

Garmin/Apollo Aviation Database

File Format

Herbert Oppmann

herby@memotech.franken.de

<http://www.memotech.franken.de/FileFormats/>

2022-06-02

Content

Garmin / Apollo Aviation Database File Format	3
Abbreviations	3
Basic data types	4
General file structure	5
Header	6
Table of contents	6
End marker	6
Range 0: Version	6
Range 1: Description	7
Range 2: Some date and time	7
Range 3: Some date	7
Range 4: Expiry date	7
Range 13: SUA?	7
Range 14:	7
Range 7: Lookup table for items	7
Range 16: Approaches	8
Range 8: Categories	8
Range 9: Countries table	8
Range 11: Double-char table	8
Range 10: Magnetic deviation data	9
Type 1 (INT) item	9
Type 2 (APT) item	10
Type 3 (VOR) item	11
Type 4 (NDB) item	11
Type 7 (??) item	12
Range 13 item	12
Range 14 item	12
Approach item	13
References	14
Used sources of information	14
Standards and specifications	14
Sources of sample files	14

Garmin / Apollo Aviation Database File Format

Filename extension *.bin

Used by the Apollo GX device series (GX50, GX55, GX60, GX65 and 2101 GPS units), which was produced by II Morrow, Inc. which was bought by UPS Aviation Technologies which was then bought by Garmin as Garmin AT.

This documentation is based on own research and the sources listed in the references section.

Abbreviations

AMSL	Height above mean sea level (in feet)
APPR	Approach
APT	Airport
ARSA	Airport Radar Service Area
ASCII	American Standard Code for Information Interchange
ATF	Air Traffic Frequency
ATIS	Automatic Terminal Information Service
ATIS	ATIS frequency (in the context of frequencies)
CLR	Clearance / Delivery
CTAF	Common Traffic Advisory Frequency
DB	Database
DEP	Departure frequency
DME	Distance Measuring Equipment
GRND	Ground frequency
ILS	Instrument Landing System
INT	En route Intersection (see [3])
LDA	Localizer Type Directional Aid (== Instrument Guidance System, IGS)
LOC	Localizer-DME
MF	Mandatory Frequency
NDB	Non-directional beacon (see [5])
SUA	Special Use Airspace
TCA	Terminal Control Area (USA und Canada) (== Terminal Manoeuvring Area, TMA, in Europe)
TRSA	Terminal Radar Service Area
TWR	Tower frequency
UNIC	Unicom frequency
Unicom	Universal Communication
VOR	Very high frequency omni-directional range (see [4])

Basic data types

All values are serialized in little-endian byte order (least significant byte first).

Type	Length	Description
char	1	ASCII character (see [6])
sbyte	1	8 bit signed integer (range -128 .. 127)
byte	1	8 bit unsigned integer (range 0 .. 255)
ushort	2	16 bit unsigned integer (range 0 .. 65535)
uint3	3	24 bit unsigned integer (range 0 .. 16777215)
int	4	32 bit signed integer (range -2147483648 .. 2147483647)
uint	4	32 bit unsigned integer (range 0 .. 4294967295)

Coord24:

Also known as “map units”. A 24 bit signed integer which has to be multiplied by 360.0° and divided by 2^{24} to get a longitude or latitude coordinate.

E.g. 0xEDA521 = -25.8117 or -25° 48' 42”

Coord32:

Also known as “map units”. A 32 bit signed integer which has to be multiplied by 360.0° and divided by 2^{32} to get a longitude or latitude coordinate.

E.g. 0xEDA52100 = -25.8117 or -25° 48' 42”

Double-char encoded string:

Each byte is decoded into one or two characters. A value of 0x20-0x5A is used directly as single ASCII character code from ' ' (space) to 'Z'. A value of 0x00 would be ignored and is probably not used. Values 0x01-0x1F are used as index 0x00-0x1E and values 0x5B-0xFE are used as index 0x1F-0xC2 in the double-char table (see range 6 below), and the two chars are taken from there. Value 0xFF is copied into the string. It is used as abbreviation for some other string which is inserted at this point. Which string is inserted depends, and is documented where used.

Note: The double-char table may be smaller than 0xC3 entries, and in this case not all byte combinations are usable.

RefToRange:

Reference to a range within the file. Consists of a byte telling the type of the range, followed by an uint3 offset and uint3 length of range.

Type	Content
byte	Type (content of the range)
uint3	Offset
uint3	Length in byte

General file structure

Header
Range 0
Range 1
Range 2
Range 3
Range 4
Range 13 items. Just before 64 KiB boundaries, a few other items are interspersed (see below).
Range 13
Range 14 items. Just before 64 KiB boundaries, a few other items are interspersed (see below).
Range 14
Other items (INT, APT, VOR, NDB and Type 7 items)
Range 7
Range 16 items (Approaches)
Range 16
Range 8
Range 9
Range 11
Range 10
Table of contents
End marker

To allow for 16 bit address calculation, all ranges and all items do not cross 64 KiB boundaries.

