Swift Navigation Devices Heading

GNSS compass configuration

Overview

This article details the current heading feature available on Piksi® Multi and Duro as of firmware release v1.3. First, the document describes how to setup the Piksi Multi evaluation kit in order to produce heading. Secondly, the document describes how heading can be configured in the general sense. These features can be used to compute the heading and/or attitude of a rigid body or to augment other attitude sensors in navigation, control, and attitude/heading reference systems.

Evaluation Kit Configuration

Physical

For the heading use case with the Piksi Multi evaluation kit the following system diagram is the recommended configuration. Two Piksi and two antennas should be placed on a moving vehicle. A crossover serial cable should be placed between the RS-232 0 ports between the two evaluation boards. One Piksi (the left Piksi) operates only to provide GNSS Observations to the other Piksi that computes an RTK derived heading (right Piksi). For the purposes of this article we will call the Piksi that operates to provide the raw GNSS observations only the “Reference Receiver” and the Piksi producing heading measurements the “Attitude Receiver.”

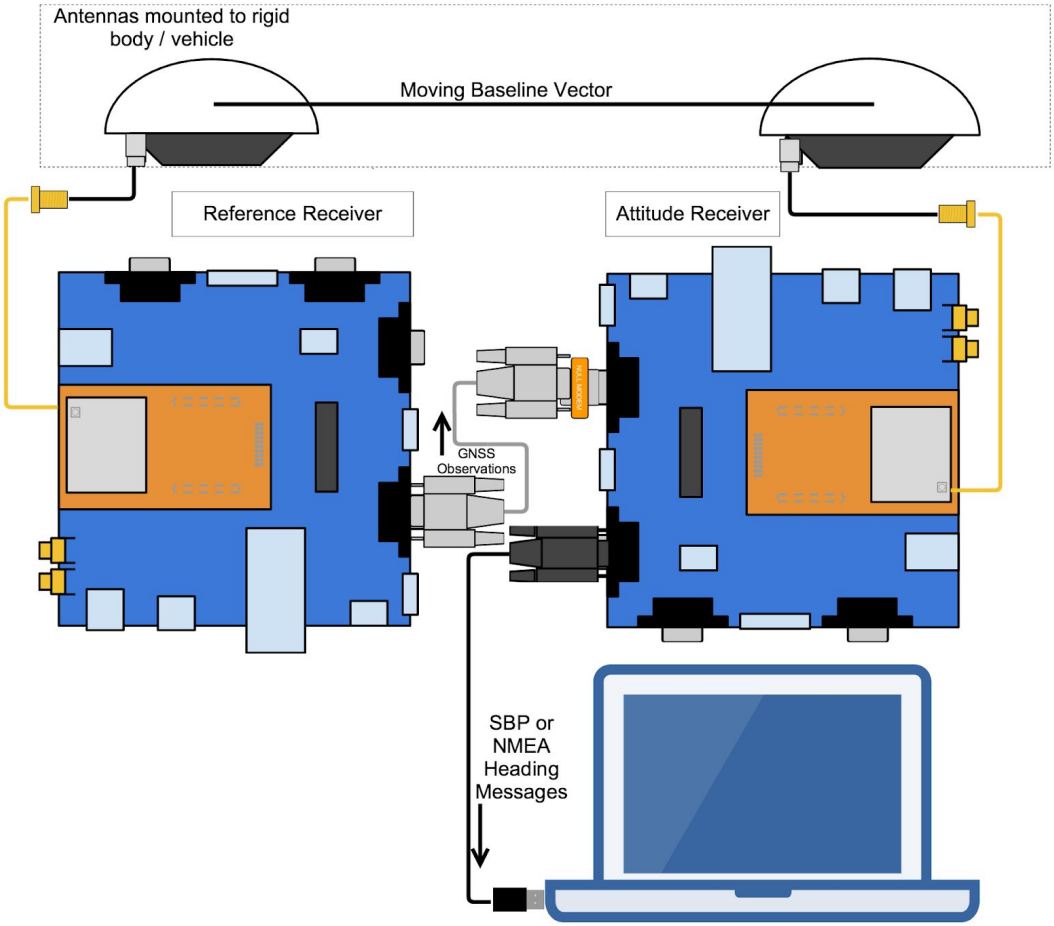

Figure 1 - RTK heading setup with Piksi Multi Evaluation kit

Software

Piksi Multi software must be configured to enable heading output. First, it must be configured to compute its differential solution in what is called “Time-matched mode”. By default, Piksi operates in “low-latency” mode in which there is an inherent assumption that the base station is stationary. In time-matched mode, each differential GNSS solution epoch is triggered by receipt of the raw observations from a moving secondary receiver. This means that the Piksi differential pair must have equal observation rates which is configured through the “solution rate” and the “output every n obs” settings. It also means that there can be additional latency on the navigation output from any communication delay. As such, we recommend using a direct serial cable rather than a radio to provide corrections. Please refer to tables 1 and 2 below to indicate the required settings.

Reference Receiver Settings

These settings are to be configured on the Reference Receiver only providing observations to the attitude receiver. The Reference Receiver can still do RTK with a stationary base station.

Name	Value	Units	Description
solution			
dgnss_solution_mode	"Low Latency"	N/A	Configures Piksi to compute a low latency RTK solution if RTK corrections are received from a stationary base station.
