

Navico (Lowrance, Simrad, B&G) Shapefile File Format

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Navico Lowrance Shapefile File Format

Filename extension *.lsf (probably "Lowrance ShapeFile")

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

Basic data types

All values are by default serialized in little-endian byte order (least significant byte first). Exceptions are explicitly noted.

| Type | Length | Description |
|--------|--------|---|
| char | 1 | UTF-8 character (see [3]) |
| byte | 1 | 8 bit unsigned integer (range 0 .. 255) |
| ushort | 2 | 16 bit unsigned integer (range 0 .. 65535) |
| uint | 4 | 32 bit unsigned integer (range 0 .. 4294967295) |
| double | 8 | 64 bit floating point value according to [4] |

Coordinates

A structure consisting of these fields:

| Type | Content |
|--------|-----------|
| double | Longitude |
| double | Latitude |

VarInt

An unsigned integer in a variable-sized encoding. Same format as in Atlas Type 5 (AT5) maps. Different format than the VarInt used by Google Protocol Buffers wire format.

Using 1 byte:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|----|
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 0 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | =1 |

Contains 7 bit. Used for numbers in the range 0 .. 0x7F.

Using 2 bytes:

| | | | | | | | | |
|---|----|----|----|----|---|---|----|----|
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 0 | 5 | 4 | 3 | 2 | 1 | 0 | =1 | =0 |
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 1 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 |

Contains 14 bit. Used for numbers in the range 0x0080 .. 0x3FFF.

Using 3 bytes:

| | | | | | | | | |
|---|----|----|----|----|----|----|----|----|
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 0 | 4 | 3 | 2 | 1 | 0 | =1 | =0 | =0 |
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 1 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 |
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 2 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 |

Contains 21 bit. Used for numbers in the range 0x004000 .. 0x1FFFFF.

Using 4 bytes: (probably, but not seen yet)

| | | | | | | | | |
|---|----|----|----|----|----|----|----|----|
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 0 | 4 | 3 | 2 | 1 | 0 | =0 | =0 | =0 |
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 1 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 |
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 2 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 |
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 3 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 |

Contains 29 bit. Used for numbers in the range 0x00200000 .. 0x1FFFFFFF.

Note: The encoding does not exclude smaller numbers to be represented in more bytes than is necessary. But this is normally not done and therefore indicates some problem.

String

A structure consisting of these fields:

| Type | Content |
|---------|------------------|
| VarInt | Length of string |
| char[n] | UTF-8 characters |

General file structure

| |
|--------------------------------|
| Header |
| Records Section (optional) |
| Attributes Section (mandatory) |

Header

| Offset | Type | Content |
|--------|---------|---|
| 0x00 | char[4] | Signature = "LSpF" |
| 0x04 | bytes | Unknown1. =01 00 01 Maybe 2 byte of this are a file format version? |
| 0x07 | uint | Maximum length of uncompressed block in Records Section (up to 512 KiB) |
| 0x0B | ushort | Unknown2. Seen values 0 and 1. Maybe a count of coordinate systems following? |

| Offset | Type | Content |
|--------|-----------|---|
| 0x0D | double | Is 0.0 when value at offset 0x0B is 0, else WGS84 equatorial radius 6378137 m |
| 0x15 | double | Is 0.0 when value at offset 0x0B is 0, else WGS84 polar semi-minor axis 6356752,3142 m |
| 0x1D | bytes[56] | Unknown3. =0. Maybe space for more values of coordinate systems if value in 0x0B is >1? |
| 0x55 | uint | Number of Records ⁽¹⁾ |
| 0x59 | uint | Unknown4. =0 |
| 0x5D | uint | Offset of Records Section (is always 0xAD) ⁽¹⁾ |
| 0x61 | uint | Unknown5. =0 |
| 0x65 | uint | Offset of Attributes Section (if Number of Records ==0, it is 0xAD) ⁽¹⁾ |
| 0x69 | uint | Unknown6. =0 |
| 0x6D | double | Min Longitude ⁽²⁾ |
| 0x75 | double | Max Longitude ⁽²⁾ |
| 0x7D | double | Min Latitude ⁽²⁾ |
| 0x85 | double | Max Latitude ⁽²⁾ |
| 0x8D | byte[16] | Unknown7. Is usually =0. Only seen != 0 in files where Number of Records =0. |
| 0x9D | double | Min Depth ⁽³⁾ |
| 0xA5 | double | Max Depth ⁽³⁾ |

(1) Or maybe these fields are ulong.

(2) Value is in degree or mercator meters.

(3) Is != 0.0 when option "Output POINTZ Features" is switched on in IMC menu Advanced Options > Sonar Options. The min value is the numeric minimum and the max value is the numeric maximum over all depth values, regardless of the IMC setting Invert Depths in menu Advanced Options > Sonar Options. The value is in feet or meter.

Maybe if NumberOfRecords is =0, the values from 0x6D-0xAC are just not written at all and are thus garbage.

Records Section

Sequence of LZ4 compressed blocks. If Number of Records = 0, the sequence and therefore the whole Section is empty. If the sequence consists of only one block, its uncompressed length is the maximum length of uncompressed block as indicated in the header. If the sequence consists of more than one block, each block holds exactly the maximum length except for the last block, which may be shorter.

