Table of Contents

1. Introduction

This document describes the SDF and SDFX data page formats for the System 3000 (NGS), System 5000 and System 5900.

2. Overview

The main data component of a Klein Sonar is the data page format. These data page formats are used to output the Sonar data from the TPU (via Ethernet) and as a data file format for output from SonarPro® (*.sdf files).

The Klein data page format name has traditionally been called SDF. This document defines the SDF format as well as an extension to the SDF format called SDFX. The SDFX format was defined in 2009 as a way to extend the SDF format while staying backwards compatible with the large amount of existing SDF files and SDF file readers. A legacy SDF file reader, if properly constructed, can read all the traditional SDF information from an SDFX file. The legacy reader simply skips over the new SDFX data. Obviously, the legacy reader would require an update to read any new data in the SDFX portion of the file or data page.

2.1. *SDF Data Page Layout*

The generic SDF data page consists of a data page header followed by a variable number of data page channels (Figure 1). The data page header is the same for all sonar types. (Note: header fields may be interpreted differently depending on the sonar type.). The data page header contains a field called "pageVersion" that determines the layout of the data page channels.

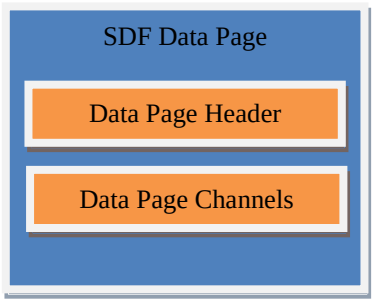

Figure 1 - SDF Data Page Layout

2.2.*SDFX Data Page Layout*

The SDFX format adds a variable sized “extension” to the end of the SDF data page (Figure 2). The Data Page Header indicates whether the data page extension is present or not via the sdfExtensionSize field.

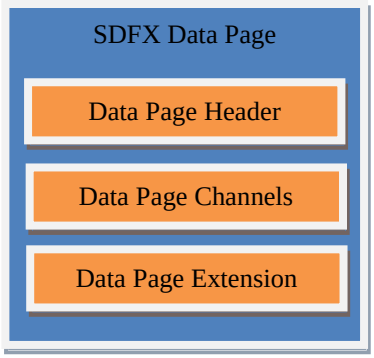

Figure 2 - SDFX Data Page Layout

3. Description

Each system has a unique data page structure as defined by the pageVersion field in the header. The header is ostensibly the same for each page structure but the data portion of a data page is unique. The pageVersion field can have the following values:

Table 1 – Valid pageVersion values

Towfish Type	Header version	pageVersion value
3000	3	3000
3000	4	3001
UUV 3500 sonar data(Obsolete)	4	3500
UUV 3500 sonar data Low Frequency	4	3501
UUV 3500 sonar data High Frequency	4	3502
UUV-3500 Bathy Pulse Compressed Data Page (4-channel)	4	5903
UUV-3500 processed bathy data	4	3511
5000	3	5000
5000	4	5001
5000 Bathy	4	5002
Reserved. Note: This was used as a prototype of the first 15 channel V2 system.	4	5003
5000 V2 Bathy w/ 3 dedicated bathy channels	4	5004
5900 Side Scan and Bathy Raw Data Page (64-Channel)	4	5900
S5900 Side Scan and Bathy Pulse Compressed Data Page (64-channel)	4	5901
S5900 Side Scan QC Beamformed page	4	5902
S5900 Bathy Pulse Compressed Data Page (For Side Scan Sonar) (4-channel)	4	5903
5900 Gap Filler and Bathy Raw Data Page (64-Channel)	4	5905
S5900 Gap Filler and Bathy Pulse Compressed Data Page (64-channel)	4	5906
5900 Side Scan Processed Data Page (no motion compensation)	4	5910
5900 Bathy Processed (For Side Scan Sonar) Data Page	4	5911
5900 Gap Filler Processed Data Page	4	5915
5900 Bathy Processed (For Gap Filler Sonar) Data Page	4	5916
5900 Side Scan Processed Data Page w/ Motion Compensation	4	5920
7180 Bathy Processed Data Page	4	7191

See section 0 for additional information on the SDF pageVersion.

