

decorations,shapes,arrows,shadows,positioning block = [draw, fill=orange!20,
rectangle, minimum height=2em, minimum width=2em] sum = [draw, fill=orange!40,
circle=0.1cm, node distance=1cm] input = [coordinate] output = [coordinate]
pinstyle = [pin edge=to-,thin,black]

*

*

0.4

section0.5in0.5in subsection0.5in0.5in -1em 1.3pt 2pt

(top_{right})at();[linewidth =
0.5pt](0,0)–
–(top_{right});[anchor =



northwest](logo) ;[linewidth =
0.5pt](logo.southwest)–
–(logo.southwest–
|top_{right});[anchor =
southeast,textwidth =
15cm,align =

right]at(–1.5cm)**Swift Navigation Binary Protocol**;
southeast,textwidth =
15cm,align =
right]at(–3.0cm)**Protocol Specification 2.5.4**;

starttoc

1 Overview

The
Swift
Nav-
i-
ga-
tion
Bi-
nary
Pro-
to-
col
(SBP)
is
a

fast,
sim-
ple,
and
min-
i-
mal
bi-
nary
pro-
to-
col
for
com-
mu-
ni-
cat-
ing
with
Swift
de-
vices.
It
is
the
na-
tive
bi-
nary
pro-
to-
col
used
by
the
Piksi
GPS
re-
ceiver

to
trans-
mit
so-
lu-
tions,
ob-
ser-
va-
tions,
sta-
tus,
and
de-
bug-
ging
mes-
sages,
as
well
as
re-
ceive
mes-
sages
from
the
host
op-
er-
at-
ing
sys-
tem,
such
as
dif-
fer-
en-

tial
cor-
rec-
tions
and
the
al-
manac.
As
such,
it
is
an
im-
por-
tant
in-
ter-
face
with
your
Piksi
re-
ceiver
and
the
pri-
mary
in-
te-
gra-
tion
method
with
other
sys-
tems.
This
doc-

u-
ment
pro-
vides
a
spec-
i-
fi-
ca-
tion
of
SBP
fram-
ing
and
the
pay-
load
struc-
tures
of
the
mes-
sages
cur-
rently
used
with
Swift
de-
vices.
SBP
client
li-
braries
in
a
va-
ri-

ety
of
pro-
gram-
ming
lan-
guages
are
avail-
able
at [https://
github.
com/
swift-nav/
libsbp](https://github.com/swift-nav/libsbp)
and
sup-
port
in-
for-
ma-
tion
for
sbp
is
avail-
able
at [https://
support.
swiftnav.
com/
customer/
en/
portal/
articles/
2492810-swift-binary-protocol](https://support.swiftnav.com/customer/en/portal/articles/2492810-swift-binary-protocol).

2 Message Framing Structure

SBP consists of two pieces:

- an over-the-wire message framing format
- structured payload definitions

As of Version 2.5.4, the frame

consists of a 6-byte binary header section, a variable-sized payload field, and a 16-bit CRC value. All multi-byte values are ordered in **little-endian** format. SBP uses the

CCITT
CRC16
(XMO-
DEM
im-
ple-
men-
ta-
tion)
for
er-
ror
de-
tec-
tion¹.

ror
De-
tec-
tion
Al-
go-
rithms
at [http:](http://www.ross.net/crc/download/crc_v3.txt)
[//](http://www.ross.net/crc/download/crc_v3.txt)
[www.](http://www.ross.net/crc/download/crc_v3.txt)
[ross.](http://www.ross.net/crc/download/crc_v3.txt)
[net/](http://www.ross.net/crc/download/crc_v3.txt)
[crc/](http://www.ross.net/crc/download/crc_v3.txt)
[download/](http://www.ross.net/crc/download/crc_v3.txt)
[crc_](http://www.ross.net/crc/download/crc_v3.txt)
[v3.](http://www.ross.net/crc/download/crc_v3.txt)
[txt](http://www.ross.net/crc/download/crc_v3.txt)

¹CCITT
16-
bit
CRC
Im-
ple-
men-
ta-
tion
uses
pa-
ram-
e-
ters
used
by
XMO-
DEM,

3 NMEA-0183

Swift
de-
vices,
such
as
the
Piksi,

i.e.
the
poly-
no-
mial:
 $x^{16} +$
 $x^{12} +$
 $x^5 +$
1.
For
more
de-
tails,
please
see
the
im-
ple-
men-
ta-
tion
at <https://github.com/swift-nav/libsbp/blob/master/c/src/edc.c#L59>.
See
also
A
*Pain-
less
Guide
to
CRC*
Er-

also
have
lim-
ited
sup-
port
for
the
stan-
dard
NMEA-
0183
pro-
to-
col.

 Note
that
NMEA-
0183
doesn't
de-
fine
stan-
dard-
ized
mes-
sage
string
equiv-
a-
lents
for
many
im-
por-
tant
SBP
mes-
sages

such
as
ob-
ser-
va-
tions,
base-
lines
and
ephemerides.
For
this
rea-
son
it
is
strongly
rec-
om-
mended
to
use
SBP
for
new
de-
vel-
op-
ment.
NMEA-
0183
out-
put
is
pro-
vided
pri-
mar-
ily

to
sup-
port
legacy
de-
vices.

4 Basic For- mats and Pay- load Struc- ture

The
bi-
nary
pay-
load
of
an
SBP
mes-
sage
de-
codes
into
struc-
tured
data
based
on
the
mes-
sage
type
de-
fined
in
the
header.
SBP
uses
sev-
eral
prim-
i-

tive
nu-
mer-
i-
cal
and
col-
lec-
tion
types
for
defin-
ing
pay-
load
con-
tents.

**Example
Mes-
sage**

As
an
ex-
am-
ple,
con-
sider
this
framed
se-
ries
of
bytes
read
from
a
se-
rial
port:

55 02 02 cc 04 14 70 3d d0 18 cf ef ff ff ef e8 ff ff f0 18 00 00 00 00 05 00

This
byte
array
decodes
into
a
MSG_BASELINE_ECEF
(see
pg. 68),
which
reports
the
base-
line
po-
si-
tion
so-
lu-
tion
of
the
rover
re-
ceiver
rel-
a-
tive
to
the
base
sta-
tion
re-
ceiver
in
Earth
Cen-
tered
Earth
Fixed

(ECEF)
co-
or-
di-
nates.
The
seg-
ments
of
this
byte
ar-
ray
and
its
con-
tents
break
down
as
fol-
lows:

5 Message Types

Packages

de-

fine

a

log-

i-

cal

col-

lec-

tion

of

SBP

mes-

sages.

The

con-

tents

and

lay-

out

of

mes-

sages

in

pack-

ages

marked

sta-

ble

are

un-

likely

to

change

in

the

fu-

ture.

Draft

mes-

sages

will

*change
with
fu-
ture
de-
vel-
op-
ment
and
are
de-
tailed
purely
for
in-
for-
ma-
tional
pur-
poses
only.*
Many
draft
mes-
sages
are
implementation-
defined,
and
some
col-
lec-
tions,
such
as
the
ac-
qui-
si-
tion
pack-
age,
are
used
for
in-

ter-
nal
de-
vel-
op-
ment.

Package	Msg ID	Name	Size (bytes)	Description
Stable				
Ext Events	0x0101	MSG_EXT_EVENT	12	Reports timestamped external
	0x0900	MSG_IMU_RAW	17	Raw IMU data
Imu	0x0901	MSG_IMU_AUX	4	Auxiliary IMU data
	0x0401	MSG_LOG	$N + 1$	Plaintext logging messages with
	0x0402	MSG_FWD	$N + 2$	Wrapper for FWD a separate s mation over SBP
Mag	0x0902	MSG_MAG_RAW	11	Raw magnetometer data
	0x0102	MSG_GPS_TIME	11	GPS Time
Navigation	0x0103	MSG_UTC_TIME	16	UTC Time
	0x0208	MSG_DOPS	15	Dilution of Precision
	0x0209	MSG_POS_ECEF	32	Single-point position in ECEF
	0x0214	MSG_POS_ECEF_COV	54	Single-point position in ECEF
	0x020A	MSG_POS_LLH	34	Geodetic Position
	0x0211	MSG_POS_LLH_COV	54	Geodetic Position
	0x020B	MSG_BASELINE_ECEF	20	Baseline Position in ECEF
	0x020C	MSG_BASELINE_NED	22	Baseline in NED
	0x020D	MSG_VEL_ECEF	20	Velocity in ECEF
	0x0215	MSG_VEL_ECEF_COV	42	Velocity in ECEF
	0x020E	MSG_VEL_NED	22	Velocity in NED
	0x0212	MSG_VEL_NED_COV	42	Velocity in NED
	0x0213	MSG_VEL_BODY	42	Velocity in User Frame
	0x0210	MSG_AGE_CORRECTIONS	6	Age of corrections
Observation	0x004A	MSG_OBS	$17N + 11$	GPS satellite observations
	0x0044	MSG_BASE_POS_LLH	24	Base station position
	0x0048	MSG_BASE_POS_ECEF	24	Base station position in ECEF
	0x0081	MSG_EPHEMERIS_GPS_DEP_E	185	Satellite broadcast ephemeris f
	0x0086	MSG_EPHEMERIS_GPS_DEP_F	183	Deprecated
	0x008A	MSG_EPHEMERIS_GPS	139	Satellite broadcast ephemeris f
	0x0089	MSG_EPHEMERIS_BDS	147	Satellite broadcast ephemeris f
	0x0095	MSG_EPHEMERIS_GAL	152	Satellite broadcast ephemeris f
	0x0082	MSG_EPHEMERIS_SBAS_DEP_A	112	Satellite broadcast ephemeris f
	0x0083	MSG_EPHEMERIS_GLO_DEP_A	112	Satellite broadcast ephemeris f
	0x0084	MSG_EPHEMERIS_SBAS_DEP_B	110	Deprecated
	0x008C	MSG_EPHEMERIS_SBAS	74	Satellite broadcast ephemeris f

