ cd sigmet_src

$ mkdir libs iris utils
```

All the main IRIS source code reside in the release directory tree starting at ${IRIS_ROOT}/src. It is all in 3 major subdirectories: libs, iris, and utils. When making a change, do not change the source in the release tree. Instead copy the files for the directory you are changing to the same subdirectory of ~/sigmet. For example, to make a change to the RainbowToIris input pipe, copy the files from ${IRIS_ROOT}/src/utils/ rainbow to ~/sigmet_src/utils/rainbow. You can then make your changes and compile there. If you are modifying one of IRIS's standard pipes, SIGMET strongly recommends that you rename it to a custom name. That way it will not get replaced by the next upgrade.

**To compile and link an IRIS library or application:**

Each directory installed on your system contains a makefile to build the application or library contained there. To run the makefile, switch to the directory containing the source code and type "`make depend`" to build the dependencies, then "`make`". To install the binaries, run "sudo make install". If you are compiling a whole tree, it is better to type "`make -sw`".

**To compile IRIS/Web code:**

You need to install the tomcat5 and Java rpms. Do this by following the instructions in the chapter on *Installing IRIS/Web Server* in the *Software Installation Manual*. Then you need to set the alternatives state of java and javac to use the newly installed rpm. Do this with the "alternatives_java" script file supplied by Vaisala.

**To compile IRIS HDF5 code:**

You need to install the hdf5-devel rpm. Mount the IRIS/RDA release cdrom and look in the directory RHEL5/extras/RPMS. If you do not have a release cdrom, you can get them from our ftp site: ftp://ftp.sigmet.com/outgoing/os_patches/RHEL5/RPMS. Install with the following command:

```
# rpm -Uhv hdf5-1.8.0-1.el5.rf.i386.rpm
```

**To compile IRIS BUFR pipes:**

You need to install the OPERA BUFR development rpm. Mount the IRIS/RDA release cdrom and look in the directory RHEL5/extras/RPMS. If you do not have a release cdrom, you can get them from our ftp site: ftp://ftp.sigmet.com/outgoing/os_patches/RHEL5/RPMS. Install with the following commands:

```
# rpm -Uhv bufr-3.0-2.i386.rpm

# rpm -Uhv bufr-devel-3.0-2.i386.rpm
```

# CHAPTER 3
# CUSTOM INPUT AND OUTPUT

## 3.1 Input Pipes

There are two different command line formats used by the IRIS input process to launch an input pipe. In **setup**, these are called "Pathnames" and "Pipe". Sigmet recommends that you code all new pipes using the more flexible Pathnames scheme. In this scheme, the pipe program is invoked with the following command line:

```
$ <pipe-path> -if:<in-file> -ip:<in-path> -op:<out-path> -
device:<number>
```

In this case, your pipe must explicitly open the input and output files. The purpose of the "-if" argument (which is somewhat redundant with "-ip") is to allow the pipe program to make nice diagnostic printouts, or to parse the filename for information, without having to search the pathname for the final "/".

The only information passed back to the calling program is the 8-bit exit status. In normal cases is should return EXIT_SUCCESS (0). If it returns EXIT_FAILURE (1), then IRIS will signal a messages saying "Error running pipe, check log". It is important for the pipe program to write diagnostic information to a log file. Sigmet suggests writing to the ${IRIS_LOG} directory.

There are 2 other possible exit returns: EXIT_RERUN (2), and EXIT_NOTHING (3). EXIT_RERUN indicates that the pipe has both produced a normal output, and wants to product a second output file. In this case, the pipe needs to store information about the second output on disk. Sigmet suggests that you write this in the ${IRIS_TEMP} directory. IRIS will process the first output, the invoke the pipe again with the following command line:

```
$ <pipe-path> -rerun -op:<out-path> -device:<number>
```

Note that the input path is gone, and the option "-rerun" is supplied. When the pipe is thus called, it can retrieve the stored information and write the second output to the specified pathname.

EXIT_NOTHING indicates that the pipe ran without error, but there was no output produced. IRIS will ignore and delete the output file. This is useful for a pipe which needs to read several input files before producing one output file. An example of such a pipe is the Rainbow input pipe RainbowToIris, found in the directory ${IRIS_ROOT}/utils/rainbow.

## 3.2 User Product Insert

Customers are generate their own IRIS products, and to process IRIS products within their own programs. The file formats are fully documented in this manual. The difficulty is often in passing the product between the user program and IRIS.

One way to do this is by using IRIS's input and output mechanisms with no handshaking. This scheme uses polling. For example the user places a product file in a know directory, IRIS checks every few seconds. When it finds a file it reads it in. Similarly, IRIS's output can place a file in a know directory, and the user's program can poll for it. When using a polling scheme, it is always desirable to first copy the file there with a "." prefix. Once the file is fully there, rename it to a name without the dot. This prevents the recipient from seeing a partial file.

User Product Insert (UPI) is an alternative mechanism which sends a message to notify the recipient of a product. This removes all time lag and cpu usage due to polling. The user routine communicates with IRIS in exactly the same manner in which different IRIS host systems communicate with each other. The user routine can execute on the same computer as the IRIS host, or it can be on a different CPU because the communication is via network socket routines.

SIGMET supplies a sample routine to get you started. The routine is written in C++, and uses sockets to communicate with a host IRIS system.

## 3.3 Building the Example Programs

There are three example programs shipped with the iris release media to demonstrate the UPI process. These are all in the utils/examples directory, and are called upi_rcv, upi_xmt, and change_product. The upi_rcv program simply receives a file from IRIS, prints out the file name, then deletes it. It can easily be customized to your requirements. The change_product program will modify an existing product file to add in a circular target. The upi_xmt program sends files back to IRIS.

To compile these programs, first configure your IRIS compiling environment as discussed in Chapter 2, Introduction to IRIS Programming, on page 15. Then go to the directory containing the source code: ${IRIS_ROOT}/utils/examples. Compile it using the resident Makefile, as follows:

```
$ make upi_rcv
```

You may want to rename it, copy it elsewhere, and make a script file to compile it. You can take the compile and link commands from the makefile.

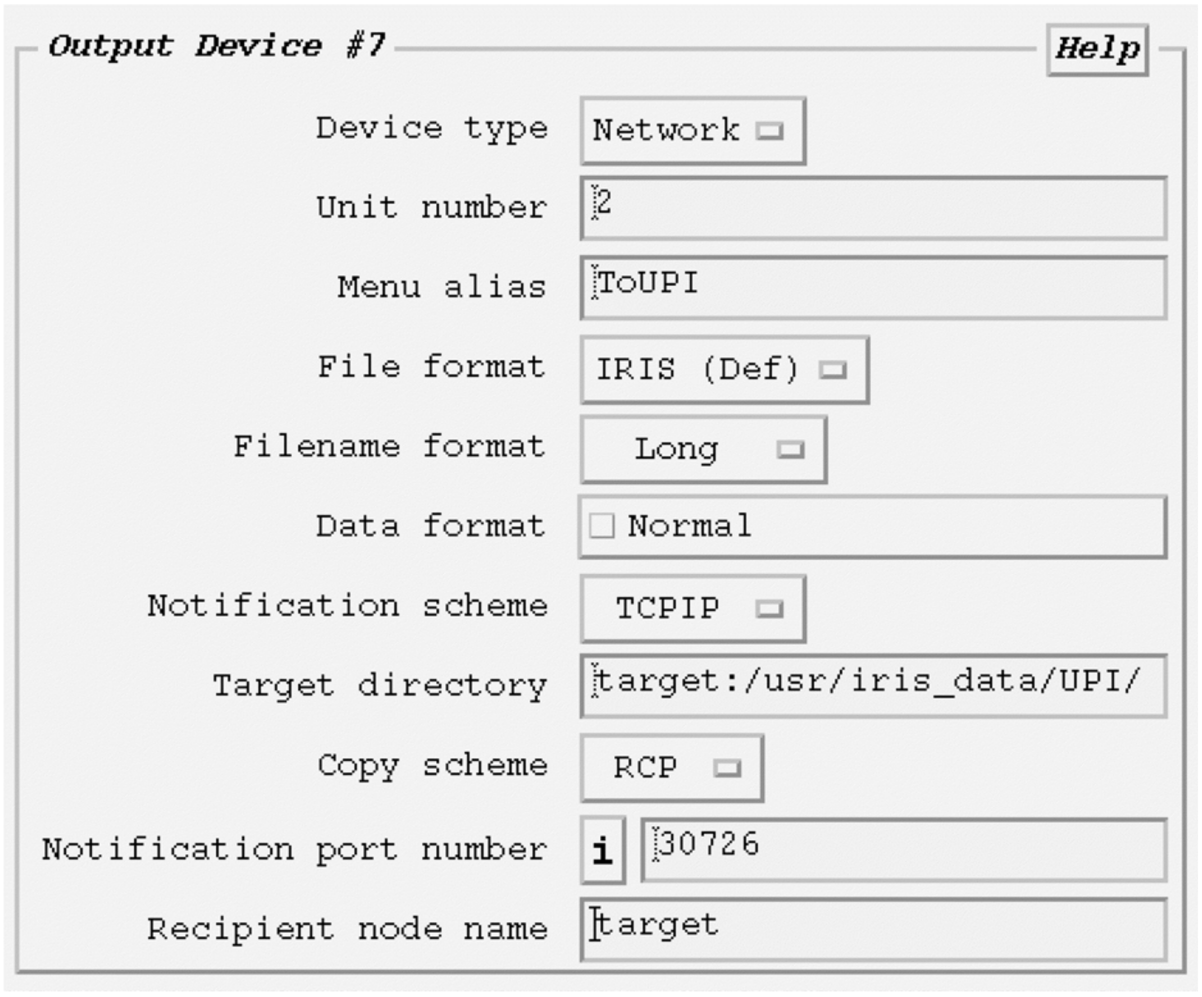
## 3.4 Running the upi_rcv Program

These instructions for running the sample program assume that you are running upi_rcv on a computer node called "target", and that IRIS is running on a computer called "host". Running on a single computer is somewhat simpler.

First create the directory on target into which IRIS can copy products. A typical example might be /usr/iris_data/UPI. The actual directory name is not important.

Copy the upi_rcv to the target computer (if it is different from where you compiled it) so it can run there. You will need to set the mode again after copying.

On the IRIS host system, create a new network output device called "ToUPI" for sending products to the upi_rcv program. This is all done from the **setup** utility - an example is shown below:



| | |
|---|---|
| Device type | Network |
| Unit number | 2 |
| Menu alias | ToUPI |
| File format | IRIS (Def) |
| Filename format | Long |
| Data format | ☐ Normal |
| Notification scheme | TCPIP |
| Target directory | target:/usr/iris_data/UPI/ |
| Copy scheme | RCP |
| Notification port number | i 30726 |
| Recipient node name | target |

Next, on the target computer, run the upi program:

```
$ upi_rcv -d /usr/iris_data/UPI
```

It should print something like the following:

```
Initializing UPI receiver

Connection established

Received file: '/usr/iris_data/UPI/host950710171113.PPI'

Connection closed
```

Finally, using the Product Output menu, send a horizontal reflectivity product to "ToUPI".

## 3.5 IRIS Product and Data Types

User generated products must fit into one of the IRIS product and data types. A good way to help understand these is to look at the display of a typical square product (such as a PPI) on a medium sized window. The product type is used by IRIS to decide in general the interpretation of the image, and the data type is used to figure out how to convert between data number and colors.

The data type in a product file controls the color legend (the box containing an array of colored rectangles with text next to them) The data type is converted to text to label the legend, and is used internally to help control how data values in Cartesian products are converted to colors. Some data types do not display a color legend. Examples of these are products like WARN, SLINE, TRACK, and VVP displayed as graphs.

The product type in a product file controls some of the text legend as well as the geometry. Based on the product type, IRIS divides products into several geometrical categories which determine what kind of overlays can be drawn on the image:

- **Horizontal:** These products (such as CAPPI) can have political overlays, product overlays, range rings, and latitude/longitude grids drawn on them. The user cursor works ok. There are minor variations within this category, such as: constant elevation (e.g. PPI), constant height (e.g. CAPPI), and no height implied (e.g. Echo tops).
- **Vertical:** These products (such as Cross Section) can have a range/ height overlay grid. The user cursor works ok.
- **None:** These products (such as VVP) have not geometrical interpretation. There are no overlays drawn, and the user cursor does not return information.
- **No Display:** These products (such as RAW) cannot be displayed.

The definitions for the data type parameters are found in the include/ dsp_lib.h file. The are also discussed in more detail in 4.3 Data Types on page 74.

The definitions for the product types are found in the include/product.h file.

## 3.6 Customizing the Legend

The legend on user defined products can be customized to some extent. The text displayed in the 5-line legend box on the window legend can be overridden as well at the 6 lines above the time on the old-medium sized legend, and the 4 lines above the time on the old-small sized legend. This is controlled by the OUTPUT_LEGEND.DAT file. An example of this file is below. As you can see, the format is more complicated. The column headed by "R" stands for resolution, the number of characters on the line. Low resolution windows can fit only 13 characters, while medium and high resolution can fit 17 characters. Therefore, in general you must add two definitions for each string you want to control. However, IRIS defaults to the 11-character format for bigger displays if no 17-character entry is defined. The column headed by "L" stands for line: "1" means line 7 on the text legend, and "2" means line 8 on the text legend. The first entry in the table is the product type, which must be USER, VUSER, or OTHER.

The general pattern of operation is as follows: When IRIS draws the legend and the product type is either PROD_USER, PROD_USERV, or PROD_OTHER, it searches this table. If it finds a match of the product type, product name, resolutions, and line number, it is considered a match. If it matches everything except the product name, then the first such match in the table is taken as a default for all product names, and is considered a match. If it would otherwise match, except that the desired resolution is larger than the table, it is considered a match. If no match is found, it displays blank.

If the flag is set to "SCALE", a 32-bit word is grabbed from the first byte of the product header "product_specific_info" field offset by the offset in the file. This number is converted to floating point, and multiplied by the scale factor in the file. The C library routine `sprintf` is called with the format statement and the resulting number as arguments. The resulting string is displayed on the legend.

If the flag is set to "REF", a pointer to the product header "product_specific_info" field offset by the offset in the file is passed to `sprintf`. This is useful if you want to display a character string from the header. The resulting string is displayed on the legend.

If the flag is neither of the above, a 32-bit word is grabbed from the first byte of the product header "product_specific_info" field offset by the offset in the file without any conversion. The C library routine `sprintf` is called with the format statement and the 32-bit number as arguments. The resulting string is displayed on the legend

```
# File: output_legend.dat

# Format:

# Valid flags are: SCALE, REF, <anything else>
```

```
                # R=resolution, L=line, O=offset

#ptype   productname   R    L    O    scale     flag     format
USER     DEFAULT       11   1    4    0.00001   SCALE    "Hght:%3.1f"
USER     Z_010_120     11   1    4    0.00001   SCALE    "Hght:%3.1f"
USER     DEFAULT       11   2    8    1         -        "Flag:%d"
USER     Z_010_120     11   2    8    1         -        " "
VUSER    DEFAULT       11   1    4    1         -        " "
USER     DEFAULT       17   1    4    0.00001   SCALE    "Height:%3.1f"
USER     Z_010_120     17   1    4    0.00001   SCALE    "Height:%3.1f"
USER     DEFAULT       17   2    8    1         -        "Flag:%d"
USER     Z_010_120     17   2    8    1         -        " "
VUSER    DEFAULT       17   1    4    1         -        " "
```

## 3.7 The NORDRAD Area Definition File

You want to make a configuration file to control converting between NORDRAD areas and IRIS sites. This file is called NORDRAD_AREAS.DAT, and it is in the IRIS_CONFIG directory. An example of this file is shown in Table 6 on page 27.

**Table 6 Example of NORDRAD_AREAS.DAT**

| |
|---|
| # Example file for NORDRAD_AREAS.DAT file |
| # This controls the scale used when converting to the RRSRT_Z product: rainfall_accumulation_span 0.01 100.0 |
| # This controls the height (in km) used when converting a NORDRAD |
| # CAPPI to IRIS if the Height attribute is missing from the header. |
| default_cappi_height 1.0 |
| # Network access information used for the NORDRAD API. |
| # Either 1 or two devices can be defined. The output device |
| # number is used to select which to use. For input, the first |
| # device is used. |
| api_device_number 1 2 |
| api_access_control "operator xxxxxx" "operator xxxxxx" |
| api_host_name "haze" "haze" |
| api_receiver_id "iris_trans" "iris_trans" |
| # Below there are two mapping tables used to convert |
| # between IRIS sites, and NORDRAD areas. One map for each direction |
| # Mapping of NORDRAD areas to IRIS sitenames |
| # areaname sitename wavelength in 1/100 of cm |
| ntoi_map FIABO1 "MASKU" 500 |
| ntoi_map FIABO2 "MASKU with s" 500 |

**Table 6 Example of NORDRAD_AREAS.DAT (Continued)**

