

HAIC Weather Radar Data

This document provides a basic description of the weather radar (WXR) data collected during the 2014 HAIC Flight Campaign (conducted near Darwin, Australia) and the data collected during the 2015 HAIC Flight Campaign (conducted near Cayenne, French Guiana).

HAIC Flight Campaign Flights for Darwin

A summary of the flights with aircraft and radar start and stop times is provided in the Table below.

Flight Number	Date	Aircraft-State Data UTC Times (hh:mm)		Radar Data UTC Times (hh:mm)	
		Start	Stop	Start	Stop
fs140001	01/16/2014	01:22	05:24	02:10	05:09
fs140002	01/16/2014	21:03	00:30	21:25	00:10
fs140003	01/17/2014	02:07	05:15	02:30	04:50
fs140004	01/18/2014	21:18	00:50	21:51	00:40
fs140005	01/21/2014	04:12	07:25	04:34	05:39
fs140006	01/23/2014	19:34	23:25	22:09	23:19
fs140007	01/24/2014	19:38	22:40	20:08	21:24
fs140008	01/27/2014	20:03	23:16	20:43	23:14
fs140009	01/28/2014	20:46	23:49	21:08	23:38
fs140010	01/29/2014	19:34	23:22	20:06	23:07
fs140011	01/30/2014	00:45	02:26	01:13	02:16
fs140012	02/02/2014	19:49	23:50	20:35	23:39
fs140013	02/03/2014	02:37	06:36	04:05	06:28
fs140014	02/04/2014	19:51	23:56	20:34	23:45
fs140015	02/05/2014	22:56	02:35	23:27	02:29
fs140016	02/07/2014	19:42	00:20	23:23	00:12
fs140017	02/08/2014	01:36	03:57	-	-
fs140018	02/08/2014	20:16	00:12	20:48	23:56
fs140019	02/09/2014	20:11	00:19	20:48	00:14
fs140020	02/10/2014	01:33	04:04	02:07	03:56
fs140021	02/17/2014	06:07	08:36	06:27	08:27
fs140022	02/17/2014	20:56	01:07	21:43	00:48
fs140023	02/18/2014	20:51	00:52	21:37	22:10

NOTE: Airbus/SAFIRE has not provided radar data for **fs140017** and the radar data for **fs140005**, **fs140006**, and **fs140016** are incomplete.

As additional summary information, all of the flight paths may be observed using Google Earth® and the following embedded KMZ file (double-click icon to run in Google Earth®).



HAICFlights.kmz

HAIC Flight Campaign Flights for Cayenne

A summary of the flights with aircraft and radar start and stop times is provided in the Table below.

Flight Number	Date	Aircraft-State Data UTC Times (hh:mm)		Radar Data UTC Times (hh:mm)	
		Start	Stop	Start	Stop
fs150009	05/09/2015	15:35	18:43	16:09	18:36
fs150010	05/10/2015	18:33	21:27	18:55	21:17
fs150011	05/12/2015	19:37	22:34	19:54	22:15
fs150012	05/14/2015	13:40	17:21	13:57	17:07
fs150013	05/15/2015	08:09	12:14	08:35	12:06
fs150014	05/16/2015	08:01	12:01	08:08	11:50
fs150015	05/16/2015	15:35	18:37	15:51	18:29
fs150016	05/18/2015	19:27	22:47	19:27	22:29
fs150017	05/19/2015	13:49	17:33	14:19	17:27
fs150018	05/23/2015	08:49	12:53	09:14	12:36
fs150019	05/23/2015	15:00	19:12	15:23	18:59
fs150020	05/24/2015	08:36	12:11	08:51	12:08
fs150021	05/25/2015	18:54	22:45	19:07	22:30
fs150022	05/26/2015	08:08	12:02	08:33	11:59
fs150023	05/26/2015	12:54	16:00	13:10	15:51
fs150024	05/27/2015	08:06	12:12	08:27	11:58
fs150025	05/28/2015	19:00	22:58	19:25	22:50
fs150026	05/29/2015	08:25	12:10	08:47	12:06

As additional summary information, all of the flight paths may be observed using Google Earth® and the following embedded KMZ file (double-click icon to run in Google Earth®).



HAICFlights2015.kmz

Available Data

There are two different kinds of data described in this document with corresponding directories of files. There is a directory labeled KMZ which provides daily 4D tracks of the aircraft that can be played within Google Earth® (for information on Google Earth® and/or its player see: <https://support.google.com/earth>). A second directory (WXR) has all the radar data. The radar data is described in the [WXR Data File Format](#) section below.

WXR Data File Format

The radar data is located in the radar directory. The radar data is organized by each flight in a separate subdirectory. Then each subdirectory has multiple data files. Each data file consists of a single sweep (± 60 degrees in azimuth) of measured radar reflectivity. The filenames are of the following format:

wsr_YYYYMMDDHHMMSS.dat

These WXR files are in binary format and the data is organized using the ARINC 708 standard; however, in addition to the standard 200 bytes per frame, these data have 4 more bytes per frame that provides UTC time information - producing a total of 204 bytes per frame. Decoding of this added time variable is analogous to decoding standard UNIX time stamps (ie, number of seconds past midnight since 01 January 1970). This UTC time variable is the same variable recorded in the aircraft state files.