	0x0085	MSG_EPHEMERIS_GLO_DEP_B	110	Satellite broadcast ephemeris B
	0x0087	MSG_EPHEMERIS_GLO_DEP_C	119	Satellite broadcast ephemeris C
	0x0088	MSG_EPHEMERIS_GLO_DEP_D	120	Deprecated
	0x008B	MSG_EPHEMERIS_GLO	92	Satellite broadcast ephemeris I
	0x0090	MSG_IONO	70	Iono corrections
	0x0091	MSG_SV_CONFIGURATION_GPS_DEP	10	L2C capability mask
	0x0096	MSG_GNSS_CAPB	110	GNSS capabilities
	0x0092	MSG_GROUP_DELAY_DEP_A	14	Group Delay
	0x0093	MSG_GROUP_DELAY_DEP_B	17	Group Delay
	0x0094	MSG_GROUP_DELAY	15	Group Delay
	0x0072	MSG_ALMANAC_GPS	94	Satellite broadcast ephemeris I
	0x0073	MSG_ALMANAC_GLO	78	Satellite broadcast ephemeris I
	0x0075	MSG_GLO_BIASES	9	GLONASS L1/L2 Code-Phase
	0x0097	MSG_SV_AZ_EL	4N	Satellite azimuths and elevation
	0x0640	MSG_OSR	19N + 11	OSR corrections
Settings	0x00A1	MSG_SETTINGS_SAVE	0	Save settings to flash
	0x00A0	MSG_SETTINGS_WRITE	N	Write device configuration settings
	0x00AF	MSG_SETTINGS_WRITE_RESP	N + 1	Acknowledgement with MSG_SETTINGS_WRITE
	0x00A4	MSG_SETTINGS_READ_REQ	N	Read device configuration settings
	0x00A5	MSG_SETTINGS_READ_RESP	N	Read device configuration settings
	0x00A2	MSG_SETTINGS_READ_BY_INDEX_REQ	2	Read setting by direct index
	0x00A7	MSG_SETTINGS_READ_BY_INDEX_RESP	N + 2	Read setting by direct index
	0x00A6	MSG_SETTINGS_READ_BY_INDEX_DONE	0	Finished reading settings
System	0xFF00	MSG_STARTUP	4	System start-up message
	0xFF02	MSG_DGNSS_STATUS	N + 4	Status of received corrections
	0xFFFF	MSG_HEARTBEAT	4	System heartbeat message
	0xFF03	MSG_INS_STATUS	4	Inertial Navigation System status
Draft				
Acquisition	0x002F	MSG_ACQ_RESULT	14	Satellite acquisition result
	0x002E	MSG_ACQ_SV_PROFILE	33N	Acquisition performance measurement
File IO	0x00A8	MSG_FILEIO_READ_REQ	N + 9	Read file from the file system
	0x00A3	MSG_FILEIO_READ_RESP	N + 4	File read from the file system
	0x00A9	MSG_FILEIO_READ_DIR_REQ	N + 8	List files in a directory
	0x00AA	MSG_FILEIO_READ_DIR_RESP	N + 4	Files listed in a directory
	0x00AC	MSG_FILEIO_REMOVE	N	Delete a file from the file system
	0x00AD	MSG_FILEIO_WRITE_REQ	N + 9	Write to file
	0x00AB	MSG_FILEIO_WRITE_RESP	4	File written to
	0x1001	MSG_FILEIO_CONFIG_REQ	4	Request advice on the optimization for FileIO.
	0x1002	MSG_FILEIO_CONFIG_RESP	16	Response with advice on the optimization for FileIO.
Linux	0x7F00	MSG_LINUX_CPU_STATE	N + 19	List CPU state on the system
	0x7F01	MSG_LINUX_MEM_STATE	N + 19	List CPU state on the system

	0x7F02	MSG_LINUX_SYS_STATE	10	CPU, Memory and Process Sta
	0x7F03	MSG_LINUX_PROCESS_SOCKET_COUNTS	$N + 9$	A list of processes with high s
	0x7F04	MSG_LINUX_PROCESS_SOCKET_QUEUES	$N + 75$	A list of processes with deep s
	0x7F05	MSG_LINUX_SOCKET_USAGE	72	Summary of socket usage acro
	0x7F06	MSG_LINUX_PROCESS_FD_COUNT	$N + 5$	Summary of processes with la
				open file descriptors
	0x7F07	MSG_LINUX_PROCESS_FD_SUMMARY	$N + 4$	Summary of open file descript
				tem
Orientation	0x020F	MSG_BASELINE_HEADING	10	Heading relative to True North
	0x0220	MSG_ORIENT_QUAT	37	Quaternion 4 component vecto
	0x0221	MSG_ORIENT_EULER	29	Euler angles
	0x0222	MSG_ANGULAR_RATE	17	Vehicle Body Frame instant
				rates
Piksi	0x0069	MSG_ALMANAC	0	Legacy message to load satellit
	0x0068	MSG_SET_TIME	0	Send GPS time from host
	0x00B6	MSG_RESET	4	Reset the device
	0x00B2	MSG_RESET_DEP	0	Reset the device
	0x00C0	MSG_CW_RESULTS	0	Legacy message for CW inter
				(Piksi = i host)
	0x00C1	MSG_CW_START	0	Legacy message for CW interf
	0x0022	MSG_RESET_FILTERS	1	Reset IAR filters
	0x0023	MSG_INIT_BASE	0	Initialize IAR from known bas
	0x0017	MSG_THREAD_STATE	26	State of an RTOS thread
	0x001D	MSG_UART_STATE	74	State of the UART channels
	0x0018	MSG_UART_STATE_DEPA	58	Deprecated
	0x0019	MSG_IAR_STATE	4	State of the Integer Ambigu
				(IAR) process
	0x002B	MSG_MASK_SATELLITE	3	Mask a satellite from use in P
	0x00B5	MSG_DEVICE_MONITOR	10	Device temperature and volta
	0x00B8	MSG_COMMAND_REQ	$N + 4$	Execute a command
	0x00B9	MSG_COMMAND_RESP	8	Exit code from executed comm
				host)
	0x00BC	MSG_COMMAND_OUTPUT	$N + 4$	Command output
	0x00BA	MSG_NETWORK_STATE_REQ	0	Request state of Piksi network
	0x00BB	MSG_NETWORK_STATE_RESP	50	State of network interface
	0x00BD	MSG_NETWORK_BANDWIDTH_USAGE	$40N$	Bandwidth usage reporting me
	0x00BE	MSG_CELL_MODEM_STATUS	$N + 5$	Cell modem information upda
	0x0051	MSG_SPECAN	$N + 28$	Spectrum analyzer
	0x00BF	MSG_FRONT_END_GAIN	16	RF AGC status
Sbas	0x7777	MSG_SBAS_RAW	34	Raw SBAS data
Ssr	0x05DD	MSG_SSR_ORBIT_CLOCK	50	Precise orbit and clock correct
	0x05DC	MSG_SSR_ORBIT_CLOCK_DEP_A	47	Precise orbit and clock correct
	0x05E1	MSG_SSR_CODE_BIASES	$3N + 10$	Precise code biases correction
	0x05E6	MSG_SSR_PHASE_BIASES	$8N + 15$	Precise phase biases correction
	0x05DB	MSG_SSR_ORBIT	38	Precise orbit correction
	0x05DA	MSG_SSR_CLOCK	26	Precise clock correction

Tracking	0x0041	MSG_TRACKING_STATE	$4N$	Signal tracking channel states
	0x0061	MSG_MEASUREMENT_STATE	$3N$	Measurement Engine signal tracking states
	0x002D	MSG_TRACKING_IQ	$4N + 3$	Tracking channel correlations
	0x002C	MSG_TRACKING_IQ_DEP_B	$8N + 3$	Tracking channel correlations
User	0x0800	MSG_USER_DATA	N	User data
Vehicle	0x0903	MSG_ODOMETRY	9	Vehicle forward (x-axis) velocity

Table 5.0.2:
SBP
message
types

6 Stable Mes- sage Def- i- ni- tions

6.1 Ext Events

Messages
re-
port-
ing
accurately-
timestamped
ex-
ter-
nal
events,
e.g.
cam-
era
shut-
ter
time.

MSG_EXT_EVENT

—
0x0101

—
257

Reports
de-
tec-
tion
of
an

ex-
ter-
nal
event,
the
GPS
time
it
oc-
curred,
which
pin
it
was
and
whether
it
was
ris-
ing
or
falling.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	2	u16	week	GPS week number
2	4	u32	ms tow	GPS time of week rounded to the nearest millisecond
6	4	s32	ns ns_residual	Nanosecond residual of millisecond-rounded TOW (ranges from -500000 to 500000)
10	1	u8	flag	Flags
11	1	u8	pin	Pin number. 0..9 = DE-BUG0..9.
12				Total Payload Length

Table 6.1.1:
MSG_EXT_EVENT

Reserved62
Time
qual-
ity
(Ta-
ble 6.1.3)11
New
level
of
pin
(Ta-
ble 6.1.2)10

Field
6.1.1:
Flags
(**flags**)

Value	Description
0	Low (falling edge)
1	High (rising edge)

Table 6.1.2:
New
level
of
pin
val-
ues
(**flags**[0])

Value	Description
0	Unknown - don't have nav solution
1	Good (j 1 microsecond)

Table 6.1.3:
Time
qual-
ity
val-
ues
(**flags**[1])

6.2 Imu

Inertial
Mea-
sure-
ment
Unit
(IMU)
mes-
sages.

MSG_IMU_RAW

—
0x0900

—
2304

Raw
data
from
the
In-
er-
tial
Mea-
sure-
ment
Unit,
con-
tain-
ing
ac-
celerom-
e-
ter
and
gy-
ro-
scope
read-
ings.

The
sense
of
the
mea-
sure-
ments
are
to
be
aligned
with
the
in-
di-
ca-
tions
on
the
de-
vice
it-
self.
Mea-
sure-
ment
units,
which
are
spe-
cific
to
the
de-
vice
hard-
ware
and
set-

tings,
are
com-
mu-
ni-
cated
via
the
MSG_IMU_AUX
mes-
sage.

Offset	Size	For	Unit	Description
(bytes)	(bytes)			

0	4	u32	ms tow	Milliseconds since start of GPS week. If the high bit is set, the time is unknown or invalid.
---	---	-----	--------	---

4	1	u8	ms tow / 256	Milliseconds since start of GPS week, fractional part
---	---	----	--------------	---

5	2	s16	acc	Acceleration in the IMU frame X axis
---	---	-----	-----	--------------------------------------

7	2	s16	acc	Acceleration in the IMU frame Y axis
---	---	-----	-----	--------------------------------------

9	2	s16	acc	Acceleration in
---	---	-----	-----	-----------------

 Version 2.5.4, May 3, 2010

32

				IMU frame Z axis
11	2	s16	gyr	Angular rate around IMU frame

MSG_IMU_AUX

0x0901

2305

Auxiliary
data
specific
to
a
partic-
ular
IMU.
The
'imu_type'
field
will
always
be
con-
sis-
tent
but
the
rest
of
the
pay-
load
is
de-
vice
spe-
cific
and

de-
pends
on
the
value
of
'imu_type'.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	1	u8	imu_type	IMU tem- per- a- ture
1	2	s16	temp	Raw IMU tem- per- a- ture
3	1	u8	imu_conf	IMU con- fig- u- ra- tion
4				Total Pay- load Length

Table 6.2.2:
MSG_IMU_AUX
0x0901
mes-
sage
struc-
ture

IMU
Type
(Table 6.2.3)80

Field
6.2.1:
IMU
type
(imu_type)

Value	Description
0	Bosch BMI160

Table 6.2.3:
IMU
Type
values
(imu_type[0:7])

Gyroscope
 Range
 (Table 6.2.5)44
 Accelerometer
 Range
 (Table 6.2.4)40

Field
 6.2.2:
 IMU
 configuration
 (imu_conf)

Value	Description
0	+/- 2g
1	+/- 4g
2	+/- 8g
3	+/- 16g

Table 6.2.4:
 Accelerometer
 Range
 values
 (imu_conf[0:3])

Value	Description
0	+/- 2000 deg / s
1	+/- 1000 deg / s
2	+/- 500 deg / s
3	+/- 250 deg / s
4	+/- 125 deg / s

Table 6.2.5:
 Gy-

Version 2.5.4, May 3, 2019
 Gyroscope
 Range
 values
 (imu_conf[4:7])

6.3 Logging

Logging
and
de-
bug-
ging
mes-
sages
from
the
de-
vice.