```
ntoi_map FIABO3 MASKU 500
ntoi_map FIABO4 MASKU 500
ntoi_map FIABO6 MASKU 500
ntoi_map FIHEL Helsinki 500
ntoi_map FIROVMTA COMPOSITE 500
ntoi_map FIROV1 ROVANIEMI 500
ntoi_map FIROV2 ROVANIEMI 500
ntoi_map FIAB01 "UND Huntsville" 500
ntoi_map FIAB03 "SIGMET, haze" 500
ntoi_map FIHOT1 "SIGMET, HOT" 500
ntoi_map FIDRY "SIGMET, dry" 500
ntoi_map FIHOT2 "SIGMET, HOT" 500
ntoi_map FISTO3 STOCKHOLM 500
ntoi_map SVNKP2 NORRK #with diaeresis# PING 500
ntoi_map SVOVIK1 OVIK 500
ntoi_map SVOVIK2 OVIK 500
# Mapping of IRIS sitenames to NORDRAD areas.
# There are two kinds of entries, iton_prod and iton_map
# Map based on sitename, product type, and product name.
# If there is an exact match here, take it. This overrides
# the iton_map lines. The first match will control. Size
# and resolution are not used for matching.
# areaname sitename ptype pname h-size v-size resolution in meters
iton_prod FIABO1 "MASKU" CAPPI DEFAULT 150000 150000 1000
# Map based on sitename and resolution. For multiple areas from
# the same sitename, look for the closest in resolution. If
# there is a resolution tie, then look for the closest in size.
# areaname sitename h-size v-size resolution in meters
iton_map FIABO1 "MASKU" 150000 150000 1000
iton_map FIABO2 "MASKU with s" 300000 300000 1000
iton_map FIROV1 ROVANIEMI 300000 300000 1000
iton_map FIROV2 ROVANIEMI 600000 600000 1000
iton_map FIAB01 "UND Huntsville" 100000 100000 1000
iton_map FIAB03 "SIGMET, haze" 200000 200000 1000
iton_map FIHOT1 "SIGMET, HOT" 200000 200000 1000
iton_map FIDRY "SIGMET, dry" 200000 200000 2000
iton_map FIHOT2 "SIGMET, HOT" 200000 200000 2000
iton_map FIVAN1 VANTA 480000 480000 1000
iton_map FIVAN10 VANTA 480000 480000 1000
iton_map SVKKR1 KARLSKRONA 480000 480000 1000
iton_map SVKKR2 KARLSKRONA 240000 240000 1000
iton_map SVOVIK1 OVIK 480000 480000 1000
iton_map SVOVIK2 OVIK 240000 240000 1000
```

The NORDRAD_AREAS.DAT file consists mainly of a list of all the NORDRAD areas with an associated IRIS site name. The file is used for conversions both ways between IRIS and NORDRAD products. When a NORDRAD product is converted to an IRIS product, the NORDRAD area name is looked up in the ntoI_map list, and the associated IRIS site name is used. There is only one entry for each area in the table. The radar wavelength in the file is put into the IRIS header. The wavelength and PRF are needed to display velocities and widths in IRIS.

When an IRIS product is converted to a NORDRAD product, the iton_map list is searched for site names that match. IRIS looks for the closest match between the product size and the size in the file. IRIS converts the product to the exact size (in meters) of the NORDRAD area by either clipping the edges or padding with blank. If you want the product to be properly handled by NORDRAD, you must make the area size match. It is slightly less important to make the resolution in pixels match. Formally, the NORDRAD area defines only a rectangle on the earth, not the resolution of the data. However to do compositing, the resolutions have to be converted, and it may be easier to start at the expected resolution. If there is an exact match to a iton_prod map, then that overrides the iton_map table.

The file can optionally include a line starting with "rainfall_accumulation_span". This is used to control the scaling of rainfall accumulation data when it is converted to NORDRAD format. The two numbers are the minimum and maximum rainfall in mm. Rainfall is converted to NORDRAD using the formula:

$$\text{FILE} = (\log 10(\text{Physical}) - \log \text{MIN}) / ((\log \text{MAX} - \log \text{MIN}) / 254)$$

The minimum must be between 0.001 and 1000.0, the maximum between 0.01 and 10000.0, and the span must be at least a factor of 10. If there is an error, IRIS will signal when it reads the file. If there is no such line, IRIS defaults to a span of 0.1 to 1000.

CHAPTER 4

# DATA FORMATS

This chapter describes the archived data formats used by IRIS. These formats include data storage on disk files, and output tape formats. Within this chapter, all sizes and addresses are given in bytes. Also included are tables of antenna, signal processor, and general-purpose constants.

## 4.1 Scalar Definitions

The file `${IRIS_ROOT}/include/sigtypes.h` defines a few scalar data typedefs that can be used across platforms. These types are listed in Table 7 on page 31. They are used by the IRIS library routines for defining return values and routine arguments.

**Table 7 IRIS Data Types**

| Type | Mapped-to | Description |
|---|---|---|
| SINT1 | int8_t | Signed 8-bit integer |
| UINT1 | uint8_t | Unsigned 8-bit integer |
| SINT2 | int16_t | Signed 16-bit integer |
| UINT2 | uint16_t | Unsigned 16-bit integer |
| SINT4 | int32_t | Signed 32-bit integer |
| UINT4 | uint32_t | Unsigned 32-bit integer |
| FLT4 | float | Floating-point number |
| FLT8 | double | Double-precision floating-point number |
| BIN2 | uint16_t | 16-bit binary angle |
| BIN4 | uint32_t | 32-bit binary angle |
| MESSAGE | uint32_t | Encoded error value |

A binary angle is an efficient way to store an angle into an integer. In this format the MSB has weight 180 degrees, the next bit means 90 degrees, the next 45 degrees, etc. So you can convert an N-bit binary angle to degrees with:

$$Degrees = 360 * (Binary\ Angle) / 2^N$$

To see C language examples of how to do these conversions, please look in src/libs/user/angle.c.

## 4.2 Structure Definitions

Structures are described in alphabetical order. Tables give the following information about each structure:

- Source — The name of the include file containing the C structure definition. The source files can be found in the `${IRIS_ROOT}/include` directories.
- Byte — The byte offset of the structure element.
- Size — The data type of the element from the above table. For structures and spare space the size in bytes is displayed here. Arrays are designated by a data type followed by a number in square brackets.
- Contents — A brief description of the structure element. Structure elements which are themselves structures are identified with angle brackets such as "<ymds_time>". Note, however, that "<spare>" indicates reserved spare space, not a special structure.

### 4.2.1 beam_psi_struct Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | UINT4 | Minimum range in cm |
| 4 | UINT4 | Maximum range in cm |
| 8 | BIN4 | Left azimuth |
| 12 | BIN4 | Right azimuth |
| 16 | BIN4 | Lower elevation |
| 20 | BIN4 | Upper elevation |
| 24 | BIN4 | Azimuth smoothing |
| 28 | BIN4 | Elevation smoothing |
| 32 | BIN4 | Az of sun at start |
| 36 | BIN4 | El of sun at start |
| 40 | BIN4 | Az of sun at end |
| 44 | BIN4 | El of sun at end |

## 4.2.2 cappi_psi_struct Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | 4 | Shear flags, same as shear_psi_struct |
| 4 | SINT4 | Height of CAPPI (cm. above reference) |
| 8 | UINT2 | Flags: bit0=make pseudo CAPPI<br>bit1=Velocity is horizontal winds |
| 10 | BIN2 | Azimuth smoothing for shear |
| 12 | char[12] | VVP name to use for shear correction |
| 24 | UINT4 | Max age for vvp shear correction in seconds |

## 4.2.3 catch_psi_struct Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | UINT4 | Flags in low 16-bits; From 8.09: RAIN1 flags in upper 16-bits<br>Bit 0: Enable warning if catchments exceed threshold |
| 4 | UINT4 | Hours of accumulation |
| 8 | SINT4 | Threshold offset in 1/1000 or mm |
| 12 | SINT4 | Threshold faction in 1/1000 |
| 16 | char[12] | Name of RAIN1 product to use |
| 28 | char[16] | Name of catchment file to use |
| 44 | UINT4 | From 8.09: Seconds of accumulation in low 16-bits |
| 48 | UINT4 | From 8.09: RAIN1 min Z |
| 52 | UINT4 | From 8.09: RAIN1 span in seconds |
| 56 | UINT4 | From 8.09: Average Gage correction factor in low 16-bits |

## 4.2.4 catch_results Structure

Source: `product.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | char[16] | Name of catchment area, null terminated |

| | | |
|---|---|---|
| 16 | UINT4 | Number of catchment area |
| 20 | BIN4 | Latitude of label |
| 24 | BIN4 | Longitude of label |
| 28 | SINT4 | Area of catchment in 1/100 of square km |
| 32 | SINT4 | Number of pixels in the catchment area |
| 36 | SINT4 | Number of pixels scanned in the catchment area |
| 40 | UINT4 | Flags<br>Bit 0: Warning enabled for this catchment<br>Bit 1: Warning triggered for this catchment |
| 44 | UINT2 | Rainfall accumulation in catchment, DB_FLIQUID2 format |
| 46 | UINT2 | Rainfall accumulation warning threshold, DB_FLIQUID2 |
| 48 | 52 | <spare> |
| 100 | UINT2[96] | Rainfall accumulation for each input, DB_FLIQUID2 format |

## 4.2.5 color_scale_def Structure

**NOTE** The changes in color_scale_def are non-critical (unused), for consistency only.

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | UINT4 | **iflags:**<br>Bit 8=COLOR_SCALE_VARIABLE<br>Bit 10=COLOR_SCALE_TOP_SAT<br>Bit 11=COLOR_SCALE_BOT_SAT<br>Bit 12=ENUMERATED DATA |
| 4 | SINT4 | **istart:** Starting level |
| 8 | SINT4 | **istep:** Level step |
| 12 | SINT2 | **icolcnt:** Number of colors in scale |
| 14 | UINT2 | **iset_and_scale:**<br>Color set number in low byte, color scale number in high byte. |
| 16 | UINT2[16] | **ilevel_seams:** Variable level starting values |

This structure appears at the end of the product_configuration structure. It holds information configured into the product about how to quantize the data into color levels for display. We may remove this structure in the near future because IRIS can override all this at display time. This is only used if the user selects "Use Default Scale" in the Color Scale Tool. The bit 11 is used to identify enumerated data type such as DB_HCLASS (DB_HCLASS2), requiring further information about the discrete data values.

There are three ways of specifying the color scale:

- a fixed scale has uniformly spaced numbers fully specified by a start and step value
- a variable scale is specified by a set of 16 individually controlled data seams
- the data are enumerated i.e. each value has an discrete meaning, defined by the string data in enumeration_def structures, which can represent enumeration data as multiples of 14 classes

The **iflags** bits COLOR_SCALE_VARIABLE, over ruled by ENUMERATED_DATA (relates to products using DB_HCLASS) indicate which mode is in effect.

In the first two cases, the number of colors can be anywhere from 2 to 16, and optionally zoomed or split to effectively give up to 32 colors. True color representation is possible in IRIS, too. The bits 10 and 11 in **iflags** specify what to do with data off the end of the scale. There are two choices, either saturate at the end (used the last color), or threshold (do not display). For example a typical treatment of reflectivity would be to saturate the high end of the scale (so as not to lose the strong features), and threshold at the low end (to inhibit display of very weak speckles).

The number of main colors and labels in the legend is set by **icolcnt**. To select which subset of colors is used for the scale, fill in the low byte of **iset_and_scale**. The upper byte is not used in the product header.

For fixed spacing, set the **istart** and **istep** to the start and step values desired. These values are integers which are 10 times the physical units as discussed in the **color_setup** utility chapter of the *IRIS Utilities Manual*. The labels of **istart**, istart+istep, istart+2*istep, etc. will show up on the right side of the IRIS legend. There are two special cases: Width assumes that the starting value is zero, and velocity assumes that the middle of the scale is at zero. If the velocity step is set to zero it means automatically scale to fit the Nyquist velocity.

For variable spacing (bit 8 ON), the numbers in the array **ilevel_seams** control the starting values for each of the colors. The first seam is the bottom of the first color. The top of the 16th color is computed by adding the step between the 15th and 16th seam to the 16th seam. These seams are data values, using the 16-bit versions of the data. For shear and height data, for which there is no 16-bit version, the 8-bit version is used.

Enumerated data (bit 12 ON) can be treated as other data types, that is either with fixed spacing or variable spacing.

### 4.2.6 cross_psi_struct Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | BIN2 | Azimuth angle of line from left to right |
| 2 | 10 | <spare> |
| 12 | SINT4 | East coordinate of center (in cm. relative to radar) |
| 16 | SINT4 | North coordinate of center (in cm. relative to radar) |
| 20 | SINT4 | [15]User miscellaneous |

### 4.2.7 dsp_data_mask Structure

Source: `sigtypes.h`

| Byte | Size | Contents | |
|---|---|---|---|
| 0 | UINT4 | Mask word 0 | |
| 4 | UINT4 | Extended header type | |
| 8 | UINT4 | Mask word 1 | Contains bits set for all data recorded. |
| 12 | UINT4 | Mask word 2 | See parameter DB_* in Table 13 on page 100 for |
| 16 | UINT4 | Mask word 3 | bit specification. |
| 20 | UINT4 | Mask word 4 | |

### 4.2.8 extended_header_v0 Structure

Source: `ingest.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | SINT4 | Time in milliseconds from the sweep starting time |
| 4 | SINT2 | Calibration Signal level |
| 6 | 14 | <spare> |

## 4.2.9 extended_header_v1 Structure

Source: `ingest.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | SINT4 | Time in milliseconds from the sweep starting time |
| 4 | SINT2 | Calibration Signal level |
| 6 | BIN2 | Azimuth (binary angle) |
| 8 | BIN2 | Elevation (binary angle) |
| 10 | BIN2 | Train Order (binary angle) |
| 12 | BIN2 | Elevation Order (binary angle) |
| 14 | BIN2 | Pitch (binary angle) |
| 16 | BIN2 | Roll (binary angle) |
| 18 | BIN2 | Heading (binary angle) |
| 20 | BIN2 | Azimuth Rate (binary angle/second) |
| 22 | BIN2 | Elevation Rate (binary angle/second) |
| 24 | BIN2 | Pitch Rate (binary angle/second) |
| 26 | BIN2 | Roll Rate (binary angle/second) |
| 28 | BIN4 | Latitude (binary angle) |
| 32 | BIN4 | Longitude (binary angle) |
| 36 | BIN2 | Heading Rate (binary angle/second) |
| 38 | SINT2 | Altitude (meters above MSL) |
| 40 | SINT2 | Velocity East (cm/second) |
| 42 | SINT2 | Velocity North (cm/second) |
| 44 | SINT4 | Time since last update (milliseconds) |
| 48 | SINT2 | Velocity Up (cm/second) |
| 50 | UINT2 | Navigation System OK flag |
| 52 | SINT2 | Radial velocity correction (same units as velocities) |

## 4.2.10 extended_header_v2 Structure

Source: none

| Byte | Size | Contents |
|---|---|---|
| 0 | SINT4 | Time in milliseconds from the sweep starting time |
| 4 | SINT2 | Calibration Signal level |
| 6 | 2 | <spare> |
| 8 | SINT4 | Number of bytes in the header |
| 12 | ? | Remainder customer specified |

## 4.2.11 fcast_psi_struct Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | UINT4 | Correlation threshold, 0—100 |
| 4 | SINT4 | Data threshold |
| 8 | SINT4 | Mean speed (cm/hour), zero if none |
| 12 | BIN4 | Direction of mean speed |
| 16 | UINT4 | Maximum time between inputs (seconds) |
| 20 | SINT4 | Maximum allowable velocity (mm/sec) |
| 24 | UINT4 | Flags |
| 28 | SINT4 | Desired output resolution (cm) |
| 32 | UINT4 | Type of input product |
| 36 | char[12] | Name of input product (space padded) |

## 4.2.12 gage_psi_struct Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | UINT4 | Time span of the rain gage data in seconds. |
| 4 | UINT4 | Flag bits:<br>0 = File has distrometers<br>1 = File does not have gages |

## 4.2.13 gage_results Structure

Source: `product.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | char[16] | Name of raingage, null terminated |
| 16 | BIN32_T | Latitude of raingage |
| 20 | BIN32_T | Longitude of raingage |
| 24 | uint16_t | Average rainrate in DB_RAINRATE2 format for the time span |
| 26 | uint16_t | Correction factor last calculated in DB_CDBZ2 format |
| 28 | uint8_t | Data Quality, range 0-10 |

| | | |
|---|---|---|
| 29 | uint8_t | Flag bits:<br>0 = Skip this gage for correction calculation<br>1 = Gage has Z/R numbers<br>2 = Gage does not have rainrate<br>3 = Radar rainrate filled in |
| 30 | uint16_t | Z/R constant in 1/10 |
| 32 | uint16_t | Z/R exponent in 1/1000 |
| 34 | uint16_t | Average radar rainrate in DB_RAINRATE2 format for the span |
| 36 | 4 | <spare> |

## 4.2.14 ingest_configuration Structure

Source: `ingest.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | char[80] | Name of file on disk |
| 80 | SINT2 | Number of associated data files extant |
| 82 | SINT2 | Number of sweeps completed so far |
| 84 | SINT4 | Total size of all files in bytes |
| 88 | 12 | <ymds_time> Time that volume scan was started, TZ spec in bytes 166 & 224 |
| 100 | 112 | <spare> |
| 112 | SINT2 | Number of bytes in the ray headers |
| 114 | SINT2 | Number of bytes in extended ray headers (includes normal ray header) |
| 116 | SINT2 | Number of task configuration table |
| 118 | SINT2 | Playback version number |
| 120 | 4 | <spare> |
| 124 | char[8] | IRIS version, null terminated |
| 132 | char[16] | Hardware name of site |
| 148 | SINT2 | Time zone of local standard time, minutes west of GMT |
| 150 | char[16] | Name of site, from setup utility |
| 166 | SINT2 | Time zone of recorded standard time, minutes west of GMT |
| 168 | BIN4 | Latitude of radar (binary angle: 20000000 hex is 45º North) |
| 172 | BIN4 | Longitude of radar (binary angle: 20000000 hex is 45º East) |
| 176 | SINT2 | Height of ground at site (meters above sea level) |
| 178 | SINT2 | Height of radar above ground (meters) |

| | | |
|---|---|---|
| 180 | UINT2 | Resolution specified in number of rays in a 360º sweep |
| 182 | UINT2 | Index of first ray from above set of rays |
| | 184 UINT2 | Number of rays in a sweep |
| 186 | SINT2 | Number of bytes in each gparam |
| 188 | SINT4 | Altitude of radar (cm above sea level) |
| 192 | SINT4[3] | Velocity of radar platform (cm/sec)(east, north, up) |
| 204 | SINT4[3] | Antenna offset from INU (cm) (starboard, bow, up) |
| 216 | UINT4 | Fault status at the time the task was started, bits: 0:Normal BITE 1:Critical BITE 2:Normal RCP 3:Critical RCP 4:Critical system 5:Product gen. 6:Output 7:Normal system |
| 220 | SINT2 | Height of melting layer (meters above sea level) MSB is complemented, zero=Unknown |
| 222 | 2 | <spare> |
| 224 | char[8] | Local timezone string, null terminated |
| 232 | UINT4 | Flags, Bit 0=First ray not centered on zero degrees |
| 226 | char[16] | Configuration name in the dpolapp.conf file, null terminated |
| 252 | 228 | <spare> |

## 4.2.15 ingest_data_header Structure

Source: `ingest.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | 12 | <structure_header> The size stored in here is the total size of the file. That is 76 + 4*Irtotl + Iwritn*raysize. |
| 12 | 12 | <ymds_time> (4.2.77 ymds_time Structure on page 74) Date and time that sweep was started TZ specified in ingest_configuration |
| 24 | SINT2 | Sweep number, origin 1 |
| 26 | SINT2 | Resolution specified in number of rays in a 360º sweep |
| 28 | SINT2 | Index of first ray from above set of rays |
| 30 | SINT2 | "Irtotl" Number of rays (and pointers) expected in the file |
| 32 | SINT2 | "Iwritn" Number of rays actually in the file |
| 34 | BIN2 | Fixed angle for this sweep (binary angle) |

| | | |
|---|---|---|
| 36 | SINT2 | Number of bits per bin for this data type |
| 38 | UINT2 | Data type in the file:<br>0=extended header<br>1=Total power (dBZ)<br>2=Reflectivity (dBZ)<br>3=Velocity<br>4=Width<br>5=ZDR |
| 40 | 36 | <spare> |

## 4.2.16 ingest_header Structure

A file containing the ingest_header structure is written for each volume scan. This file is updated each time a sweep has finished. This allows product generators to get data from the ingest files as soon as a sweep is completed. Note on RVP6 and 7 the GPARM is read just after the processor is configured. It will contain configuration fault bits, but not the results of a noise sample taken before that task. On the RVP8 starting in release 8.09 it is read with the first valid ray of the task.

Source: `ingest.h`

| |
|---|
| <structure_header> 12 Bytes |
| <ingest_configuration> 480 Bytes |
| <task_configuration> 2612 Bytes |
| Spare 732 Bytes |
| GPARM from DSP 128 Bytes |
| Reserved 920 Bytes |

## 4.2.17 max_psi_struct Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | 4 | <spare> |
| 4 | SINT4 | Bottom of interval in cm |
| 8 | SINT4 | Top of interval in cm |
| 12 | SINT4 | Number of pixels in side panels |
| 16 | SINT2 | Horizontal smoother in side panels |
| 18 | SINT2 | Vertical smoother in side panels |

## 4.2.18 ndop_input Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | char[12] | Task name |
| 12 | char[3] | Site code |
| 15 | UINT1 | Flags |

## 4.2.19 ndop_psi_struct Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | 3*16 | <ndop_input> |
| 48 | SINT4 | Time window |
| 52 | SINT4 | Cappi height (cm above reference) |
| 56 | SINT4 | Output resolution (cm) |
| 60 | BIN4 | Minimum permitted crossing angle |
| 64 | UINT4 | Flags: Bit 0=Make diagnostic products |
| 68 | char[4] | Output site code, added in 8.09.6, use first input if zeroed |
| 72 | 8 | <spare> |

## 4.2.20 ndop_results Structure

Used for both the NDOP and FCAST products. The change rate is always zero in NDOP products. The SQI is unused in FCAST products. The SQI is a function of the variance of the calculated velocity normalized such that random vectors at half the Nyquist velocity would produce an SQI of zero.

$$SQI = 1 - \left[\sqrt{\frac{VarianceEast + VarianceNorth}{2}}\right] / Vnorm$$

Source: `product.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | UINT2 | Velocity East in cm/second (DB_VEL2 format) |
| 2 | UINT2 | Velocity North in cm/second |
| 4 | UINT2 | Change rate in db/min (DB_CDBZ2 format) |
| 6 | UINT1 | Signal Quality Index * 256 |
| 7 | 5 | <spare> |

## 4.2.21 one_protected_region Structure

Source: `setup.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | SINT4 | East center from radar in cm |
| 4 | SINT4 | |
| North center from radar in cm | | |
| 8 | SINT4 | East-West size in cm |
| 12 | SINT4 | North-South size in cm |
| 16 | UINT2 | Orientation angle in binary angle |
| 18 | 2 | <spare> |
| 20 | char[12] | Name of the region, all spaces means unused |

## 4.2.22 ppi_psi_struct Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | BIN2 | Elevation angle |

## 4.2.23 product_configuration Structure

Source: `product.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | 12 | <Structure_Header> |
| 12 | UINT2 | Product type code:<br>1:PPI 2:RHI 3:CAPPI 4:CROSS<br>5:TOPS 6:TRACK 7:RAIN1 8:RAINN<br>9:VVP 10:VIL 11:SHEAR 12:WARN<br>13:CATCH 14:RTI 15:RAW 16:MAX<br>17:USER 18:USERV 19:OTHER 20:STATUS<br>21:SLINE 22:WIND 23:BEAM 24:TEXT<br>25:FCAST 26:NDOP 27:IMAGE 28:COMP<br>29:TDWR 30:GAGE 31:DWELL 32:SRI<br>33:BASE 34:HMAX |
| 14 | UINT2 | Scheduling code: 0:hold; 1:next; 2:all |
| 16 | SINT4 | Number of seconds to skip between runs |
| 20 | 12 | <ymds_time> (4.2.77 ymds_time Structure on page 74) Time product was generated (UTC) |

| | | |
|---|---|---|
| 32 | 12 | <ymds_time> (4.2.77 ymds_time Structure on page 74) Time of input ingest sweep (TZ flex) |
| 44 | 12 | <ymds_time> (4.2.77 ymds_time Structure on page 74) Time of input ingest file (TZ flexible) |
| 56 | 6 | <spare> |
| 62 | char[12] | Name of the product configuration file |
| 74 | char[12] | Name of the task used to generate the data |
| 86 | UINT2 | Flag word: (Bits 0,2,3,4,8,9,10 used internally)<br>Bit1: TDWR style messages<br>Bit5: Keep this file<br>Bit6: This is a clutter map<br>Bit7: Speak warning messages<br>Bit11: This product has been composited<br>Bit12: This product has been dwelled<br>Bit13: Z/R source0, 0:Type-in; 1:Setup; 2:Disdrometer<br>Bit14: Z/R source1 |
| 88 | SINT4 | X scale in cm/pixel |
| 92 | SINT4 | Y scale in cm/pixel |
| 96 | SINT4 | Z scale in cm/pixel |
| 100 | SINT4 | X direction size of data array |
| 104 | SINT4 | Y direction size of data array |
| 108 | SINT4 | Z direction size of data array |
| 112 | SINT4 | X location of radar in data array (signed 1/1000 of pixels) |
| 116 | SINT4 | Y location of radar in data array (signed 1/1000 of pixels) |
| 120 | SINT4 | Z location of radar in data array (signed 1/1000 of pixels) |
| 124 | SINT4 | Maximum range in cm (used only in version 2.0, raw products) |
| 128 | 2 | <spare> |
| 130 | UINT2 | Data type generated (See 4.8 Constants on page 100 for values) |
| 132 | char[12] | Name of projection used |
| 144 | UINT2 | Data type used as input (See 4.8 Constants on page 100 for values) |
| 146 | UINT1 | Projection type: 0=Centered Azimuthal, 1=Mercator |
| 147 | 1 | <spare> |
| 148 | SINT2 | Radial smoother in 1/100 of km |
| 150 | SINT2 | Number of times this product configuration has run |

|  |  |  |
|---|---|---|
| 152 | SINT4 | Z/R relationship constant in 1/1000 |
| 156 | SINT4 | Z/R relationship exponent in 1/1000 |
| 160 | SINT2 | X-direction smoother in 1/100 of km |
| 162 | SINT2 | Y-direction smoother in 1/100 of km |
| 164 | 80 | <product_specific_info> |
| 244 | char[16] | List of minor task suffixes, null terminated |
| 260 | 12 | <spare> |
| 272 | 48 | <color_scale_def>(4.2.5 color_scale_def Structure on page 34) Color scale definition May be removed in the future. |

### 4.2.24 product_end Structure

Source: `product.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | char[16] | Site name — where product was made (space padded) |
| 16 | char[8] | IRIS version where product was made (null terminated) |
| 24 | char[8] | IRIS version where ingest data came from |
| 32 | 12 | <ymds_time> Time of oldest input ingest file (only RAIN1 and RAINN, TZ flexible) |
| 44 | 28 | <spare> |
| 72 | SINT2 | Number of minutes local standard time is west of GMT |
| 74 | char[16] | Hardware name where ingest data came from (space padded) |
| 90 | char[16] | Site name where ingest data came from (space padded) |
| 106 | SINT2 | Number of minutes recorded standard time is west of GMT |
| 108 | BIN4 | Latitude of center (binary angle)[1] |
| 112 | BIN4 | Longitude of center (binary angle)[2] |
| 116 | SINT2 | Signed ground height in meters relative to sea level |
| 118 | SINT2 | Height of radar above the ground in meters |
| 120 | SINT4 | PRF in hertz |
| 124 | SINT4 | Pulse width in 1/100 of microseconds |
| 128 | UINT2 | Type of signal processor used |
| 130 | UINT2 | Trigger rate scheme |
| 132 | SINT2 | Number of samples used |
| 134 | char[12] | Clutter filter file name |
| 146 | UINT2 | Number of linear based filter for the first bin |
| 148 | SINT4 | Wavelength in 1/100 of centimeters |
| 152 | SINT4 | Truncation height (cm above the radar) |
| 156 | SINT4 | Range of the first bin in cm |
| 160 | SINT4 | Range of the last bin in cm |
| 164 | SINT4 | Number of output bins |
| 168 | UINT2 | Flag word<br>Bit0: Disdrometer failed, we used setup for Z/R source instead |

| | | |
|---|---|---|
| 170 | SINT2 | Number of ingest or product files used to make this product (only on RAIN1 and RAINN) |
| 172 | UINT2 | Type of polarization used |
| 174 | SINT2 | I0 cal value, horizontal pol, in 1/100 dBm |
| 176 | SINT2 | Noise at calibration, horizontal pol, in 1/100 dBm |
| 178 | SINT2 | Radar constant, horizontal pol, in 1/100 dB |
| 180 | UINT2 | Receiver bandwidth in kHz |
| 182 | SINT2 | Current noise level, horizontal pol, in 1/100 dBm |
| 184 | SINT2 | Current noise level, vertical pol, in 1/100 dBm |
| 186 | SINT2 | LDR offset, in 1/100 dB |
| 188 | SINT2 | ZDR offset, in 1/100 dB |
| 190 | uint16_t | TCF Cal flags, see struct task_calib_info (added in 8.12.3) |
| 192 | uint16_t | TCF Cal flags2, see struct task_calib_info (added in 8.12.3) |
| 194 | uint8_t | if enumerated data (DB_HCLASS) the identifier of classifier in the first bit segment else <spare> |
| 195 | uint8_t | if enumerated data (DB_HCLASS) the identifier of classifier in the 2nd bit segment else <spare> |
| 196 | uint8_t | if enumerated data (DB_HCLASS) the identifier of classifier in the 3rd bit segment else <spare> |
| 197 | uint8_t | if enumerated data (DB_HCLASS2) the identifier of the 4th classifier else <spare> |
| 198 | uint8_t | if enumerated data (DB_HCLASS2) the identifier of the 5th classifier else <spare> |
| 199 | uint8_t | if enumerated data (DB_HCLASS2) the identifier of the 6th classifier else <spare> |
| 200 | 12 | <spare> |
| 212 | BIN4 | More projection info these 4 words: Standard parallel #1 |
| 216 | BIN4 | Standard parallel #2 |
| 220 | UINT4 | Equatorial radius of the earth, cm (zero = 6371km sphere) |
| 224 | UINT4 | 1/Flattening in 1/1000000 (zero = sphere) |
| 228 | UINT4 | Fault status of task, see ingest_configuration 4.2.14 ingest_configuration Structure on page 39 for details |
| 232 | UINT4 | Mask of input sites used in a composite |
| 236 | UINT2 | Number of log based filter for the first bin |
| 238 | UINT2 | Nonzero if cluttermap applied to the ingest data |
| 240 | BIN4 | Latitude of projection reference[3] |
| 244 | BIN4 | Longitude of projection reference[4] |

| | | |
|---|---|---|
| 248 | SINT2 | Product sequence number |
| 250 | 32 | <spare> (was used before 8.11.4) |
| 282 | SINT2 | Melting level in meters, msb complemented (0=unknown) |
| 284 | SINT2 | Height of radar above reference height in meters |
| 286 | SINT2 | Number of elements in product results array |
| 288 | UINT1 | Mean wind speed |
| 289 | BIN1 | Mean wind direction (unknown if speed and direction 0) |
| 290 | 2 | <spare> |
| 292 | char[8] | TZ Name of recorded data |
| 300 | UINT4 | Offset to extended product header from file (added in 8.13.0) |
| 304 | 4 | <spare> |

1. Note on Latitude and longitudes: Interpretation varies with product type. They are as documented for CAPPI, FCAST, MAX, NDOP, PPI, RAIN1, RAINN, SHEAR, SLINE, TOPS, TRACK, VIL, USER and WARN. For all other products, the Center location is the radar location, and the reference location is zero.
2. Note on Latitude and longitudes: Interpretation varies with product type. They are as documented for CAPPI, FCAST, MAX, NDOP, PPI, RAIN1, RAINN, SHEAR, SLINE, TOPS, TRACK, VIL, USER and WARN. For all other products, the Center location is the radar location, and the reference location is zero.
3. Note on Latitude and longitudes: Interpretation varies with product type. They are as documented for CAPPI, FCAST, MAX, NDOP, PPI, RAIN1, RAINN, SHEAR, SLINE, TOPS, TRACK, VIL, USER and WARN. For all other products, the Center location is the radar location, and the reference location is zero.
4. Note on Latitude and longitudes: Interpretation varies with product type. They are as documented for CAPPI, FCAST, MAX, NDOP, PPI, RAIN1, RAINN, SHEAR, SLINE, TOPS, TRACK, VIL, USER and WARN. For all other products, the Center location is the radar location, and the reference location is zero.

### 4.2.25 product_hdr Structure

Source: `product.h`

| |
|---|
| <structure_header> (4.2.48 structure_header Structure on page 61) 12 Bytes |
| <product_configuration> (4.2.23 product_configuration Structure on page 43) 320 Bytes |
| <product_end> (4.2.24 product_end Structure on page 46) 308 Bytes |
| Data Size Varies |

Starting with version 7.31, IRIS allows data to be recorded in UTC on computers with a timezone set to local time. IRIS also records timezone information about the local computer to support optional displaying of different times at output time. Table 8 on page 49 documents the way this information is stored in the product and ingest headers. For backwards compatibility, **iMinutesWest** (byte 106 in product_end) is the difference between the recorded standard time and UTC. All other field are new in version 7.31. **iLocalWest** (byte 72) is the difference between local standard time and UTC. **sTZName** is the text name for the local timezone at the radar. There are also 3 new bits recorded in the upper bits of the milliseconds field of the milliseconds field of all ymds_time structures: **UTC** means that the time is recorded in UTC. **DST** means that the time is in summer time. **LDST** means that the local time on the computer is in summer time. A 60 minute adjustment to the times may be required to correctly deal with summer times. Because the **sLocalTZName** field is new, all old data when displayed using local time will display with a timezone offset, such as "-05" for US EST. Note that ascope recorded data before 7.31 did not include the timezone, so all old data will display with "+00" for a timezone, independent of what was recorded.

Previous to 7.31, IRIS acted as if the new setup question was set to record data using local time. Some systems had their timezone set to UTC to make sure data was recorded in UTC. This can now be changed. It is never recommended to record data using summer time.

**Table 8 IRIS Timezone Recording**

| System | Record UTC in setup | Record Local in setup |
|---|---|---|
| Computer timezone UTC | iMinutesWest=0<br>iLocalWest=0<br>sLocalTZName="UTC"<br>UTC Flag=1<br>DST Flag=0<br>LDST Flag=0<br>Default Display is "UTC" | iMinutesWest=0<br>iLocalWest=0<br>sLocalTZName="UTC"<br>UTC Flag=0<br>DST Flag=0<br>LDST Flag=0<br>Default Display is "UTC" |
| Computer timezone EST | iMinutesWest=0<br>iLocalWest=300<br>sLocalTZName="EST"<br>UTC Flag=1<br>DST Flag=0<br>LDST Flag=0<br>Default Display="UTC" | iMinutesWest=300<br>iLocalWest=300<br>sLocalTZName="EST"<br>UTC Flag=0<br>DST Flag=0<br>LDST Flag=0<br>Default Display is "EST" |
| Computer timezone EDT | iMinutesWest=0<br>iLocalWest=300<br>sLocalTZName="EDT"<br>UTC Flag=1<br>DST Flag=0<br>LDST Flag=1<br>Default Display is "UTC" | iMinutesWest=300 **DO**<br>iLocalWest=300 **NOT**<br>sLocalTZName="EDT"<br>**RECORD**<br>UTC Flag=0 **SUMMER**<br>DST Flag=1 **TIME**!<br>LDST Flag=1<br>Default Display is "EDT" |

## 4.2.26 product_header_extensions

If the hdr.end.iExtendedHeaderOffset is non-zero, then there is a product header extension, and this number if the byte offset from the beginning of the file to the extension.

This product header extension is an ASCII format, containing meta-data in name=value pairs. The name value pairs are separated by newline characters. The ASCII meta-data section is terminaled by an ASCII zero. This null may be followed by more null, and will finally end with a 0xff. This allows a parser to find the end by looking for a final 0x00 followed by a 0xff, and allows the sized to be padded to make the next section aligned, if desired. Following this product header extension, there may be a binary data section. This binary data section will be aligned based on the size of the data elements, which is specified in the meta-data. This is a general design intended to handle many needs for extending headers, such as listing sites in a composite, or listing algorithm attributes used to generate a data moment. In some cases, we might have multiple product header extension sections.

For example, in the the echo thickness product, we store two binary data arrays, the first one is the thickness, and the second one is the average reflectivity over that interval. The following name value pairs (the values shown are example, but the names shown will be used: “data_type=Z”, “data_units=dBZ”, “x_size=120”, “y_size=120”, “data_storage=uint8_t”, “data_bits=8”, “data_source=DB_DBZ”, “data_size=14400”. We then add a binary blob after the extension containing the average reflectivity.

## 4.2.27 product_specific_info Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | 10 | <cappi_psi_struct> (if CAPPI) |
| 0 | 44 | <catch_psi_struct> (if CATCH) |
| 0 | 80 | <cross_psi_struct> (if XSECT or USERV) |
| 0 | 48 | <fcast_psi_struct> (if FCAST) |
| 0 | 20 | <maximum_psi_struct> (if MAX) |
| 0 | 2 | <ppi_psi_struct> (if PPI) |
| 0 | 24 | <rain_psi_struct> (if RAIN1 or RAINN) |
| 0 | 20 | <raw_psi_struct> (if RAW) |
| 0 | 2 | <rhi_psi_struct> (if RHI) |
| 0 | 28 | <shear_psi_struct> (if SHEAR) |
| 0 | 60 | <sline_psi_struct> (if SLINE) |

| | | |
|---|---|---|
| 0 | 14 | <tdwr_psi_struct> (if TDWR) |
| 0 | 6 | <top_psi_struct> (if TOPS, BASE, HMAX, or THICK) |
| 0 | 52 | <track_psi_struct> (if TRACK) |
| 0 | 16 | <vad_psi_struct> (if VAD) |
| 0 | 4 | <vil_psi_struct> (if VIL) |
| 0 | 28 | <vvp_psi_struct> (if VVP) |
| 0 | 80 | <warn_psi_struct> (if WARN) |
| 0 | 40 | <wind_psi_struct> (if WIND) |
| 0 | 80 | <spare> (if USER, OTHER, TEXT) |

## 4.2.28 protect_setup Structure

Source: `setup.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | 1024 | <one_protected_region>[32] Protected region definitions |

## 4.2.29 rain_psi_struct Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | UINT4 | Minimum Z to accumulate (in 2-byte Reflectivity Format) |
| 4 | UINT2 | Average gage correction factor |
| 6 | UINT2 | Seconds of accumulation (Starting at 8.09) |
| 8 | UINT2 | Flag word: Bit0: Apply clutter map<br>Bit1: Apply gage correction<br>Bit2: Clutter map was applied<br>Bit3: Gage correction was applied |
| 10 | SINT2 | Number of hours to accumulate (RAINN only) |
| 12 | char[12] | Name of input product to use (space padded) |
| 24 | UINT4 | From 8.09: Span in seconds of the input files |

## 4.2.30 raw_prod_bhdr Structure

Source: `product.h`

| Byte | Size | Contents |
|---|---|---|

| | | |
|---|---|---|
| 0 | SINT2 | Record number within the file (origin 0: record 3 contains a 2) |
| 2 | SINT2 | Sweep number (1 is first sweep) |
| 4 | SINT2 | Byte offset of first full ray in this record (-1 if none) |
| 6 | SINT2 | Ray number within sweep for above pointed to ray |
| 8 | UINT2 | Flags |
| 10 | 2 | <spare> |

## 4.2.31 raw_psi_struct Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | UINT4 | Data type mask word 0 |
| 4 | SINT4 | Range of last bin in cm |
| 8 | UINT4 | Format conversion flag:<br>0=Preserve all ingest data<br>1=Convert 8-bit data to 16-bit data<br>2=Convert 16-bit data to 8-bit data |
| 12 | UINT4 | Flag word:<br>Bit 0=Separate product files by sweep<br>Bit 1=Mask data by supplied mask |
| 16 | SINT4 | Sweep number if separate files, origin 1 |
| 20 | 4 | Xhdr type (unused) |
| 24 | 4 | Data type mask 1 |
| 28 | 4 | Data type mask 2 |
| 32 | 4 | Data type mask 3 |
| 36 | 4 | Data type mask 4 |
| 40 | 4 | Playback version (low 16-bits) |

## 4.2.32 ray_header Structure

Source: `ingest.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | BIN2 | Azimuth at beginning of ray (binary angle)<br>If dual-PRF: bit0=ray's PRF was high |
| 2 | BIN2 | Elevation at beginning of ray (binary angle)<br>If trigger blanking on: bit0=Trigger was not blanked |

| | | |
|---|---|---|
| 4 | BIN2 | Azimuth at end of ray (binary angle) |
| 6 | BIN2 | Elevation at end of ray (binary angle) |
| 8 | SINT2 | Actual number of bins in the ray |
| 10 | UINT2 | Time in seconds from start of sweep (unsigned) |

## 4.2.33 rhi_psi_struct Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | BIN2 | Azimuth angle |

## 4.2.34 rti_psi_struct Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | BIN4 | Nominal sweep angle |
| 4 | UINT4 | Starting time offset from sweep time, ms |
| 8 | UINT4 | Ending time offset |
| 12 | BIN4 | Azimuth of the first ray in the file |
| 16 | BIN4 | Elevation of the first ray in the file |

## 4.2.35 shear_psi_struct Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | BIN4 | Azimuthal smoothing angle |
| 4 | BIN2 | Elevation angle |
| 6 | 2 | <spare> |
| 8 | UINT4 | Flag word:<br>Bit0=Do radial shear<br>Bit1=Do azimuthal shear<br>Bit2=Do mean wind correction to azimuthal shear using VVP<br>Bit3=Mean wind correction to azimuthal shear done<br>Bit4=Unfolding done in associated VVP product<br>Bit5=Do elevation shear |
| 12 | char[12] | Name of VVP product to use (space padded) |
| 24 | UINT4 | Maximum age of VVP to use (seconds) |

## 4.2.36 sline_psi_struct Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | SINT4 | Area in square meters |
| 4 | SINT4 | Shear threshold (cm/sec/km) |
| 8 | UINT4 | Bit flags to choose protected areas |
| 12 | SINT4 | Maximum forecast time in seconds |
| 16 | UINT4 | Maximum age between products for motion calculation |
| 20 | SINT4 | Maximum velocity allowed (mm/sec) |
| 24 | UINT4 | Flag word:<br>Bit0=Do radial shear<br>Bit1=Do azimuthal shear (both bits mean do combined)<br>Bit2=Do mean wind correction to azimuth shear using VVP<br>Bit3=Mean wind correction to azimuthal shear done<br>Bit4=Unfolding done in associated VVP product<br>Bit8=Use two elevation angles<br>Bit9=Generate diagnostic output<br>Bit10=Max centroid count exceeded |
| 28 | BIN4 | Azimuthal smoothing angle (0=none) |
| 32 | BIN4 | Elevation binary angle |
| 36 | BIN4 | Elevation binary angle |
| 40 | char[12] | Name of VVP task |
| 52 | UINT4 | Maximum age of VVP in seconds |
| 56 | SINT4 | Curve fit standard deviation threshold in cm. |
| 60 | UINT4 | Low byte: Min length of sline (unsigned 1/10 km) |

## 4.2.37 sline_results Structure

Source: `product.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | SINT4 | East coordinate of center point, cm |
| 4 | SINT4 | North coordinate of center point, cm |
| 8 | BIN4 | Rotation angle to X-Y coordinates of curve fit polynomial Span is -90 to +90 degrees. |
| 12 | SINT4 | X coordinate of left of curve, cm |
| 16 | SINT4 | X coordinate of right of curve, cm |

| | | |
|---|---|---|
| 20 | SINT4[6] | 6 polynomial coefficients |
| 44 | SINT4 | Standard deviation of fit |
| 48 | SINT4 | Propagation speed (mm/second) |
| 52 | BIN4 | Propagation direction (binary angle) |
| 56 | SINT4 | Reference side wind speed (mm/second) |
| 60 | BIN4 | Reference side wind direction (binary angle) |
| 64 | SINT4 | Other side wind speed (mm/second) |
| 68 | BIN4 | Other side wind direction (binary angle) |
| 72 | SINT4[32] | ETA in seconds for each protected area (0 if in area, -1 if not expected) |
| 200 | UINT4 | Flags:<br>Bit0=Propagation speed available<br>Bit1=Wind speeds valid |
| 204 | 796 | <spare> |

The polynomial curve fit is calculated as follows: First, threshold a shear product based on the shear threshold specified in the product configuration. Let *East* and *North* refer to the distance of the center of each pixel from the radar position in centimeters. This coordinate system is rotated by an angle θ clockwise about the radar location to produce a new coordinate system with distances also in centimeters. This is the "Rotation angle to X-Y coordinates of curve fit polynomial" above. I use the variables X and Y in this coordinate system. The equations for the transformation are:

$$X = North\sin\theta + East\cos\theta$$

$$Y = North\cos\theta - East\sin\theta$$

Call this transformation $T_{\text{rotate}}$, and the reverse transformation $T^{-1}_{\text{rotate}}$.

In this coordinate system, I will call the *X*-coordinate of the left most end of the line $X_l$ and similarly the right most end $X_r$. Next we shift and scale the coordinate system to keep the polynomial coefficients from becoming too large. The equations for the transformation are:

$$X' = \frac{X - X_l}{X_r - X_l}$$

$$Y' = Y$$

Call this transformation $T_{\text{scale}}$, and the reverse transformation $T^{-1}_{\text{scale}}$.

In this new coordinate system, the polynomial is simple to express:

$$Y' = A_0 + A_1X' + A_2X'^2 + A_3X'^3 + A_4X'^4 + A_5X'^5$$

or

$$Y' = P[X']$$

The standard standard deviation is computed as follows: Let $[X'_i, Y'_i]$ represent the *i*th point in the data set in the rotated and scaled coordinate system, and *N* the total number of points, then the standard deviation is:

$$standard\ deviation = \sqrt{\frac{1}{N} \sum_{i=1,N} [Y'_i - P[X'_i]]^2}$$

The center point is computed as follows: Let $[East_i, North_i]$ represent the *i*th point in the data set in the original coordinate system, and *N* the total number of points, then the center point is:

$$East\ center = \frac{1}{N} \sum_{i = 1, N} East_i$$

$$North\ center = \frac{1}{N} \sum_{i = 1, N} North_i$$

## 4.2.38 mlhgt_psi_struct Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | unit32_t | Flag word:<br><br>Bit 0: localize observed BB altitudes<br>Bit 1: the product is processed from RHI scans<br>Bit 2: extrapolate promptly to fair weather areas<br>Bit 3: arrangement to display confidence levels interleaved with data |
| 4 | int16_t | Momentary ML altitude averaged through the product area [m] (MSL) |
| 8 | int16_t | Interval of acceptable ML altitudes, from climatology [m] |
| 12 | int16_t | Vertical spacing in the likelihood grid [m] |
| 16 | uint16_t | Number of Az sectors in the internal polar grid |

| | | |
|---|---|---|
| 20 | uint32_t | Relaxation time of the MLHGT confidence (exponential decay) [seconds] |
| 24 | uint16_t | Modeled fraction of the correct Melt classifications [1/(256*256)] |
| 28 | uint16_t | Modeled fraction of the correct NoMelt classifications [1/(256*256)] |
| 32 | uint16_t | Minimum confidence for acceptance to a local cluster [DB_LDR] |

### 4.2.39 sri_psi_struct Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | UINT4 | Flags<br>Bit 0=Do profile correction<br>Bit 3& 4: Melt src: 0=Ingest, 1=Setup, 2=TypeIn<br>Bit 5=Check for convection |
| 4 | SINT4 | Total number of bins inserted |
| 8 | SINT4 | Number of bins with data |
| 12 | SINT4 | Number of data bins profile corrected |
| 16 | SINT2 | Surface height (m above reference) |
| 18 | SINT2 | Maximum height (m above reference) |
| 20 | SINT2 | Melting height (m above MSL) |
| 22 | SINT2 | Melting level thickness (m) |
| 24 | SINT2 | Gradient above melting (1/100 dB/km) |
| 26 | SINT2 | Gradient below melting (1/100 dB/km) |
| 28 | SINT2 | Convective check height (m above melting) |
| 30 | SINT2 | Convective check level (DB_DBZ2 format) |

### 4.2.40 status_antenna_info Structure

Source: `product.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | BIN4 | Azimuth position |
| 4 | BIN4 | Elevation position |
| 8 | UINT4 | Azimuth velocity |
| 12 | UINT4 | Elevation velocity |
| 16 | UINT4 | Command bits |
| 20 | UINT4 | Command bit availability mask |
| 24 | UINT4 | Status bits |

| | | |
|---|---|---|
| 28 | UINT4 | Status bit availability mask |
| 32 | UINT4 | Bite fault flag, 0=OK, 1=Fault, 2=Critical |
| 36 | SINT4 | Lowest field number generating a fault |
| 40 | UINT4 | Status bits which can cause critical faults |
| UINT4[3] | Mask indicating the state of each BITE field | 44 |
| 56 | UINT4[3] | Mask indicating which BITE fields are faulted |
| 68 | 32 | <spare> |

## 4.2.41 status_device_info Structure

Source: `product.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | 40 | <status_one_device> dsp |
| 40 | 40 | <status_one_device> antenna |
| 80 | 720 | <status_one_device>[18] output devices |

## 4.2.42 status_message_info Structure

Source: `product.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | SINT4 | Message count |
| 4 | MESSAGE | Actual message number |
| 8 | SINT4 | Number of times it was repeated |
| 12 | char[16] | Process name, null terminated |
| 28 | char[80] | Text of message, null terminated |
| 108 | char[32] | Name of signal, null terminated |
| 140 | 20 | <serv_ymds_time> Time of message (TZ flexible) |
| 160 | UINT4 | Message type: 1=info, 2=normal, 3=say |
| 164 | 36 | <spare> |

## 4.2.43 status_misc_info Structure

Source: `product.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | char[16] | Radar status configuration name, null terminated |
| 16 | char[16] | Task configuration name, null terminated |
| 32 | char[16] | Product scheduler configuration name, null terminated |
| 48 | char[16] | Product output configuration name, null terminated |
| 64 | char[16] | Active task name, null terminated |
| 80 | char[16] | Active product name, null terminated |
| 96 | UINT4 | Site type (IRIS style) |
| 100 | SINT4 | Number of incoming network connects |
| 104 | SINT4 | Number of IRIS clients connected |
| 108 | 4 | <spare> |
| 112 | SINT4 | Number of output devices |
| 116 | UINT4 | Flags: bit 0=Automatic mode switching is enabled<br>bit 1=Regular Fault<br>bit 2=Critical Fault<br>bit 3=Regular message fault<br>bit 4=Critical message fault |
| 120 | char[4] | Node status fault site |
| 124 | 12 | <ymds_time> Time of active task (TZ flexible) |
| 136 | 64 | <spare> |

## 4.2.44 status_one_device Structure

Source: `product.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | UINT4 | Device type |
| 4 | SINT4 | Unit number |
| 8 | UINT4 | Status |
| 12 | 4 | <spare> |
| 16 | UINT4 | Mode from process table |
| 20 | char[16] | String (null terminated) |
| 36 | 4 | <spare> |

### 4.2.45 status_one_process Structure

Source: `product.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | UINT4 | Command |
| 4 | UINT4 | Mode |
| 8 | 12 | <spare> |

### 4.2.46 status_process_info Structure

Source: `product.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | 20 | <status_one_process> Ingest process |
| 20 | 20 | <status_one_process> Ingfio process |
| 40 | 20 | <spare> |
| 60 | 20 | <status_one_process> Output master process |
| 80 | 20 | <status_one_process> Product process |
| 100 | 20 | <status_one_process> Watchdog process |
| 120 | 20 | <status_one_process> Reingest process |
| 140 | 20 | <status_one_process> Network process |
| 160 | 20 | <status_one_process> Nordrad process |
| 180 | 20 | <status_one_process> Server process |
| 200 | 20 | <status_one_process> RibBuild process |
| 220 | 180 | <spare> |

### 4.2.47 status_results Structure

Source: `product.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | 200 | <status_misc_info> Miscellaneous info |
| 200 | 400 | <status_process_info> Status of processes |
| 600 | 800 | <status_device_info> Status of devices |
| 1400 | 100 | <status_antenna_info> Status of antenna |
| 1500 | 200 | <status_message_info> Message information |

## 4.2.48 structure_header Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | SINT2 | Structure identifier:<br>Value; Description<br>22 Task_configuration<br>23 Ingest_header<br>24 Ingest_data_header<br>25 Tape_inventory<br>26 Product_configuration<br>27 Product_hdr<br>28 Tape_header_record |
| 2 | SINT2 | Format version number (see headers.h) |
| 4 | SINT4 | Number of bytes in the entire structure |
| 8 | SINT2 | Reserved |
| 10 | SINT2 | Flags: bit0=structure complete |

## 4.2.49 tape_header_record Structure

Source: `output.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | 12 | <structure_header> |
| 12 | char[16] | Tape identification name |
| 28 | char[16] | Name of site that created tape |
| 44 | 12 | <ymds_time> Time that the tape was created (TZ flexible) |
| 56 | 4 | <spare> |
| 60 | char[8] | IRIS version when tape was initialized |
| 68 | 252 | <spare> |

## 4.2.50 task_calib_info Structure

Source: `iris_task.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | SINT2 | Reflectivity slope (4096*dB/ A/D count) |
| 2 | SINT2 | Reflectivity noise threshold (1/16 dB above Noise) |
| 4 | SINT2 | Clutter Correction threshold (1/16 dB) |

| | | |
|---|---|---|
| 6 | SINT2 | SQI threshold (0–1)*256 |
| 8 | SINT2 | Power threshold (1/16 dBZ) |
| 10 | 8 | <spare> |
| 18 | SINT2 | Calibration Reflectivity (1/16 dBZ at 1 km) |
| 20 | UINT2 | Threshold flags for uncorrected reflectivity |
| 22 | UINT2 | Threshold flags for corrected reflectivity |
| 24 | UINT2 | Threshold flags for velocity |
| 26 | UINT2 | Threshold flags for width |
| 28 | UINT2 | Threshold flags for ZDR |
| 30 | 6 | <spare> |
| 36 | UINT2 | Flags:<br>Bit 0: Speckle remover for log channel<br>Bit 3: Speckle remover for linear channel<br>Bit 4: Flag to indicate data is range normalized<br>Bit 5: Flag to indicate pulse at beginning of ray<br>Bit 6: Flag to indicate pulse at end of ray<br>Bit 7: Vary number of pulses in dual PRF<br>Bit 8: Use 3 lag processing in PP02<br>Bit 9: Apply velocity correction for ship motion<br>Bit 10: Vc is unfolded<br>Bit 11: Vc has fallspeed correction<br>Bit 12: Zc has beam blockage correction<br>Bit 13: Zc has Z-based attenuation correction<br>Bit 14: Zc has target detection<br>Bit 15: Vc has storm relative velocity correction |
| 38 | 2 | <spare> |
| 40 | SINT2 | LDR bias in signed 1/100 dB |
| 42 | SINT2 | ZDR bias in signed 1/16 dB |
| 44 | SINT2 | NEXRAD point clutter threshold in 1/100 of dB |
| 46 | UINT2 | NEXRAD point clutter bin skip in low 4 bits |
| 48 | SINT2 | I0 cal value, horizontal pol, in 1/100 dBm |
| 50 | SINT2 | I0 cal value, vertical pol, in 1/100 dBm |
| 52 | SINT2 | Noise at calibration, horizontal pol, in 1/100 dBm |
| 54 | SINT2 | Noise at calibration, vertical pol, in 1/100 dBm |
| 56 | SINT2 | Radar constant, horizontal pol, in 1/100 dB |
| 58 | SINT2 | Radar constant, vertical pol, in 1/100 dB |
| 60 | UINT2 | Receiver bandwidth in kHz |
| 62 | uint16_t | Flags2:<br>Bit 0: Zc and ZDRc has DP attenuation correction<br>Bit 1: Z and ZDR has DP attenuation correction |
| 64 | 256 | <spare> |

## 4.2.51 task_configuration Structure

Source: `iris_task.h`

| |
|---|
| <structure_header>(4.2.48 structure_header Structure on page 61) 12 Bytes |
| <task_sched_info>(4.2.62 task_sched_info Structure on page 67) 120 Bytes |
| <task_dsp_info>(4.2.52 task_dsp_info Structure on page 63) 320 Bytes |
| <task_calib_info>(4.2.50 task_calib_info Structure on page 61) 320 Bytes |
| <task_range_info>(4.2.59 task_range_info Structure on page 66) 160 Bytes |
| <task_scan_info>(4.2.61 task_scan_info Structure on page 67) 320 Bytes |
| <task_misc_info>(4.2.57 task_misc_info Structure on page 65) 320 Bytes |
| <task_end_info>(4.2.54 task_end_info Structure on page 64) 320 Bytes |
| Comments 720 Bytes |

## 4.2.52 task_dsp_info Structure

Source: `iris_task.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | UINT2 | Major mode |
| 2 | UINT2 | DSP type |
| 4 | 24 | <dsp_data_mask> (4.2.7 dsp_data_mask Structure on page 36) Current Data type mask |
| 28 | 24 | <dsp_data_mask> (4.2.7 dsp_data_mask Structure on page 36) Original Data type mask |
| If Batch Major mode: | | |
| 52 | 32 | <task_dsp_mode_batch> |
| Else: | | |
| 52 | 32 | <task_dsp_mode_other> |
| 84 | 52 | <spare> |
| 136 | SINT4 | PRF in Hertz |
| 140 | SINT4 | Pulse width in 1/100 of microseconds |
| 144 | UINT2 | Multi PRF mode flag: 0=1:1, 1=2:3, 2=3:4, 3=4:5 |
| 146 | SINT2 | Dual PRF delay |
| 148 | UINT2 | AGC feedback code |
| 150 | SINT2 | Sample size |
| 152 | UINT2 | Gain Control flag (0=fixed, 1=STC, 2=AGC) |
| 154 | char[12] | Name of file used for clutter filter |
| 166 | UINT1 | Linear based filter number for first bin |
| 167 | UINT1 | Log based filter number for first bin |
| 168 | SINT2 | Attenuation in 1/10 dB applied in fixed gain mode |
| 170 | UINT2 | Gas attenuation in 1/100000 dB/km for first 10000, then stepping in 1/10000 dB/km |

| | | |
|---|---|---|
| 172 | UINT2 | Flag nonzero means cluttermap used |
| 174 | UINT2 | XMT phase sequence: 0:Fixed, 1:Random, 3:SZ8/64 |
| 176 | UINT4 | Mask used for to configure the ray header. |
| 180 | UINT2 | Time series playback flags, see OPTS_* in dsp.h |
| 182 | 2 | <spare> |
| 184 | char[16] | Name of custom ray header |
| 200 | 120 | <spare> |

### 4.2.53 task_dsp_mode_batch Structure

Source: `iris_task.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | UINT2 | Low PRF in Hz |
| 2 | UINT2 | Low PRF fraction part, scaled by 2**–16 |
| 4 | SINT2 | Low PRF sample size |
| 6 | SINT2 | Low PRF range averaging in bins |
| 8 | SINT2 | Theshold for reflectivity unfolding in 1/100 of dB |
| 10 | SINT2 | Threshold for velocity unfolding in 1/100 of dB |
| 12 | SINT2 | Threshold for width unfolding in 1/100 of dB |
| 14 | 18 | <spare> |

### 4.2.54 task_end_info Structure

Source: `iris_task.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | SINT2 | Task major number |
| 2 | SINT2 | Task minor number |
| 4 | char[12] | Name of task configuration file |
| 16 | char[80] | Task description |
| 96 | SINT4 | Number of tasks in hybrid task |
| 100 | UINT2 | Task state: 0=no task; 1=task being modified; 2=inactive; 3=scheduled, 4=running. |
| 102 | 2 | <spare> |
| 104 | 12 | <ymds_time> Data time of task (TZ flexible) |
| 116 | UINT1[6] | Identifiers of the echo classifiers in the HCLASS bit segments |
| 122 | 198 | <spare> |

## 4.2.55 task_file_scan_info Structure

Source: `iris_task.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | UINT2 | First azimuth angle (binary angle) |
| 2 | UINT2 | First elevation angle (binary angle) |
| 4 | char[12] | Filename for antenna control |
| 16 | 184 | <spare> |

## 4.2.56 task_manual_scan_info Structure

Source: `iris_task.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | UINT2 | Flags: bit 0=Continuous recording |
| 2 | 198 | <spare> |

## 4.2.57 task_misc_info Structure

Source: `iris_task.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | SINT4 | Wavelength in 1/100 of cm |
| 4 | char[16] | T/R Serial Number |
| 20 | SINT4 | Transmit Power in watts |
| 24 | UINT2 | Flags:<br>Bit 0: Digital signal simulator in use<br>Bit 1: Polarization in use<br>Bit 4: Keep bit |
| 26 | UINT2 | Type of polarization |
| 28 | SINT4 | Truncation height (centimeters above the radar) |
| 32 | 18 | <spare for polarization spec> |
| 50 | 12 | <spare> |
| 62 | SINT2 | Number of bytes of comments entered |
| 64 | BIN4 | Horizontal beamwidth (binary angle, starting in 7.18) |
| 68 | BIN4 | Vertical beamwidth (binary angle, starting in 7.18) |
| 72 | UINT4[10] | Customer defined storage (starting in 7.27) |
| 112 | 208 | <spare> |

## 4.2.58 task_ppi_scan_info Structure

Source: `iris_task.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | BIN2 | Left azimuth limit (binary angle, only for sector) |
| 2 | BIN2 | Right azimuth limit (binary angle, only for sector) |
| 4 | UINT2[40] | List of elevations (binary angles) to scan at |
| 84 | 115 | <spare> |
| 199 | 1 | Start of first sector sweep: 0=Nearest, 1=Left, 2=Right Sector sweeps alternate in direction.s |

## 4.2.59 task_range_info Structure

Source: `iris_task.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | SINT4 | Range of first bin in centimeters |
| 4 | SINT4 | Range of last bin in centimeters |
| 8 | SINT2 | Number of input bins |
| 10 | SINT2 | Number of output range bins |
| 12 | SINT4 | Step between input bins |
| 16 | SINT4 | Step between output bins (in centimeters) |
| 20 | UINT2 | Flag for variable range bin spacing (1=var, 0=fixed) |
| 22 | SINT2 | Range bin averaging flag |
| 24 | 136 | <spare> |

## 4.2.60 task_rhi_scan_info Structure

Source: `iris_task.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | UINT2 | Lower elevation limit (binary angle, only for sector) |
| 2 | UINT2 | Upper elevation limit (binary angle, only for sector) |
| 4 | UINT2[40] | List of azimuths (binary angles) to scan at |
| 84 | 115 | <spare> |
| 199 | 1 | Start of first sector sweep: 0=Nearest, 1=Lower, 2=Upper Sector sweeps alternate in direction. |

## 4.2.61 task_scan_info Structure

Source: `iris_task.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | UINT2 | Antenna scan mode<br>1:PPI sector, 2:RHI, 3:Manual, 4:PPI cont, 5:file |
| 2 | SINT2 | Desired angular resolution in 1/1000 of degrees |
| 4 | 2 | <spare> |
| 6 | SINT2 | Number of sweeps to perform |
| If RHI scan: | | |
| 8 | 200 | <task_rhi_scan_info> |
| If PPI sector, or PPI continuous scan: | | |
| 8 | 200 | <task_ppi_scan_info> |
| If File scan: | | |
| 8 | 200 | <task_file_scan_info> |
| If PPI Manual or RHI Manual scan: | | |
| 8 | 200 | <task_manual_scan_info> |
| In all cases: | | |
| 208 | 112 | <spare> |

## 4.2.62 task_sched_info Structure

Source: `iris_task.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | SINT4 | Start time (seconds within a day) |
| 4 | SINT4 | Stop time (seconds within a day) |
| 8 | SINT4 | Desired skip time (seconds) |
| 12 | SINT4 | Time last run (seconds within a day)(0 for passive ingest) |
| 16 | SINT4 | Time used on last run (seconds) (in file time to writeout) |
| 20 | SINT4 | Relative day of last run (zero for passive ingest) |
| 24 | UINT2 | Flag: Bit 0 = ASAP<br>Bit 1 = Mandatory<br>Bit 2 = Late skip<br>Bit 3 = Time used has been measured<br>Bit 4 = Stop after running |
| 26 | 94 | <spare> |

## 4.2.63 tdwr_psi_struct Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | UINT4 | Flags, bit0=LLWAS, bit1=WARN, bit2=SLINE |
| 4 | UINT4 | Maximum range in cm |
| 8 | char[4] | Source ID |
| 12 | char[3] | Center field wind direction |
| 15 | UINT1 | <spare> |
| 16 | char[2] | Center field wind speed |
| 18 | char[2] | Center field gust speed |
| 20 | UINT4 | Mask of protected areas checked |
| 24 | UINT4 | Warning count |
| 28 | UINT4 | SLINE count |
| 32 | UINT4 | Forecast time |

## 4.2.64 tdwr_results Structure

Source: `product.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | char[16] | Corridor name, null terminated |
| 16 | char[8] | Arena Name, null terminated |
| 24 | char[3] | Alert Type |
| 27 | 1 | <spare> |
| 28 | char[3] | Threshold direction |
| 31 | 1 | <spare> |
| 32 | char[2] | Threshold speed |
| 34 | 2 | <spare> |
| 36 | SINT4 | Alert speed loss/gain in mm/sec, negative=loss |
| 40 | UINT4 | Mask of protected areas checked for this corridor |
| 44 | UINT4 | Mask of protected areas hit in this corridor |
| 48 | 52 | <spare> |

## 4.2.65 text_results Structure

Source: `product.h`

| Byte | Size | Contents |
|---|---|---|

| | | |
|---|---|---|
| 0 | char[512] | null terminated string of arbitrary text to be spoken by IRIS |

## 4.2.66 top_psi_struct Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | uint32_t | Flags:<br>Bit 0: For THICK product only, make pseudo thickness |
| 4 | int16_t | Z threshold in 1/16 dBZ |

## 4.2.67 track_psi_struct Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | SINT4 | Centroid area threshold in square meters |
| 4 | SINT4 | Threshold level for centroid |
| 8 | UINT4 | Protected area mask |
| 12 | SINT4 | Maximum forecast time in seconds |
| 16 | UINT4 | Maximum age between products for motion calculation |
| 20 | SINT4 | Maximum motion allowed in mm/sec |
| 24 | UINT4 | Flag word: Bit9=Generate diagnostic output |
| 28 | SINT4 | Maximum span of track points in the file (seconds) |
| 32 | UINT4 | Input product type |
| 36 | char[12] | Input product name |
| 48 | SINT4 | Point connecting error allowance |

## 4.2.68 track_results Structure

Source: `product.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | BIN4 | Latitude (32-bit binary angle) |
| 4 | BIN4 | Longitude |
| 8 | SINT4 | Height (cm. above reference) |

| | | |
|---|---|---|
| 12 | UINT4 | Flags: bit0=forecast, bit1=manual, bit2=text, bit3=icon |
| 16 | SINT4 | Area of centroid (1/100 of square km) |
| 20 | SINT4 | Major axis of equal area ellipse (cm) |
| 24 | SINT4 | Minor axis of equal area ellipse (cm) |
| 28 | BIN4 | Orientation angle of ellipse |
| 32 | UINT4 | Protected area mask of areas hit |
| 36 | SINT4 | Maximum value of data within area |
| 40 | 8 | <spare> |
| 48 | SINT4 | Average value of data within area |
| 52 | 8 | <spare> |
| 60 | SINT4 | Scale factor of input data |
| 64 | SINT4 | Track index number |
| 68 | char[32] | Text |
| 100 | 12 | <ymds_time> Time (TZ flexible) |
| 112 | SINT4[32] | ETA in seconds for each protected area (0 if in area, -1 if not expected) |
| 240 | UINT4 | Data type of input data |
| 244 | 8 | <spare> |
| 252 | SINT4 | Propagation speed (mm/second) |
| 256 | BIN4 | Propagation direction (binary angle) |
| 260 | UINT4 | Text size |
| 264 | UINT4 | Color |
| 268 | 32 | <spare> |

## 4.2.69 vad_psi_struct Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | int32_t | Minimum slant range in cm. |
| 4 | int32_t | Maximum slant range in cm. |
| 8 | uint32_t | Flags:<br>Bit 0: Unfold based on VVP product |
| 12 | uint32_t | Count of the number of elevation angles in the file |

## 4.2.70 vad_results Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|

| | | |
|---|---|---|
| 0 | BIN2 | Elevation angle |
| 2 | BIN2 | Azimuth angle |
| 4 | uint16_t | Count of the number of bins averaged |
| 6 | uint16_t | Average velocity (DB_VEL2 format) |
| 8 | uint16_t | Standard deviation (cm/sec) |
| 10 | uint16_t | Elevation index, origin 0 |
| 12 | 8 | <spare> |

## 4.2.71 vvp_psi_struct Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | SINT4 | Minimum range to process in cm |
| 4 | SINT4 | Maximum range to process in cm |
| 8 | SINT4 | Minimum height to process (cm above reference) |
| 12 | SINT4 | Maximum height to process (cm above reference) |
| 16 | SINT2 | Number of intervals to process at |
| 18 | uint16_t | Minimum velocity (cm/sec) (version 8.13 and later, previously 0.02 times nyquist) |
| 20 | SINT4 | Quota number of bins per interval |
| 24 | SINT4 | Wind parameters mask.<br>See bits defined in vvp_results structure below. |

## 4.2.72 vvp_results Structure

Source: `product.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | SINT4 | Number of data points used |
| 4 | SINT4 | Height of the center of interval (cm above reference) |
| 8 | SINT4 | Number of reflectivity data points used |
| 12 | 8 | <spare> |
| | | Bit Description |
| 20 | SINT2 | 0 Wind speed in cm/sec |
| 22 | SINT2 | 1 Wind speed standard deviation |
| 24 | SINT2 | 2 Wind direction in 1/10 of degrees |
| 26 | SINT2 | 3 Wind direction standard deviation |
| 28 | SINT2 | 4 Vertical wind speed in cm/sec |
| 30 | SINT2 | 5 Vertical wind speed standard deviation |

| | | |
|---|---|---|
| 32 | SINT2 | 6 Horizontal divergence in 10**–7/sec |
| 34 | SINT2 | 7 Horizontal divergence standard deviation |
| 36 | SINT2 | 8 Radial velocity standard deviation |
| 38 | SINT2 | 9 Linear averaged reflectivity (DB_CDBZ2 format) |
| 40 | SINT2 | 10 Log averaged reflectivity standard deviation |
| 42 | SINT2 | 11 Deformation in 10**–7/sec |
| 44 | SINT2 | 12 Deformation standard deviation |
| 46 | SINT2 | 13 Axis of dilatation in 1/10 of degrees |
| 48 | SINT2 | 14 Axis of dilatation standard deviation |
| 50 | SINT2 | 15 Log averaged reflectivity (DB_CDBZ2 format) |
| 52 | SINT2 | 16 Linear averaged reflectivity standard deviation |
| 54 | 30 | <spare> |

## 4.2.73 warn_psi_struct Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | SINT4 | Centroid area threshold in square meters |
| 4 | SINT4[3] | Threshold levels (1/100 of user units) |
| 16 | SINT2[3] | Data valid times (seconds) |
| 22 | 2 | <spare> |
| 24 | char[12] | Symbol to display |
| 36 | char[36] | Names of the product files |
| 72 | UINT1[3] | Product types |
| 75 | char[1] | <spare> |
| 76 | UINT4 | Protected area bit flag |

## 4.2.74 warning_results Structure

Source: `product.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | BIN4 | Latitude (32-bit binary angle) |
| 4 | BIN4 | Longitude |
| 8 | SINT4 | Height (cm above reference) |
| 12 | UINT4 | Flags: Bit 0: Skip data label |
| 16 | SINT4 | Area of centroid (1/100 of square km) |
| 20 | SINT4 | Major axis of equal area ellipse (cm) |

| | | |
|---|---|---|
| 24 | SINT4 | Minor axis of equal area ellipse (cm) |
| 28 | BIN4 | Orientation angle of ellipse |
| 32 | UINT4 | Protected area mask of areas hit |
| 36 | SINT4[3] | Maximum value of data within the area (1/100 of user units) |
| 48 | SINT4[3] | Average value of data within the area (1/100 of user units) |
| 60 | SINT4 | Scale factor of input data |
| 64 | 4 | <spare> |
| 68 | char[16] | Text, null-terminated |
| 84 | 156 | <spare> |
| 240 | UINT4[3] | Data type of input data |
| 252 | SINT4 | Propagation speed (mm/second) |
| 256 | BIN4 | Propagation direction (binary angle) |
| 260 | 40 | <spare> |

## 4.2.75 wind_psi_struct Structure

Source: `headers.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | SINT4 | Minimum height (cm above reference) |
| 4 | SINT4 | Maximum height (cm above reference) |
| 8 | SINT4 | Minimum range in cm |
| 12 | SINT4 | Maximum range in cm |
| 16 | SINT4 | Number of point in range |
| 20 | SINT4 | Number of points in panels |
| 24 | SINT4 | Sector length in cm |
| 28 | BIN4 | Sector width in binary angle |
| 32 | UINT4 | Flag word: bit0=Subtract mean wind |
| 36 | UINT4 | Wind parameters mask of included VVP |

## 4.2.76 wind_results Structure

Source: `product.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | SINT4 | Number of possible hits based on geometry |
| 4 | SINT4 | Number of data points actually used |
| 8 | SINT4 | Range of center of sector |
| 12 | BIN2 | Azimuth of center of sector |

| | | |
|---|---|---|
| 14 | SINT2 | Velocity East in cm/second |
| 16 | SINT2 | Velocity East standard deviation in cm/second |
| 18 | SINT2 | Velocity North in cm/second |
| 20 | SINT2 | Velocity North standard deviation in cm/second |
| 22 | 10 | <spare> |

### 4.2.77 ymds_time Structure

Source: `sigtypes.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | SINT4 | Seconds since midnight |
| 4 | UINT2 | Milliseconds in lower 10 bits.<br>Bit 10: Time is daylight savings time<br>Bit 11: Time is UTC<br>Bit 12: Local time is daylight savings time |
| 6 | SINT2 | Year |
| 8 | SINT2 | Month |
| 10 | SINT2 | Day |

## 4.3 Data Types

The following sections document the data formats for both ingest data (stored in the raw product) and other products. The data formats for reflectivity, velocity, width, and ZDR differ slightly in the two cases. When these data types are converted to a Cartesian product, the data values of 255 are replaced with 254, and 255 takes on the meaning of area not scanned. Polar data does not have this meaning. The name in parenthesis after each section title is the data type name used by IRIS to identify the data. Parameters for these numbers are defined in the sigtypes.h file.

### 4.3.1 Extended_Header Format (DB_XHDR)

The extended header is optionally recorded, as controlled by a question in Setup. There are two versions, either extended_header_v0 or extended_header_v1. Generally, the v1 version is used for moving-platform systems, such as on ships.

## 4.3.2 2-byte Axis of Dilliation Format (DB_AXDIL2)

The angle in degrees is stored as a signed number in tenths of degrees.

$$angle = \frac{N}{10}$$

| | |
|---|---|
| -1800 | -180.0 degrees |
| 0 | 0.0 degrees |
| 10 | 1.0 degree |

## 4.3.3 1-byte Reflectivity Format (DB_DBT& DB_DBZ)

For reflectivity data, the number in decibels is computed from the unsigned output with the formula:

$$dBZ = \frac{N-64}{2}$$

The overall range is from -31.5 dBZ to +95.5 dBZ in half dB steps as follows. In data product files, the value of 255 indicates areas not scanned.

| | **Ingest Data** | **Products** |
|---|---|---|
| 0 | No data available | No data available |
| 1 | -31.5 dBZ | -31.5 dBZ |
| 64 | 0.0 dBZ | 0.0 dBZ |
| 128 | 32.0 dBZ | 32.0 dBZ |
| 129 | 32.5 dBZ | 32.5 dBZ |
| 254 | 95.0 dBZ | 95.0 dBZ or above |
| 255 | 95.5 dBZ or above | Area not scanned |

## 4.3.4 2-byte Reflectivity Format (DB_DBT2& DB_DBZ2)

For reflectivity data, the number in decibels is computed from the unsigned output with:

$$dBZ = \frac{N-32768}{100}$$

The overall range is from -327.67 to +327.66 in 1/100 of a dB steps as follows.

| | |
|---|---|
| 0 | No data available |
| 1 | -327.67 dBZ |
| 32768 | 0.00 dBZ |
| 32769 | 0.01 dBZ |
| 65534 | 327.66 dBZ |
| 65535 | Reserved for area not scanned in product files |

## 4.3.5 2-byte Deformation Format (DB_DEFORM2)

Deformation is stored in a signed 16-bits number scaled to 10**-7. Only positive numbers are possible. These number are normally displayed in units of 10**-4.

| | |
|---|---|
| 0 | 0 deformation |
| 1 | 0.001 10**-4 deformation |
| 32766 | 32.766 10**-4 deformation |
| 32767 | Area not scanned |

## 4.3.6 2-byte Divergence Format (DB_DIVERGE2)

Divergence is stored in a signed 16-bits number scaled to 10**-7. Positive number indicate divergence while negative are convergence. These number are normally displayed in units of 10**-4.

| | |
|---|---|
| -32768 | 32.768 10**-4 convergence |
| 0 | 0 divergence |
| 1 | 0.001 10**-4 divergence |
| 32766 | 32.766 10**-4 divergence |
| 32767 | Area not scanned |

## 4.3.7 2-byte Floating Liquid Format (DB_FLIQUID2)

Rainfall accumulations are stored in 16-bit floating-point representation of a 27-bit integer in units of 0.001 mm. This product does not have a code for thresholded data, instead that area is assumed to have zero rain. The floating-point number consists of a 4-bit exponent in the high four bits, followed by a 12-bit mantissa. It uses implied digits and soft underflow. If the exponent is 0, the mantissa consists of the value. If the exponent is 1 through 15, the 12-bit mantissa has a 1 prefixed to it and is shifted up by one less than the exponent. The table below gives some examples:

| **Float** | | **Fixed** | **Meaning** |
|---|---|---|---|
| 0 | —> | 0 | 0.000 mm |
| 1 | —> | 1 | 0.001 mm |
| 255 | —> | 255 | 0.255 mm |
| 1000 | —> | 1000 | 1.000 mm |
| 9096 | —> | 10000 | 10.000 mm |
| 22634 | —> | 100000 | 100.000 mm |
| 34922 | —> | 800000 | 800.000 mm |
| 50000 | —> | 10125312 | 10125.312 mm |
| 65534 | —> | 134184960 | 134184.960 mm or above |
| 65535 | —> | | Area not scanned |

## 4.3.8 1-byte HydroClass Format (DB_HCLASS)

HydroClass consists of enumerated data to communicate echo identification results. The 1-byte data type can accommodate results from upto three independent identification methods or classification hypotheses, as described next. The decimal values of "0" (0x00) and "255" (0x255) are reserved for special uses of "No data" and "Area not scanned", respectively.

1-byte of binary DB_HCLASS data is split into three bit segments as follows:

```
 7  6  5  4  3  2  1  0 .
________________________
|  |  |  |  |  |  |  |  |
| C2  |    C1    |   C0   |
|_______________________|
```

Each segment can be associated with an identification method (echo classifier). The available classification methods are listed as enumerated logical names in the public IRIS/RDA header *sig_data_types.h*.

The bytes "Enums" of the task_dsp_info structure (see 4.2.52 task_dsp_info Structure on page 63) contain the list of classification methods (if any) that have been allocated to each bit segment of the HClass data. The information are associated to each IRIS RAW data file header, and can be inspected with the **productx** utility.

The bits in each segment are interpreted as an unsigned integer value belonging to an enumerated class type (the class base), specific to each classifier. The enumerated class types are defined in *sig_data_types.h*, too, by using unambiguous logical names that are short but meteorologically explicit.

For DB_HCLASS data generated with an IRIS/RDA version of 8.12.5 or older, all the values of DB_HCLASS (as well as DB_HCLASS2) in the range (1..7) are interpreted as classification results of the HydroClass (METEOCLASSIFIER). These results are stored in the first method space (C0), with the following logical names:

| | |
|---|---|
| DV_HCLASS_THRESHOLD | =0 No data available |
| DV_HCLASS_NON_MET | =1 Non-meteorological target |
| DV_HCLASS_RAIN | =2 Rain |
| DV_HCLASS_WET_SNOW | =3 Wet Snow |
| DV_HCLASS_SNOW | =4 Snow |
| DV_HCLASS_GRAUPEL | =5 Graupel |
| DV_HCLASS_HAIL | =6 Hail |
| | =7 Unused |

In the IRIS/RDA version 8.12.6 and later, the default configuration of IRIS/RDA delivers the following echo classification results (the configuration can be modified by settings in *dpolapp_*.conf*).

Method 1 - METEOCLASSIFIER (HydroClass):

| | |
|---|---|
| MET_CLASS_THRESHOLD | =0 No data available |
| MET_CLASS_NON_MET | =1 Non-meteorological target |
| MET_CLASS_RAIN | =2 Rain |
| MET_CLASS_WET_SNOW | =3 Wet Snow |
| MET_CLASS_SNOW | =4 Snow |
| MET_CLASS_GRAUPEL | =5 Graupel |
| MET_CLASS_HAIL | =6 Hail |
| | =7 Unused |

Method 2 - PRECIPCLASSIFIER:

| | |
|---|---|
| PRE_CLASS_THRESHOLD | =0 No data available |
| PRE_CLASS_GC_AP | =1 Ground clutter / anomalous propagation |
| PRE_CLASS_BIO | =2 Bio scatter |
| PRE_CLASS_PRECIP | =3 Precipitation |
| PRE_CLASS_LARGE_DROPS | =4 Large drops |
| PRE_CLASS_LIGHT_PRECIP | =5 Light precipitation |
| PRE_CLASS_MODERATE_PRECIP | =6 Moderate precipitation |
| PRE_CLASS_HEAVY_PRECIP | =7 Unused |

For PRECIPCLASSIFIER, the interpretations into classes  from "Large Drops" to "Heavy precipitaion"  are optional, available in case HClass PrecipClassifier is configured ON. Without PrecipClassifier, all precipitation are classified as "Precipitation".

Method 3 - CELLCLASSIFIER:

| | |
|---|---|
| CELL_CLASS_STRATIFORM | =0 Stratiform |
| CELL_CLASS_CONVECTION | =1 Convection |
| | =2 Unused |
| | =3 Forbidden |

The value 255 (0xFF) of DB_HCLASS is reserved for "area not scanned", and the use of value 3 (0x03) is forbidden in Method 3.

The methods METEO- and PRECIPCLASSIFIER are available both in RDA real-time ray level processing, as well as in IRIS reprocessing (reingest). CELLCLASSIFIER is available in IRIS post-processing, only, and its outcomes can be interpreted in the context of ray level classifications.

Further classification information may become available, which can be appended to HydroClass data of the 2-byte mode, see 4.3.9 2-byte HydroClass Format (DB_HCLASS2) on page 79.

## 4.3.9 2-byte HydroClass Format (DB_HCLASS2)

The interpretation of the eight least significant bits is the same as the 1-byte format, except that 65535 (0xFFFF) is used for "area not scanned". Currently available identification methods (as of IRIS/RDA 8.12.6) can be accomodated in the 8 least significant bits of DB_HCLASS2, see 4.3.8 1-byte HydroClass Format (DB_HCLASS) on page 77.

As default, the remaining 8 most significant bits of DB_HCLASS2 replicate the same formatting as the lower 1-byte bits, for support of three further identification methods. They are reserved for future uses, such as re-analysis of precipitation type at surface. It is also possible to merge the bit segments by combining the segments within the 8 most significant bits, multiplicatively. In that scenario, DB_HCLASS2 data type is capable of supporting a user specified identification method in large bases up to 7x7x3= 147 classes.

### 4.3.10 1-byte Echo Tops Format (DB_HEIGHT)

Echo tops are stored to the nearest 100 meters above the ground. Because 0 is the code for no data, values stored in the bytes can be converted to kilometers by subtracting 1 and dividing by 10. The value 254 indicates that an echo is known to exist from the data, but it could not be measured.

| | |
|---|---|
| 0 | No echo tops data available |
| 1 | 0.0 km |
| 128 | 12.7 km |
| 129 | 12.8 km |
| 253 | 25.2 km or above |
| 254 | Top exists above the maximum tilt |
| 255 | Area not scanned |

### 4.3.11 2-byte Horizontal wind direction Format (DB_HDIR2)

The angle in degrees is stored as a signed number in tenths of degrees.

$$angle = \frac{N}{10}$$

| | |
|---|---|
| -1800 | -180.0 degrees |
| 0 | 0.0 degrees |
| 10 | 1.0 degree |

## 4.3.12 1-byte KDP Format (DB_KDP)

Specific differential phase (KDP) is stored in a signed 8-bit number using a log scale. The KDP angles are multiplied by the wavelength in cm then scaled using a log scale separately for both signs. The minimum value is 0.25, and the maximum value is 150.0 deg*cm/km. KDP values are defined as the one-way differential effect of the intervening weather. The table below gives some examples:

$$KDP \times \lambda = minimum \times \left[\frac{minimum}{maximum}\right]^{\left[\frac{N-129}{126}\right]}$$

Here is the conversion equation for positive values (stored value above 128):

$$KDP \times \lambda = 0.25 \times 600^{\left[\frac{N-129}{126}\right]}$$

Here is the conversion equation for negative values (stored value below 128):

$$KDP \times \lambda = -\,0.25 \times 600^{\left[\frac{127-N}{126}\right]}$$

| Value | Meaning KDP*L | KDP for 10 cm | KDP for 5 cm |
|---|---|---|---|
| 0 | No data available | | |
| 1 | -150.00 deg*cm/km | -15.00 deg/km | -30.00 deg/km |
| 2 | -142.58 | -14.26 | -28.51 |
| 127 | -0.250 | -0.025 | -0.050 |
| 128 | 0.000 | 0.000 | 0.000 |
| 129 | 0.250 | 0.025 | 0.050 |
| 130 | 0.263 | 0.026 | 0.053 |
| 254 | 142.58 | 14.58 | 28.51 |
| 255 | Area not scanned | | |

## 4.3.13 2-byte KDP Format (DB_KDP2)

Specific differential phase (KDP) in degrees per kilometer is computed from the unsigned output with:

$$KDP = \frac{N-32768}{100}$$

The overall range is from -327.67 to +327.66 in 1/100 of a degree/ kilometer steps as follows.

| | |
|---|---|
| 0 | No data available |
| 1 | -327.67 deg/km |
| 32768 | 0.00 deg/km |
| 32769 | 0.01 deg/km |
| 65534 | 327.66 deg/km |
| 65535 | Reserved for area not scanned in product files |

## 4.3.14 1-byte LDR Format (DB_LDRH & DB_LDRV)

LDR is short for "Linear Depolarization Ratio". This is the ratio of the power received in the depolarized channel to the power received in the main channel. There are 2 flavors: If you are transmitting horizontal, then the ratio of the vertical power to the horizontal power is "LDRH". Similarly if transmitting vertical then the ratio of horizontal power to vertical power is "LDRV". Note that in simultaneous transmission LDR cannot be computed because the signal in the depolarized channel is dominated by co-polarized returns.

$$LDR(db) = \frac{N-1}{5} - 45.0$$

Like most power ratios this is expressed in dB. The overall range is from -45 to +5.6 in steps of 0.2 dB as follows.

| | |
|---|---|
| 0 | No data available |
| 1 | -45.0 dB |
| 2 | -44.8 dB |
| 226 | 0.0 dB |
| 254 | +5.6 dB |
| 255 | Reserved for area not scanned in product files |

## 4.3.15 2-byte LDR Format (DB_LDRH2 & DB_LDRV2)

Same as DB_DBZ2 format, see 4.3.4 2-byte Reflectivity Format (DB_DBT2& DB_DBZ2) on page 75.

## 4.3.16 1-byte Phi Format (DB_PHIH & DB_PHIV)

The cross channel differential phase. Same format as DB_PHIDP, see 4.3.18 1-byte PhiDP Format (DB_PHIDP) on page 83.

## 4.3.17 2-byte Phi Format (DB_PHIH2 & DB_PHIV2)

The cross channel differential phase. Same format as DB_PHIDP2, see 4.3.19 2-byte PhiDP Format (DB_PHIDP2) on page 83.

## 4.3.18 1-byte PhiDP Format (DB_PHIDP)

PhiDP is defined as the two-way measured phase effect after the signal has travelled through the intervening weather twice. Differential phase (PhiDP) in degrees is computed from the unsigned output with:

$$\Phi_{DP} \bmod 180 = 180 * \frac{N-1}{254}$$

The overall range is from 0 to 180 degrees in steps of 0.71 as follows.

| | |
|---|---|
| 0 | No data available |
| 1 | 0.00 deg |
| 2 | 0.71 deg |
| 101 | 70.87 deg |
| 254 | 179.29 deg |
| 255 | Reserved for area not scanned in product files |

## 4.3.19 2-byte PhiDP Format (DB_PHIDP2)

PhiDP is defined as the two-way measured phase effect after the signal has travelled through the intervening weather twice. Differential phase (PhiDP) in degrees is computed from the unsigned output with:

$$\Phi_{DP} \bmod 360 = 360 * \frac{N-1}{65534}$$

The overall range is from 0 to 360 degrees in steps of 0.0055 as follows. In cases where the transmitter was alternating polarization, or the data was converted from 1–byte format the values will only cover 0–180 degrees.

| | |
|---|---|
| 0 | No data available |
| 1 | 0.0000 deg |
| 2 | 0.0055 deg |
| 65534 | 359.9945 deg |
| 65535 | Reserved for area not scanned in product files |

### 4.3.20 2-byte Rainfall Rate Format (DB_RAINRATE2)

Rainfall rates are stored in 16-bit floating-point representation of a 27-bit integer in units of 0.0001 mm/hr. The floating-point number consists of a 4-bit exponent in the high four bits, followed by a 12-bit mantissa. It uses implied digits and soft underflow. If the exponent is 0, the mantissa consists of the value. If the exponent is 1 through 15, the 12-bit mantissa has a 1 prefixed to it, making it a 13-bit mantissa. This 13-bit mantissa is shifted up by one less than the exponent. The table below gives some examples:

| **Float** | | **Fixed** | **Meaning** |
|---|---|---|---|
| 0 | —> | 0 | No data available |
| 1 | —> | 1 | 0.0000 mm/hr |
| 2 | —> | 2 | 0.0001 mm/hr |
| 225 | —> | 225 | 0.0254 mm/hr |
| 1000 | —> | 1000 | 0.0999 mm/hr |
| 9096 | —> | 10000 | 0.9999 mm/hr |
| 22634 | —> | 100000 | 9.9999 mm/hr |
| 34922 | —> | 800000 | 79.9999 mm/hr |
| 50000 | —> | 10125312 | 1012.5311 mm/hr |
| 65534 | —> | 134184960 | 13418.4959 mm/hr or above |
| 65535 | —> | | Area not scanned |

### 4.3.21 1-byte Rho Format (DB_RHOH & DB_RHOV)

The cross channel correlation coefficient. Same format as DB_RHOHV, see 4.3.23 1-byte RhoHV Format (DB_RHOHV) on page 85.

### 4.3.22 2-byte Rho Format (DB_RHOH2 & DB_RHOV2)

The cross channel correlation coefficient. Same format as DB_SQI2, see 4.3.27 2-byte Signal Quality Index Format (DB_SQI2) on page 86.

### 4.3.23 1-byte RhoHV Format (DB_RHOHV)

RhoHV a measure of how correlated the power fluctuations in reflectivity in the horizontal receiver is to the vertical receiver. It is a dimensionless number on a scale for which 0 means no correlation, and 1 means complete correlation. Since numbers are more likely near 1, the data is scaled with a square root.

$$RhoHV = \sqrt{\frac{N-1}{253}}$$

| | |
|---|---|
| 0 | Data not available at this range |
| 1 | 0.0000 |
| 2 | 0.0629 |
| 128 | 0.7085 |
| 253 | 0.9980 |
| 254 | 1.0000 |
| 255 | Area not scanned |

### 4.3.24 2-byte RhoHV Format (DB_RHOHV2)

Same format as DB_SQI2, see 4.3.27 2-byte Signal Quality Index Format (DB_SQI2) on page 86.

## 4.3.25 1-byte Wind Shear Format (DB_SHEAR)

Wind shear is stored to the nearest 0.2 meters per second per kilometer. This is a signed number, with positive indicating wind is increasing in velocity away from the radar with increasing range. To convert, subtract 128 and multiply by 0.2.

| | |
|---|---|
| 0 | No wind shear data available |
| 1 | -25.4 m/s/km or above |
| 128 | 0.0 m/s/km |
| 129 | +0.2 m/s/km |
| 254 | +25.2 m/s/km or above |
| 255 | Area not scanned |

## 4.3.26 1-byte Signal Quality Index Format (DB_SQI)

The Signal Quality Index (SQI) is the ratio of the magnitude of R1 to the magnitude of R0. It is a dimensionless number on a scale for which 0 means pure noise, and 1 means a pure sine wave.

$$SQI = \sqrt{\frac{N-1}{253}}$$

| | |
|---|---|
| 0 | SQI data not available at this range |
| 1 | 0.0000 |
| 2 | 0.0629 |
| 128 | 0.7085 |
| 253 | 0.9980 |
| 254 | 1.0000 |
| 255 | Area not scanned |

## 4.3.27 2-byte Signal Quality Index Format (DB_SQI2)

Stored linearly using 16-bits as follows:

$$SQI = \frac{(N-1)}{65533}$$

| | |
|---|---|
| 0 | SQI data not available at this range |
| 1 | 0.00000 |
| 2 | 0.00002 |
| 128 | 0.00194 |
| 65533 | 0.99998 |
| 65534 | 1.00000 |
| 65535 | Area not scanned |

### 4.3.28 2-byte Time Format (DB_TIME2)

Stored as time in seconds, so in minutes the conversion is as follows:

$$Time = \frac{N-32768}{60}$$

| | |
|---|---|
| 0 | Time data not available at this range |
| 1 | - 9:06:07: |
| 32768 | 00:00:00 |
| 32828 | 00:01:00 |
| 65535 | Area not scanned |

### 4.3.29 1-byte Velocity Format (DB_VEL)

Mean velocity is with respect to the Nyquist velocity, and is expressed as follows. In data product files, the value 255 is used to indicate area not scanned. The Nyquist velocity is wavelength times PRF divided by 4. For 2:3 dual PRF mode, it is doubled; for 4:3 PRF mode, it is tripled, and for 4:5 PRF mode it is quadrupled over that of the higher PRF. For alternating polarization it is halved.

$$Velocity = \frac{N-128}{127} \times Nyquist$$

| | |
|---|---|
| 0 | Velocity data not available at this range |
| 1 | Unambiguous velocity towards the radar |
| 128 | Zero velocity |
| 255 | Unambiguous velocity away from the radar |

## 4.3.30 2-byte Velocity Format (DB_VEL2)

Mean velocity in meters per second is computed from the unsigned output with

$$velocity = \frac{N - 32768}{100}$$

The overall range is from -327.67 to +327.66 in 1/100 of a meter per second steps as follows.

| | |
|---|---|
| 0 | No data available |
| 1 | -327.67 m/s (towards the radar) |
| 32768 | 0.00 m/s |
| 32769 | 0.01 m/s |
| 65534 | 327.66 m/s (away from the radar) |
| 65535 | Reserved for area not scanned in product files |

## 4.3.31 1-byte Unfolded Velocity Format (DB_VELC)

This is mean radial velocity corrected for both Nyquist folding and fall speed. It is scaled to cover a fixed span of +/- 75 meters/second. In data product files, the value 255 is used to indicate area not scanned.

| | |
|---|---|
| 0 | Velocity data not available at this range |
| 1 | -75.0 m/s (towards the radar) |
| 2 | -74.4 m/s |
| 128 | Zero velocity |
| 129 | +0.6 m/s |
| 254 | +75.0 m/s (away from the radar) |
| 255 | Area not scanned |

## 4.3.32 2-byte Unfolded Velocity Format (DB_VELC2)

Mean velocity in meters per second is computed from the unsigned output with

$$velocity = \frac{N - 32768}{100}$$

The overall range is from -327.67 to +327.66 in 1/100 of a meter per second steps as follows.

| | |
|---|---|
| 0 | No data available |
| 1 | -327.67 m/s (towards the radar) |
| 32768 | 0.00 m/s |
| 32769 | 0.01 m/s |
| 65534 | 327.66 m/s (away from the radar) |
| 65535 | Reserved for area not scanned in product files |

### 4.3.33 2-byte VIL Format (DB_VIL2)

Vertically integrated liquid is stored in 16-bits to the nearest 0.001 mm. Because 0 is the code for no data, values stored in the bytes can be converted to millimeters by subtracting 1 and dividing by 1000.

| | |
|---|---|
| 0 | No VIL data available |
| 1 | 0.000 mm |
| 128 | 0.127 mm |
| 129 | 0.128 mm |
| 255 | 0.254 mm |
| 65534 | 65.533 mm or above |
| 65535 | Area not scanned |

### 4.3.34 2-byte Vertical Velocity Format (DB_VVEL2)

Vertical velocity is stored in a signed 16-bits number scaled to 0.01 meters/ second. Positive number indicate upward motion, negative downward.

| | |
|---|---|
| -32768 | 327.68 m/s upward motion |
| 0 | 0 motion |
| 1 | 0.01 m/s fall speed |
| 32766 | 327.66 m/s fall speed |
| 32767 | Area not scanned |

### 4.3.35 1-byte Width Format (DB_WIDTH)

Spectrum width is computed from the unsigned output as:

$$W = \frac{n}{256}$$

The overall range is therefore a fraction between 1/256 and 255/256. The code of 0 indicates that width data is not available at this range. To convert the width to meters per second, multiply by the unambiguous velocity. Thus the width has twice the resolution of the velocity. This unambiguous velocity is not enlarged by the dual PRF scheme, but is halved by alternating polarization. In data products, the value 255 indicates area not scanned. Note that width unambiguous velocities are not changed for dual PRF unfolding.

### 4.3.36 2-byte Width Format (DB_WIDTH2)

Spectral width in meters per second is computed from the unsigned output with

$$width = \frac{N}{100}$$

The overall range is from 0.01 to 655.34 in 1/100 of a meter per second steps as follows.

| | |
|---|---|
| 0 | No data available |
| 1 | 0.01 m/s |
| 32768 | 327.68 m/s |
| 32769 | 327.69 m/s |
| 65534 | 655.34 m/s |
| 65535 | Reserved for area not scanned in product files |

### 4.3.37 1-byte ZDR Format (DB_ZDR)

For differential reflectivity data, the number in decibels is computed from the unsigned output with the formula:

$$dB(ZDR) = \frac{N-128}{16}$$

The overall range is from -7.94 dBZ to +7.94 dBZ in sixteenth of a dB steps as shown below. Positive ZDR means that the horizontal return is stronger than the vertical return. In data products, the value 255 indicates area not scanned.

| | |
|---|---|
| 0 | No ZDR data available |

| | |
|---|---|
| 1 | -7.94 dB |
| 128 | 0.00 dB |
| 129 | +0.06 dB |
| 255 | +7.94 dB |

### 4.3.38 2-byte ZDR Format (DB_ZDR2)

For differential reflectivity data, the number in decibels is computed from the unsigned output with

$$dB(ZDR) = \frac{N - 32768}{100}$$

The overall range is from -327.67 to +327.66 in 1/100 of a dB steps as follows.

| | |
|---|---|
| 0 | No data available |
| 1 | -327.67 dB |
| 32768 | 0.00 dB |
| 32769 | 0.01 dB |
| 65534 | 327.66 dB |
| 65535 | Reserved for area not scanned in product files |

## 4.4 Ingest Data File Format

Each ingest data file contains one data type from one sweep of a volume. If extended headers are recorded, they are treated as another data type and are placed in a separate file. Each of these files consists of a fixed length ingest_data_header structure followed by a variable-length ray pointer table, followed by a variable-length segment of data, as shown in Table 9 on page 91. The ray pointer table contains a 32-bit pointer for each ray in the file. These are byte pointers (origin one) referenced to the beginning of the data area. Thus, a pointer value of 1 refers to the first byte of the data area. Ray data are forced onto 16-bit word boundaries, so all the pointers are odd. A pointer value of 0 indicates that no data are available for that slot.

**Table 9 Ingest Data File Format**

| |
|---|
| <ingest_data_header><br>76 Bytes |
| Pointer Table<br>4 Bytes per expected ray |
| Data Area<br>Undetermined Size |

Ray data are partially compressed with a truncation scheme. If a ray does not contain data all the way out to the last range bin, those trailing bins are removed from the archive. This means that the storage space required for each ray varies, which requires the pointer table for quick random access. The pointer points to a ray_header structure, which is followed by an array of range bins. The count of the number of range bins could be zero, in which case the ray contains only the 12-byte ray header.

### 4.4.1 Ingest File Names

The IRIS ingest data for a volume scan is stored on disk in multiple files. The ingest summary file name is just the prefix with a trailing ".", but without the suffix. Each sweep and data type is stored in a separate file. These files must be named correctly, **siris** will delete any with an incorrect name. If the two-digit year is less than 50, it means add 2000, otherwise add 1900.

| General Format | Example |
|---|---|
| SSSYYMMDDHHMMSS.##DD | SIG010620141921.01dBZ |
| Where: | |
| SSS—Three letter site code from Setup | SIG—Abbreviation for SIGMET |
| YYMMDDHHMMSS—Data time | 940620141921—14:19:21 20 June 2001 |
| ##—Two-digit sweep number | 01—Sweep #1 |
| DD—data type (1–5 chars) | dBZ—Reflectivity |

## 4.5 Product File Format

Each product is stored in a separate file in the directory specified by the `IRIS_PRODUCT` environment variable. Raw products are stored in a separate directory specified by the `IRIS_PRODUCT_RAW` environment variable. Product file names consist of the 15-character site and time to the left of the dot, and a 7-character product type code and machine generated string to the right.

The file consists of the product_hdr structure followed by the data. The product configuration structure is exactly what is in one of the product configuration files. It specifies how a product should be generated, and so includes some information not strictly required to appear in the final disk file.

| |
|---|
| <product_hdr> (3.2.28)<br>640 Bytes |
| Optional <protect_setup> (3.2.31)<br>1024 Bytes |
| Binary Data Area<br>Variable Size |
| Optional Extended Product Header<br>Variable Size |
| Optional Additional Binary Data Area<br>Variable Size |

**Figure 2 Product File Format**

## 4.5.1 Cartesian Product Format

The data portion of Cartesian product files is not compressed and consists of an array. The first byte contains the lower left corner of the image, the second contains the pixels to the right of that, and so on from the bottom of the window to the top. For 3-D products, the lowest 2-D image comes first.

In some cases we will add a product header extension to the Cartesian products, and may store multiple data types. See section 4.2.26 product_header_extensions on page 50 for details.

## 4.5.2 MLHGT Product Format

The MLHGT product format is the same as other Cartesian products except that the data elements also include the uncertainties. Additional information about the Melting layer classifier and the product are included in the header.

## 4.5.3 FCAST Product Format

The FCAST product format is the same as other Cartesian products except that the data elements consist of the ndop_results structure, rather than a 1- or 2-byte number.

## 4.5.4 NDOP Product Format

The NDOP product format is the same as other Cartesian products except that the data elements consist of the ndop_results structure, rather than a 1- or 2-byte number. 3-D data is supported.

## 4.5.5 RAW Product Format

The RAW product is a collection of all raw ingest data acquired during a run of a single task (volume scan). Whereas the ingest data files are stored on disk separately by sweep and by data moment, the raw product is a single file into which many ingest files have been incorporated. For hybrid tasks, individual raw Products are made from each of the individual tasks that make up the overall scan. Optionally the RAW product can be made in separate files on a sweep-by-sweep basis.

Raw product files are blocked into 6144-byte records, which match the record length used if and when the files are eventually written to tape. Mimicking the tape structure on disk permits error recovery to be built directly into the raw data format. For all other types of products, if a tape I/O error occurs within the product's records on tape, then the entire product is lost. For raw archive this would be too great a penalty, since an entire volume scan is at stake. The blocking scheme permits partial error recovery while still maintaining a one-to-one mapping between disk and tape formats.

**NOTE** Note: The records are for IRIS interpretation only and do not refer to any operating system file records.

The first 6144 byte record of a RAW product holds the product_hdr (4.2.25 product_hdr Structure on page 48) structure. Thus, the RAW product begins with a product_hdr like all the other types of products. The only difference is the zero padding out to 6144 bytes. The next record holds the ingest_header (4.2.16 ingest_header Structure on page 41) structure for the volume scan that supplied the data. Again, this structure is zero-padded to fill the entire second record. All subsequent records hold the actual data, and each record begins with the raw_prod_bhdr structure described in 4.3.29 1-byte Velocity Format (DB_VEL) on page 87.

Records hold data from one and only one sweep, and the sweep number is found in each record's header. The data for the sweep is the concatenation of all the data from as many records as pertain to that sweep. When data for a sweep ends short of the 6144 byte record size, the remainder of that record is padded with zeros. Each of these sweep data sets begins with the ingest_data_header (4.2.15 ingest_data_header Structure on page 40) structures for each data type that was recorded. The same number of headers are found in the beginning of a sweep's data as there are data types acquired during the sweep. The list of data types recorded is specified by the data collection mask in the task_dsp_info within the task_configuration within the ingest_header. The actual rays of data are found immediately after the headers.

Rays are ordered within a sweep by the same ordering sequence used for the ingest data file pointer table. If a ray is missing from the ingest file, a zero-length ray is inserted into the product file as a placeholder. Thus, the number of compressed rays in the file is equal to the product of the number of data types recorded and the number of angles sampled. This is true even if data were not actually acquired at some of those angles. Within a ray, the recorded data are ordered by increasing data type number. See the task_dsp_info structure for a definition of the data type numbers. All data rays are compressed using the algorithm described in 4.5.5.1 Data Compression Algorithm on page 95. Note that the raw product headers and the ingest data headers are not compressed. The overall organization of the file is shown below. Raw product files are blocked into 6144-byte records, and all but the first two records begin with the raw_prod_bhdr 12-byte structure.