Using the ARINC 708 data standard, the files have antenna azimuth angle, antenna elevation angle, range setting, gain setting (as well as other radar parameters), and 512 range bins of reflectivity. This recorded reflectivity only consists of the displayed color, not an actual dBZ value. These data are provided at intervals of once per radar frame as specified in the 708 standard. Since the range setting is included in each frame of data, this range setting can change within a sweep and therefore within a file. A description of reading the ARINC radar files and the subroutines used to read these files in C++ are shown below and included in the radar data subdirectory.

Each radar WXR data file (*.dat*) file has a corresponding image file (*.png*) in images subdirectory. This image is a screen capture of the radar PPI display.

It is important to note that time is recorded as whole numbers of seconds, and since radar frames occur more quickly, times does not increment (change) every frame - but a time value is always provided.

708 File Attributes

Color Scale

The reflectivity color labels are conforming to the scale provided in Table 5-6 of the Honeywell Primus 660 Digital Weather Radar System Pilot's Manual (Revision 3, August 2003). The 5 color labels are

label	color	Min dBZ (\geq)	Max dBZ ($<$)
0	black		23
1	Green	23	33
2	Yellow	33	40
3	Red	40	53
4	Magenta	53	

Gain Mapping

The Honeywell Primus 660 marketing literature states the variable gain range is from +3 dB to -15 dB.

Range Bin Mapping

The installed Honeywell Primus 660 Digital Weather Radar allows the pilot to select any one of eight different range settings. The (.dat) files consist of radar data from the first range bin (at zero range) to the 512th range bin (located at a distance equal to the radar's range setting).

Reading 708 Radar Files

As mentioned above the 708 ARINC standard has 1600 bits (200 bytes). The files from Darwin and Cayenne are 204 bytes with the extra 4 bytes containing the time variable. The ARINC 708 format includes the 64 bits of header, then 1536 bits of reflectivity (3 bits for each 512 range bins). The following figure shows a representation of the 708 reflectivity data with the added 4 bytes for time. The time variable has a resolution of one second, therefore each frame has a value but the time is not unique for each frame.