MSG_LOG

—
0x0401
—
1025

This
mes-
sage
con-
tains
a
human-
readable
pay-
load
string
from
the
de-
vice
con-
tain-
ing
er-
rors,
warn-

ings
and
in-
for-
ma-
tional
mes-
sages
at
ER-
ROR,
WARN-
ING,
DE-
BUG,
INFO
log-
ging
lev-
els.

Offset (bytes)	Size (bytes)	Format	Unit	Name	Description
0	1	u8	level	Logging level	
1	N	string	text	Human-readable string	
	N+1			Total Payload Length	

Table 6.3.1:
MSG_LOG
0x0401
mes-
sage
struc-
ture

Reserved53

Log-
ging
level
(Ta-
ble 6.3.2)30

Field

6.3.1:

Log-
ging
level
(level)

Value	Description
0	EMERG
1	ALERT
2	CRIT
3	ERROR
4	WARN
5	NOTICE
6	INFO
7	DEBUG

Table 6.3.2:

Log-
ging
level
val-
ues
(level[0:2])

MSG_FWD

0x0402

1026

This
mes-
sage
pro-
vides
the
abil-
ity
to
for-
ward
mes-
sages
over
SBP.
This
may
take
the
form
of
wrap-
ping
up
SBP
mes-
sages
re-
ceived
by
Piksi
for
log-
ging

pur-
poses
or
wrap-
ping
an-
other
pro-
to-
col
with
SBP.

 The
source
iden-
ti-
fier
in-
di-
cates
from
what
in-
ter-
face
a
for-
warded
stream
de-
rived.
The
pro-
to-
col
iden-
ti-
fier
iden-

ti-
fies
what
the
ex-
pected
pro-
to-
col
the
for-
warded
msg
con-
tains.
Pro-
to-
col
0
rep-
re-
sents
SBP
and
the
re-
main-
ing
val-
ues
are
im-
ple-
men-
ta-
tion
de-
fined.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	1	u8	source	source
			iden-	
			ti-	
			fier	
1	1	u8	protocol	protocol
			iden-	
			ti-	
			fier	
2	N	string	payload	payload
			length	length
			wrapped	wrapped
			bi-	
			nary	
			mes-	
			sage	
	$N+2$		Total	Total
			Pay-	Pay-
			load	load
			Length	Length

Table 6.3.3:
MSG_FWD
0x0402
mes-
sage
struc-
ture

6.4 Mag

Magnetometer
(mag)
mes-
sages.

MSG_MAG_RAW

—
0x0902

—
2306

Raw
data
from
the
mag-
ne-
tome-
ter.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	4	u32 ms	time	Milliseconds since start of GPS week. If the high bit is set, the time is unknown or invalid.
4	1	u8 ms	time	Milliseconds since start of GPS week, fractional part
5	2	s16 micromag	magnetic field	Magnetic field in the body frame X axis
7	2	s16 micromag	magnetic field	Magnetic field in the body frame Y axis
9	2	s16 micromag	magnetic field	Magnetic field in the body frame Z axis

6.5 Navigation

Geodetic

nav-

i-

ga-

tion

mes-

sages

re-

port-

ing

GPS

time,

po-

si-

tion,

ve-

loc-

ity,

and

base-

line

po-

si-

tion

so-

lu-

tions.

For

po-

si-

tion

so-

lu-

tions,

these

mes-

sages

de-

fine
sev-
eral
dif-
fer-
ent
po-
si-
tion
so-
lu-
tions:
single-
point
(SPP),
RTK,
and
pseudo-
absolute

po-
si-
tion
so-
lu-
tions.

 The
SPP
is
the
stan-
dalone,
ab-
so-
lute
GPS
po-
si-
tion
so-

lu-
tion
us-
ing
only
a
sin-
gle
re-
ceiver.

The
RTK

so-
lu-
tion

is
the
dif-
fer-

en-
tial
GPS

so-
lu-
tion,
which

can
use
ei-
ther

a
fixed/integer

or
float-
ing

car-
rier
phase
am-

bi-
gu-
ity.
The
pseudo-
absolute
po-
si-
tion
so-
lu-
tion
uses
a
user-
provided,
well-
surveyed
base
sta-
tion
po-
si-
tion
(if
avail-
able)
and
the
RTK
so-
lu-
tion
in
tan-
dem.
When
the
in-

er-
tial
nav-
i-
ga-
tion
mode
in-
di-
cates
that
the
IMU
is
used,
all
mes-
sages
are
re-
ported
in
the
ve-
hi-
cle
body
frame
as
de-
fined
by
de-
vice
set-
tings.
By
de-
fault,

the
ve-
hi-
cle
body
frame
is
con-
fig-
ured
to
be
co-
in-
ci-
dent
with
the
an-
tenna
phase
cen-
ter.
When
there
is
no
in-
er-
tial
nav-
i-
ga-
tion,
the
so-
lu-
tion
will

be
re-
ported
at
the
phase
cen-
ter
of
the
an-
tenna.
There
is
no
in-
er-
tial
nav-
i-
ga-
tion
ca-
pa-
bil-
ity
on
Piksi
Multi
or
Duro.

MSG_GPS_TIME

—

0x0102

—

258

This
mes-

sage
re-
ports
the
GPS
time,
rep-
re-
sent-
ing
the
time
since
the
GPS
epoch
be-
gan
on
mid-
night
Jan-
uary
6,
1980
UTC.
GPS
time
counts
the
weeks
and
sec-
onds
of
the
week.
The
weeks

begin
at
the
Saturday/Sunday
transition.
GPS
week
0

begin
at
the
beginning
of
the
GPS
time
scale.

Within
each
week
number,
the
GPS
time
of
the
week
is
between

between
0
and
604800
seconds
(=60*60*24*7).
Note
that
GPS
time
does
not
ac-
cu-
mu-
late
leap
sec-
onds,
and
as
of
now,
has
a
small
off-
set
from
UTC.
In
a
mes-
sage
stream,
this
mes-

sage
pre-
cedes
a
set
of
other
nav-
i-
ga-
tion
mes-
sages
ref-
er-
enced
to
the
same
time
(but
lack-
ing
the
ns
field)
and
in-
di-
cates
a
more
pre-
cise
time
of
these
mes-
sages.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	2	u16	week	GPS week num- ber
2	4	u32	ms tow	GPS time of week rounded to the near- est mil- lisc- ond
6	4	s32	ns ns_resid	Residual resid- ual of millisecond- rounded TOW (ranges from - 500000 to 500000)
10	1	u8	flags	Status flags (re- served)
11				Total Pay- load Length

Table 6.5.1:
MSG_GPS_TIME
0x0102
mes-
sage
struc-

Reserved53

Time

source

(Ta-

ble 6.5.2)30

Field

6.5.1:

Sta-

tus

flags

(re-

served)

(**flags**)

Value	Description
0	None (invalid)
1	GNSS Solution
2	Propagated

Table 6.5.2:

Time

source

val-

ues

(**flags**[0:2])

MSG.UTC_TIME

0x0103

259

This
mes-
sage
re-
ports
the
Uni-
ver-
sal
Co-
or-
di-
nated
Time
(UTC).
Note
the
flags
which
in-
di-
cate
the
source
of
the
UTC
off-
set
value
and
source
of
the

time
fix.

Offset (bytes)	Size (bytes)	Field Name	Description
0	1	u8 flags	Indicates source and time va- lid- ity
1	4	u32ns towGPS	time of week rounded to the near- est mil- lisc- ond
5	2	u16yearYear	Year
7	1	u8 monthMonth	Month (range 1 .. 12)
8	1	u8 dayday	days in the month (range 1- 31)
9	1	u8 hourhour	hours of day (range 0- 23)
10	1	u8 minuteminutes	minutes of hour (range 0- 59)
11	1	u8 secondseconds	seconds
12	4	u32nanosecseconds	nanoseconds of

Reserved35
 UTC
 off-
 set
 source
 (Ta-
 ble 6.5.5)23
 Time
 source
 (Ta-
 ble 6.5.4)30

Field
 6.5.2:
 In-
 di-
 cates
 source
 and
 time
 va-
 lid-
 ity
 (**flags**)

Value	Description
0	None (invalid)
1	GNSS Solution
2	Propagated

Table 6.5.4:
 Time
 source
 val-
 ues
 (**flags**[0:2])

Value	Description
0	Factory Default
1	Non Volatile Memory
2	Decoded this Session

Table 6.5.5:
 UTC
 off-
 set
 source

val-
 ues
 (**flags**[3:4])

MSG_DOPS

0x0208

520

This
di-
lu-
tion
of
pre-
ci-
sion
(DOP)
mes-
sage
de-
scribes
the
ef-
fect
of
nav-
i-
ga-
tion
satel-
lite
ge-
om-
e-
try
on
po-
si-
tional
mea-
sure-
ment

pre-
ci-
sion.
The
flags
field
in-
di-
cated
whether
the
DOP
re-
ported
cor-
re-
sponds
to
dif-
fer-
en-
tial
or
SPP
so-
lu-
tion.

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	4	u32	time	GPS Time of Week
4	2	u16.0.0	gdop	Geometric Dilution of Precision
6	2	u16.0.0	pdop	Position Dilution of Precision
8	2	u16.0.0	tdop	Time Dilution of Precision
10	2	u16.0.0	hdop	Horizontal Dilution of Precision
12	2	u16.0.0	vdop	Vertical Dilution of Precision
14	1	u8	flag	Indicates

RAIM

re-

pair

flag17

Re-

served43

Fix

mode

(Ta-

ble 6.5.7)30

Field

6.5.3:

In-

di-

cates

the

po-

si-

tion

so-

lu-

tion

with

which

the

DOPS

mes-

sage

cor-

re-

sponds

(flags)

Value	Description
0	Invalid
1	Single Point Position (SPP)
2	Differential GNSS (DGNSS)
3	Float RTK
4	Fixed RTK
5	Undefined
6	SBAS Position

Table 6.5.7:

Fix

mode

val-

ues

(flags[0:2])

MSG_POS_ECEF

0x0209

521

The
po-
si-
tion
so-
lu-
tion
mes-
sage
re-
ports
ab-
so-
lute
Earth
Cen-
tered
Earth
Fixed
(ECEF)
co-
or-
di-
nates
and
the
sta-
tus
(sin-
gle
point
vs
pseudo-
absolute

RTK)
of
the
po-
si-
tion
so-
lu-
tion.
If
the
rover
re-
ceiver
knows
the
sur-
veyed
po-
si-
tion
of
the
base
sta-
tion
and
has
an
RTK
so-
lu-
tion,
this
re-
ports
a
pseudo-
absolute

po-
si-
tion
so-
lu-
tion
us-
ing
the
base
sta-
tion
po-
si-
tion
and
the
rover's
RTK
base-
line
vec-
tor.
The
full
GPS
time
is
given
by
the
pre-
ced-
ing
MSG_GPS_TIME
with
the
match-
ing

time-
of-
week
(tow).

