IM-8084 A1 Lodestar Integration Guide – Robotics Pack USBL aiding SPRINT addendum

Contents

Confidentiality Statement:

Section 1 – USBL aiding of Sonardyne SPRINT

USBL aiding a SPRINT product is outlined in the main SPRINT integration guide but is focused around USBL aiding a tethered vehicle such as an ROV. This document will describe a methodology for using Sonardyne acoustic (SPOS) position aiding as a SPRINT position source for untethered vehicles such as AUVs.

Sonardyne will support the integrator through this integration process by reviewing configuration setup and trials data.

1.1 Scenario

This addendum to the integration guide will be scenario based and will have the following components:

- SPRINT-Nav or SPRINT DVL/INS hybrid navigation system, henceforward “SPRINT”
- Sonardyne AvTrak6 transceiver - connected to AUV control system
- Sonardyne 6G USBL
- AUV control system (management layer)
- AUV

1.2 System Architecture

As shown in Figure 1 there is a required set of messages that need to be passed between the AUV control system, SPRINT and AvTrak6 to allow USBL aiding. Note the vehicle control acts as a management layer, reformatting the SPOS message into a USBL message accepted by the SPRINT.

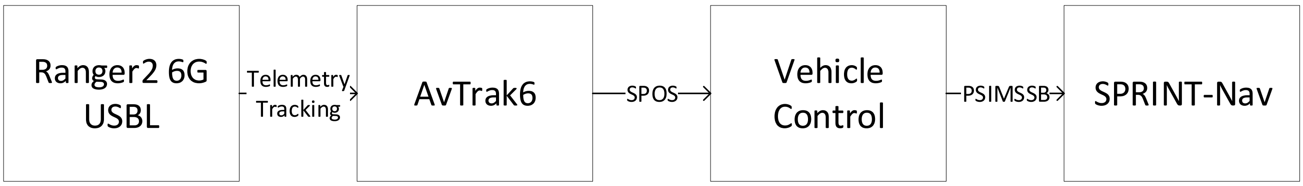

Figure 1 – SPRINT – USBL system architecture

1.3 General configuration tips

- It is recommended to use the fastest reliable telemetry scheme in Ranger 2 so data is provided to the AvTrak and therefore the SPRINT with minimal latency.
- It is recommended to use the fastest tracking speed available in Ranger 2 so data is provided to the AvTrak and therefore the SPRINT with minimal latency.
- Avoid aiding the SPRINT with multiple aiding sources at once I.e. USBL/XPOS/GPS especially when SPRINT KFHPOSBOOST is enabled as this can cause the SPRINT position to jump rapidly between aiding position.

- It is recommended to do this by manipulating the INS USE command so that the INS only uses one absolute aiding source at a time, this is preferred as then all data is available in the log files for post processing. I.e. configure SPRINT to, the below when USBL aiding.
    - INS USE PRESS DVL SUSBL
- To disable the position boost functionality enabled in INS KFHPOSBOOST the following command should be used. This is covered in section 7.6.11.2 INS Configuration of the main integration guide.
    - INS KFHPOSBOOST 0

1.4 SPOS format & PSIMSSB

When tracking an AvTrak 6 in Ranger 2 with telemetry tracking enabled every tracking cycle the position calculated on the previous tracking cycle is passed out of the subsea AvTrak6 via an SPOS message as below. When tracking multiple 6G transponders with telemetry tracking simultaneously then data for all transponders is available as in String 2, note when tracking multiple transponders, they will not always be in a fixed order.