```
Record #1     { <product_hdr> 0,0,0... }
Record #2     { <ingest_header> 0,0,0... }
Record #3     { <raw_prod_bhdr> <ingest_data_header(s)> Data... }
Record #4     { <raw_prod_bhdr> Data... }
.             . .
.             . .
Record #N     { <raw_prod_bhdr> Data 0... }
Record #N+1   { <raw_prod_bhdr> <ingest_data_header(s)> Data... }
Record #N+2   { <raw_prod_bhdr> Data... }
.             . .
.             . .
Record #M     { <raw_prod_bhdr> Data 0... }
```

#### 4.5.5.1 Data Compression Algorithm

To make the best use of storage, all radar rays are compressed before being inserted into the file. The compression algorithm is 16-bit word based, and simply removes runs of zeros. This complements the signal processor, which zeros data that does not meet the threshold requirements in effect. Runs of one or two zeros are not removed because there is no benefit. The data field starts with a compression code value. The code either indicates the number of zeros that were skipped, or the number of data words that follow. In the case of a zero skipped code, it is immediately followed with another code value. In the case of a data code, the next code follows the data.

**Table 10 Compression Code Meanings**

| MSB | Low-bits | Meaning |
|---|---|---|
| 0 | 0 | <unused> |
| 0 | 1 | End of ray |
| 0 | 2 | <unused> |
| 0 | 3 – 32767 | 3 to 32767 zeros skipped |
| 1 | 0 | <unused> |
| 1 | 1 – 32767 | 1 to 32767 data words follow |

### 4.5.5.2 Raw Product Example

Here is an example of what the third record of a simple raw product would look like. This product is for data with only velocity recorded. Shown is the first ray of a PPI at azimuth 0 to 1 degree, elevation 0.5 degrees. It has 200 range bins, with no data for the first 100 bins, then one bin of zero velocity, then 99 bins with no data.

**Table 11 Raw Product Example**

| Byte | Size | Contents | |
|---|---|---|---|
| 0 | 12 | <raw_prod_bhdr> | |
| 12 | 76 | <ingest_data_header> | |
| 88 | SINT2 | -32762 (code for six data words to follow) | |
| 90 | BIN2 | 0 (starting azimuth) | Six |
| 92 | BIN2 | 91 (starting elevation) | words |
| 94 | BIN2 | 182 (ending azimuth) | referred |
| 96 | BIN2 | 91 (ending elevation) | to |
| 98 | SINT2 | 200 (number of range bins) | above |
| 100 | UINT2 | 3 (time) | |
| 102 | SINT2 | 50 (code for fifty zeros skipped) | |
| 104 | SINT2 | -32767 (code for one data word follows) | |
| 106 | SINT2 | 128 (zero velocity value) | One data word |
| 108 | SINT2 | 49 (code for forty nine zeros skipped) | |
| 110 | SINT2 | 1 (code for end of ray) | |
| 112 | | | |
| | | (Continues on to next ray) | |

## 4.5.6 SLINE Product Format

The first 1024 bytes of the product hold a copy of the protect_setup structure described in 4.2.28 protect_setup Structure on page 51. This is followed by an array of sline_results structures one for each shearline found. The "Number of elements in product results array" element of the product_end structure in the product_hdr indicates the number of points in the array. Generally there is at most 1 shearline found.

## 4.5.7 TDWR Product Format

The first 1024 bytes of the product hold a copy of the protect_setup structure described in 4.2.28 protect_setup Structure on page 51. This structure is copied from the setup files on the integrating computer. This is followed by an array of tdwr_results structures, one for each corridor. The "Number of elements in product results array" element of the product_end structure in the product_hdr indicates the number of elements in the array. Only corridors covered by one of the input products to the integrator will be included, and corridors which are unused at generation time will normally be removed. This is followed by an array of warning_results structures copied from the WARN input product, if any. This is followed by an array of sline_results structures copied from the SLINE input product, if any. The sizes of these arrays are in the tdwr_psi_struct portion of the product header.

## 4.5.8 TRACK Product Format

The first 1024 bytes of the product hold a copy of the protect_setup structure described in 4.2.28 protect_setup Structure on page 51. This is followed by an array of track_results structures, one for each track point. The "Number of elements in product results array" element of the product_end structure in the product_hdr indicates the number of points in the array. Points must be in time order, with the oldest first. Within points of the same time, they are sorted by index number. Only one data point of each index value at each time is allowed, except that multiple text points are allowed (which have index set to zero).

## 4.5.9 VAD Product Format

The velocities produced by the VAD product are stored in an array of vad_results structures. This is essentially a 2D array of results. First included are all the results from the first elevation sweep, followed by the second, etc. You can use the structure vad_product defined in product.h to reference this data. Note that only data bins with valid velocities are included in the average. Is is possible that the number of azimuths would be different for different elevations if this is a hybrid input.

### 4.5.10 VVP Product Format

The winds produced by the VVP product are stored in an array of vvp_results structures for each height. Note that if less than 30 range bins are found in the height interval, then the whole structure is zeroed. Therefore any analysis program should check the "Number of data points used" field. Also if the calculation cannot be performed for some other reason, then the standard deviation will be set to 32767. Analysis programs should also check the standard deviations. Data fields which are turned off in the product configuration will be set to zero. Therefore the "Wind parameters mask" in the vvp_psi_struct in the product header needs to be checked also. Note that only data bins with valid velocities not near zero are included in the calculation. To compute the average reflectivity, bins must also have a valid reflectivity. Because of this, it can produce a lower number of valid bins, so the number of valid reflectivity bins is also recorded. Same for RhoHV.

### 4.5.11 WARN Product Format

The first 1024 bytes of the product hold a copy of the protect_setup structure described in 4.2.28 protect_setup Structure on page 51. This is followed by an array of warning_results structures. The number of warning_results structures in the array is given in the product_end structure, part of the product_hdr.

### 4.5.12 WIND Product Format

The first 84 bytes of the product hold a vvp_results structure for the whole volume. This is followed by an array of wind_results structures. The number of wind_results structures in the array is determined by multiplying the number of points in range by the number of points in azimuth stored in the product_specific_info structure in the header.

### 4.5.13 Product File Names

Because IRIS product files are computer accessed, actual file names are unimportant. IRIS can handle a product with any file name up to 23 characters. When IRIS creates a product file in its own product directory, it uses the following file name syntax. The two digit year used is simply the year modulo 100. Since the product file names are never parsed to generate a full date, there is no need to ever reconstruct the correct century.

| General Format | Example |
|---|---|
| SSSYYMMDDHHMMSS.PPPXXXX | SIG940620141921.TRAE090 |
| Where: | |
| SSS—Three letter site code from Setup | SIG—Abbreviation for SIGMET |
| YYMMDDHHMMSS—Data time | 940620141921—14:19:21 20 June 1994 |
| PPP—Three-letter product type | TRA—Track product |
| XXXX—Characters for uniqueness | E090 |

When IRIS copies files to other directories using the network product output, it must generate a file name that is unique in the target directory. To see the choices available for this, see the SETUP/OUTPUT section of the *IRIS Utilities Manual*.

## 4.6 Tape Format

All tapes made by IRIS hold exact images of corresponding disk-based product files. The tapes are always written using fixed-length 6144-byte records, where the last tape record is padded with zeros, if necessary, to the full 6144-byte length. Products are separated on tape by end-of-file (EOF) marks. Prior to Version 5.00, tapes ended with a double EOF. Because all disk product files begin with a product_hdr structure, this is also the structure initially encountered in the first record of each product on tape. By examining the headers, you can determine what kinds of product files have been stored on the tape.

There is a special short record at the beginning of the tape that serves to identify how and when the tape was initially created by the `init_iris_tape` utility. This record contains the tape_header_record structure, and is followed by an EOF and the product files, if any. There are no special directory or inventory records on the tape. After a tape has been started, the only additional writing that can be done is to append more product file images to the end.

## 4.7 TIFF Output Format

IRIS can output images over the network in TIFF format. These files conform to the TIFF revision 6.0 standard. This standard supports many different types of images. Only a small subset of this is required. IRIS uses only baseline TIFF, and none of the TIFF extensions. Only one image is included in each file. It is a Palette Color image. The table below lists all the fields set by IRIS. The Image Description contains the 5 character product type, followed by the 12 character product configuration name. Compression is controlled by a setup question for the output device.

**Table 12 TIFF Fields Used by IRIS**

| | | |
|---|---|---|
| Software | 305 | "IRIS 5.56" for example |
| ImageDescription | 270 | "IRIS PPPPP NNNNNNNNNNNN" |
| DateTime | 306 | Time of ingest data |
| ImageWidth | 256 | Width of image in pixels |
| ImageLength | 247 | Height of image in pixels |
| Compression | 259 | Either none or PackBits |
| PlanarConfiguration | 284 | 1 (Chunky) |
| SamplesPerPixel | 277 | 1 |
| Orientation | 274 | 1 (Top Left) |
| RowsPerStrip | 278 | Height of image in pixels |

## 4.8 Constants

**Table 13 Data Type Constants — /include/sigtypes.h**

| **Extended Header is included here though it is not generated by the DSP. In general, types 0–31 could be produced by the DSP.** | | |
|---|---|---|
| DB_XHDR | (0) | Extended Headers |
| DB_DBT | (1) | Total power (1 byte) |
| DB_DBZ | (2) | Reflectivity (1 byte) |
| DB_VEL | (3) | Velocity (1 byte) |
| DB_WIDTH | (4) | Width (1 byte) |
| DB_ZDR | (5) | Differential reflectivity (1 byte) |
| DB_DBZC | (7) | Corrected reflectivity (1 byte) |
| DB_DBT2 | (8) | Total power (2 byte) |
| DB_DBZ2 | (9) | Reflectivity (2 byte) |
| DB_VEL2 | (10) | Velocity (2 byte) |
| DB_WIDTH2 | (11) | Width (2 byte) |
| DB_ZDR2 | (12) | Differential reflectivity (2 byte) |
| DB_RAINRATE2 | (13) | Rainfall rate (2 byte) |
| DB_KDP | (14) | KDP (Differential phase) (1 byte) |
| DB_KDP2 | (15) | KDP (Differential phase) (2 byte) |
| DB_PHIDP | (16) | PhiDP(Differential phase) (1 byte) |
| DB_VELC | (17) | Corrected velocity (1 byte) |
| DB_SQI | (18) | SQI (1 byte) |
| DB_RHOHV | (19) | RhoHV (1 byte) |
| DB_RHOHV2 | (20) | RhoHV (2 byte) |
| DB_DBZC2 | (21) | Corrected Reflectivity (2 byte) |
| DB_VELC2 | (22) | Corrected velocity (2 byte) |
| DB_SQI2 | (23) | SQI (2 byte) |
| DB_PHIDP2 | (24) | PhiDP (Differential phase) (2 byte) |
| DB_LDRH | (25) | LDR xmt H, rcv V (1 byte) |
| DB_LDRH2 | (26) | LDR xmt H, rcv V (2 byte) |

**Table 13 Data Type Constants — /include/sigtypes.h (Continued)**

| **Extended Header is included here though it is not generated by the DSP. In general, types 0–31 could be produced by the DSP.** | | |
|---|---|---|
| DB_LDRV | (27) | LDR xmt V, rcv H (1 byte) |
| DB_LDRV2 | (28) | LDR xmt V, rcv H (2 byte) |
| . . . | | |
| DB_HEIGHT | (32) | Height (1/10 km) (1 byte) |
| DB_VIL2 | (33) | Linear liquid (.001mm) (2 byte) |
| DB_RAW | (34) | Raw Data |
| DB_SHEAR | (35) | Wind Shear (1 byte) |
| DB_DIVERGE2 | (36) | Divergence (2 byte) |
| DB_FLIQUID2 | (37) | Floated liquid (2 byte) |
| DB_USER | (38) | User type, unspecified data (1 byte) |
| DB_OTHER | (39) | Unspecified data, no color legend (1 byte) |
| DB_DEFORM2 | (40) | Deformation (2 byte) |
| DB_VVEL2 | (41) | Vertical velocity (2 byte) |
| DB_HVEL2 | (42) | Horizontal velocity (2 byte) |
| DB_HDIR2 | (43) | Horizontal wind direction(2 byte) |
| DB_AXDIL2 | (44) | Axis of dilatation (2 byte) |
| DB_TIME2 | (45) | Time in seconds (2 byte) |
| DB_RHOH | (46) | Rho, xmt H, rcv V (1 byte) |
| DB_RHOH2 | (47) | Rho, xmt H, rcv V (2 byte) |
| DB_RHOV | (48) | Rho, xmt V, rcv H (1 byte) |
| DB_RHOV2 | (49) | Rho, xmt V, rcv H (2 byte) |
| DB_PHIH | (50) | Phi, xmt H, rcv V (1 byte) |
| DB_PHIH2 | (51) | Phi, xmt H, rcv V (2 byte) |
| DB_PHIV | (52) | Phi, xmt V, rcv H (1 byte) |
| DB_PHIV2 | (53) | Phi, xmt V, rcv H (2 byte) |
| DB_USER2 | (54) | User type, unspecifed data (2 byte) |
| DB_HCLASS | (55) | Hydrometeor class (1 byte) |
| DB_HCLASS2 | (56) | Hydrometeor class (2 byte) |
| DB_ZDRC | (57) | Corrected differential reflectivity (1 byte) |
| DB_ZDRC2 | (58) | Corrected differential reflectivity (2 byte) |

# CHAPTER 5
# UTILITIES

## 5.1 Productx

The **productx** utility, or "product examiner," displays the information contained in a specified product file.

For all product types, **productx** displays the product header, including information such as the site where the ingest data came from, the date and time when the ingest data was gathered, and its size. This is followe by product-specific meta-data from the header for many product types. Finally it displays the data values from the file. Note that for Cartesian data files, this could be a large number of pixels. In this case it skips data to present a summary display which fits on the terminal. If you want no skipping, then specify a very large terminal width, say 10000.

### 5.1.1 Invoking Productx

**Command**