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	4	u32	time_of_week	GPS Time of Week
4	8	double	ehex_X	ECEF X co-ordinate
12	8	double	ehex_Y	ECEF Y co-ordinate
20	8	double	ehex_Z	ECEF Z co-ordinate
28	2	uint16	macd_pos	Position estimated standard deviation
30	1	u8	n_sats	Number of satellites used in solution
31	1	u8	flags	Status flags
32				Total
Version 2.5.4, May 3, 2019				Pay-load Length

Table 6.5.8:
MSG_POS_ECEF
0x0209
mes-
sage
struc-

Reserved35

In-

er-

tial

Nav-

i-

ga-

tion

Mode

(Ta-

ble 6.5.10)23

Fix

mode

(Ta-

ble 6.5.9)30

Field

6.5.4:

Sta-

tus

flags

(flags)

Value	Description
0	Invalid
1	Single Point Position (SPP)
2	Differential GNSS (DGNSS)
3	Float RTK
4	Fixed RTK
5	Dead Reckoning
6	SBAS Position

Table 6.5.9:

Fix

mode

val-

ues

(flags[0:2])

Value	Description
0	None
1	INS used

Table 6.5.10:

In-

er-

tial

Nav-

i-

ga-

tion

Mode

val-

ues

(flags[3:4])

MSG_POS_ECEF_COV

0x0214

532

The
po-
si-
tion
so-
lu-
tion
mes-
sage
re-
ports
ab-
so-
lute
Earth
Cen-
tered
Earth
Fixed
(ECEF)
co-
or-
di-
nates
and
the
sta-
tus
(sin-
gle
point
vs
pseudo-
absolute

RTK)
of
the
po-
si-
tion
so-
lu-
tion.
The
mes-
sage
also
re-
ports
the
up-
per
tri-
an-
gu-
lar
por-
tion
of
the
3x3
co-
vari-
ance
ma-
trix.
If
the
re-
ceiver
knows
the
sur-

veyed
po-
si-
tion
of
the
base
sta-
tion
and
has
an
RTK
so-
lu-
tion,
this
re-
ports
a
pseudo-
absolute
po-
si-
tion
so-
lu-
tion
us-
ing
the
base
sta-
tion
po-
si-
tion
and
the

rover's
RTK
base-
line
vec-
tor.
The
full
GPS
time
is
given
by
the
pre-
ced-
ing
MSG_GPS_TIME
with
the
match-
ing
time-
of-
week
(tow).

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	4	u32	time	GPS Time of Week
4	8	double	ehex	ECEF X co- or- di- nate
12	8	double	ehex	ECEF Y co- or- di- nate
20	8	double	ehex	ECEF Z co- or- di- nate
28	4	float ²	cov	Estimated vari- ance of x
32	4	float ²	cov	Estimated co- vari- ance of x and y
36	4	float ²	cov	Estimated co- vari- ance of x and z
40	4	float ²	cov	Estimated co- vari- ance of y and z
44	4	float ²	cov	Estimated co- vari- ance of y

Reserved35

In-

er-

tial

Nav-

i-

ga-

tion

Mode

(Ta-

ble 6.5.13)23

Fix

mode

(Ta-

ble 6.5.12)30

Field

6.5.5:

Sta-

tus

flags

(flags)

Value	Description
0	Invalid
1	Single Point Position (SPP)
2	Differential GNSS (DGNSS)
3	Float RTK
4	Fixed RTK
5	Dead Reckoning
6	SBAS Position

Table 6.5.12:

Fix

mode

val-

ues

(flags[0:2])

Value	Description
0	None
1	INS used

Table 6.5.13:

In-

er-

tial

Nav-

i-

ga-

tion

Mode

val-

ues

(flags[3:4])

MSG_POS_LLH

0x020A

522

This
po-
si-
tion
so-
lu-
tion
mes-
sage
re-
ports
the
ab-
so-
lute
geode-
tic
co-
or-
di-
nates
and
the
sta-
tus
(sin-
gle
point
vs
pseudo-
absolute
RTK)
of
the

po-
si-
tion
so-
lu-
tion.
If
the
rover
re-
ceiver
knows
the
sur-
veyed
po-
si-
tion
of
the
base
sta-
tion
and
has
an
RTK
so-
lu-
tion,
this
re-
ports
a
pseudo-
absolute
po-
si-
tion

so-
lu-
tion
us-
ing
the
base
sta-
tion
po-
si-
tion
and
the
rover's
RTK
base-
line
vec-
tor.
The
full
GPS
time
is
given
by
the
pre-
ced-
ing
MSG_GPS_TIME
with
the
match-
ing
time-
of-
week

(tow).

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	4	u32	time_of_week	GPS Time of Week
4	8	double	lat	Latitude
12	8	double	lon	Longitude
20	8	double	height	Height above WGS84 el- lip- soid
28	2	u16	h_accuracy	Horizontal po- si- tion es- ti- mated stan- dard de- vi- a- tion
30	2	u16	v_accuracy	Vertical po- si- tion es- ti- mated stan- dard de- vi- a- tion
32	1	u8	n_satellites	Number of satel- lites used in so-
33	1	u8	status_flags	Status flags
34				Total Pay- load Length

Reserved35

In-

er-

tial

Nav-

i-

ga-

tion

Mode

(Ta-

ble 6.5.16)23

Fix

mode

(Ta-

ble 6.5.15)30

Field

6.5.6:

Sta-

tus

flags

(flags)

Value	Description
0	Invalid
1	Single Point Position (SPP)
2	Differential GNSS (DGNSS)
3	Float RTK
4	Fixed RTK
5	Dead Reckoning
6	SBAS Position

Table 6.5.15:

Fix

mode

val-

ues

(flags[0:2])

Value	Description
0	None
1	INS used

Table 6.5.16:

In-

er-

tial

Nav-

i-

ga-

tion

Mode

val-

ues

(flags[3:4])

MSG_POS_LLH_COV

0x0211

529

This
po-
si-
tion
so-
lu-
tion
mes-
sage
re-
ports
the
ab-
so-
lute
geode-
tic
co-
or-
di-
nates
and
the
sta-
tus
(sin-
gle
point
vs
pseudo-
absolute
RTK)
of
the

po-
si-
tion
so-
lu-
tion
as
well
as
the
up-
per
tri-
an-
gle
of
the
3x3
co-
vari-
ance
ma-
trix.
The
po-
si-
tion
in-
for-
ma-
tion
and
Fix
Mode
flags
should
fol-
low
the

MSG_POS_LLH

mes-
sage.
Since
the
co-
vari-
ance
ma-
trix
is
com-
puted
in
the
local-
level
North,
East,
Down
frame,
the
co-
vari-
ance
terms
fol-
low
with
that
con-
ven-
tion.
Thus,
co-
vari-
ances
are
re-

ported
against
the
"down-
ward"
mea-
sure-
ment
and
care
should
be
taken
with
the
sign
con-
ven-
tion.

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
-------------------	-----------------	------	------------	-------------

0	4	u32	timeToGPS	Time of Week
4	8	double	degLat	Latitude
12	8	double	degLon	Longitude
20	8	double	height	Height above WGS84 ellipsoid
28	4	float ²	covEstimNorth	Estimated variance of northing
32	4	float ²	covCovNorthEast	Covariance of northing and easting
36	4	float ²	covCovNorthDown	Covariance of northing and downward measurement
40	4	float ²	covEstimEast	Estimated variance of easting
44	4	float ²	covCovEastDown	Covariance of easting and downward measurement

Version 2.5.4, May 3, 2019

Reserved35

In-

er-

tial

Nav-

i-

ga-

tion

Mode

(Ta-

ble 6.5.19)23

Fix

mode

(Ta-

ble 6.5.18)30

Field

6.5.7:

Sta-

tus

flags

(flags)

Value	Description
0	Invalid
1	Single Point Position (SPP)
2	Differential GNSS (DGNSS)
3	Float RTK
4	Fixed RTK
5	Dead Reckoning
6	SBAS Position

Table 6.5.18:

Fix

mode

val-

ues

(flags[0:2])

Value	Description
0	None
1	INS used

Table 6.5.19:

In-

er-

tial

Nav-

i-

ga-

tion

Mode

val-

ues

(flags[3:4])

MSG_BASELINE_ECEF

0x020B

523

This
mes-
sage
re-
ports
the
base-
line
so-
lu-
tion
in
Earth
Cen-
tered
Earth
Fixed
(ECEF)
co-
or-
di-
nates.
This
base-
line
is
the
rel-
a-
tive
vec-
tor
dis-
tance

from
the
base
sta-
tion
to
the
rover
re-
ceiver.
The
full
GPS
time
is
given
by
the
pre-
ced-
ing
MSG_GPS_TIME
with
the
match-
ing
time-
of-
week
(tow).

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	4	u32ms	time_of_week	GPS Time of Week
4	4	s32mmx	baseline_x	Baseline ECEF X co-ordinate
8	4	s32mmy	baseline_y	Baseline ECEF Y co-ordinate
12	4	s32mmz	baseline_z	Baseline ECEF Z co-ordinate
16	2	u16mmacc	position_stddev	Position estimated standard deviation
18	1	u8	n_sats	Number of satellites used in solution
19	1	u8	status	Status flags
Version 2.5.4, May 3, 2019				94
20				Total Payload Length

Table 6.5.20:
MSG_BASELINE_ECEF
0x020B

Reserved53

Fix

mode

(Ta-

ble 6.5.21)30

Field

6.5.8:

Sta-

tus

flags

(**flags**)

Value	Description
0	Invalid
1	Reserved
2	Differential GNSS (DGNSS)
3	Float RTK
4	Fixed RTK
5	Reserved
6	Reserved

Table 6.5.21:

Fix

mode

val-

ues

(**flags**[0:2])

MSG_BASELINE_NED

0x020C

524

This
mes-
sage
re-
ports
the
base-
line
so-
lu-
tion
in
North
East
Down
(NED)
co-
or-
di-
nates.
This
base-
line
is
the
rel-
a-
tive
vec-
tor
dis-
tance
from
the

base
sta-
tion
to
the
rover
re-
ceiver,
and
NED
co-
or-
di-
nate
sys-
tem
is
de-
fined
at
the
lo-
cal
WGS84
tan-
gent
plane
cen-
tered
at
the
base
sta-
tion
po-
si-
tion.
The
full

GPS
time
is
given
by
the
pre-
ced-
ing
MSG_GPS_TIME
with
the
match-
ing
time-
of-
week
(tow).