The data page structure is the data page produced by the System's Transceiver and Processing Unit (TPU). See the section 4 for how these individual data pages are concatenated into ".sdf" files.

3.1. *Data Page Header*

The data page header is the same for all sonar types. The interpretation of individual fields may be different for the various sonars. This is particularly true for the header fields that represent a sonar setting, e.g., a transmit waveform value of 1 will not indicate the same pulse length for a 3000 system as compared

to a 5000 system. Table 2 defines the data page header fields, definitions, and the usage by the different sonar systems and applications. For each sonar system/application column, a value of "X" or a more detailed explanation of a field's use indicates it is used. A value of "NA" that it is not applicable (not used) to that system/application. Unused values default to 0.

Table 2 - Data Page Header Definition

Field #	Field	Definition	3000	3900	5000	5900	3500
1	U32 numberBytes	total number of bytes in page	X	X	X	X	X
2	U32 pageVersion	data page structure	X (Note 1)	X (Note 1)	X (Note 1)	X (Note 1)	X
3	U32 configuration	Bit field indicates which channels or beams are populated in the data page channels.	X (Note 2)	X (Note 2)	X (Note 2)	N/A	X (Note 2)
4	U32 pingNumber	increments by 1 for each sonar ping.	X	X	X	X	X
5	U32 numSamples	count of samples in processed side-scan data, if processed data exists in page, or count of samples in rawdata channels if no processed data exists. The difference is stored in numSamplesExtra (type3 header).	X	X	X	X	X
6	U32 beamsToDisplay	Bit field indicates which side scan channels should be used to form the raster image.	N/A	N/A	X (Note 3)	N/A	N/A
7	U32 errorFlags	Bit field: Bit 0: Invalid speed Bit 1: GPS data error Bit 2: Telemetry error Bit 3: Sensor Checksum Error Bit 4: Towfish Leak Bit 5: Bad Data Bit 6: Watchdog Bit 7: Compass Error Bit 8: No GPS Lat/Lon sentence input Bit 9: No GPS speed sentence input Bit 10: No GPS ZDA sentence input Bit 11: No data from Motion Reference Unit or MRU error Bit 12: No 1 PPS input Not all bits are valid for all sonar configurations. For example, towfish must be equipped with a leak sensor to set the towfish leak flag.	X	X	X	X	X
8	U32 range	m	X	X	X	X	X

Field #	Field	Definition	3000	3900	5000	5900	3500
9	U32 speedFish	cm/s. If manualSpeedSwitch set, this value was entered manually. Otherwise, calculated from speed source (generally GPS). If the speedFilterSwitch field is set, the value is filtered with a 90/10 low pass filter.	X	X	X (Note 14)	X	X
10	U32 speedSound	speed of sound at the transducer arrays from a specified source. Sound Speed value (cm/s)	X	X	X	X	X
11	U32 resMode	System 5000 page versions: 0 = Normal (20 cm) 1 = High Resolution (10 cm) System 5900 pageVersion = 5002: QC Beamformer Resolution: 0 = "W0" (0.5m resolution) 1 = "W1" (1m resolution) System 5900 pageVersion = 5910,5920 0 = Resolution 0 1 = Resolution 1	N/A	N/A	X	X	N/A
12	U32 txWaveform	Transmit waveform number (Note 17)	X	X	X	X	X
13	U32 respDiv	Responder divisor	X	X	X	X	X
14	U32 respFreq	Responder frequency enum	X	X	X	X	X
15	U32 manualSpeedSwitch	0 = speedFish is from speed sensor 1 = speedFish is manual value from master	X	X	X	X	X
16	U32 despeckleSwitch	0 = Despeckling off 1 = Low 2 = Medium 3 = High	X	X	X (Note 4)	N/A	N/A
17	U32 speedFilterSwitch	Bit 0: 0 = speed filter is off 1 = speed filter is on Bits 31-1: Reserved	X	X	X	X	X
18	U32 year	TPU Time of ping, Calendar Year (includes century) (Note 15)	X	X	X	X	X
19	U32 month	TPU Time of ping, Calendar month (1-12) (Note 15)	X	X	X	X	X
20	U32 day	TPU Time of ping, Calendar day (1-31) (Note 15)	X	X	X	X	X
21	U32 hour	TPU Time of ping, hour (0-23) (Note 15)	X	X	X	X	X
22	U32 minute	TPU Time of ping, minute (0-59) (Note 15)	X	X	X	X	X