```
productx [options] filename
```

`filename` is the name of a product file stored in `/usr/iris_data/product`.

Raw products are stored in a separate directory — **/usr/iris_data/product_raw**.

**Options**

| | |
|---|---|
| `-help` | Prints the list of options. |
| `<filename>` | Specify which ingest header file to read. |
| `-sweep:#` | Specify sweep number, origin 1. Z-axis for 3D data. |

| | |
|---|---|
| `-version` | Print out just the version number. |
| `-width=#` | Specify maximum line with for data display. |

Each product file has a unique name based on the site ID, date, and a randomize algorithm. The first three letters of the file extension state the kind of product stored in the file:

| Abbreviation | Product Type | Abbreviation | Product Type |
|---|---|---|---|
| BEA | BEAM product | SLI | SLINE product |
| CAP | CAPPI product | STA | STAT product |
| FCA | FCAST product | TDW | TDWR product |
| IMG | IMAGE product | TOP | TOPS product |
| MAX | MAX product | TRA | TRACK product |
| OTH | OTHER product | TXT | TEXT product |
| PPI | PPI product | USE | USER product |
| RAW | RAW product | VUS | VUSER product |
| RN1 | RAIN1 product | VIL | VIL product |
| RNN | RAINN product | VVP | VVP product |
| RHI | RHI product | WND | WIND product |
| RTI | RTI product | WRN | WARN product |
| SHE | Shear product | XSE | XSECT product |

## 5.1.2 Productx Examples

A Status product shows the status of the IRIS processes at a particular site:

```
$ productx HOT000602152122.STAZ0GN
------------- Product Summary for HOT000602152122.STAZ0GN -------------
Ingest site name : 'SIGMET, HOT', Version: 7.17
Ingest hardware name : 'SIGMET, HOT'
Product site name : 'SIGMET, HOT', Version: 7.17
File size: 2340 bytes (Disk space: 2340 bytes)
Product type is: Status
PCO name: SIGMET, HOT, TCO name: FAULT
PRF: 500Hz, Wavelength: 5.00cm, Nyquist: 6.25m/s(V), 6.25m/s(W)
Polarization: Horizontal, wind:???
Heights: Radar: 600m, Ground: 100m, Melting: ???m MSL
Size is: 0x0x0 pixels
Center Location: 42_33.0'N, 71_25.8'W, ref: 600 meters
Projection type is: Azimuthal Equidistant
Projection Reference Point: 42_33.0'N, 71_25.8'W
Radar position is: 0.0, 0.0 pixels
Scale is: 0.000 x 0.000 x 0.000 km/pixel
Product data type is Xhdr (0)
Maximum range: 0.0 km
Ingest time: 15:21:22 2 JUN 2000 UTC (0 minutes west) DST:0/1
Volume scan time: 15:21:22 2 JUN 2000 (LT: EDT 300 minutes)
Oldest Ing time: 15:21:22 2 JUN 2000
Product Gen time: 15:21:22 2 JUN 2000
Input count: 1
Product is not composited
Site style is: RADAR
Overall status is: FAULT
Status of IRIS_INGEST ON/Idle
Status of IRIS_INGFIO ON/NA
Status of IRIS_OUTPUT ON/NA
Status of IRIS_PRODUCT ON/Idle
Status of IRIS_WATCHDOG ON/Running
Status of IRIS_REINGEST ON/Idle
Status of IRIS_NETWORK ON/Idle
Status of IRIS_NORDRAD OFF/Stopped
Status of IRIS_SERVER ON/Idle
Status of IRIS_RIBBON OFF/Stopped
Status of IRIS_INPUT ON/Idle
Status of DSP N/A Stopped
Status of RCP Critical N/A DEAD
Status of WINDOW1 OK Idle test
Status of NETWORK1 OK Idle ToArchive2
Status of NETWORK2 OK Idle netcdf_out
Status of NETWORK3 OK Idle ToBufr
Status of NETWORK4 OK Idle ToHDF5
Status of WINDOW2 OK Idle Joe
Status of ARCHIVE1 OK Idle archive
RST mode: ’DEFAULT’
```

```
TSC mode: 'DEFAULT'
PSC mode: 'DEFAULT'
POM mode: 'DEFAULT'
Active task: ''
Active product: ''
Antenna Position, azimuth: 20.00, elevation: –0.99
Bite fault summary shows 2
Low Airflow: OK
Interlock: OK
Waveguide: OK
Top message #9, Repeats: 1
Problem starting scan at EL=6 (AZ velocity out of range)
Process: IRIS_INGEST, Name: F:202 M:3
Time: 16:34:36 30 MAY 2000
Message list contains 0 messages:
```

A PPI product shows useful header information:

```
$ productx TMS090520180345.PPIFD6W -width:80
------------- Product Summary for TMS090520180345.PPIFD6W -------------
Ingest site name :'tms_rad1', Version: 8.11
Ingest hardware name :'tms_rad1'
Product site name :'SIGMET, dry2', Version: 8.12
File size: 519040 bytes (Disk space: 519040 bytes)
Product type is: PPI
PCO name: DEF_DBZ, TCO name: PPIVOL_B
PRF: 840/560Hz, Wavelength: 10.63cm, Nyquist: 44.65m/s(V), 22.32m/s(W)
XMT Polarization: Horizontal, Wind:???
Constant:72.06 dB, I0:-104.82 dBm, Cal Noise:-70.66 dBm, Bandwidth:0 kHz.
ZFlags: SP_T, block_zc, attn_zc, target_zc, dpatten_zc, dpatten_z
VFlags: SP_V, 3lag_w, ship_v, unfold_vc, FALL_VC, storm_vc
Heights: Radar: 970m, Ground: 948m, Melting: 4900m MSL
Size is: 720x720x1 pixels
Scale is: 500.00 x 500.00 x 0.00 m/pixel
Center Location: 22 24.7'N, 114 7.4'E, ref: 0 meters
Projection type is: Eqdist Cylinder
Projection Reference Point: 22 24.7'N, 114 7.4'E
Equitorial Radius: 0.00000 km, Flattening: 1/0.00000
Radar position is: 360.0, 360.0 pixels
Product data type is dBZ (2)
Color count:16, Color set: 1, variable
Seams: 16452.00 16702.00 16952.00 17252.00 17402.00 17502.00 17752.00
18052.00
18202.00 18302.00 18552.00 18852.00 19002.00 19102.00 19352.00 19652.00
Maximum range: 180.0 km

PPI elevation angle: 6.60 degrees

Ingest time: 18:03:45 20 MAY 2009 HKT (–480 minutes west) DST:0/0
Volume scan time: 18:03:45 20 MAY 2009 HKT (LT: HKT –480 minutes)
Oldest Ing time: 18:03:45 20 MAY 2009 LT
Product Gen time: 19:23:31 17 JUN 2009 UTC

Input count: 1
Product is not composited.
Displaying cartesian data with skip factor 40


719:255 255 255 255 255 255 255 255 255 255 255 255 255 255 255 255 255 255

679:255 255 255 255 255 255 0   0   0   0   0   0   0   255 255 255 255 255

639:255 255 255 255 0   0   0   0   0   0   0   0   0   0   0   255 255 255

599:255 255 255 0   0   0   0   0   0   0   0   0   0   0   0   0   255 255

559:255 255 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   255

519:255 255 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   255

479:255 0   0   0   0   0   0   0   105 117 104 66  0   0   0   0   0   0

439:255 0   0   0   0   0   82  85  121 57  0   101 81  0   0   0   0   0

399:255 0   0   0   0   0   83  111 136 78  0   0   0   0   0   0   0   0

359:255 0   0   0   0   0   83  169 71  0   0   0   0   0   0   0   0   0

319:255 0   0   0   0   0   133 87  0   0   0   0   0   0   0   0   0   0

279:255 0   0   0   0   0   97  93  0   0   0   0   0   0   0   0   0   0

239:255 0   0   0   0   0   78  77  64  0   0   0   0   0   0   0   0   0

199:255 255 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   255

159:255 255 0   0   0   0   0   0   0   0   0   255 0   0   0   0   0   255

119:255 255 255 0   0   0   0   0   0   0   0   0   0   0   0   0   255 255

79: 255 255 255 255 0   0   0   0   0   0   0   0   255 0   0   255 255 255

39: 255 255 255 255 255 255 0   0   0   0   0   0   0   255 255 255 255 255
```

## 5.2 Rays

The **rays** utility gives information about ingest files. You can choose to display information about various parameters of the ingest data.

### 5.2.1 Invoking Rays

**Command**

```
rays [options] filename
```

`filename` is the name of an ingest header file stored in the directory `/usr/iris_data/ingest`. Ingest files are named for the date and time when the data were gathered. For example, ingest data gathered at 10:17:30 on December 2, 1994 would be stored in a file named `941202101730`.

**Options**

| | |
|---|---|
| `-help` | Prints the list of options. |
| `-data:dtype` | Specify which data type to display. |
| `[-if:]filename` | Specify which ingest header file to read. |
| `-inter` | Run in interactive mode. This is the old style, **rays** will then prompt for some of the options. |
| `-perf` | Performance test, display ray headers only. |
| `-range:#` | Specify starting range in km. |
| `-sweep:#` | Specify sweep number, origin 1. |
| `-terse` | Skip showing ingest header info. |
| `-width:#` | Specify maximum line with for data display. |

To make it easier to enter the names of the ingest files, change your default directory to the ingest directory and get a listing of all the header files (with "ls *."). Then select the name of a file with the mouse and paste it into the command line.

### 5.2.2 Rays Examples

#### 5.2.2.1 Headers only Example

In the following example, **rays** uses the **-perf** option to display the ray header information only. This format lets you evaluate the speed of IRIS or the signal processor and look for missing rays. Note that there are two azimuth and elevation angles recorded with each ray. These are angles at the beginning and ending of each ray.