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	4	u32	time_towGPS	Time of Week
4	4	s32	baseline_n	Baseline North co-ordinate
8	4	s32	baseline_e	Baseline East co-ordinate
12	4	s32	baseline_d	Baseline Down co-ordinate
16	2	u16	horiz_acc	Horizontal position estimated standard deviation
18	2	u16	vert_acc	Vertical position estimated standard deviation
20	1	u8	n_sats	Number of satellites used in

Reserved53

Fix

mode

(Ta-

ble 6.5.23)30

Field

6.5.9:

Sta-

tus

flags

(**flags**)

Value	Description
0	Invalid
1	Reserved
2	Differential GNSS (DGNSS)
3	Float RTK
4	Fixed RTK
5	Reserved
6	Reserved

Table 6.5.23:

Fix

mode

val-

ues

(**flags**[0:2])

MSG_VEL_ECEF

0x020D

525

This
mes-
sage
re-
ports
the
ve-
loc-
ity
in
Earth
Cen-
tered
Earth
Fixed
(ECEF)
co-
or-
di-
nates.
The
full
GPS
time
is
given
by
the
pre-
ced-
ing
MSG_GPS_TIME
with
the

match-
ing
time-
of-
week
(tow).

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	4	u32ms	time_of_week	GPS Time of Week
4	4	s32mm/s	velocity_x	Velocity ECEF X co-ordinate
8	4	s32mm/s	velocity_y	Velocity ECEF Y co-ordinate
12	4	s32mm/s	velocity_z	Velocity ECEF Z co-ordinate
16	2	u16mm/s	velocity_stddev	Velocity estimated standard deviation
18	1	u8	n_sats	Number of satellites used in solution
19	1	u8	status	Status flags
<hr/>				
Version 2.5.4, May 3, 2019				
20				Total Payload Length

Table 6.5.24:
MSG_VEL_ECEF
0x020D

Reserved35
INS
Nav-
i-
ga-
tion
Mode
(Ta-
ble 6.5.26)23
Ve-
loc-
ity
mode
(Ta-
ble 6.5.25)30

Field
6.5.10:
Sta-
tus
flags
(**flags**)

Value	Description
0	Invalid
1	Measured Doppler derived
2	Computed Doppler derived
3	Dead Reckoning

Table 6.5.25:
Ve-
loc-
ity
mode
val-
ues
(**flags**[0:2])

Value	Description
0	None
1	INS used

Table 6.5.26:
INS
Nav-
i-
ga-
tion
Mode
val-
ues
(**flags**[3:4])

MSG_VEL_ECEF_COV

0x0215

533

This
mes-
sage
re-
ports
the
ve-
loc-
ity
in
Earth
Cen-
tered
Earth
Fixed
(ECEF)
co-
or-
di-
nates.
The
full
GPS
time
is
given
by
the
pre-
ced-
ing
MSG_GPS_TIME
with
the

match-
ing
time-
of-
week
(tow).

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	4	u32ms	timeToGPS	Time of Week
4	4	s32mm/s	velocityECEF_X	Velocity ECEF X co-ordinate
8	4	s32mm/s	velocityECEF_Y	Velocity ECEF Y co-ordinate
12	4	s32mm/s	velocityECEF_Z	Velocity ECEF Z co-ordinate
16	4	float ² /s ²	estimatedCovariance_x	Estimated variance of x
20	4	float ² /s ²	estimatedCovariance_xy	Estimated co-variance of x and y
24	4	float ² /s ²	estimatedCovariance_xz	Estimated co-variance of x and z
28	4	float ² /s ²	estimatedCovariance_yz	Estimated co-variance of y and z
32	4	float ² /s ²	estimatedCovariance_zz	Estimated variance of z

Reserved35

INS

Nav-

i-

ga-

tion

Mode

(Ta-

ble 6.5.29)23

Ve-

loc-

ity

mode

(Ta-

ble 6.5.28)30

Field

6.5.11:

Sta-

tus

flags

(flags)

Value	Description
0	Invalid
1	Measured Doppler derived
2	Computed Doppler derived
3	Dead Reckoning

Table 6.5.28:

Ve-

loc-

ity

mode

val-

ues

(flags[0:2])

Value	Description
0	None
1	INS used

Table 6.5.29:

INS

Nav-

i-

ga-

tion

Mode

val-

ues

(flags[3:4])

MSG_VEL_NED

0x020E

526

This
mes-
sage
re-
ports
the
ve-
loc-
ity
in
lo-
cal
North
East
Down
(NED)
co-
or-
di-
nates.
The
NED
co-
or-
di-
nate
sys-
tem
is
de-
fined
as
the
lo-

cal
WGS84
tan-
gent
plane
cen-
tered
at
the
cur-
rent
po-
si-
tion.
The
full
GPS
time
is
given
by
the
pre-
ced-
ing
MSG_GPS_TIME
with
the
match-
ing
time-
of-
week
(tow).

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	4	u32ms	timeToGPS	Time of Week
4	4	s32mm/s	velocityNorth	Velocity North co-ordinate
8	4	s32mm/s	velocityEast	Velocity East co-ordinate
12	4	s32mm/s	velocityDown	Velocity Down co-ordinate
16	2	u16mm/s	horizontalVelocity	Horizontal velocity estimated standard deviation
18	2	u16mm/s	verticalVelocity	Vertical velocity estimated standard deviation
20	1	u8	n_sat	Number of satellites used in

Reserved35
INS
Nav-
i-
ga-
tion
Mode
(Ta-
ble 6.5.32)23
Ve-
loc-
ity
mode
(Ta-
ble 6.5.31)30

Field
6.5.12:
Sta-
tus
flags
(**flags**)

Value	Description
0	Invalid
1	Measured Doppler derived
2	Computed Doppler derived
3	Dead Reckoning

Table 6.5.31:
Ve-
loc-
ity
mode
val-
ues
(**flags**[0:2])

Value	Description
0	None
1	INS used

Table 6.5.32:
INS
Nav-
i-
ga-
tion
Mode
val-
ues
(**flags**[3:4])

MSG_VEL_NED_COV

0x0212

530

This
mes-
sage
re-
ports
the
ve-
loc-
ity
in
lo-
cal
North
East
Down
(NED)
co-
or-
di-
nates.
The
NED
co-
or-
di-
nate
sys-
tem
is
de-
fined
as
the
lo-

cal
WGS84
tan-
gent
plane
cen-
tered
at
the
cur-
rent
po-
si-
tion.
The
full
GPS
time
is
given
by
the
pre-
ced-
ing
MSG.GPS_TIME
with
the
match-
ing
time-
of-
week
(tow).
This
mes-
sage
is
sim-

i-
lar
to
the
MSG_VEL_NED,
but
it
in-
cludes
the
up-
per
tri-
an-
gu-
lar
por-
tion
of
the
3x3
co-
vari-
ance
ma-
trix.

Offset (bytes)	Size (bytes)	Unit	Name	Description
-------------------	-----------------	------	------	-------------

0	4	u32ms	timeToGPS	Time of Week
4	4	s32mm/s	velocityNorth	Velocity North co-ordinate
8	4	s32mm/s	velocityEast	Velocity East co-ordinate
12	4	s32mm/s	velocityDown	Velocity Down co-ordinate
16	4	float ²	covEstimNorthward	Estimated variance of northward measurement
20	4	float ²	covCovNorthwardEastward	Covariance of northward and eastward measurement
24	4	float ²	covCovNorthwardDownward	Covariance of northward and downward measurement
28	4	float ²	covEstimDownward	Estimated variance of downward measurement

Reserved35
INS
Nav-
i-
ga-
tion
Mode
(Ta-
ble 6.5.35)23
Ve-
loc-
ity
mode
(Ta-
ble 6.5.34)30

Field
6.5.13:
Sta-
tus
flags
(**flags**)

Value	Description
0	Invalid
1	Measured Doppler derived
2	Computed Doppler derived
3	Dead Reckoning

Table 6.5.34:
Ve-
loc-
ity
mode
val-
ues
(**flags**[0:2])

Value	Description
0	None
1	INS used

Table 6.5.35:
INS
Nav-
i-
ga-
tion
Mode
val-
ues
(**flags**[3:4])

MSG_VEL_BODY

0x0213

531

This
mes-
sage
re-
ports
the
ve-
loc-
ity
in
the
Ve-
hi-
cle
Body
Frame.
By
con-
ven-
tion,
the
x-
axis
should
point
out
the
nose
of
the
ve-
hi-
cle
and

rep-
re-
sent
the
for-
ward
di-
rec-
tion,
while
as
the
y-
axis
should
point
out
the
right
hand
side
of
the
ve-
hi-
cle.
Since
this
is
a
right
handed
sys-
tem,
z
should
point
out
the

bot-
tom
of
the
ve-
hi-
cle.
The
ori-
en-
ta-
tion
and
ori-
gin
of
the
Ve-
hi-
cle
Body
Frame
are
spec-
i-
fied
via
the
de-
vice
set-
tings.
The
full
GPS
time
is
given
by

the
pre-
ced-
ing
MSG_GPS_TIME
with
the
match-
ing
time-
of-
week
(tow).
This
mes-
sage
is
only
pro-
duced
by
in-
er-
tial
ver-
sions
of
Swift
prod-
ucts
and
is
not
avail-
able
from
Piksi
Multi
or

Duro.

Offset for field
(bytes)

Size (bytes)	Unit	Description
0 4	u32ms tow	GPS Time of Week
4 4	s32mm/s	Velocity in x direction
8 4	s32mm/s	Velocity in y direction
12 4	s32mm/s	Velocity in z direction
16 4	float ^{^2} cov	Estimated variance of x
20 4	float ^{^2} cov	Covariance of x and y
24 4	float ^{^2} cov	Covariance of x and z
28 4	float ^{^2} cov	Estimated variance of y
32 4	float ^{^2} cov	Covariance of y and z
36 4	float ^{^2} cov	Estimated variance of z
40 1	u8	n_sats

Reserved35
INS
Nav-
i-
ga-
tion
Mode
(Ta-
ble 6.5.38)23
Ve-
loc-
ity
mode
(Ta-
ble 6.5.37)30

Field
6.5.14:
Sta-
tus
flags
(**flags**)

Value	Description
0	Invalid
1	Measured Doppler derived
2	Computed Doppler derived
3	Dead Reckoning

Table 6.5.37:
Ve-
loc-
ity
mode
val-
ues
(**flags**[0:2])

Value	Description
0	None
1	INS used

Table 6.5.38:
INS
Nav-
i-
ga-
tion
Mode
val-
ues
(**flags**[3:4])

MSG_AGE_CORRECTIONS

0x0210

528

This
mes-
sage
re-
ports
the
Age
of
the
cor-
rec-
tions
used
for
the
cur-
rent
Dif-
fer-
en-
tial
so-
lu-
tion

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	4	u32	ms towGPS	Time of Week
4	2	u16	decAge	Age of the cor- rec- tions (0xFFFF in- di- cates in- valid)
6				Total Pay- load Length

Table 6.5.39:
MSG_AGE_CORRECTIONS
0x0210
mes-
sage
struc-
ture

6.6 Observation

Satellite
ob-
ser-
va-
tion
mes-
sages
from
the
de-
vice.