Field #	Field	Definition	3000	3900	5000	5900	3500
23	U32 second	TPU Time of ping, second (0-59) (Note 15)	X	X	X	X	X
24	U32 hSecond	TPU Time of ping, hundredths of second (1-99) (Note 15)	X	X	X	X	X
25	U32 fixTimeHour	Time of last serial NMEA message, hour	X	X	X	X	X
26	U32 fixTimeMinute	Time of last serial NMEA message, minute	X	X	X	X	X
27	float fixTimeSecond	Time of last serial NMEA message, second	X	X	X	X	X
28	float heading	heading from towfish compass (deg.) (Note 18)	X	X	X	X	X
29	float pitch	pitch from compass (deg.)	X	X	X	X	X
30	float roll	roll from compass (deg.)	X	X	X	X	X
31	float depth	from towfish (Volts) (Note 5)	X	X	X	X	X
32	float altitude	from towfish (meters)	X	X	X	X	X
33	float temperature	from towfish (Degrees C)	X	X	X	X	X
34	float speed	from serial NMEA, updated on GPS update, m/s	X	X	X	X	X
35	float shipHeading	from serial NMEA – Course Over Ground, Degrees	X	X	X	X	X
36	float magneticVariation	from serial NMEA $--RMC message,	X	X	X	X	X
37	double shipLat	from serial NMEA, radians	X	X	X	X	X
38	double shipLon	from serial NMEA, radians	X	X	X	X	X
39	double fishLat	from serial NMEA, radians (Note 6)	X	X	X	X	X
40	double fishLon	from serial NMEA, radians (Note 6)	X	X	X	X	X
	Added at version 3 (Note 13)						
41	U32 tvgPage	System 5000: TVG page number System 3000: Bits 7- 0: Low Frequency TVG page number Bits 15 – 8: High Frequency TVG page number System UUV-3500 0 = Low Gain 1 = High Gain System 5900: Bits 7-0: Receiver Side Scan Gain number (Note 16) Bits 15-8: Receiver Bathymetry Gain number (Note 16)	X	X	X	X	X
42	U32 headerSize	number of bytes in header	X	X	X	X	X

Field #	Field	Definition	3000	3900	5000	5900	3500
43	U32 fixTimeYear	Time of last serial NMEA message, year	X	X	X	X	X
44	U32 fixTimeMonth	Time of last serial NMEA message, month	X	X	X	X	X
45	U32 fixTimeDay	Time of last serial NMEA message, day	X	X	X	X	X
46	float auxPitch	aux data from AUV or other sensors (Note 7). Units are sensor or AUV specific.	X	X	X	X	X
47	float auxRoll		X	X	X	X	X
48	float auxDepth		X	X	X	X	X
49	float auxAlt		X	X	X	X	X
50	float cableOut	m (Note 8)	X	X	X	X	X
51	float fseconds	TPU Time of ping, fractional seconds (seconds) (Note 15)	X	X	X	X	X
52	U32 altimeter	altimeter off/on 0 = off 1 = on	X	X	X	X	X
53	U32 sampleFreq	Hz	X	X	X	X	X
54	U32 depressorType	towfish wing type enum (Note 8)	X	X	X	X	X
55	U32 cableType	towfish cable type enum (Note 8)	X	X	X	X	X
56	F32 shieveXoff	X winch offset from datum (m) (Note 8)	X	X	X	X	X
57	F32 shieveYoff	Y winch offset from datum (m) (Note 8)	X	X	X	X	X
58	F32 shieveZoff	Vertical winch offset from datum (m) (Note 8)	X	X	X	X	X
59	F32 GPSheight	Vertical GPS Offset from datum (m) (Note 8)	X	X	X	X	X