All offsets (except the RefToRange in the header pointing to the table of contents) point backwards. That means, items always appear before the table(s) that reference them.

There is something special about the INT, APT, VOR, NDB, and Type 7 items (called “other items” above): They “flow around” the other ranges and tables. That means, bigger ranges and tables often start at a 64 KiB boundary, and other items fill the space after the end of the range / table up to the next 64 KiB boundary. There is even a special record with type 0 that is a kind of continuation record. It points to the next other item in this flow.

Continuation record

Type	Content
ushort	Bit 15-11: Item type, always =0 Bit 10-0: Length of item in byte, including this length field, always =11
byte[6]	always =0
uint3	Offset of next other item Either after the next big range or table, or the next 64 KiB boundary

The space between the end of the continuation record and the next 64 KiB boundary is filled with 0xFF.

Header

Type	Content
RefToRange	Type = 0, points to table of contents Length seen 98 (means: table of contents has 14 RefToRange entries)
char[]	"Copyright 1993, II Morrow of America Inc. All Rights Reserved"

Table of contents

At the end of the file, just before the end marker, is the table of contents. Each entry is a RefToRange.

Seen ranges and their order:

Range	Content
0	Data base version
1	Data base description
2	Some date and time? (before some date)
3	Some date (before expiry date) – could be release date of magnetic deviation data
4	Expiry date
13	Table of offsets to ? SUA data?
14	Table of offsets to ?
7	Lookup table for items
16	Table of offsets to approaches The GX Simulator basic data bases have an error here: Range 16 is cut off at the end, and consequently, some un-referenced Range 16 entries exist! The GX Simulator deluxe data bases are correct.
8	Categories
9	Countries table
11	Double-char table
10	Magnetic deviation data
12	Not really a range. The length, and the most significant byte of the offset, are always 0. This leaves a 16 bit value in the two least significant bytes of the offset. This value is probably some kind of checksum.

The order of appearance of the RefToRange entries in the table of contents is also the order of ranges within the file. In other words, from each entry to the next, the offset is increasing.

End marker

Sequence of 0xFF bytes – at least four, up to the next multiple of 32. Followed by a sequence of 0x00 bytes, up to the next multiple of 512.

Range 0: Version

Type	Content
3 x byte	01 0B 00 – Version 1.11

Range 1: Description

Type	Content
char[17]	"Americas DB " or "International DB " or "World Wide DB "
char[19]	"Mercury Opt. 01 "

Range 2: Some date and time

Type	Content
byte[6]	seen 62 06 04 08 08 03 – year (add 1900), month, day, hour, minute, second

Range 3: Some date

Type	Content
byte[3]	e.g. 62 06 12 – year, month, day If year < 80? add 2000 else add 1900

Range 4: Expiry date

Type	Content
byte[3]	e.g. 62 07 0F – year, month, day year < 80? year-2000 else year-1900

Range 13: SUA?

Type	Content
uint3[]	Table of offsets to ? (Range13 items)

Range 14:

Type	Content
uint3[]	Table of offsets to ? (Range14 items)

Range 7: Lookup table for items

Type	Content
Each entry: (entries are sorted in ascending order of latitude, then longitude)	
sbyte	Most significant byte of latitude
sbyte	Most significant byte of longitude
uint3	Offset to item Not only to items of type INT, APT, VOR and NDB (1-4), but also to items of type 7 which are not referenced from somewhere else

Range 16: Approaches

Type	Content
uint3[]	Table of offsets to approach item The approaches appear alphabetically sorted by their name.

Range 8: Categories

Type	Content
Category	APTs
Category	VORs
Category	NDBs
Category	INTs
optional:	
Category	INTs – which partially point to the same INT items than the previous Category!

Structure of Category:

Type	Content
byte	Category record length in bytes, including this length field
char[4]	Short name, in lower case, right-padded with space Seen: "int " for INT, "arpt" for APT, "vor " for VOR, and "ndb " for NDB
char[10]	Long name, in upper case, right-padded with space Seen: "INT ", "INT (K) ", "INT (O) ", "INT (W) " for INT, "AIRPORT " for APT, "VOR " for VOR and "NDB " for NDB
byte	Seen value 1
byte	Item Type 1=INT, 2=APT, 3=VOR, 4=NDB
byte	Number of tables
Number of tables times:	
ushort	Length of table (is a multiple of 3)
uint3	Offset of table containing uint3 offsets to the individual items

The different tables have the same size (same number of entries) and they point to the same set of items (so each item is referenced from each table). Only the order of the items is different, so these tables may represent different sort orders.

If there is more than one Category with the same item type, their respective tables may share same items.