MSG_OBS

—
0x004A
—

74

The
GPS
ob-
ser-
va-
tions
mes-
sage
re-
ports
all
the
raw
pseu-
do-
r-
ange
and
car-
rier
phase
ob-

ser-
va-
tions
for
the
satel-
lites
be-
ing
tracked
by
the
de-
vice.
Car-
rier
phase
ob-
ser-
va-
tion
here
is
rep-
re-
sented
as
a
40-
bit
fixed
point
num-
ber
with
Q32.8
lay-
out
(i.e.

32-
bits
of
whole
cy-
cles
and
8-
bits
of
frac-
tional
cy-
cles).
The
ob-
ser-
va-
tions
are
be
in-
ter-
op-
er-
a-
ble
with
3rd
party
re-
ceivers
and
con-
form
with
typ-
i-
cal

RTCMv3
GNSS
ob-
ser-
va-
tions.

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	4	u32	header_ticks	Number of milliseconds since start of GPS week
4	4	s32	header_residual	Residual of millisecond-rounded TOW (ranges from -500000 to 500000)
8	2	u16	header_gps_t.wn	GPS week number
10	1	u8	header_obs	Number of observations. First nibble is the size of the sequence (n), second nibble is the zero-indexed counter (ith packet of n)

RAIM

ex-

clu-

sion

(Ta-

ble 6.6.6)17

Re-

served34

Doppler

valid

(Ta-

ble 6.6.5)13

Half-

cycle

am-

bi-

gu-

ity

(Ta-

ble 6.6.4)12

Car-

rier

phase

valid

(Ta-

ble 6.6.3)11

Pseu-

do-

r-

ange

valid

(Ta-

ble 6.6.2)10

Field

6.6.1:

Mea-

sure-

ment

sta-

tus

flags.

A

bit

field

of

flags

pro-

Version 2.5.4, May 3, 2019

vid-

ing

the

sta-

tus

of

this

ob-

ser-

va-

(Table 6.6.7)80

Field

6.6.2:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(sid.code)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 6.6.7:

val-

ues

(sid.code[0:7])

MSG_BASE_POS_LLH

0x0044

68

The
base
sta-
tion
po-
si-
tion
mes-
sage
is
the
po-
si-
tion
re-
ported
by
the
base
sta-
tion
it-
self.
It
is
used
for
pseudo-
absolute
RTK
po-
si-
tion-
ing,

and
is
re-
quired
to
be
a
high-
accuracy
sur-
veyed
lo-
ca-
tion
of
the
base
sta-
tion.
Any
er-
ror
here
will
re-
sult
in
an
er-
ror
in
the
pseudo-
absolute
po-
si-
tion
out-
put.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	8	double	lat	Latitude
8	8	double	lon	Longitude
16	8	double	height	Height
24				Total Pay- load Length

Table 6.6.8:
MSG_BASE_POS_LLH
0x0044
mes-
sage
struc-
ture

MSG_BASE_POS_ECEF

0x0048

72

The
base
sta-
tion
po-
si-
tion
mes-
sage
is
the
po-
si-
tion
re-
ported
by
the
base
sta-
tion
it-
self
in
ab-
so-
lute
Earth
Cen-
tered
Earth
Fixed
co-
or-

di-
nates.
It
is
used
for
pseudo-
absolute
RTK
po-
si-
tion-
ing,
and
is
re-
quired
to
be
a
high-
accuracy
sur-
veyed
lo-
ca-
tion
of
the
base
sta-
tion.
Any
er-
ror
here
will
re-
sult

in
an
er-
ror
in
the
pseudo-
absolute
po-
si-
tion
out-
put.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	8	double	u hlex	ECEF X cood- i- nate
8	8	double	u hley	ECEF Y co- or- di- nate
16	8	double	u hleZ	ECEF Z co- or- di- nate
24				Total Pay- load Length

Table 6.6.9:
MSG_BASE_POS_ECEF
0x0048
mes-
sage
struc-
ture

MSG_EPHEMERIS_GPS_DEP_E

0x0081

129

The
ephemeris
mes-
sage
re-
turns
a
set
of
satel-
lite
or-
bit
pa-
ram-
e-
ters
that
is
used
to
cal-
cu-
late
GPS
satel-
lite
po-
si-
tion,
ve-
loc-
ity,
and

clock
off-
set.
Please
see
the
Navs-
tar
GPS
Space
Seg-
ment/Navigation
user
in-
ter-
faces
(ICD-
GPS-
200,
Ta-
ble
20-
III)
for
more
de-
tails.

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	2	u16	constellation	Constellation-specific satellite identifier. Note: unlike GnssSignal, GPS satellites are encoded as (PRN - 1). Other constellations do not have this offset.
2	1	u8	signal.id.code	Signal constellation, band and code
3	1	u8	reserved	Reserved
4	4	u32	milliseconds since start	Milliseconds since start
8	2	u16	GPS week number	GPS week number
10	8	double	user range	User range

(Table 6.6.11)80

Field

6.6.3:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(`common.sid.code`)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P

Table 6.6.11:

val-

ues

(`common.sid.code[0:7]`)

MSG_EPHEMERIS_GPS_DEP_F

0x0086

134

This
ob-
ser-
va-
tion
mes-
sage
has
been
dep-
re-
cated
in
fa-
vor
of
ephemeris
mes-
sage
us-
ing
floats
for
size
re-
duc-
tion.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	1	u8	constellation	Constellation-specific satellite identifier. This field for Glonass can either be (100+FCN) where FCN is in [-7,+6] or the Slot ID in [1,28]
1	1	u8	signal.id.code	Signal constellation, band and code
2	4	u32	seconds.tow	Seconds since start of GPS week
6	2	u16	seconds.toe.wn	GPS week number
<hr/>				
8	8	double	user.range	Range Accuracy
16	4	u32	corvfit.interval	Corvfit interval

(Table 6.6.13)80

Field

6.6.4:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(common.sid.code)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 6.6.13:

val-

ues

(common.sid.code[0:7])

MSG_EPHEMERIS_GPS

0x008A

138

The
ephemeris
mes-
sage
re-
turns
a
set
of
satel-
lite
or-
bit
pa-
ram-
e-
ters
that
is
used
to
cal-
cu-
late
GPS
satel-
lite
po-
si-
tion,
ve-
loc-
ity,
and

clock
off-
set.
Please
see
the
Navs-
tar
GPS
Space
Seg-
ment/Navigation
user
in-
ter-
faces
(ICD-
GPS-
200,
Ta-
ble
20-
III)
for
more
de-
tails.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	1	u8	constellation	Constellation-specific satellite identifier. This field for Glonass can either be (100+FCN) where FCN is in [-7,+6] or the Slot ID in [1,28]
1	1	u8	signal.id.code	Signal constellation, band and code
2	4	u32	seconds.tow	Seconds since start of GPS week
6	2	u16	seconds.toe.wn	GPS week number
<hr/>				
Version 2.5.4, May 3, 2019				
8	4	float	user.range	Range Accuracy
12	4	u32	convfit.interval	Convfit interval

(Table 6.6.15)80

Field

6.6.5:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(`common.sid.code`)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 6.6.15:

val-

ues

(`common.sid.code[0:7]`)

MSG_EPHEMERIS_BDS

0x0089

137

The
ephemeris
mes-
sage
re-
turns
a
set
of
satel-
lite
or-
bit
pa-
ram-
e-
ters
that
is
used
to
cal-
cu-
late
BDS
satel-
lite
po-
si-
tion,
ve-
loc-
ity,
and

clock
off-
set.
Please
see
the
Bei-
Dou
Nav-
i-
ga-
tion
Satel-
lite
Sys-
tem
SIS-
ICD
Ver-
sion
2.1,
Ta-
ble
5-
9
for
more
de-
tails.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	1	u8	constellation	Constellation-specific satellite identifier. This field for Glonass can either be (100+FCN) where FCN is in [-7,+6] or the Slot ID in [1,28]
1	1	u8	signal.id.code	Signal constellation, band and code
2	4	u32	seconds.tow	Seconds since start of GPS week
6	2	u16	seconds.toe.wn	GPS week number
<hr/>				
Version 2.5.4, May 3, 2019				
8	4	float	user.range	Range Accuracy
12	4	u32	convfit.interval	Convfit interval

(Table 6.6.17)80

Field

6.6.6:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(common.sid.code)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 6.6.17:

val-

ues

(common.sid.code[0:7])

MSG_EPHEMERIS.GAL

0x0095

149

The
ephemeris
mes-
sage
re-
turns
a
set
of
satel-
lite
or-
bit
pa-
ram-
e-
ters
that
is
used
to
cal-
cu-
late
Galileo
satel-
lite
po-
si-
tion,
ve-
loc-
ity,
and

clock
off-
set.
Please
see
the
Sig-
nal
In
Space
ICD
OS
SIS
ICD,
Is-
sue
1.3,
De-
cem-
ber
2016
for
more
de-
tails.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	1	u8	constellation	Constellation-specific satellite identifier. This field for Glonass can either be (100+FCN) where FCN is in [-7,+6] or the Slot ID in [1,28]
1	1	u8	signal.id.code	Signal constellation, band and code
2	4	u32	seconds.tow	Seconds since start of GPS week
6	2	u16	seconds.toe.wn	GPS week number
<hr/>				
Version 2.5.4, May 3, 2019				
8	4	float	user.range	Range Accuracy
12	4	u32	convfit.interval	Convfit interval

(Table 6.6.19)80

Field

6.6.7:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(common.sid.code)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 6.6.19:

val-

ues

(common.sid.code[0:7])

MSG_EPHEMERIS_SBAS_DEP_A

0x0082

130

Offset	Size	Unit	Name	Description
(bytes)	(bytes)			
0	2	u16	constellation	Constellation-specific satellite identifier. Note: unlike GnssSignal, GPS satellites are encoded as (PRN - 1). Other constellations do not have this offset.
2	1	u8	signal.code	Signal constellation
<hr/>				
Version 2.5.4, May 3, 2019				
				161
3	1	u8	reserved	Reserved
4	4	u32ns	time.to.now	Time to now since start of

(Table 6.6.21)80

Field

6.6.8:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(`common.sid.code`)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P

Table 6.6.21:

val-

ues

(`common.sid.code[0:7]`)

MSG_EPHEMERIS_GLO_DEP_A

0x0083

131

The
ephemeris
mes-
sage
re-
turns
a
set
of
satel-
lite
or-
bit
pa-
ram-
e-
ters
that
is
used
to
cal-
cu-
late
GLO
satel-
lite
po-
si-
tion,
ve-
loc-
ity,
and

clock
off-
set.
Please
see
the
GLO
ICD
5.1
"Ta-
ble
4.5
Char-
ac-
ter-
is-
tics
of
words
of
im-
me-
di-
ate
in-
for-
ma-
tion
(ephemeris
pa-
ram-
e-
ters)"
for
more
de-
tails.