Field #	Field	Definition	3000	3900	5000	5900	3500
60	U32 rawDataConfig	System 5000: Bit field indicates which raw data channels are populated in the data page. Bits 15-0: Port raw data config, bit 0 is channel 0, bit 1 is channel 1, etc. Bits 31-16: Stbd raw data config, bit 16 is channel 0, bit 17 is channel 1, etc. System UUV-3500, Hydroscan: 0 = standard operation 1 = factory test mode	N/A	N/A	X	N/A	X
	Added at version 4 (Note 13)						
	Size of this header addition should stay 256 bytes (64 U32s)		X	X	X	X	X
61	U32 header3ExtensionSize	Size of only this header extension. Must be equal to 256 bytes.	X	X	X	X	X
62	U32 sbpTxWaveform	Tx waveform for Sub Bottom Profiler (SBP)	X	N/A	N/A	N/A	N/A
63	U32 sbpPreAmpGain	0 = low 1 = high	X	N/A	N/A	N/A	N/A
64	U32 sbpDataRaw	0 = Processed SBP data, 1 = Raw SBP data	X	N/A	N/A	N/A	N/A
65	U32 sbpNumSamples	Number of SBP samples in data page. May be different from side scan.	X	N/A	N/A	N/A	N/A
66	U32 sbpSampleFreq	Sample frequency of SBP channel	X	N/A	N/A	N/A	N/A
67	U32 sbpTxWaveformVersion	Tx waveform version of the SBP Tx board.	X	N/A	N/A	N/A	N/A
68	float wingAngle	Angle of actuated wing in degrees	N/A	N/A	X (Note 10)	N/A	N/A
69	U32 emergencySwitchState	State of system emergency switch - 1 = on, 0 = off	N/A	N/A	X (Note 10)	N/A	N/A
	Layback position parameters set by SonarPro. Set to zero by TPU.						
70	U32 laybackMethod	Method used to calculate layback. 0 = Pythagorean theorem (Note 9) 1 = Hull Mount system. Calculated transducer positions from SDFX Ship Config Info.	X	X	X	X	X

Field #	Field	Definition	3000	3900	5000	5900	3500
71	double laybackFishLat	fish latitude as determined by layback calculation (in radians) (Note 9) or latitude of transducer for hull mount system.	X	X	X	X	X
72	double laybackFishLon	fish longitude as determined by layback calculation (in radians) (Note 9) or longitude of transducer for hull mount system.	X	X	X	X	X
73	float fishHeadingOffset	Magnetic heading offset applied to towfish heading, in degrees (Note 11)	X	X	X	X	X
74	float pressureSensorOffset	psi (Note 12)	X	X	X	X	X
	Added at TPU s/w version 6.13						
75	U32 tpuSwVersion	Version of the TPU s/w, 0xVVNNMMDD where VV = Major Version Number NN = Minor Version Number MM = Month DD = Day	X	X	X	X	X
	Added at vxWorks version 6.17						

