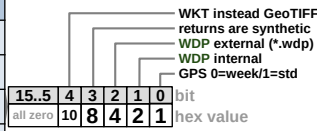


LAS LAZ cheatsheet

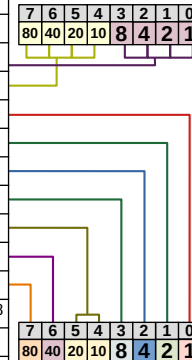
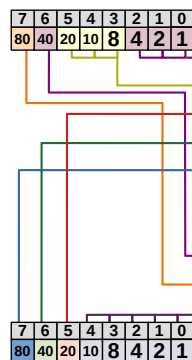


LAS LAZ File Header	Range	Offset
File Sign. "LASF" 4C 41 53 46	c[4]	0
File Source ID	U16	4
Global Encoding	U16	6
Project ID GUID [8]-[4]-[4]-[4]-[12]	U8[16]	8
Version Major 1	U8	24
Version Minor 0.4	U8	25
System Identifier	c[32]	26
Generating Software	c[32]	58
File Creation Day of Year	U16	90
File Creation Year	U16	92
Header Size max 375	U16	94
Offset to Point Data	U32	96
Number of VLRs	U32	100
Point Data Record Format	U8	104
Point Data Record Length	U16	105
Legacy # of Points <-4.29 billion	U32	107
Legacy # of Point [Return]	U32[5]	111
X Scale Factor	F64	131
Y Scale Factor	F64	139
Z Scale Factor	F64	147
X Offset $X=X_{point} * X_{scale} + X_{offset}$	F64	155
Y Offset	F64	163
Z Offset	F64	171
Max X	F64	179
Min X	F64	187
Max Y	F64	195
Min Y	F64	203
Max Z	F64	211
Min Z	F64	219
Start WDP Waveform Data Packet	U64	227
Start First EVLR	U64	235
Number of EVLRs	U32	243
Number of Point Records	U64	247
Number of Points by Return	U64[15]	255
	Total:	375



LAS / LAZ file structure			
File header			
VLRs include LAZ VLR			
LAS compressed data or LAS point data	Field chunk table start position	Chunks	Chunk 1 1st record compressed Chunk 2 1st record compressed Chunk [n] ... compressed
			Chunk table
EVLRS			
Field chunk table start position			

Point Data Records LAS/LAZ Format	v 1.0/ 1.1	v 1.2+	v 1.3+	v 1.4+	Range
Point data record format	0 1	2 3	4 5	6 7 8 9 10	
X					I32
Y					I32
Z					I32
Intensity normalized to FFFFhex					U16
Return Number	0..7			0..15	0..7/15
Number of Returns	0..7			0..15	0..7/15
Synthetic Flag					0..1
Key-Point Flag					0..1
Withheld Flag					0..1
Overlap Flag				X X X X X X	0..1
Scanner Channel				X X X X X X	0..3
Scan Direction Flag					0..1
Edge of Flight Line Flag					0..1
Classification	0..31			0..255	0..31/U8
User Data optional					U8
Scan Angle $90..+90^{\circ}$ $-0.006^{\circ} (+/- 180^{\circ})$	-90..90			-180..180	I8/I16
Point Source ID					U16
GPS Time	X	X X X X	X X X X	X X X X	F64
Red		X X X X	X X X X	X X X X	U16
Green		X X X X	X X X X	X X X X	U16
Blue		X X X X	X X X X	X X X X	U16
NIR				X X X X	U16
WDP desc.idx n+99			X X	X X	U8
WDP offset			X X	X X	U64
WDP paket size			X X	X X	U32
WDP return point locate			X X	X X	F32
Parametric dx $X=X_0+t*d_x$			X X	X X	F32
Parametric dy			X X	X X	F32
Parametric dz			X X	X X	F32
Total bytes per point	20	28	26 34 57 63	30 36 38 59 67	
Point data record format	0 1	2 3	4 5	6 7 8 9 10	



Classification	
0	Never classified
1	Unassigned
2	Ground
3	Low Vegetation (0.5 < h <=2m)
4	Medium Vegetation (2 < h <5m)
5	High Vegetation (>5m)
6	Building
7	Low Point
8	Reserved (o:Model Key-Point)
9	Water
10	o Rail
11	o Road Surface
12	o Reserved (o:Overlap)
13	x Wire - Guard (Shield)
14	x Wire - Conductor (Phase)
15	x Transmission Tower
16	x Wire-Structure Connector (Insulator)
17	x Bridge Deck
18	x High Noise
19	x Overhead Structure
20	x Ignored ground
21	x Snow
22	x Temporal Exclusion (e.g. landslide)
23..63	x Reserved
64..255	x User

Range	
U8	0 .. 255
U16	0 .. 65,535
U32	0 .. 4,294,967,295
U64	0 .. 2 ⁶⁴ -1
I8	-128 .. 127
I16	-32,768 .. 32,767
I32	-2,147,483,648 .. 2,147,483,647
c[n]	char array
[n]	array of len n
F32	single float
F64	double float

VLR / EVLR header	54 bytes	Range	Offset	
Reserved	U16	0	always 0	
User ID	c[16]	2	creating user	
Record ID	U16	18		
Record Length	U16	20	size of the VLR data (excl. header)	
Description	c[32]	22	optional	

VLRs	Record ID	Name
LASF_Projection	2111	OGC Math Transform WKT Record
LASF_Projection	2112	OGC Coordinate System WKT Record
LASF_Projection	34735	GeoTIFF Georeferencing: GeoKeyDirectoryTag
LASF_Projection	34736	GeoTIFF Georeferencing: GeoDoubleParamsTag
LASF_Projection	34737	GeoTIFF Georeferencing: GeoAsciiParamsTag
LASF_Spec	0	Classification Lookup 256 records * (U8(class)+char[15](desc))
LASF_Spec	3	Text Area Description
LASF_Spec	4	Extra Bytes n descriptors * 192 bytes
LASF_Spec	7	Superseded
LASF_Spec	100..354	Waveform Data Packet Descriptor WDP desc.idx + 99
laszip encoded	1240	rapidlasso LAZ compression
laszip encoded	22204	rapidlasso LAZ compression + reserved = 43707 (AABBhex) or 0
LAStools	1284	rapidlasso LAStools
BayesMap	3001++	BayesMap strip alignment
copc	1000	copc EPT hierarchy
copc	1306	copc index
ggis	0	calculated statistics

Abbreviations	
VLR	Variable length record
EVLR	Extended VLR
WDP	Waveform data packet
WKT	Well known text
GUID	Globally Unique Identifier
OGC	Open Geospatial Consortium
GPS	Global Positioning System

LAStools

LiDAR processing