For each compressed block:

| Type | Content |
|--------|--|
| VarInt | Length of LZ4 compressed data |
| uint | Length of uncompressed data, in big endian!! |
| | LZ4 compressed data, see [1] |

Attributes Section

General structure:

| Type | Content |
|---------|---|
| VarInt | Number of entries (may be 0) |
| Attr[n] | Consecutive list of attribute entries, typically sorted alphabetically (case-sensitive) |

Attribute entry:

| Type | Content |
|--------|--|
| String | Attribute name |
| byte | Data type of attribute 0 = String 1 = double |

Attributes seen with their type and seen values. For a description of the meaning of the attributes and their allowed values, see [2], page 18ff.

| Type | Name | Values seen |
|--------|---------------------------|--|
| double | BDR_COLOR | |
| double | BDR_PATTERN | |
| double | BFR_COLOR | |
| String | BFR_PATTERN or BFR_PATTER | |
| double | BFR_WIDTH | |
| String | CHANNEL | "DOWNSCAN", "PRIMARY", "SECONDARY", "SIDESCAN" |
| double | COLOR | |
| double | DEPTH | |
| String | FILT_SRCH | |
| String | FONT | |
| double | HAL_COLOR | |
| String | ICON | |
| double | IMG_RENDER | |
| String | INFO_BOX | |
| double | L_ELIMIT | |
| double | L_LIMIT | |
| double | LAYER | |
| String | MAJ_CAT | See list below |
| String | MIN_CAT | See list below |
| String | MODE | "T" |
| double | P_ELIMIT | |
| String | PATTERN | |
| double | QUALITY | 0.0 |
| double | RecNum | |
| double | RTP_COLOR | |
| double | RTP_ELIMIT | |
| double | RTP_LIMIT | |
| double | SPEED | |
| double | U_ELIMIT | |

| Type | Name | Values seen |
|--------|------------|-------------|
| double | U_LIMIT | |
| String | VALUE | |
| String | VALUE2 | |
| double | WIDTH | |
| double | WIDTH_MULT | |

Seen major categories with their minor categories. See [2], page 23ff.

| Seen major .. | .. minor categories |
|----------------|--------------------------------|
| -empty- | -empty- |
| Goods/Services | Drinking Establishment |
| | Education |
| | Emergency |
| | Entertainment |
| | Equipment Manufacturing/Repair |
| | Equipment Rental |
| | Equipment Service |
| | Financial |
| | Fuel |
| | Government |
| | Historic/Cultural |
| | Hospitality |
| | Misc |
| | Outdoor/Fishing |
| | Pharmacy/Healthcare |
| | Public Facility |
| | Recreation |
| | Religion |
| | Restaurant |
| | Retail/Wholesale |
| | Sport Facility |
| | Tourism |
| | Waste Management |
| Land Use | Building |
| | Forest |
| | Game Management |
| | Geopolitical Boundary |
| | Government Land |
| | Land Feature |
| | Misc |
| | Park |
| | Private Land |
| | Wetland |
| Misc | Misc |
| Nautical | Depth Contours |
| | Dock |
| | Dyke |
| | Gate |

| Seen major .. | .. minor categories |
|----------------|------------------------|
| | Harbour Facility |
| | Lake |
| | Land Area |
| | Land Region |
| | River |
| | Shoreline Construction |
| | Water |
| Transportation | Airport |
| | Cableway/Lift |
| | Highway |
| | Mass Transit |
| | Misc |
| | Parking |
| | Railroad |
| | Roads |
| | Ship/Ferry Route |
| | Trail |

Records Section after decompression

Consecutive list of Records, with the following basic structure:

| Type | Content |
|----------|--|
| Byte | Record type Seen: 1, 2, 3, 5 and 11 |
| ... | Fixed fields according to the record type |
| VarInt | Number of attribute values which follow |
| Value[n] | Consecutive list of attribute values, typically sorted by increasing index in list of attributes |

Attribute value:

| Type | Content |
|---|---------------------------------------|
| VarInt | Index in list of attributes (0-based) |
| String or double, depending on data type of attribute | Value |

Record type 1 (Point)

Fixed fields:

| Type | Content |
|-------------|---------|
| Coordinates | |

Record type 2 and 3

Fixed fields:

| Type | Content |
|---------|---|
| uint | Number of lists Seen values for record type 2: ? Seen values for record type 3: 1 .. 17 |
| List[n] | List of coordinates |

List of coordinates:

| Type | Content |
|--------------------------|---------------------------------|
| uint | Number of entries in this lists |
| Number of entries times: | |
| Coordinates | |

Record type 5

Fixed fields:

| Type | Content |
|---------|--|
| uint | Number of lists Seen values: 1, 2, 3, 4, 7, 9, 10, 11, 12, 13, 18, 20, 22, 32, 52, 99 and many more |
| List[n] | List of coordinates |

List of coordinates:

| Type | Content |
|--------------------------|---------------------------------|
| uint | Number of entries in this lists |
| Number of entries times: | |
| byte | Seen values: 0 and 7 |
| Coordinates | |

Record type 11 (PointZ)

Fixed fields:

| Type | Content |
|-------------|---------|
| Coordinates | |
| double | =0.0 |
| double | Depth |

References

Used sources of information

- [1] LZ4 lossless compression algorithm <https://lz4.github.io/lz4/>
- [2] Insight Map Creator Documentation 0.7.4.0
<https://web.archive.org/web/20190701055707/https://gofreemarine.com/developers/insight-map-creator/>, in mapcreator.zip, IMC_Documentation\InsightMapCreator_0740.pdf

Standards and specifications

- [3] UTF-8, a transformation format of ISO 10646, <https://tools.ietf.org/html/rfc3629>
- [4] ISO/IEC/IEEE 60559:2011 Information technology – Microprocessor Systems – Floating-Point arithmetic (or IEEE Std 754-2019)

Sources of sample files

- [5] Converting *.lsg and *.ls2 sample files to *.lsf files using Insight Map Creator in Sonar Mode Window
- [6] While creating AT5 map files with Insight Map Creator: Intermediate files in directory "Clipped" before operation is complete.