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	2	u16	constellation	Constellation-specific satellite identifier. Note: unlike GnssSignal, GPS satellites are encoded as (PRN - 1). Other constellations do not have this offset.
2	1	u8	signal.id.code	Signal constellation, band and code
3	1	u8	reserved	Reserved
4	4	u32	milliseconds since start	Milliseconds since start
8	2	u16	GPS week number	GPS week number
10	8	double	user range	User range

(Table 6.6.23)80

Field

6.6.9:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(`common.sid.code`)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P

Table 6.6.23:

val-

ues

(`common.sid.code[0:7]`)

MSG_EPHEMERIS_SBAS_DEP_B

0x0084

132

This
ob-
ser-
va-
tion
mes-
sage
has
been
dep-
re-
cated
in
fa-
vor
of
ephemeris
mes-
sage
us-
ing
floats
for
size
re-
duc-
tion.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	1	u8	constellation	Constellation-specific satellite identifier. This field for Glonass can either be (100+FCN) where FCN is in [-7,+6] or the Slot ID in [1,28]
1	1	u8	signal.id.code	Signal constellation, band and code
2	4	u32	seconds.tow	Seconds since start of GPS week
6	2	u16	seconds.toe.wn	GPS week number
<hr/>				
8	8	double	user.range	Range Accuracy
16	4	u32	corvfit.interval	Corvfit interval

(Table 6.6.25)80

Field

6.6.10:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(common.sid.code)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 6.6.25:

val-

ues

(common.sid.code[0:7])

MSG_EPHEMERIS_SBAS

0x008C

140

Offset	Size	Unit	Name	Description
(bytes)	(bytes)			
0	1	u8	const id.sat	Constellation-specific satellite identifier. This field for Glonass can either be (100+FCN) where FCN is in [-7,+6] or the Slot ID in [1,28]
1	1	u8	const id.code	Signal constellation, band and code
2	4	n32	const tow	Since start of GPS week
6	2	u16	const toe.wn	GPS toe week number

(Table 6.6.27)80

Field

6.6.11:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(`common.sid.code`)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 6.6.27:

val-

ues

(`common.sid.code[0:7]`)

MSG_EPHEMERIS_GLO_DEP_B

0x0085

133

The
ephemeris
mes-
sage
re-
turns
a
set
of
satel-
lite
or-
bit
pa-
ram-
e-
ters
that
is
used
to
cal-
cu-
late
GLO
satel-
lite
po-
si-
tion,
ve-
loc-
ity,
and

clock
off-
set.
Please
see
the
GLO
ICD
5.1
"Ta-
ble
4.5
Char-
ac-
ter-
is-
tics
of
words
of
im-
me-
di-
ate
in-
for-
ma-
tion
(ephemeris
pa-
ram-
e-
ters)"
for
more
de-
tails.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	1	u8	constellation	Constellation-specific satellite identifier. This field for Glonass can either be (100+FCN) where FCN is in [-7,+6] or the Slot ID in [1,28]
1	1	u8	signal.id.code	Signal constellation, band and code
2	4	u32	seconds.tow	Seconds since start of GPS week
6	2	u16	seconds.toe.wn	GPS week number
<hr/>				
8	8	double	user.range	Range Accuracy
16	4	u32	corvfit.interval	Corvfit interval

(Table 6.6.29)80

Field

6.6.12:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(`common.sid.code`)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 6.6.29:

val-

ues

(`common.sid.code[0:7]`)

MSG_EPHEMERIS_GLO_DEP_C

0x0087

135

The
ephemeris
mes-
sage
re-
turns
a
set
of
satel-
lite
or-
bit
pa-
ram-
e-
ters
that
is
used
to
cal-
cu-
late
GLO
satel-
lite
po-
si-
tion,
ve-
loc-
ity,
and

clock
off-
set.
Please
see
the
GLO
ICD
5.1
"Ta-
ble
4.5
Char-
ac-
ter-
is-
tics
of
words
of
im-
me-
di-
ate
in-
for-
ma-
tion
(ephemeris
pa-
ram-
e-
ters)"
for
more
de-
tails.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	1	u8	constellation	Constellation-specific satellite identifier. This field for Glonass can either be (100+FCN) where FCN is in [-7,+6] or the Slot ID in [1,28]
1	1	u8	signal.id.code	Signal constellation, band and code
2	4	u32	seconds.tow	Seconds since start of GPS week
6	2	u16	seconds.toe.wn	GPS week number
8	8	double	user.range.accuracy	Range Accuracy
16	4	u32	corvfit.interval	Corvfit interval

(Table 6.6.31)80

Field

6.6.13:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(common.sid.code)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 6.6.31:

val-

ues

(common.sid.code[0:7])

MSG_EPHEMERIS_GLO_DEP_D

0x0088

136

This
ob-
ser-
va-
tion
mes-
sage
has
been
dep-
re-
cated
in
fa-
vor
of
ephemeris
mes-
sage
us-
ing
floats
for
size
re-
duc-
tion.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	1	u8	constellation	Constellation-specific satellite identifier. This field for Glonass can either be (100+FCN) where FCN is in [-7,+6] or the Slot ID in [1,28]
1	1	u8	signal.id.code	Signal constellation, band and code
2	4	u32	seconds.tow	Seconds since start of GPS week
6	2	u16	seconds.toe.wn	GPS week number
<hr/>				
8	8	double	user.range	Range Accuracy
16	4	u32	corvfit.interval	Corvfit interval

(Table 6.6.33)80

Field

6.6.14:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(`common.sid.code`)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 6.6.33:

val-

ues

(`common.sid.code[0:7]`)

MSG_EPHEMERIS_GLO

0x008B

139

The
ephemeris
mes-
sage
re-
turns
a
set
of
satel-
lite
or-
bit
pa-
ram-
e-
ters
that
is
used
to
cal-
cu-
late
GLO
satel-
lite
po-
si-
tion,
ve-
loc-
ity,
and

clock
off-
set.
Please
see
the
GLO
ICD
5.1
"Ta-
ble
4.5
Char-
ac-
ter-
is-
tics
of
words
of
im-
me-
di-
ate
in-
for-
ma-
tion
(ephemeris
pa-
ram-
e-
ters)"
for
more
de-
tails.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	1	u8	constellation	Constellation-specific satellite identifier. This field for Glonass can either be (100+FCN) where FCN is in [-7,+6] or the Slot ID in [1,28]
1	1	u8	signal.id.code	Signal constellation, band and code
2	4	u32	seconds.tow	Seconds since start of GPS week
6	2	u16	seconds.toe.wn	GPS week number
<hr/>				
Version 2.5.4, May 3, 2019				
8	4	float	user.range	Range Accuracy
12	4	u32	convfit.interval	Convfit interval

(Table 6.6.35)80

Field

6.6.15:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(common.sid.code)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 6.6.35:

val-

ues

(common.sid.code[0:7])

MSG_IONO

0x0090

144

The
iono-
spheric
pa-
ram-
e-
ters
which
al-
low
the
"L1
only"
or
"L2
only"
user
to
uti-
lize
the
iono-
spheric
model
for
com-
pu-
ta-
tion
of
the
iono-
spheric
de-

lay.
Please
see
ICD-
GPS-
200
(Chap-
ter
20.3.3.5.1.7)
for
more
de-
tails.

Offset (bytes)	Size (bytes)	Field Name	Description
0	4	u32	t_{now} seconds since start of GPS week
4	2	u16	GPS week number
6	8	double	a_0
14	8	double	$\frac{1}{k_1} \cdot \text{circle}$
22	8	double	$\frac{1}{k_2} \cdot (\text{circle})^2$
30	8	double	$\frac{1}{k_3} \cdot (\text{circle})^3$
38	8	double	b_0
46	8	double	$\frac{1}{k_1} \cdot \text{circle}$
54	8	double	$\frac{1}{k_2} \cdot (\text{circle})^2$
62	8	double	$\frac{1}{k_3} \cdot (\text{circle})^3$
70			Total Payload Length

Table 6.6.36:
MSG_IONO
0x0090
mes-
sage
struc-
ture

MSG_SV_CONFIGURATION_GPS_DEP

0x0091

145

Please

see

ICD-

GPS-

200

(Chap-

ter

20.3.3.5.1.4)

for

more

de-

tails.

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	4	u32	t_nsec seconds	since start of GPS week
4	2	u16	week_n GPS week number	GPS week num- ber
6	4	u32	12clk_mask	mask ca- pa- bil- ity mask, SV32 bit be- ing MSB, SV1 bit be- ing LSB
10				Total Pay- load Length

Table 6.6.37:
MSG_SV_CONFIGURATION_GPS_DEP
0x0091
mes-
sage
struc-
ture

MSG_GNSS_CAPB**0x0096****150**

Offset	Size	Unit	Field Name	Description
(bytes)	(bytes)			

0	4	u32	time since start of GPS week	time since start of GPS week
4	2	u16	GPS week number	GPS week number
6	8	u64	gc.gpsActiveSV mask	GPS Active SV active mask
14	8	u64	gc.gpsL2CActive mask	GPS L2C active mask
22	8	u64	gc.gpsL5Active mask	GPS L5 active mask
30	4	u32	gc.gloActive mask	GLONASS active mask
34	4	u32	gc.gloL2OF mask	GLONASS L2OF active mask
38	4	u32	gc.gloL3Active mask	GLONASS L3 active mask

Version 2.5.4, May 3, 2019

194

MSG_GROUP_DELAY_DEP_A

0x0092

146

Please

see

ICD-

GPS-

200

(30.3.3.3.1.1)

for

more

de-

tails.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	4	u32	time	Time in milliseconds since start of GPS week
4	2	u16	week	GPS week number
6	1	u8	prn	Satellite number
7	1	u8	valid	bit-field indicating validity of the values, LSB indicating validity of the values, etc. 1 = value is valid, 0 = value is not valid.
8	2	s16s	tgd	2^{-35}
10	2	s16s	isc_l1ca	2^{-25}

MSG_GROUP_DELAY_DEP_B

0x0093

147

Please

see

ICD-

GPS-

200

(30.3.3.3.1.1)

for

more

de-

tails.