soln_freq	10	Hz	10 Hz is the current maximum RTK low latency solution rate on Piksi Multi.
output_every_n_obs	2	N/A	Enables 5 Hz raw observation output to the attitude receiver. Observation rate must be the same as on the attitude receiver.
uart0			
enabled_sbp_messages	74,117	N/A	Configures Piksi to send its raw observations and GLONASS biases to the attitude receiver.

Table 1: Reference receiver only settings

Attitude Receiver Settings

These settings are to be configured on only the Attitude Receiver computing the RTK heading.

Name	Value	Units	Description
solution			
dgnss_solution_mode	"Time Matched"	N/A	Configures Piksi to compute a time-matched solution on receipt of observations from a base station.
soln_freq	5	Hz	5 Hz is the current maximum time-matched solution rate on Piksi Multi.
output_every_n_obs	1	N/A	Enables 5 Hz raw observation on base and rover. Observation rate must be the same as on the reference receiver.
send_heading	True	bool	Enables SBP heading output. Heading is calculated from base station to rover and represents the inverse tangent of the north and east components of the baseline. No smoothing or additional processing is provided to improve heading output.
heading_offset	Depends on vehicle	degrees	Adds an offset to the heading output to rotate the heading vector to align the baseline heading with a desired 0 heading.

			Valid values are -180.0 to 180.0 degrees. See figure 3 for detail of how this offset is applied in a real system
uart0			
enabled_sbp_messages	0	N/A	Configures Piksi to not send any data from UART0.

Table 2: Attitude receiver only settings

Heading Communication (SBP and NMEA)

Heading output will be sent provided the "output_heading" setting is True and the Piksi is in RTK Fixed mode. The heading produced is intended to be the vehicle heading and includes the heading_offset. The heading output is produced by the Attitude receiver in the differential pair.

SBP

For interfaces that are configured in SBP mode, the heading output can take the form of the Swift Binary Protocol (SBP) MSG_BASELINE_HEADING message which is a message id of 0x020F in hexadecimal or 527 in decimal format. This message contents is detailed below as an excerpt from the Swift binary protocol document; please refer to the SBP support portal page for more information about SBP and the baseline heading message.

MSG_BASELINE_HEADING — 0x020F — 527

This message reports the baseline heading pointing from the base station to the rover relative to True North. The full GPS time is given by the preceding MSG_GPS_TIME with the matching time-of-week (tow). It is intended that time-matched RTK mode is used when the base station is moving.