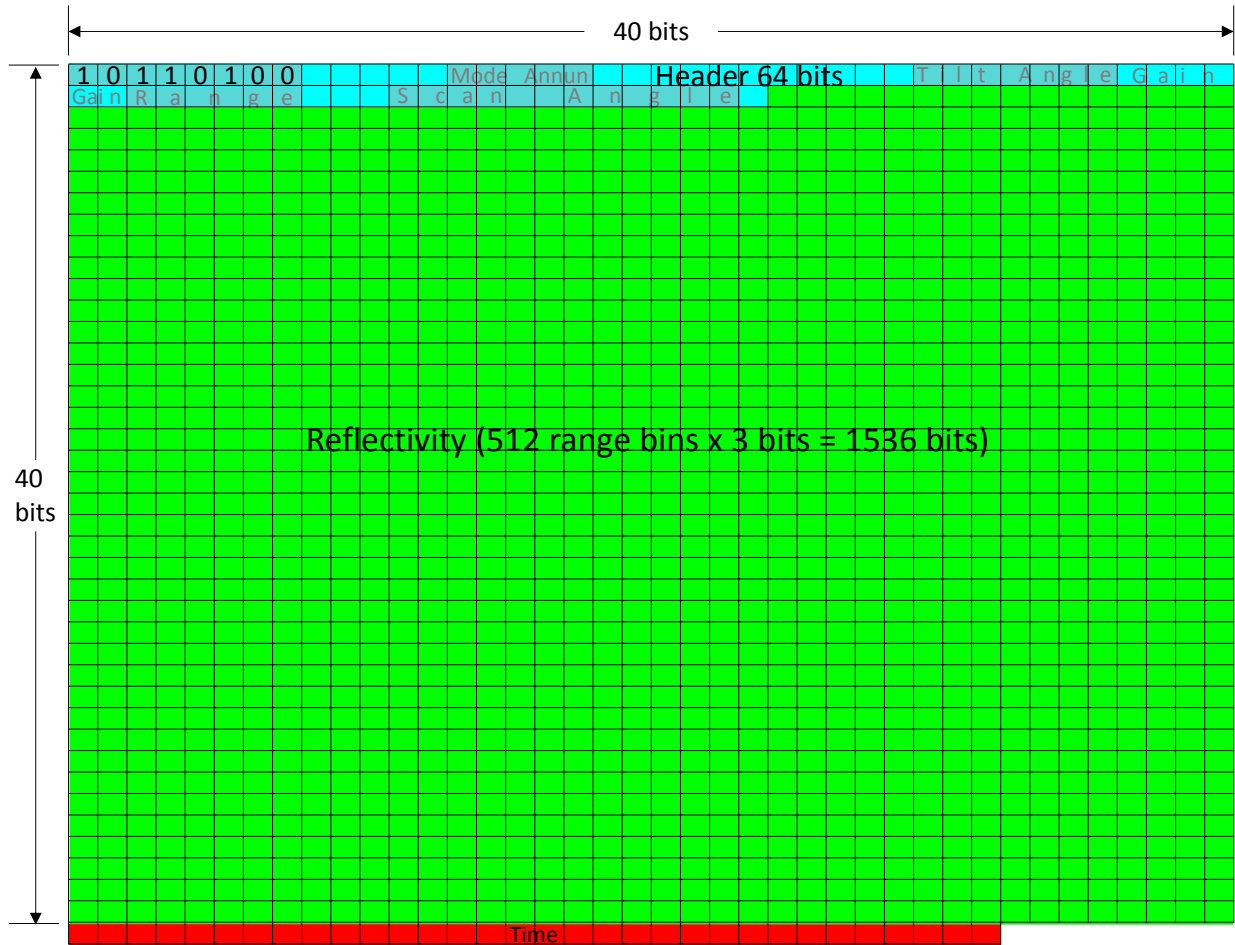


Figure 1: Graphical Representation of the 708 Format from Darwin and Cayenne.

Included in the radar subdirectories are source code files for C++ classes to read these modified 708 data files from Darwin and Cayenne. The reader is provided to support analysis and visualization by simply extracting and decoding the information from the data files and making it available through a defined interface. Because analysis goals, environments, and tools vary, no additional functionality is provided.

The source code files include header files (*.h) for declaring the class definitions and source files (*.cpp) for implementing the class methods. The base class (read708) is designed for standard ARINC data files. A derived class (readFalcon) extends the base class to read the modified files containing time information. The classes are contained in unique namespaces to avoid naming conflicts. Standard Doxygen annotations are included for documenting the public interfaces of the classes. (See: www.doxygen.org for more information).

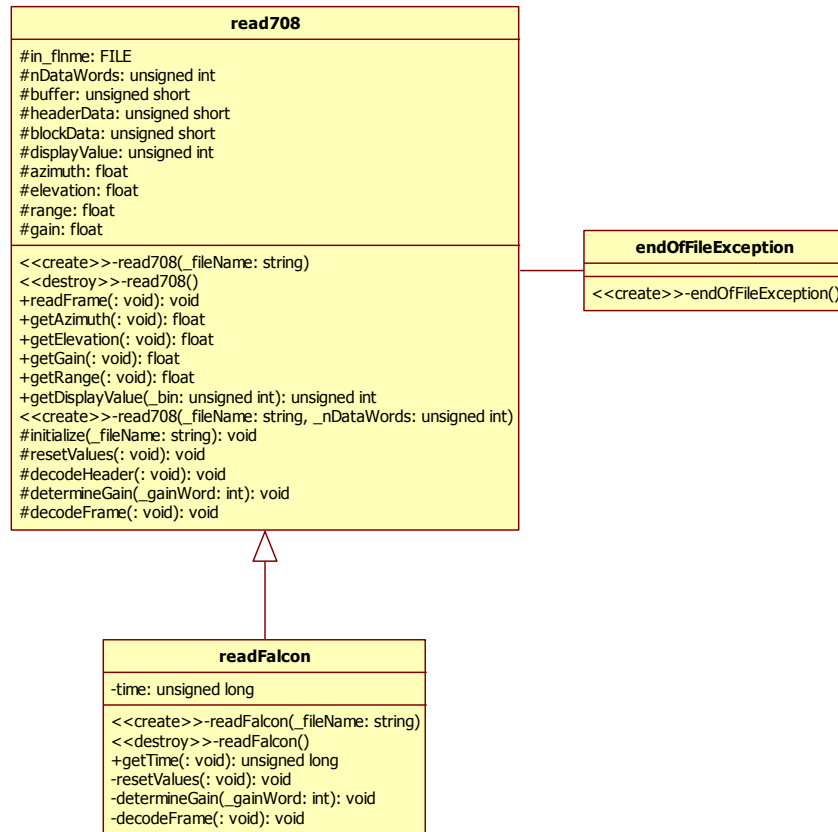


Figure 2: 708 Data File Reader UML Class Diagram

The public interface provides methods for reading a single frame of data at a time and then retrieving the information for the frame. The readFrame method throws a custom endOfFile exception when the end of the file is reached or a runtime error when there is an error reading the frame. Azimuth (scan angle) and elevation (tilt) angles are provided in degrees. Range is provided in nautical miles. Gain is provided in dB. Display value is provided for a given range bin and corresponds to the label provided in the table in section Color Scale above. Because the ARINC 708 standard defines 512 range bins, only values of 0-511 are valid inputs and zero is returned for all other inputs. In addition, the extended readFalcon class provides UTC time in seconds as described in WXR Data File Format above.

Support

Any questions regarding the 2014 and 2015 HAIC flight data should be addressed to:

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