Field #	Field	Definition	3000	3900	5000	5900	3500
76	U32 capabilityMask	Bit mask defining various system capabilities. * Bit 0 = Configured for raw data (System 5000 only) * Bit 1 = Configured for actuated wing * Bit 2 = Configured with Sub Bottom Profiler option * Bit 3 = Configured with header ver. 4 * Bit 4 = Configured to allow a single oversampled frequency (3000 only) * Bit 5 = Configured to allow dual frequency operation (3000 only) * Added at tpuSwVersion 6.17. * Bit 6 = 5000 (V1 or V2) system with ver. 2 Demux * Bit 7 = 5000 V2 towfish * Added at tpuSwVersion 7.00 * Bit 8 = Configured for external trigger (Slave mode) * Added at tpuSwVersion 8.00 Bit 9 = Configured with hull mount transducers Bit 10 = Configured to accept input from array sound speed sensor. Bit 11 = Pressure sensor parameters are valid in header. Bit 12 = Configured with psig pressure sensor. Otherwise, psia assumed. Bit 13 = 3900 system configured with 1dB TVG steps from -7dB to +7dB for high frequency. Otherwise, configured for 3dB steps from -21dB to +21dB. Bit 14 = Configured as UUV-3500. This is a "3000-like" multi-channel single beam system.	X	X	X	X	X
	Added at vxWorks version V6.19						
77	U32 txVersion	TPU Transmitter Version 0 = 5000, 1 = 5000 V2	N/A	N/A	X	N/A	N/A
	Added at vxWorks version V6.22						
78	U32 numSamplesExtra	The extra number of samples included in each data channel to account for chirp Tx waveforms. This value is zero for other waveforms.	N/A	N/A	X	N/A	X
	Added at vxWorks version V7.00						

Field #	Field	Definition	3000	3900	5000	5900	3500
79	U32 postProcessVersion	The version of software that was used to post-process this data. Set to 0 by TPU as default. * Bits 31-24: Major version number of post-processing software. * Bits 23-16: Minor version number of post-processing software * Bits 15-0: Bit mask which defines the type of post processing performed as follows: Bit 13: Bathymetric processing results include intensity, signal-to-noise ratio, and uncertainty data. Bit 12: Sound velocity value used comes from sound velocity profile at depth Bit 11: Set when 5900 beamformer interpolation mode. Clear when 5900 "5000-like" integral ping mode. Bit only valid for System 5900 when Bit 0 is set. Bit 10: Set when 5900 Motion focus radius override correction applied Bit 9: Set when 5900 Motion steer correction applied Bit 8: Set when 5900 Motion altitude correction applied Bit 7: Set when 5900 Motion Pitch Rate correction applied Bit 6: Set when 5900 Motion Initial Pitch correction applied Bit 5: Set when 5900 Motion Yaw correction applied Bit 4: Set when Bathy V2 processing done with new scale factors Bit 3: Set when Bathy processing included ship geometry (lever arms) correction Bit 2: Set when Bathy processing included sound velocity correction Bit 1: Set for Bathy processing Bit 0: Set for 5000/5900 Beamform processing	N/A	N/A	X	X	X
80	U16 motionSensorType	The type of motion sensor present in the towfish 0 = Standard TCM Compass 1 = KMS-01 Configuration 1 2 = POS MV Version 3 or 4	N/A	N/A	X	X	N/A

Field #	Field	Definition	3000	3900	5000	5900	3500
81	U16 pingTimeRefCount	TPU Reference counter value when ping trigger from fish received	N/A	N/A	X	X	N/A
82	U16 extTrigTimeRefCount	TPU Reference counter value when external trigger received	N/A	N/A	X	X	N/A
83	U16 onePpsTimeRefCount	TPU Reference counter value when 1PPS signal received.	N/A	N/A	X	X	N/A
84	U32 timeRefCountWeight	1 LSB of TPU time reference counter value in nanoseconds	N/A	N/A	X	X	N/A
85	F32 altitudeBathy	The altitude used to compute the bathymetric solution	N/A	N/A	X	X	X
86	F32 pingInterval	The ping interval in seconds	N/A	N/A	X	X	X
	Added at vxWorks version V8.00						
87	U32 sdfExtensionSize	Size (in bytes), of the SDF extension area. If 0, no extension present.	N/A	N/A	X	X	X
88	double secondsOfWeek	The seconds of the week ping trigger time. Useful for comparing to sensors (like the Applanix POS MV) who provide time stamps as seconds of the week. Computed from header year, month, day, hour, minute, fseconds	X	X	X	N/A	N/A
89	U32 speedSoundSource	The source of the header speedSound value: 0 = manual speed of sound 1 = array speed of sound sensor	X	X	X	X	X
90	F32 pressureSensorMax	maximum pressure reading of pressure sensor	X	X	X	X	X
91	F32 pressureSensorVoltageMin	minimum voltage reading from pressure sensor (Volts)	X	X	X	X	X
92	F32 pressureSensorVoltageMax	maximum voltage reading from pressure sensor (Volts)	X	X	X	X	X
93	U32 processedPingNumber	increments by 1 for each processed ping				X	N/A
94	F32 processedPingSpacing	The along track spacing of the processed ping (meters)	N/A	N/A	N/A	X	N/A
95	F32 temperatureAmbient	Towfish internal temperature (Degrees C)	N/A	N/A	N/A	X	X
99	S32 saturationDetectThreshold	Saturation Detect Threshold System 5900/ System UUV-3500: -1 = Off 0 = 0% 1 = 12% 2 = 25% 3 = 38% 4 = 50% 5 = 62% 6 = 75% 7 = 88%	N/A	N/A	N/A	X	X
100	U32 sonarFreq	The operating frequency of the Sonar (kHz)					X