```
$ rays -perf -terse DRY020418160516. | more

Reading file: /usr/iris_data/ingest/DRY020418160516.01dBT
```

```
# 0  Az:     359.80,0.99   El:    0.48,  0.48   Size: 967   16:05:33
# 1  Missing
# 2  Az:     0.99,  2.20   El:    0.48,  0.48   Size: 967   16:05:33
# 3  Az:     2.20,  3.38   El:    0.48,  0.48   Size: 967   16:05:33
# 4  Az:     3.38,  4.59   El:    0.48,  0.48   Size: 967   16:05:33
# 5  Az:     4.59,  5.78   El:    0.48,  0.48   Size: 967   16:05:34
# 6  Az:     5.78,  6.99   El:    0.48,  0.48   Size: 967   16:05:34
# 7  Missing
# 8  Az:     6.99,  8.17   El:    0.48,  0.48   Size: 967   16:05:34
# 9  Az:     9.38,  9.38   El:    0.48,  0.48   Size: 967   16:05:34
# 10 Az:     9.38,  10.57  El:    0.48,  0.48   Size: 967   16:05:34
# 11 Az:     10.57, 11.78  El:    0.48,  0.48   Size: 967   16:05:34
# 12 Az:     11.78, 12.96  El:    0.48,  0.48   Size: 967   16:05:34
# 13 Missing
# 14 Az:     14.17, 14.17  El:    0.48,  0.48   Size: 967   16:05:34
# 15 Az:     14.17, 15.36  El:    0.48,  0.48   Size: 967   16:05:34
# 16 Az:     15.36, 16.57  El:    0.48,  0.48   Size: 967   16:05:34
# 17 Az:     16.57, 17.75  El:    0.48,  0.48   Size: 967   16:05:34
# 18 Az:     17.75, 18.96  El:    0.48,  0.48   Size: 967   16:05:34
# 19 Az:     18.96, 18.96  El:    0.48,  0.48   Size: 967   16:05:34
# 20 Az:     18.96, 20.15  El:    0.48,  0.48   Size: 967   16:05:34
# 21 Az:     20.15, 21.36  El:    0.48,  0.48   Size: 967   16:05:34
# 22 Az:     21.36, 22.54  El:    0.48,  0.48   Size: 967   16:05:34
# 23 Az:     22.54, 23.75  El:    0.48,  0.48   Size: 967   16:05:34
# 24 Az:     23.75, 24.94  El:    0.48,  0.48   Size: 967   16:05:34
```

#### 5.2.2.2 Velocity Example

You can choose any of the data parameters — V in this example — and rays then displays the header, followed by range bins starting from the specified bin.

```
$ rays XXX041029121855. -data:v2 | more
[joe@localhost ingest]$ rays COX071115233217. -data:v | more
Task Summary for: COX071115233217.
Site name: 'cox-radar', Task name: 'PPI_C'
Scan: PPI, Speed: 9.00 deg/sec, Resolution:1.00 deg
Description: 'Doppler Velocity Volume Scan'
Location: 21 26.0'N 91 58.6'E, Altitude: 64 meters, Melting height:Unknown
Dpolapp config:
Volume Time: 23:32:17.442 15 NOV 2007 UTC (0 min. west) (LT: BDT -360 min.)
ZFlags: SP_T, block_zc, attn_zc, target_zc, dpatten_zc, dpatten_z

VFlags: SP_V, 3lag_w, ship_v, unfold_vc, fall_vc, storm_vc
PRF: 720/576Hz, PulseWidth: 1.00 usec (1)
BeamWidth: 1.46/1.50 deg.
Radar constant: 0.00/0.00 dB, Receiver bandwidth 0 kHz.
Calibration I0: -111.95/-113.03 dBm, with noise -79.70/-76.95 dBm.
LOG-Noise: 0.1776, Lin-Noise: 0.1776, I-Off: 0.0000, Q-Off: 0.0000

SOPRM Flags: 0x04af, LOG Slope: 0.480, Z-Cal: -36.81dBZ, H/V: 0.00 dB
Filters: Dop:6, Log:0; PntClt: 3, Thresh: 1.0 dB; Samples: 80
Processing Mode: FFT, Xmt Phase: Fixed

Zdr Threshold: LOG GDR = 0.00 dB, XDR = 0.00 dB
T Threshold: LOG LOG = 2.4 dB
Z Threshold: LOG & CSR SIG = 5.0 dB
V Threshold: SQI & CSR CSR = 15.0 dB
W Threshold: SIG & SQI & LOG SQI = 0.42

Available moments are: dBZ V
Original moments were: dBT dBZ V W
Starting range 0.125 km, range bin spacing 625 meters
There are 8 sweeps, each having 360 rays and 320 bins
Angle list: 0.0 1.5 3.0 4.5 6.0 9.0 12.0 15.0
Reading file: /usr/iris_data/ingest/COX071115233217.01V
Sweep Time: 23:32:17.442 15 NOV 2007
Starting at range 0.12 km (bin 1), bin step: 0.62 km
```

```
# 0 Az: 359.52, 0.47 El: 0.02, 0.02 Size: 320 23:32:32
--.- --.- --.- --.- --.- --.- --.- 17.3 17.3 17.3 17.3 --.- --.- --.-
# 1 Az: 0.47, 1.51 El: 0.02, 0.02 Size: 320 23:32:32
--.- --.- --.- -61.5 -61.5 -62.1 -62.1 -62.7 59.7 59.1 --.- --.- --.- --.-
# 2 Az: 1.53, 2.52 El: 0.02, 0.02 Size: 320 23:32:32
--.- --.- --.- --.- --.- --.- --.- --.- --.- --.- --.- --.- --.- --.-
# 3 Az: 2.54, 3.50 El: 0.02, 0.02 Size: 320 23:32:32
--.- --.- --.- --.- --.- --.- --.- --.- --.- 34.6 -38.8 -1.8 --.- --.-
# 4 Az: 3.52, 4.53 El: 0.02, 0.02 Size: 320 23:32:33
--.- --.- -31.0 -31.0 -31.0 -31.0 -31.0 -30.4 -30.4 -30.4 56.1 -1.8 -1.8 -
1.8
--More--
```

Where no data is available for a ray, it displays "Missing." When no data is available for a range bin within the ray, it displays a series of dashes.

#### 5.2.2.3 Extended Header Example

On shipboard systems, additional housekeeping information can be stored for each ray in what is called an "extended header". If your ingest file has this, you can display it with the option "-data:xhdr". Notice that the extended header includes time recorded to the nearest millisecond.

```
$ rays -data:xhdr -terse -if:DRY020418160516. | more
Reading file: /usr/iris_data/ingest/DRY020418041055.01Xhdr
Starting at range 0.00 km (bin 1), bin step: 0.30 km
# 0 Az: 359.80, 0.55 El: 0.42, 0.42 Size: 1 4:11:08.055
Az: 350.95 El: 0.40 Pitch: -0.13 Roll: -1.10 Head: 346.79
Vel: 18.72 deg/s 0.04 0.70 359.82 359.82

Tr: 2.29 El_or: 0.31 Lat: 1#section#45.5'N Long:138#section# 2.8'E Alt: 14
Cor: 3.59 Age: 291 Vel: 3.69 m/s 0.00 -0.17
```

Here are details, see also the extended_header_v1 structure in the *IRIS Programmer's Manual*.

```
Az : 350.95 El: 0.40 Pitch: -0.13 Roll: -1.10 Head: 346.79

Vel : 18.72 deg/s 0.04 0.70 359.82 359.82
```

This shows the azimuth and elevation of the antenna, as well as the pitch, roll, and heading of the platform. Also shown are the derivatives of those five numbers in degrees/second. The extended header information is recorded from a serial data stream transmitted from the RCP. Typically this is configured to transmit updates at the maximum possible speed of about

20 times per second. Because rays can be recorded at up to 40 rays per second, and because of pipeline delays in the serial data, it is possible for the extended header azimuth to lag the actual azimuth by up to several degrees. Normally the platform motion period is far slower.