Range 9: Countries table

Type	Content
char[6][]	Table of country names

Range 11: Double-char table

Type	Content
char[2][]	Table of double-character combinations

Range 10: Magnetic deviation data

Type	Content
Header	
DeviationsForLongitude[]	Deviations for each latitude raster

Range 10 Header:

Type	Content
Coord32	Minimum Latitude seen: 0xCC000000 = ca. -73°
Coord32	Maximum Latitude seen: 0x34000000, 0x36000000 = ca. 73° / 76°
Coord32	Minimum Longitude seen: 0x80000000 = -180°
Coord32	Maximum Longitude seen: 0x7C000000 = ca. 174°
Coord32	Raster seen: 0x02000000 = ca. 2.8°
short	Bit shift according to the raster seen: 0x0019 = 25
ushort	Size of each Entry, seen 0x007E = 126
ushort	Total size of data, seen: 0x1998 = 6552 = 52 x 126 when maximum latitude = 0x34000000 0x1A16 = 6678 = 53 x 126 when maximum latitude = 0x36000000

Range 10 DeviationsForLongitude: Magnetic deviation values for a given latitude raster value

Type	Content
sbyte[size of entry]	List of magnetic deviations for each longitude raster value within a fixed latitude raster value.

Calculation:

Latitude and Longitude are given as Coord32. Latitude must be > minimum latitude and < (maximum latitude – raster) or calculation returns with 0.

(Latitude – minimum Latitude) >> bit shift → Index for Entry.

(Longitude – minimum Longitude) >> bit shift → Index within Entry.

Three bytes are read: from the position calculated, from the following position, and from the same position in the following entry. This allows interpolation in longitude and latitude direction.

Type 1 (INT) item

Intersection

Type	Content
ushort	Bit 15-11: Item type, always 1=INT

Type	Content
	Bit 10-0: Length of item in byte, including this length field
Coord24	Latitude
Coord24	Longitude
char[5]	Ident (see [3])
ushort	Bit 15-9: Unused? Seen value 0. Bit 8-0: Country (index in Country Table)

Type 2 (APT) item

Airport

Type	Content
ushort	Bit 15-11: Item type, always 2=APT Bit 10-0: Length of item in byte, including this length field
Coord24	Latitude
Coord24	Longitude
char[4]	Ident (ICAO 4-letter airport code, see [7])
ushort	Bit 15-14: Radar 0=(nothing), 1=TRSA, 2=ARSA, 3=TCA Bit 13-12: Fuel 0=No Fuel, 1=Avgas, 2=Jet, 3=Avgas/Jet Bit 11: Beacon 0=No Beacon, 1=Beacon Bit 10-9: Use 0=Private, 1 (and 3)=Public, 2=Military Bit 8-0: Country (index in Country Table)
ushort	Altitude (AMSL) in feet
byte	Lengths of facility and city fields Bit 7-4: Length of city field in byte Bit 3-0: Length of facility field in byte
byte	Number of further fields Bit 7-4: Number of runways Bit 3-0: Number of frequencies
byte[length of facility]	Name of facility as double-char encoded string A byte 0xFF is used as shortcut for the name of the city.
byte[length of city]	Name of city as double-char encoded string
Number of runways times:	
byte	Bit 7-5: Surface 0=Hard, 1=Gravel, 2=Dirt, 3=Water, 4=Wood, 5=----, 6=Turf, 7=---- (What is the difference between 5 and 7?) Bit 0-4: len of runway data in byte
byte	Bit 7-5: Suffix letters 0=L/R, 1=R/L, 2=C/C, 3= / , 4=A/A, 5=S/S, 6=W/W, 7=U/U Bit 4-0=1-18 heading, 19=ALL WAY, 20=BALLOON, 21=HELIPAD, 22=E/W, 23=N/S, 24=NE/SW, 25=NW/SE
byte	Runway length in x 100 ft, or ?? in x 10 when HELIPAD
byte	Bit 7-6: 0=none, 1=ILS, 2=, 3= (LDA/LOC/ILS) Bit 4+0: 0=none, <>0 = "Lit" Bit 3-2: 0=none, 1=ILS, 2=, 3= (LDA/LOC/ILS)
byte	?