SMS:2701,C2|SPOS:1;51.33153;-0.83553,2101;202114.557;51.330757;-0.835471;130.2;1.6;0;0

String 1 - single AvTrak6 SPOS

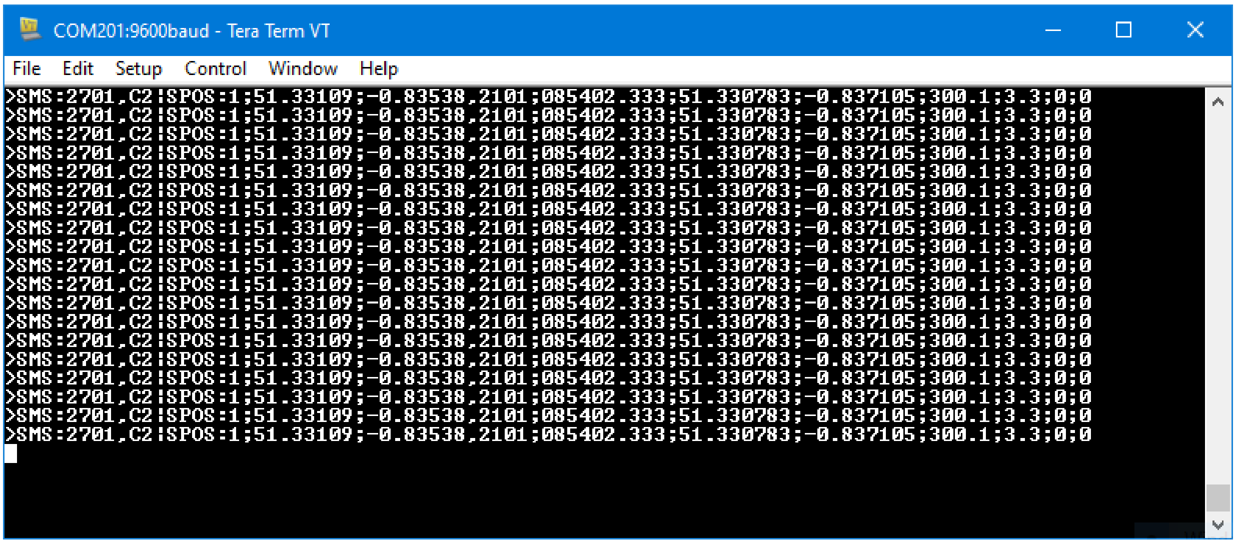

Figure 2 – SPOS output from AvTrak 6 as seen in Tera Term

SMS = message format
2701 = Address of message originator i.e Ranger2 USBL system
C2 = unique message ID for Ranger2 SMS messages
| = separator
SPOS = Sonardyne positioning message
1 = Position message version
51.33153 = latitude of vessel
-0.83553 = longitude of vessel
2101 = ID of a tracked transponder
202114.557 = UTC time tag of time of validity of following position
51.330757 = latitude of ID 2101
-0.835471 = longitude of ID2101
130.2 = depth of ID2101
1.6 = SD estimate for 21
01 (independent of error propagation i.e. not including GPS error)
0 = message exchange status
0 = data payload (if user is sending small payload messages from topside (4 ascii hex)

SMS:2701,C2|SPOS:1;51.33066;-0.83426,2101;211917.897;51.330484;-0.835552;130.2;1.6;1;0,2102;211917.911;51.330641;-0.835689;150.0;1.8;0;0

String 2 - multiple AvTrak6 SPOS

Of key interest to the user is the section in purple which contains the navigation information for the tracked AUV AvTrak6, in this case ID 2101.

In order to aid the SPRINT with remote USBL updates the SPOS format above needs to be reformatted by the AUV computer into either PSIMSSB or (USBL) GGA message format which the SPRINT will then accept as a USBL message. See section 7.5.2.1 of the Lodestar integration guide which covers this in detail – see 8.2.15 for PSIMSSB specification. An example is also provided below in String 3.

$PSIMSSB,202114.56,B01,A,,R,N,M,0.895890717,-0.014581720,130.2,1.6,N,,*53

String 3 - PSIMSSB from String 1

Note

In general it may be easier to form a PSIMSSB rather than a GGA as then only the MID (see section 5.1 of main integration guide) in the SPRINT multiplex format needs to be changed for the message to be recognised by the SPRINT as a USBL message. PSIMSSB and GGA specification is provided in the main integration guide.