Field #	Field	Definition	3000	3900	5000	5900	3500
	U32 reserved3[26]	Reserved data portion. Array size set to keep this header addition at 256 bytes.	X	X	X	X	

Notes:

1. See Table 1 for valid pageVersion values.
2. The configuration bit field is system type dependent. The System 3000, 3900, and 5000 Mk1 use this field to indicate which data page channels are populated (A 1 in a particular bit indicates the data page channel for that field will contain data). The UUV-3500 uses this field to indicate which channels have been enabled for data acquisition.

System 3000/3900	System 5000 Mk1	System 5000 V2	UUV-3500
Bit 0 – Low Frequency Port channel populated Bit 1 – Low Frequency Stbd channel populated Bit 2 – High Frequency Port channel populated Bit 3 – High Frequency Stbd channel populated Bit 4 – Sub Bottom Profiler channel populated Bits 31-5: Reserved	Bit 0: Beam 1 populated Bit 1: Beam 2 populated Bit 2: Beam 3 populated Bit 3: Beam 4 populated Bit 4: Beam 5 populated Bit 5: Beam 6 populated Bit 6: Beam 7 populated Bit 7: Beam 8 populated Bit 8: Beam 9 populated Bit 9: Beam 10 populated Bits 21-10: Reserved Bit 22: Echo 1 populated Bit 23: Echo 2 populated Bit 24: Reserved Bit 25: Reserved Bit 26: Roll populated Bit 27: Yaw populated Bit 28: Aux Record 1 pop. Bit 29: Aux Record 2 pop. Bit 30: Reserved Bit 31: Reserved	N/A	Bit 0 – Channel 0 (LF Port side scan/Bathy) Bit 1 – Channel 1 (LF Stbd side scan/Bathy) Bit 2 – Channel 2 (HF Port side scan) Bit 3 – Channel 3 (HF Stbd side scan) Bit 4 – Channel 4 (LF Bathy) Bit 5 – Channel 5 (LF Bathy) Bit 6 – Channel 6 (LF Bathy) Bit 7 – Channel 7 (LF Bathy) Bits 23-8: Reserved. Bits 31-24: Framing Mode, coded as follows: 0 – Reserved 1 – LF Side Scan Only 2 – HF Side Scan Only 3 – LF and HF Side Scan 4 – Reserved (LF Bathy only) 5 – LF Side Scan and LF Bathy only 6 – LF Bathy and HF Side Scan 7 – LF and HF Side Scan and LF Bathy 8 – 255 – Reserved.

3. beamsToDisplay is a 5-bit wide field with bit 0 indicating that channels 1,6 are to be displayed, bit 1 indicating that channels 2,7 are to be displayed,...,bit 4 indicating that channels 5 and 10 are to be displayed. For a System 5000, channels 1-5 are port and 6-10 starboard, where 1 and 6 are the latest in time (beams 1/6 are fore and 5/10 are aft on fish).