Type	Content
	Frequency for this specific runway
Number of frequencies times:	
byte	Bit 7-4: Type of frequency 1=APPR, 3=ATIS, 4=CLR, 5=DEP, 6=GRND, 8=UNIC, 9=TWR, 10=CTAF, 11=ATF, 12=MF Bit 0-3: len of frequency data in byte, including this length byte. Seen value 3.
ushort	Radio Frequency. Value has to be scaled by 100.0 and offset by 108.0 to get to the frequency in MHz. E.g. 0x4EC = 1260; x MHz / 100.0 = 12.6 MHz; +108.0 MHz = 120.6 MHz

Type 3 (VOR) item

Very high frequency omni-directional range

Type	Content
ushort	Bit 15-11: Item type, always 3=VOR Bit 10-0: Length of item in byte, including this length field
Coord24	Latitude
Coord24	Longitude
char[3]	Ident (typically a three-letter Morse code callsign)
ushort	Bit 15-9: ? Seen values 0, 1, 3, 7, 16, 17, 18, 19, 20, 21, 22, 23, 64, 65, 66, 67, 68, 69, 70, 71, 73, 77, 79, 80, 81, 82, 83, 84, 85, 86, 87, 89, 91, 93, 95 Bit 8-0: Country (index in Country Table)
ushort	Bit 15-12: Length of name field in byte Bit 11-0: Radio frequency. Value has to be scaled by 100.0 and offset by 108.0 to get to the frequency in MHz. E.g. 0x4EC = 1260; x MHz / 100.0 = 12.6 MHz; +108.0 MHz = 120.6 MHz
byte[length of name]	Name as double-char encoded string

Type 4 (NDB) item

Non-directional beacon

Type	Content
ushort	Bit 15-11: Item type, always 4=NDB Bit 10-0: Length of item in byte, including this length field
Coord24	Latitude
Coord24	Longitude
char[3]	Ident (one, two, or three-letter Morse code callsign)
ushort	Bit 15-9: ? Seen values 0, 1, 2, 3, 4, 5, 6, 7, 9, 13, 15 Bit 8-0: Country (index in Country Table)
ushort	Bit 15-12: Length of name field in byte Bit 11-0: Radio frequency. Value has to be scaled by 10.0 and offset by 190.0 to get to the frequency in kHz. E.g. 0x5AA = 1450; x kHz / 10.0 = 145.0 kHz; +190.0 kHz = 335.0 kHz
byte[length of name]	Name as double-char encoded string

Type 7 (??) item

Type	Content
ushort	Bit 15-11: Item type, always 7=?? Bit 10-0: Length of item in byte, including this length field
Coord24	Latitude
Coord24	Longitude
ushort[]	In each entry, there are from 1 to 21 values, which differ only slightly.

Range 13 item

SUA?

Type	Content
byte	bit 7: ? bit 6-0: Number of entries
Coord24	Latitude
Coord24	Longitude
byte	Bit 7-4: Length of name field in byte -1 Bit 3-0: Seen values: 0-10, 12 and 13
byte[3]	Seen value: 0
uint	Bit 31-30: ? Bit 29-27: Seen value 4 Bit 26-17: is multiplied with 100 (Probably some height in feet) Bit 16-14: Seen value 4 Bit 13-4: is multiplied with 100 Bit 3-0: ?
byte[length of name]	Name of item as double-char encoded string
uint3[number of entries]	? Probably defining some polygon of the airspace
If number of entries == 0:	
byte[5]	? Seen: 76 82 31 FA 00, EF C4 4D F4 01, 0C 73 6C 44 01, ...

Range 14 item

??

Type	Content
sbyte	signed value
byte	Bit 7-5: ? Bit 4: 1 = item length is 33, 0 = item length is just up to next R14 item Bit 3-0: signed value
byte	Bit 7-3: Bit 2-0:

Type	Content
??	

Approach item

Type	Content
byte	Number of waypoints
byte	Bit 7-4: Length of name field in byte Bit 3-0: ? Seen values: 1, 2, 3, 4, 5
byte[length of name]	Name of item as double-char encoded string
waypoint[number of waypoints]	

Waypoint:

Type	Content
byte	? Seen: 1E, 1F, 22, 3F, ...
uint3	Offset of NDB, INT or R14 item Sometimes not a valid offset – seems to depend on the byte before

References

Used sources of information

- [1] GX Simulator Basic Edition and Deluxe Edition
<https://www8.garmin.com/include/gxsimulator/SimulatorPopupGX.html>
- [2] GX 60 manuals <https://web.archive.org/web/20040805215653/http://www.garmin.com/support/userManual.jsp?market=1&subcategory=28&product=999-99999-63>
- [3] Intersection (INT) [https://en.wikipedia.org/wiki/Intersection_\(aeronautics\)](https://en.wikipedia.org/wiki/Intersection_(aeronautics))
- [4] Very high frequency omni-directional range (VOR)
https://en.wikipedia.org/wiki/VHF_omnidirectional_range
- [5] Non-directional beacon (NDB) https://en.wikipedia.org/wiki/Non-directional_beacon

Standards and specifications

- [6] ISO/IEC 646:1991, Information technology – ISO 7-bit coded character set for information interchange
- [7] ICAO airport code https://en.wikipedia.org/wiki/ICAO_airport_code

Sources of sample files

- [8] Americas, International and Worldwide database within the GX Simulators
<https://www8.garmin.com/include/gxsimulator/SimulatorPopupGX.html>