Offset (bytes)	Size (bytes)	Format	Units	Name	Description
0	4	u32	ms	`tow`	GPS Time of Week
4	4	u32	mdeg	`heading`	Heading
8	1	u8		`n_sats`	Number of satellites used in solution
9	1	u8		`flags`	Status flags
	10				Total Payload Length

Table 6.2.24: MSG_BASELINE_HEADING 0x020F message structure

Figure 2: SBP baseline heading message excerpt from SBP documentation

NMEA

If an interface is configured in NMEA mode, the heading output is the NMEA HDT message. The HDT message consists of a single field representing the true heading in degrees that should take the form: " $GPHDT,x.x,T*hh<CR><LF>"

Generalized Heading Information

In general, the key thing that is required to produce heading output are Piksi and two antennas on the same moving vehicle and raw GNSS observation communication between the two Piksis. When an RTK fixed baseline is achieved, the heading is output by the device. This heading is derived from the baseline vector and the heading_offset setting through the equation below. Where is the heading communicated by Piksi, $E_{baseline}$ is the East component of the baseline vector, $N_{baseline}$ is the North component of the baseline vector, and θ_{offset} is the heading offset setting, and σ is the baseline heading computed from the baseline vector. The vehicle heading, labeled ψ, is computed from the baseline heading plus the heading offset setting (θ_{offset}) configured by the user. Equation 1 and Figure 3 below visually represents these mathematical relationships.

$$Baseline\ Heading\ = \sigma = Tan^{-1}(\frac{N_{baseline}}{E_{baseline}})$$

$$Vehicle\ Heading\ = \psi\ = \sigma + \theta_{offset}$$

Equation 1: baseline heading computation

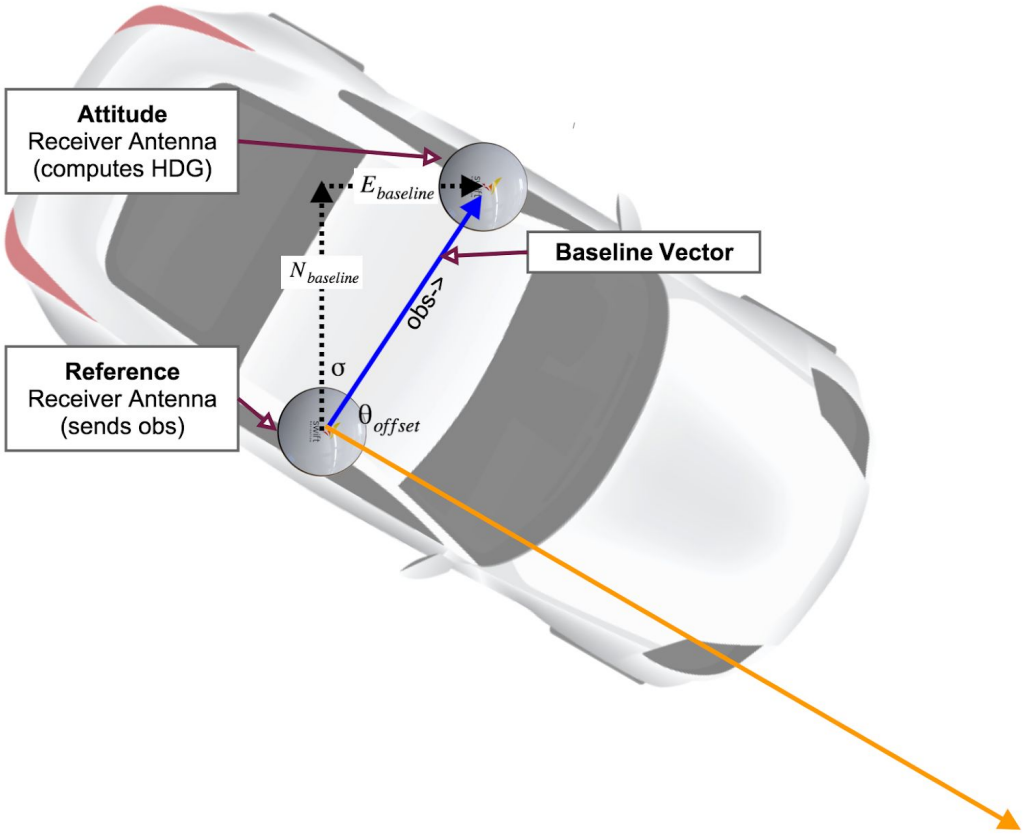

Figure 3: Visual depiction of the relationship between the baseline vector components, the two heading antennas, the Heading output (HDG) and the heading_offset setting