```
Tr: 2.29 El_or: 0.31 Lat: 1#section#45.5'N Long:138#section#
2.8'E Alt: 14

Cor: 3.59 Age: 291 Vel: 3.69 m/s 0.00 -0.17
```

"Tr" is the training angle, which is the pedestal relative azimuth of the pedestal. Similarly "El_or" is the pedestal relative elevation angle. "Cor" is the velocity correction in meters/second applied to the velocity data to correct for platform motion. "Age" is the time in milliseconds since this update arrived from the RCP. Finally the position and motion of the platform is recorded. Altitude is in meters, and motions are in meters/ second.

# APPENDIX A
# RADAR CONTROL PROTOCOL

The interface to the RCP is typically via network UDP multicast packets. Alternatively we can use a serial line, or a UNIX FIFO. When using the network, all transmissions both directions are sent to the same address and port number. This allows the seamless merging of data from multiple clients. It also means that there is no longer a separate wire for transmit and receive as with a serial cable. The data format consists of exactly the serial format with a 16-byte prefix. The prefix consists of the packet size in ASCII (8-bytes), followed by a ASCII code for the type of packet. The first letter of the type is either "T" or "R" for transmit or receive. This is relative to the main controlling host. If coding this up, you will need to filter on the direction.

For coding examples, please look in the utils/antx.C program, as well as in the libs/antenna/ant_netrcv.c and libs/user/UdpSupport.c files. The only coding differences for multicast packets over broadcast packets are that you should specify the interface to use, and issue the IP_ADD_MEMBERSHIP call. Also, you should read a standard network textbook on multicast addressing. There are certain reserved addresses. We recommend using *site-local* addresses.

When using a two-way asynchronous RS-232 data line, the baud rate is typically 9600 (19200+ for shipboard systems). Through this link, IRIS controls the servo and antenna and receives feedback status. Information is transferred in packets consisting of two or more bytes. Each packet begins with a SYNC byte and ends with an END byte of FF(Hex). All SYNC bytes have the MSB set, and the particular value indicates the type of packet to follow. Types currently available are 80(hex) for antenna, C0(hex) for BITE, AF(hex) for Q-BITE, and B0(hex) for time. The packet layouts are shown below. Each type of packet has a specific direction of travel (to or from IRIS), but packets can arrive in any order within the serial stream.

Several types of antenna communication formats are supported. Older systems use the RCV01 and XMT01 formats but the newer systems can use the RCV02 and the XMT02 formats. The RCV03 format is intended for systems on moving platforms, such as ships or airplanes. One of the challenges of these systems is to correct the radar's measured radial velocity for the motion of the platform. To make this correction, the three-dimensional velocity and orientation of the platform must be recorded. Typically, the information comes from an inertial navigation system. For shipboard system, an update rate of approximately 20 reports per second can satisfy the velocity correction requirements at 19200 baud.

The following angles, with the exception of the latitude and the longitude, are transmitted as 14-bit binary angles. The latitude and longitude are both 21-bit binary angles.

- azimuth and elevation
- train order
- pitch, roll, and heading

In the XMT01 format, the angular speed is a signed number in units of 0.55º/sec. In all other formats, the angular rates are in signed 14-bit binary angles per second. Therefore, the largest possible value is 180º/sec (30 rpm) and the step is 0.022º/sec. All velocities are in signed cm/sec with the altitude in signed meters. If some of the information is not available at the full resolution of the data format, the low bits are filled with zeros.

The azimuth and the elevation angles are corrected angles relative to the north and are the angles that the antenna is pointed relative to the deck of the platform. These calculations are derivable from the other angles but are also reported to assist in the data analysis, especially if one of the sensors or the stabilization fails.

The pitch is the angle between the fore-and-aft axis of the platform and the horizontal is measured in the vertical plane. The pitch is positive when the bow is down and the roll is the rotation angle about the fore-and-aft axis in its pitched position. The pitch is measured in the plane perpendicular to the fore-and-aft axis, which is generally not the vertical plane, and the roll is positive when the deck is down on the port side.

**NOTE**

Note: The pitch can be directly measured by a level on the fore-and-aft axis but the roll cannot be directly measured by a one-axis tilt meter.

The heading is referred to as the direction the platform is pointed but is not the same as direction of motion. The platform could be pointed one way and drifting backwards.

The time stamp is a 14-bit counter incremented by the RCP once per millisecond. The RCP should latch all the data for a packet at the same time. This counter allows the host computer to accurately judge the time between samples without the serial line latencies and fluctuations due to the time sharing operating system.

The position of the platform is reported by the latitude, the longitude, and the altitude. Since the altitude may not be implemented for systems on ships, the setting will be zero.

**Table 14 Status Packet RCV01 Format (RCP to Host)**

| Char | Function |
|---|---|
| 1 | SYNC Byte (80 Hex) |
| 2 | Azimuth Low 7 bits |
| 3 | Azimuth High 7 bits |
| 4 | Elevation Low 7 bits |
| 5 | Elevation High 7 bits |
| 6 | Status #1<br>D6 = Low air flow<br>D5 = Low Waveguide pressure<br>D4 = Servo power<br>D3 = Antenna Local mode<br>D2 = Interlock<br>D1 = Standby<br>D0 = Radiate On |
| 7 | Status #2<br>D6 = RCP02 is shutdown<br>D5 = LSB pulse width<br>D4 = T/R power On<br>D3 = T/R Local mode<br>D2 = Encoders calibrated<br>D1 = MSB pulse width<br>D0 = Magnetron current normal |
| 8 | End Of Message (FF Hex) |

**Table 15 Control Packet XMT01 Format (Host to RCP)**

| Char | Function |
|---|---|
| 1 | SYNC Byte (80 Hex) |
| 2 | Azimuth Low 7 bits |
| 3 | Azimuth High 7 bits |
| 4 | Elevation Low 7 bits |
| 5 | Elevation High 7 bits |

**Table 15 Control Packet XMT01 Format (Host to RCP)**

| Char | Function |
|---|---|
| 6 | Control Word #1<br>D6 = MSB of Pulse Width<br>D5 = Leave Pulse width unchanged<br>D4 = Spare<br>D3 = Signal Generator On<br>D2 = Signal Generator CW<br>D1 = EL (1 = Scan, 0 = Position)<br>D0 = AZ (1 = Scan, 0 = Position) |
| 7 | Control Word #2<br>D6 = Reset RCP02 on edge<br>D5 = Noise Source On<br>D4 = LSB of Pulse width<br>D3 = Radiate On complemented<br>D2 = Radiate On<br>D1 = Servo Power On<br>D0 = T/R Power On |
| 8 | Control Word #3 (all spare) |
| 9 | Signal generator level (unsigned 0–127dB attenuation) |
| 10 | AZ/EL Antenna speed (signed 7 bit, 0.55 degree resolution) |
| 11 | END OF MESSAGE (FF Hex) |

**Table 16 Status Packet RCV02 / RCV04 Format (RCP to Host)**

| Char | Function |
|---|---|
| 1 | SYNC Byte (80 Hex) |
| 2 | Azimuth Low 7 bits |
| 3 | Azimuth High 7 bits |
| 4 | Elevation Low 7 bits |
| 5 | Elevation High 7 bits |
| 6 | Azimuth Rate Low 7 bits |
| 7 | Azimuth Rate High 7 bits |
| 8 | Elevation Rate Low 7 bits |
| 9 | Elevation Rate High 7 bits |
| 10 | Status #1<br>D6 = Low air flow<br>D5 = Low Waveguide pressure<br>D4 = Servo Power<br>D3 = Antenna Local mode<br>D2 = Interlock Open<br>D1 = Standby<br>D0 = Radiate On |

**Table 16 Status Packet RCV02 / RCV04 Format (RCP to Host)**

| Char | Function |
|---|---|
| 11 | Status #2<br>D6 = RCP02 is shutdown<br>D5 = LSB pulse width<br>D4 = T/R Power On<br>D3 = T/R Local mode<br>D2 = Azimuth encoder calibrated<br>D1 = MSB pulse width<br>D0 = Mag. current normal |
| 12 | Status #3<br>D6 = IRIS Mode 2<br>D5 = IRIS Mode 1<br>D4 = IRIS Mode 0<br>D3 = Elevation encoder calibrated<br>D2 = Signal Generator fault<br>D1 = Signal Generator On<br>D0 = Signal Generator CW |
| 13 | Signal generator level (0=max power) |
| 14 | Time Stamp Low 7 bits |
| 15 | Time Stamp High 7 bits |
| 16 | END OF MESSAGE (FF Hex) |

**Table 17 Control Packet XMT02 / XMT04 Format (Host to RCP)**

| Char | Function |
|---|---|
| 1 | SYNC Byte (80 Hex) |
| 2 | Azimuth Low 7 bits |
| 3 | Azimuth High 7 bits |
| 4 | Elevation Low 7 bits |
| 5 | Elevation High 7 bits |
| 6 | Control Word #1<br>D6 = MSB of Pulse Width<br>D5 = Leave Pulse Width unchanged<br>D4 = Spare<br>D3 = Signal Generator On<br>D2 = Signal Generator CW<br>D1 = EL (1 = Scan 0 = Position)<br>D0 = AZ (1 = Scan 0 = Position)<br>Note: If EL in position mode, maximum positive velocity is sent in the velocity field, if EL in scan mode, maximum or minimum elevation position is sent in the position field. If AZ in position mode, maximum positive velocity is sent in the velocity field, if AZ in scan mode, 0 is sent in the position field. |

**Table 17 Control Packet XMT02 / XMT04 Format (Host to RCP) (Continued)**

| Char | Function |
|---|---|
| 7 | Control Word #2<br>D6 = Reset RCP02 on rising edge<br>D5 = Noise Source On<br>D4 = LSB of Pulse width<br>D3 = Radiate On complemented<br>D2 = Radiate On<br>D1 = Servo Power On<br>D0 = T/R Power On |
| 8 | Control Word #3<br>D6 = IRIS Mode 2<br>D5 = IRIS Mode 1<br>D4 = IRIS Mode 0<br>D3 = Radar Workstation A okay<br>D2 = Radar Workstation B okay<br>D1 = Data Processor A okay<br>D0 = Data Processor B okay |
| 9 | Signal Generator level (0–127 dB attenuation) |
| 10 | AZ Antenna Speed Low 7 bits |
| 11 | AZ Antenna Speed High 7 bits |
| 12 | EL Antenna Speed Low 7 bits |
| 13 | EL Antenna Speed High 7 bits |
| 14 | END OF MESSAGE (FF Hex) |

**Table 18 Status Packet RCV03 Format (RCP to Host)**

| Char | Function |
|---|---|
| 1 | SYNC Byte (80 Hex) |
| 2 | Identification byte |
| 3 | Azimuth Low 7 bits (Earth relative) |
| 4 | Azimuth High 7 bits |
| 5 | Elevation Low 7 bits (Earth relative) |
| 6 | Elevation High 7 bits |
| 7 | Train Order Low 7 bits (azimuth of pedestal relative to the ship) |
| 8 | Train Order High 7 bits |
| 9 | Elevation Order Low 7 bits (elevation of pedestal relative to the ship) |
| 10 | Elevation Order High 7 bits |
| 11 | Pitch Low 7 bits |
| 12 | Pitch High 7 bits |
| 13 | Roll Low 7 bits |
| 14 | Roll High 7 bits |
| 15 | Heading Low 7 bits |
| 16 | Heading High 7 bits |
| 17 | Azimuth Rate Low 7 bits |
| 18 | Azimuth Rate High 7 bits |

**Table 18 Status Packet RCV03 Format (RCP to Host)**

| Char | Function |
|---|---|
| 19 | Elevation Rate Low 7 bits |
| 20 | Elevation Rate High 7 bits |
| 21 | Pitch Rate Low 7 bits (LSB = Zero) |
| 22 | Pitch Rate High 7 bits |
| 23 | Roll Rate Low 7 bits (LSB = Invalid Roll) |
| 24 | Roll Rate High 7 bits |
| 25 | Heading Rate Low 7 bits (LSB = Invalid Heading) |
| 26 | Heading Rate High 7 bits |
| 27 | Status #1<br>D6 = Low air flow<br>D5 = Low Waveguide pressure<br>D4 = Servo power<br>D3 = Antenna Local mode<br>D2 = Interlock open<br>D1 = Standby<br>D0 = Radiate ON |
| 28 | Status #2<br>D6 = RCP02 is shutdown<br>D5 = LSB pulse width<br>D4 = T/R Power on<br>D3 = T/R Local mode<br>D2 = Azimuth encoder calibrated<br>D1 = MSB pulse width<br>D0 = Mag. current normal |
| 29 | Status #3<br>D6 = Reserved<br>D5 = Reserved<br>D4 = Reserved<br>D3 = Elevation encoder calibrated<br>D2 = Signal Generator fault<br>D1 = Signal Generator On<br>D0 = Signal Generator CW |
| 30 | Signal generator value (0=full signal) |
| 31 | Time Stamp Low 7 bits |
| 32 | Time Stamp High 7 bits |
| 33 | Latitude Low 7 bits |
| 34 | Latitude Middle 7 bits |
| 35 | Latitude High 7 bits |
| 36 | Longitude Low 7 bits |
| 37 | Longitude Middle 7 bits |
| 38 | Longitude High 7 bits |
| 39 | Altitude Low 7 bits |
| 40 | Altitude High 7 bits |
| 41 | Velocity East Low 7 bits (LSB = Invalid Lat/Lon) |
| 42 | Velocity East High 7 bits |
| 43 | Velocity North Low 7 bits (LSB = Zero) |
| 44 | Velocity North High 7 bits |

**Table 18 Status Packet RCV03 Format (RCP to Host)**

| Char | Function |
|---|---|
| 45 | Velocity Up Low 7 bits (LSB = Invalid Altitude) |
| 46 | Velocity Up High 7 bits |
| 47 | END OF MESSAGE (FF Hex) |

**Table 19 Status Packet RCV05 Format (RCP to Host)**

| Char | Function |
|---|---|
| 1–15 | These bytes exactly match the RCV02 / RCV04 format |
| 16 | Dual-System Status<br>D6 = RCP02 is configured as a Dual-System<br>D5 = Dual-System Mode MSB<br>D4 = Dual-System Mode LSB<br>D3 = This packet was sent from Unit "A"<br>D2 = Information is known about the "Other" unit<br>D1 = Unit "A" is the preferred system<br>D0 = Unit "B" is disabled<br>Note: The 2-bit Dual-System Mode codes are:<br>00 : Unknown mode 01 : System "A" 10: System "B" 11 : Auto Switch |
| 17 | Dual-System Status<br>D6 = Unit "B" is okay<br>D5 = Unit "B" Activity Code MSB<br>D4 = Unit "B" Activity Code LSB<br>D3 = Unit "A" is disabled<br>D2 = Unit "A" is okay<br>D1 = Unit "A" Activity Code MSB<br>D0 = Unit "A" Activity Code LSB<br>Note: The 2-bit Dual-System Activity codes are:<br>00 : Inactive 01 : Warmup 10: Active Now 11 : Reserved |
| 18 | Dual-System Status<br>D6 = RCP02 is configured for voluntary flipping<br>D5 = Unit "B" is offering to give up control<br>D4 = Unit "A" is offering to give up control<br>D3 = Unit "B" would be used if it were available<br>D2 = Unit "A" would be used if it were available |
| 19 | D0:2 = Current Polarization XMT control<br>0=Horizontal; 1=Vertical; 2=Alternating; 3=Simultaneous<br>D3 = Polarization switch is OK to run |
| 20 | Spare |
| 21 | Spare |
| 22 | Spare |
| 23 | Spare |
| 24 | END OF MESSAGE (FF Hex) |

**Table 20 Control Packet XMT05 Format (Host to RCP)**

| Char | Function |
|---|---|
| 1–13 | These bytes exactly match the XMT02 / XMT04 format |

**Table 20 Control Packet XMT05 Format (Host to RCP)**

| Char | Function |
|---|---|
| 14 | Control Word #4<br>D6 = Dual-System: Mode MSB<br>D5 = Dual-System: Mode LSB<br>D4 = Dual-System: Offer to relinquish control<br>D3 = Dual-System: Unit would be used if available<br>D2 = Spare<br>D1 = Spare<br>D0 = Spare<br>Note: The 2-bit Dual-System Mode codes are:<br>00 : No mode 01 : System "A"<br>10: System "B" 11 : Auto Switch |
| 15 | D0:2 = Requested Polarization XMT control<br>0=Horizontal; 1=Vertical; 2=Alternating; 3=Simultaneous; 7=Unchanged |
| 16 | Spare |
| 17 | Spare |
| 18 | END OF MESSAGE (FF Hex) |

**Table 21 Time Packet (RCP to Host)**

| Char | Function |
|---|---|
| 1 | SYNC Byte (B0 Hex) |
| 2 | Year Low 7 bits |
| 3 | Year High 7 bits |
| 4 | Month |
| 5 | Day |
| 6 | Hour |
| 7 | Minute |
| 8 | Second |
| 9 | 1/100 of Second |
| 10 | Status |
| 11 | END OF MESSAGE (FF Hex) |

**Table 22 Generic BITE Status Packet (Both ways)**

| Char | Function |
|---|---|
| 1 | SYNC Byte (C0 Hex) |
| 2 | BITE Unit ID byte (selectable in the range 00–7F Hex) |
| 3 | Status byte #1 |
| 4 | Status byte #2 |
| . | |
| . | |
| . | |
| N–1 | Status byte #N–3 |
| N | END OF MESSAGE (FF Hex) |

The BITE status packet consists of from 3 to 20 bytes. The first two and the last bytes are used for identification purposes. The middle bytes must have the MSB set to zero and can contain arbitrary status in the lower 7 bits. Typically this is used to report back individual bits containing the results of tests such as cabinet interlocks, airflow sensors, and power supply checks. This report should be sent by the BITE every time the status changes. It should also send a report in response to the interrogate command. IRIS sends the interrogate command every 60 seconds.

**Table 23 BITE Command Packet (Both ways)**

| Char | Function |
|---|---|
| 1 | SYNC Byte (C0 Hex) |
| 2 | Command (0x4D = Interrogate, 0x44=Sample Data, 0x43=Reset) |
| 3 | End Of Message (FF Hex) |

**Table 24 Auxiliary Control BITE Packets (Both ways)**

| Char | Function | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | SYNC Byte (C0 Hex) | | | | | | | |
| 2 | BITE Unit ID byte (User Choice) | | | | | | | |
| 3 | Control/Status Bits | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 4 | Control/Status Bits | 13 | 12 | 11 | 10 | 9 | 8 | 7 |
| 5 | Control/Status Bits | 20 | 19 | 18 | 17 | 16 | 15 | 14 |
| 6 | Control/Status Bits | 27 | 26 | 25 | 24 | 23 | 22 | 21 |
| 7 | Control/Status Bits | 34 | 33 | 32 | 31 | 30 | 29 | 28 |
| 8 | Control/Status Bits | 41 | 40 | 39 | 38 | 37 | 36 | 35 |
| 9 | Control/Status Bits | 48 | 47 | 46 | 45 | 44 | 43 | 42 |
| 10 | Control/Status Bits | 55 | 54 | 53 | 52 | 51 | 50 | 49 |
| 11 | Control/Status Bits | 62 | 61 | 60 | 59 | 58 | 57 | 56 |
| 12 | Control/Status Bit | | | | | | | 63 |
| 13 | END OF MESSAGE (FF Hex) | | | | | | | |

This example BITE packet is supported by the SIGMET RCP02 and RCP8 Radar Control Processors, and is an example of a mapping of arbitrary control and status bits into a BITE packet.

These RCPs contains 64 auxiliary status and control variables, labeled S[0:63] and C[0:63]. These bits may be sent to and from the host computer in the form of 13-byte BITE packets holding the full set of 64 bits. The format of these packets is the same in both directions, and the identification byte is selectable so that conflicts with other BITE packets can be avoided.

**Table 25 Q-BITE Status Packet (Both ways)**

| Char | Function |
|---|---|
| 1 | SYNC Byte (AF Hex) |
| 2 | BITE Unit ID byte (selectable in the range 00-7F Hex) |

**Table 25 Q-BITE Status Packet (Both ways) (Continued)**

| Char | Function |
|---|---|
| 3 | Status byte #1 |
| 4 | Status byte #2 |
| . | |
| . | |
| . | |
| N–1 | Status byte #N–3 |
| N | END OF MESSAGE (FF Hex) |

The Q-BITE (Quantitative byte) status packets consists of from 3 to 128 bytes. The first two and last bytes are used for identification purposes. The middle bytes must have the MSB set to zero and can contain an arbitrary value in the lower 7 bits. Typically this is used to report back voltage/ power levels. This report should not be sent by the BITE every time the status changes. This report is sent in response to the Q-bite interrogate command. IRIS sends the interrogate command every 60 seconds.

The Q-BITE data stream consists of a series of integer values. Each value is packed into a series of 7-bit characters, using between 1 and 5 depending on the desired resolution. The low bits come first, and IRIS supports up to 32 bits per value. IRIS can easily be configured to display any such values with appropriate units and scaling.

**Table 26 Simple Q-BITE Example**

| Char | Function |
|---|---|
| 1 | SYNC Byte (AF Hex) |
| 2 | BITE Unit ID byte (Selectable in range 00–7F) |
| 3 | V1 Trigger frequency (Hz) (low bits) |
| 4 | V1 Trigger frequency (Hz) (High bits) |
| 5 | V2 Thyratron voltage (0.1 Volts) (low bits) |
| 6 | V2 Thyratron voltage (0.1 Volts) (high bits) |
| 7 | END OF MESSAGE (FF Hex) |

**Table 27 Q-BITE Interrogate Packet (Both ways)**

| Char | Function |
|---|---|
| 1 | SYNC Byte (90 Hex) |
| 2 | Command (0x01 or 0x4D=Interrogate, 0x44=Sample Data, 0x43=Reset) |
| 3 | End Of Message (FF Hex) |

**Table 28 BITE Individual Command Packet (Host to RCP)**

| Char | Function |
|---|---|
| 1 | SYNC Byte (C1 Hex) |

**Table 28 BITE Individual Command Packet (Host to RCP)**

| Char | Function |
|---|---|
| 2 | ID of the BITE unit for which the command will be applied |
| 3 | Command: 0x4D=Interrogate, 0x44=Sample Data, 0x43=Reset |
| 4 | END OF MESSAGE (FF Hex) |

The BITE individual command packet is used to request information about a single BITE unit, separate from all the others.

The RCP should respond to an **Interrogate** packet by sending the current version of the specified BITE status packet. The RCP should respond to a **Sample Data** packet by sending requests out the the remote device to get information, then responding to the host computer with the new BITE status packet when the information arrives. The RCP should responds to the **Reset** packet by sending a reset command to the remote device.

**Table 29 Chat-Mode Packet (Both ways)**

| Char | Function |
|---|---|
| 1 | SYNC Byte (F1 Hex) |
| 2...7 | 7-Bit ASCII characters (possibly NULL terminated) |
| 8 | END OF MESSAGE (FF Hex) |

These packets are sent in both directions to convey serial TTY communication. Up to six 7-bit characters can be sent in each packet with two characters of overhead for SYNC and END. This allows up to 75% of the available serial bandwidth to be used for chatting. If a "chat" mode packet contains fewer than six characters, then a NULL (zero byte) is inserted after the last one.

# APPENDIX B
# LINK TRANSMISSION FORMATS

## B.1 AWS (Austrian Weather Service) Format

This format uses an 8-bit data stream and can transmit an image of and rectangular product up to 256 pixels high with compression for horizontal runs of the same data. For flexibility, IRIS supports a mapping table to convert the IRIS product color levels to the transmitted levels. Note the expanded color scales with more than 16 colors are not availble for link outputs. Throughout this discussion, hexadecimal notation is often used, and those numbers are denoted with a suffix of "h." For example, 12h means 12 base 16, or 18 base 10. Also for this discussion, all line and pixel numbers are origin 1. The upper left pixel is line 1, pixel 1.

All picture transmissions begin with a station ID code, followed by a time code, followed by the data section, followed by the end-of-image code. The data section consists of a series of line number codes, followed by compressed data. Data for a line ends when the next line number code is encountered. All unfilled pixels are assumed to be of the value 0. If a line is repeated in the data stream, any new data overwrites old data. If a line number code is never transmitted, the line is assumed to be filled with zeros.

The meaning of a byte is generally found by looking at the upper 4-bits. If those bits are a value between 0h and Eh, insert the data value in the low 4-bits between 1 and 15 times. If those bits are an Fh, it can be interpreted as one of the following special commands.

**FFh — Line number follows in the next byte**

The following byte contains one less than the line number for data that follows. For example, FFh 0Ch means line 13 follows. This command also implies that the previous line is zeroed from the current position to the end.

**FEh — Extended data repeat command, information in next two bytes**

This command is the same as the normal data repeat command, except that the repeat count is 12 bits. The high 8 bits of the repeat count are in the following byte, and the low 4 bits are in the high 4 bits of the third byte. The data value is in the low 4 bits of the third byte. For example, FEh 12h 34h means insert the data value 4 292 times.

**FBh — Station identifier follows in next byte**

The station identifier is configured from the **setup** utility. If multiple FBh commands are received for a given image, the last one takes effect. There must be at least one FBh command in each image. This command allows data from multiple sites to be merged on one transmission line. IRIS transmits only host site data.

**FAh — Date and time follows in next 18 bytes**

This command specifies the time of the data in the current image. If multiple FAh commands are received for a given image, the last one takes effect. There must be at least one FAh command in each image. The 18-byte string contains a text version of the time, such as "10-MAY-91 15:45:00." There is one space between the year and hours, and all numeric fields are two digits, with leading zeros, if required. The month contains the first three letters of the English month name.

**F8h — End-of-Image**

This indicates that an image has been completely sent. Any future transmissions relate to another image. After an F8h command and before an FFh command, only FBh, FAh commands are processed. All other commands are ignored.

## B.2 HKO (HongKong Observatory) Format

This format uses an 8-bit data stream and can transmit an image of and rectangular product up to 255 pixels high with compression for horizontal runs of the same data. For flexibility, IRIS supports a mapping table to convert the IRIS product color levels to the transmitted levels. Note the expanded color scales with more than 16 colors are not availble for link outputs. Throughout this discussion, hexadecimal notation is often used, and those numbers are denoted with a suffix of "h." For example, 12h means 12 base 16, or 18 base 10. Also for this discussion, all line and pixel numbers are origin 1. The upper left pixel is line 1, pixel 1.

All picture transmissions begin with a picture type ID code, followed by a header code, followed by the data section, followed by the end-of-image code. The data section consists of a series of line number codes, each followed by compressed data. Data for a line ends when the next line number code is encountered. All unfilled pixels are assumed to be of the value 1. If a line is repeated in the data stream, any new data overwrites old data. If a line number code is never transmitted, the line is assumed to be filled with ones.

The only use of a zero byte is to immediatly proceed on the the commands below. This make it easy to sync up to the data stream.

### 00h 01h — Picture type follows in the next byte

**Table 30 HKO Picture types**

| | | | | |
|---|---|---|---|---|
| 1 | All PPIs | | | |
| 2 | CAPPI | >2.5 km height | <96 km range | data not velocity |
| 3 | CAPPI | all heights | <96 km range | data is velocity |
| 4 | CAPPI | <2.5 km height | <96 km range | data not velocity |
| 5 | CAPPI | >2.5 km height | 96<range<192 | data not velocity |
| 6 | CAPPI | all heights | 96<range<192 | data is velocity |
| 7 | CAPPI | <2.5 km height | 96<range<192 | data not velocity |
| 8 | CAPPI | all heights | >192 km range | data not velocity |
| 9 | CAPPI | all heights | >192 km range | data is velocity |
| 10 | All other products | | | |

### 00h 02h — Header follows in the next 40 bytes

The format of the header is "HHPPPPPPPPPPPPhh:mm DD-MM-YYYY ". Where "HH" is the CAPPI height in km, "PPPPPPPPPPPP" is the product name. All numeric fields are two digits, with leading zeros, if required.

### 00h 03h — Line number follows in the next byte

The following byte contains the origin 1 line number in the range 1–255. This is followed by a variable length string of bytes containing a data number followed by a repeat count. Data numbers are in the range 1 through 16.

### 00h 04h — End-of-Image

This indicates that an image has been completely sent. Any future transmissions relate to another image.

# APPENDIX C
# UF FORMAT

## C.1 Introduction

UF (short for "Universal Format") is a radar data format originally proposed and documented in the "Report on a Meeting to Establish a Common Doppler Radar Data Exchange Format", page 1401 of the November 1980 *Bulletin of the American Meteorological Society*.

## C.2 Single UF Ray Structure

The data consists of a single file for a complete volume scan. Within this file are a series of stand-alone rays (data acquired for a given pointing direction). All header information is duplicated for each ray. Within a ray, the data is basically all organized as 16-bit words, byte swapped in the big endian convention. The exception to this is that each ray starts and ends with a 32-bit record size indicating the number of bytes in the ray. All ASCII text is supposed to be left justified, space padded but some converter programs produce null terminated text, so the reader must be tollerant. The data format does support breaking a large ray into several records. In this case, the multiple records within the ray will have identical formats, they will have different field headers and data fields. The IRIS convertor programs do not support this feature, and will always place a ray in a single record. The optional header is only placed in the ray for the first ray of a file.

Please look in our uf.h header file for additional documentation. These structure names generally end with a "2" to indicate that they are 2-byte aligned. The default is that all IRIS structures are 4-byte alligned unless they end in a 2 or 8.

| |
|---|
| ray size 4 Bytes |
| <uf_mandatory_header2> 45 Words |

| |
|---|
| <uf_optional_header> 0 or 12 Words |
| <uf_data_header2> 3 + 2N Words |
| <uf_field_header2> #1 19 or 21 or 25 Words |
| data from field #1 M Words |
| <uf_field_header2>#2 19 or 21 or 25 Words |
| data from field #2 M Words |
| ...(repeats for each data type)... |
| ray size 4 Bytes |

## C.3 uf_mandatory_header2 Structure

Source: `uf.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | char[2] | Text "UF" |
| 2 | int16_t | Record Size in 16-bit words |
| 4 | int16_t | Offset to start of optional header, origin 1 |
| 6 | int16_t | Local-Use Header Position (origin 1) |
| 8 | int16_t | Data Header Position (origin 1) |
| 10 | int16_t | Record Number (origin 1) |
| 12 | int16_t | Volume number on tape, n/a for disk |
| 14 | int16_t | Ray number within the volume scan |
| 16 | int16_t | Record number within ray (origin 1) |
| 18 | int16_t | Sweep number within the volume scan |
| 20 | char[8] | Radar name |
| 28 | char[8] | site name |
| 36 | int16_t | Latitude degrees (North positive, South negative) |
| 38 | int16_t | Latitude minutes |
| 40 | int16_t | Latitude seconds*64 |
| 42 | int16_t | Longitude degrees (East positive, West negative) |
| 44 | int16_t | Longitude Minutes |
| 46 | int16_t | Longitude Seconds |
| 48 | int16_t | Height of antenna above sea level in meters |
| 50 | int16_t | Year (time of data acquisition) |
| 52 | int16_t | Month |
| 54 | int16_t | Day |
| 56 | int16_t | Hour |
| 58 | int16_t | Minute |
| 60 | int16_t | Second |
| 62 | char[2] | Time zone, "UT" for universal |
| 64 | int16_t | Azimuth (degrees*64) of midpoint of sample |
| 66 | int16_t | Elevation (degrees*64) |

| | | |
|---|---|---|
| 68 | int16_t | Sweep mode:<br><br>0:Cal 1:PPI 2:Coplane 3:RHI<br><br>4:Vertical 5:Target 6:Manual 7:Idle |
| 70 | int16_t | Fixed angle (degrees*64) |
| 72 | int16_t | Sweep rate ((degrees/second)*64) |
| 74 | int16_t | Year (generation data of UF format) |
| 76 | int16_t | Month |
| 78 | int16_t | Day |
| 80 | char[8] | Name of UF generator program |
| 88 | int16_t | Value stored for deleted or missing data (0x8000) |

## C.4 uf_optional_header Structure

Source: `uf.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | char[8] | sProjectName[8] |
| 8 | int16_t | iBaselineAzimuth |
| 10 | int16_t | iBaselineelevation |
| 12 | int16_t | iVolumeScanHour /* Time of start of current volume scan */ |
| 14 | int16_t | iVolumeScanMinute |
| 18 | char[8] | sFieldTapeName[8] |
| 24 | int16_t | iFlag |

## C.5 uf_data_header2 Structure

Source: `uf.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | int16_t | Number of fields in this ray |
| 2 | int16_t | Number of records in this ray |
| 4 | int16_t | Number of fields in this record |
| 6 | int16_t | Data type of field #1 (SIGMET standard):<br>VR:velocity SW:spectrum width DR:ZDR<br>CZ:Corrected dBZ DZ:Total dBZ RH:RhoHV<br>PH:PhiDP KD:KDP LH:LdrH<br>LV:LdrV |
| 8 | int16_t | Field #1 field header position |

| | | |
|---|---|---|
| 10 | int16_t | Data type of field #2 |
| 12 | int16_t | Field #2 field header position |
| ... | | |

## C.6 uf_field_header2 Structure

Source: `uf.h`

| Byte | Size | Contents |
|---|---|---|
| 0 | int16_t | Data offset from start of record, origin 1 |
| 2 | int16_t | Scale factor, met units = file value/scale |
| 4 | int16_t | Start range km |
| 6 | int16_t | Start range meters |
| 8 | int16_t | Bin spacing in meters |
| 10 | int16_t | Bin count |
| 12 | int16_t | Pulse width in meters |
| 14 | int16_t | Horizontal beam width in degrees*64 |
| 16 | int16_t | Vertical beam width in degrees*64 |
| 18 | int16_t | Receiver bandwidth in Mhz*64 ? |
| 20 | int16_t | Polarization: 1:horz 2:vert 3:circular 4:ellip. |
| 22 | int16_t | Wave length in cm*64 |
| 24 | int16_t | Sample size |
| 26 | char[2] | Type of data used to threshold |
| 28 | int16_t | Threshold value |
| 30 | int16_t | Scale |
| 32 | char[2] | EditCode |
| 34 | int16_t | PRT in microseconds |
| 36 | int16_t | Bits per bin, must be 16 |
| 38 | 12 | <uf_fsi2> |

## C.7 uf_fsi2 Structure

Source: `uf.h`

| Byte | Size | Contents |
|---|---|---|
| If velocity data: | | |
| 0 | int16_t | Nyquist velocity |
| 2 | int16_t | <spare> |
| If DM data: | | |
| 0 | int16_t | Radar Constant |

| | | |
|---|---|---|
| 2 | int16_t | Noise Power |
| 4 | int16_t | Receiver Gain |
| 6 | int16_t | Peak Power |
| 8 | int16_t | Antenna Gain |
| 10 | int16_t | Pulse Duration (microseconds*64) |

If Other data:
nothing

# APPENDIX D
# RTD FORMATS

## D.1 Introduction

IRIS can output a real-time display data stream using UDP data packets. There are several formats provided, and the customer can also write their own. The source code for these transmitter programs is in ${IRIS_ROOT}/ libs/rtq. The formats are documented in detail in the sig_rtdisp.h file.

Any computer running IRIS on that network can receive and process (display) the real time display data. One nice factor about the real time display is that it is completely scalable. If the IRIS Radar server is sending real time display data, the load induced on the network, and the servers CPU is constant no matter if none, one or a hundred machines are on that network receiving and processing the real time display data. This is made possible by the fact that the real time display is done in broadcast mode.

It should also be noted that UDP data does not get retransmitted upon packet loss, and at the application level in IRIS, there is no attempt done at detected packet losses nor asking for retransmissions. If such a loss occurs at the transmitter, on the network, or at one or more receiving hosts, then a gap would occur in the picture being drawn on the destination real time displays. This of course differs from IRIS product transmission which are done point-to-point via TCP and are reliable due to error checking and retransmissions.

The load induced on the network by a real time display server broadcasting is a function of the following: Number of moments being broadcast (up to 3 – Z, V and W), the number of bins per radial and the scan rate of the antenna. The total number of bins (combined for all moments) is approximately 1400 per radial. An overhead of about 100 bytes per ray exists. Each bin requires one byte of data. Thus this a scan rate of 5 RPM (30 radials per second), requires about 1500 * 30 = 45000 bytes per second. One must remember that the real time display bandwidth must be added to any other IRIS and other bandwidth being occupied on your network. Therefore, running the real time display on a remote radar connected via a 56K baud link would not be practical.

The real time display data stream can be configured to transmit using up to 6 different formats, IP addresses, and ports. See the **setup** utility documentation in the *SIGMET Utilities Manual*. Normally gateways, such as multi-homed hosts, bridges and routers will NOT pass IRIS real time display data. This is because such devices are built to filter broadcast data. This is the mechanism that keeps the real time display data on a single network. However, it is usually possible to configure such devices to pass broadcast data that is occurring on a specific port (like the real time display port). This may be convenient in some installations.

To receive real time display data, the receive process needs to issue a socket and a bind system call. Following this, the receiver can read messages from the socket as they are transmitted.

## D.2 Rtd_v1_xmt

There are three different messages transmitted as part of the real time display data stream. The messages are distinguished by the the first two bytes (SHORT) in the message summarized in the following table (see definitions in sig_rtdisp.h):

RTRAY_TYPE_HEADER

RTRAY_TYPE_RAY

RTRAY_TYPE_RAY

The message RTRAY_TYPE_HEADER consists of the two byte ID followed by a struct rtd_v1_vol_header. This message is sent either at the beginning of a new elevation sweep, or periodically if a new sweep has not started recently.

The message RTRAY_TYPE_RAY begins with the two byte ID. What this is followed by depends on the type of data being transmitted by the real time display sender. This is chosen in the senders **setup** utility and can consists of 1, 2 or 3 data types being Z, V or W. The volume header indicates which data types are currently being transmitted and in which order the data types are being presented. For example, if only Z and V are being transmitted, the RTRAY_TYPE_RAY message will consist of its two byte message ID, followed by a struct rtd_v1_ray_header, followed by the data elements for Z, followed by the V elements. The Z and V elements are presented as one byte per range bin. The scaling of the elements is defined in 4.3 Data Types on page 74. For example, if the volume header indicates that 200 bins of each type are being transmitted, then the Z elements (and the V elements) would each be 200 bytes long each, with each byte representing one range bin. The spacing between the range bins is also defined by the volume header.

## D.3 Rtd_v2_xmt

This format is designed to support the full number of range bins, almost the full number of data types, and both 8-bit and 16-bit data formats. As a result each radial must be split into potentially many individual 1500 byte UDP packets. Similar to rtd_v1_xmt, the volume header rtd_v2_vol_header is sent periodically. Every 25 rays, or when there is a change. Otherwise the rtd_v2_ray_header is sent followed by data.

## D.4 Rtd_nids3_xmt

This format is designed to support a legacy data format used by Radtec. All packets are the same format, with minimal header information. Data can be either 8-bit or 4-bit format. There is a config file rtd_nids3_xmt.conf which controls some details.

# INDEX

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