1.5 Configuring SPRINT to accept USBL

IN x MSG + SUSBL

Adds SUSBL message macro group (section 6.4.3 of main integration guide) to a user defined input port so GGA/PSIMSSB are accepted on this port. If sending a GGA the SID needs to be configured so it is recognised as a USBL GGA not GPS GGA. Note the IN format is different for network ports.

INS USE + SUSBL

Adds USBL aiding to the INS so it can be used as an aiding source

INS KFDELAY 5

Sets SPRINT to accept data into the kalman filter that is up to 5 seconds latent, if data is older than this it will not be accepted. This value should not be changed to higher than this without consulting Sonardyne as using values >5s can cause problems. See Appendix A for simulated USBL latency.

*If it is not possible to restrict latency to <5 seconds and the best possible absolute accuracy is not mission critical then an easy workaround is to use USBL time-of-arrival at SPRINT as the position time tag, see section "*SUSBL TSOURCE TTAG*" hereafter. Alternatively contact Sonardyne.*

INS SUSBL KFHPOS 2

Sets a fixed error estimate for USBL aiding of SPRINT. It is recommended that the user always set a conservative fixed error estimate. If using the error in the SPOS format it is worth noting that this is based purely on acoustic signal reception quality so should not be trusted 100% and is commonly scaled by a factor of 2 or 3.

INS KFHPOSBOOST x

This SPRINT parameter "boosts" INS Kalman filter position uncertainty by x (default 8) meters when switching between different types of absolute position information aiding sensors which may have systematic differences, e.g. deep water USBL and LBL. Boosting the position uncertainty makes the transition between inconsistent (fixed bias/offset) absolute position sources faster and more robust.

This functionality can be disabled for a typical AUV use case including calibrated USBL and GPS.

SUSBL TSOURCE TTAG

Sets SPRINT to always use the time tag in the USBL message for aiding. This is important as USBL data sent via acoustics will be latent. If data is consistently expected to be >5s latent this should be set to TOA (Time of Arrival). Configuring the SUSBL to TOA means that USBL data will not be rejected based on time tag, however the user should be aware that feeding in measurements that are known to be old using TOA will degrade positioning accuracy as a result of feeding in knowingly latent data, without providing the SPRINT with knowledge of how latent it is. Quality metrics produced by SPRINT will not reflect any decrease in absolute accuracy as a result of supplying latent data to the SPRINT, without an appropriate time tag.

SUSBL TSYNCSDLIM 2

If the user expects long duration AUV missions and wants to aid the INS with timestamped USBL data then it may be necessary to extend the above parameter. Which checks the standard deviation of the SPRINT time synchronisation, and only accepts time tagged messages into the SPRINT if the SD value is lower than specified here. The SD of the time system can be monitored in JANUS post dive, and the user should ascertain what an acceptable value is here.

Note

When tracking in Ranger2 if a position cannot be calculated, the SMS/SPOS message will continue to broadcast the last known position and timetag. As such when using TOA mode in the SPRINT, the user should not forward any PSIMSSB messages to the SPRINT, generated from SPOS messages which have identical timestamps to the preceeding messasge. This will avoid feeding erroneous data to the SPRINT.

Appendix A – Telemetry speeds at 2000m water depth

The below latency times are simulated by Sonardyne and valid for 2000m range, provided the following conditions are met:

- Tracking only one transponder with telemetry tracking.
- No user data being sent in either direction.
- Tracking update rate set to 1s in Ranger2 (Ranger 2 will automatically negotiate maximum update rate).
- Turn Around Time (TAT) of 320ms.
- Does not include processing time for the AUV management layer to format the USBL message and pass it to the SPRINT.
- Good acoustic link, with successful exchanges in both directions.

Telemetry speed	UTC time	SPOS time	Latency
9000bps	11:46:26.831	11:46:23.234	00:00:03.6
6000bps	11:47:13.911	11:47:10.311	00:00:03.6
900bps	11:47:48.988	11:47:45.425	00:00:03.6
400bps	11:48:35.612	11:48:31.570	00:00:04.0
200bps	11:49:21.003	11:49:16.720	00:00:04.3

Table 1- 2000m water depth