Offset	Size	Unit	Field Name	Description
(bytes)	(bytes)			
0	4	u32	time t_ofset	seconds since start of GPS week
4	2	u16	week week_of_gps	GPS week number
6	2	u16	sid sid	satellite constellation-specific identifier. Note: unlike GnssSignal, GPS satellites are encoded as (PRN - 1). Other constellations do not have this offset.
8	1	u8	sid sid	Signal constellation, band and code
9	1	u8	sid sid	Reserved
10	1	u8	val val	bit-field

(Table 6.6.41)80

Field

6.6.16:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(sid.code)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P

Table 6.6.41:

val-

ues

(sid.code[0:7])

MSG_GROUP_DELAY

0x0094

148

Please

see

ICD-

GPS-

200

(30.3.3.3.1.1)

for

more

de-

tails.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	4	u32	t_of seconds	seconds since start of GPS week
4	2	u16	week_of_gps	GPS week number
6	1	u8	sid sat	satellite constellation-specific identifier. This field for Glonass can either be (100+FCN) where FCN is in [-7,+6] or the Slot ID in [1,28]
7	1	u8	sid signal	signal constellation, band and

8 1 u8 ~~val~~ ~~bit~~
field indicating validity

(Table 6.6.43)80

Field

6.6.17:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(sid.code)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 6.6.43:

val-

ues

(sid.code[0:7])

MSG_ALMANAC_GPS

0x0072

114

The
al-
manac
mes-
sage
re-
turns
a
set
of
satel-
lite
or-
bit
pa-
ram-
e-
ters.
Al-
manac
data
is
not
very
pre-
cise
and
is
con-
sid-
ered
valid
for
up

to
sev-
eral
months.
Please
see
the
Navs-
tar
GPS
Space
Seg-
ment/Navigation
user
in-
ter-
faces
(ICD-
GPS-
200,
Chap-
ter
20.3.3.5.1.2
Al-
manac
Data)
for
more
de-
tails.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	1	u8	constellation	Constellation-specific satellite identifier. This field for Glonass can either be (100+FCN) where FCN is in [-7,+6] or the Slot ID in [1,28]
1	1	u8	signal.id.code	Signal constellation, band and code
2	4	u32	seconds.toa	Seconds since start of GPS week
6	2	u16	seconds.toa.weeknum	GPS toa week number
8	8	double	user.range.accuracy	User Range Accuracy
16	4	u32	corvfit.interval	Corvfit interval

(Table 6.6.45)80

Field

6.6.18:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(common.sid.code)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 6.6.45:

val-

ues

(common.sid.code[0:7])

MSG_ALMANAC_GLO

0x0073

115

The
al-
manac
mes-
sage
re-
turns
a
set
of
satel-
lite
or-
bit
pa-
ram-
e-
ters.
Al-
manac
data
is
not
very
pre-
cise
and
is
con-
sid-
ered
valid
for
up

to
sev-
eral
months.
Please
see
the
GLO
ICD
5.1
”Chap-
ter
4.5
Non-
immediate
in-
for-
ma-
tion
and
al-
manac”
for
de-
tails.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	1	u8	constellation	Constellation-specific satellite identifier. This field for Glonass can either be (100+FCN) where FCN is in [-7,+6] or the Slot ID in [1,28]
1	1	u8	signal.id.code	Signal constellation, band and code
2	4	u32	seconds.toa	Seconds since start of GPS week
6	2	u16	seconds.toa.weeknum	GPS toa week number
8	8	double	user.range.accuracy	User Range Accuracy
16	4	u32	corvfit.interval	Corvfit interval

(Table 6.6.47)80

Field

6.6.19:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(`common.sid.code`)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 6.6.47:

val-

ues

(`common.sid.code[0:7]`)

MSG_GLO_BIASES

0x0075

117

The
GLONASS
L1/L2
Code-
Phase
bi-
ases
al-
lows
to
per-
form
GPS+GLONASS
in-
te-
ger
am-
bi-
gu-
ity
res-
o-
lu-
tion
for
base-
lines
with
mixed
re-
ceiver
types
(e.g.
re-

ceiver
of
dif-
fer-
ent
man-
u-
fac-
tur-
ers)

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	1	u8	mask	GLONASS FDMA sig- nals mask
1	2	s16m	11c	GLONASS L1 C/A Code- Phase Bias
		*	0.02	
3	2	s16m	11p	GLONASS L1 P Code- Phase Bias
		*	0.02	
5	2	s16m	12c	GLONASS L2 C/A Code- Phase Bias
		*	0.02	
7	2	s16m	12p	GLONASS L2 P Code- Phase Bias
		*	0.02	
9				Total Pay- load Length

Table 6.6.48:
MSG_GLO_BIASES
0x0075
mes-
sage
struc-
ture

MSG_SV_AZ_EL

0x0097

151

Azimuth
and
el-
e-
va-
tion
an-
gles
of
all
the
vis-
i-
ble
satel-
lites
that
the
de-
vice
does
have
ephemeris
or
al-
manac
for.

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
4N+0	u8	az	MSG_SV_AZ_EL	specific satel- lite iden- ti- fier. This field for Glonass can ei- ther be (100+FCN) where FCN is in [- 7,+6] or the Slot ID in [1,28]
4N+1	u8	az	MSG_SV_AZ_EL	Signal con- stel- la- tion, band and code
4N+2	u8	deg	MSG_SV_AZ_EL	an- gle (range 0..179)
4N+3	s8	deg	MSG_SV_AZ_EL	an- gle (range 90..90)
4N				Total Pay- load Length

Table 6.6.49:
MSG_SV_AZ_EL

(Table 6.6.50)80

Field
6.6.20:
Sig-
nal
con-
stel-
la-
tion,
band
and
code
(`sid.code`)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 6.6.50:
val-
ues
(`sid.code[0:7]`)

MSG_OSR

0x0640

1600

The
OSR
mes-
sage
con-
tains
net-
work
cor-
rec-
tions
in
an
observation-
like
for-
mat

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	4	u32	header_ticks	Number of milliseconds since start of GPS week
4	4	s32	header_residual	Nanoseconds residual of millisecond-rounded TOW (ranges from -500000 to 500000)
8	2	u16	header_gps_t.wn	GPS week number
10	1	u8	header_n_obs	Number of observations. First nibble is the size of the sequence (n), second nibble is the zero-indexed counter (ith packet of n)

Full
fix-
ing
flag
(Ta-
ble 6.6.54)12
Par-
tial
fix-
ing
flag
(Ta-
ble 6.6.53)11
Cor-
rec-
tion
va-
lid-
ity
(Ta-
ble 6.6.52)10

Field
6.6.21:
Cor-
rec-
tion
flags.
(**flags**)

Value	Description
0	Do not use signal
1	Valid signal

Table 6.6.52:
Cor-
rec-
tion
va-
lid-
ity
val-
ues
(**flags**[0])

Value	Description
0	Partial fixing unavailable
1	Partial fixing available

Table 6.6.53:

Par-
tial
fix-
ing
flag
val-
ues

(Table 6.6.55)80

Field
6.6.22:
Sig-
nal
con-
stel-
la-
tion,
band
and
code
(`sid.code`)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 6.6.55:
val-
ues
(`sid.code[0:7]`)

6.7 Settings

Messages
for
read-
ing,
writ-
ing,
and
dis-
cov-
er-
ing
de-
vice
set-
tings.
Set-
tings
with
a
"string"
field
have
mul-
ti-
ple
val-
ues
in
this
field
de-
lim-
ited
with
a
null
char-
ac-

ter
(the
c
style
null
ter-
mi-
na-
tor).
For
in-
stance,
when
query-
ing
the
'firmware_version'
set-
ting
in
the
'sys-
tem_info'
sec-
tion,
the
fol-
low-
ing
ar-
ray
of
char-
ac-
ters
needs
to
be
sent

for
the
string
field
in
MSG_SETTINGS_READ:
"sys-
tem_info\0firmware_version\0",
where
the
de-
lim-
it-
ing
null
char-
ac-
ters
are
spec-
i-
fied
with
the
es-
cape
se-
quence
'\0'
and
all
quo-
ta-
tion
marks
should
be
omit-
ted.

In
the
mes-
sage
de-
scrip-
tions
be-
low,
the
generic
strings
SEC-
TION_SETTING
and
SET-
TING
are
used
to
re-
fer
to
the
two
strings
that
com-
prise
the
iden-
ti-
fier
of
an
in-
di-
vid-
ual

set-
ting.In
firmware_version
ex-
am-
ple
above,
SEC-
TION_SETTING
is
the
'sys-
tem_info',
and
the
SET-
TING
por-
tion
is
'firmware_version'.

See
the
"Soft-
ware
Set-
tings
Man-
ual"
on
sup-
port.swiftnav.com
for
de-
tailed
doc-
u-
men-
ta-

tion
about
all
set-
tings
and
sec-
tions
avail-
able
for
each
Swift
firmware
ver-
sion.
Set-
tings
man-
u-
als
are
avail-
able
for
each
firmware
ver-
sion
at
the
fol-
low-
ing
link:
[Piksi](#)
[Multi](#)
[Spec-](#)
[i-](#)

fi-
ca-
tions.

The
lat-
est
set-
tings
doc-
u-
ment
is

also
avail-
able
at
the
fol-
low-
ing
link:

Lat-
est
set-
tings
doc-
u-
ment

.
See
lastly
set-
tings.py

,
the
open
source
python
com-

mand
line
util-
ity
for
read-
ing,
writ-
ing,
and
sav-
ing
set-
tings
in
the
piksi_tools
repos-
i-
tory
on
github
as
a
help-
ful
ref-
er-
ence
and
ex-
am-
ple.

MSG_SETTINGS_SAVE

0x00A1

161

The
save
set-
tings
mes-
sage
per-
sists
the
de-
vice's
cur-
rent
set-
tings
con-
fig-
u-
ra-
tion
to
its
on-
board
flash
mem-
ory
file
sys-
tem.

Offset (bytes)	Size (bytes)	Unit (bits)	Name	Description
0			Total Pay- load Length	

Table 6.7.1:
MSG_SETTINGS_SAVE
0x00A1
mes-
sage
struc-
ture

MSG_SETTINGS_WRITE

0x00A0

160

The
set-
ting
mes-
sage
writes
the
de-
vice
con-
fig-
u-
ra-
tion
for
a
par-
tic-
u-
lar
set-
ting
via
A
NULL-
terminated
and
NULL-
delimited
string
with
con-
tents
”SEC-

TION_SETTING\0SETTING\0VALUE\0”

where

the

’\0’

es-

cape

se-

quence

de-

notes

the

NULL

char-

ac-

ter

and

where

quo-

ta-

tion

marks

are

omit-

ted.

A

de-

vice

will

only

pro-

cess

to

this

mes-

sage

when

it

is

re-

ceived
from
sender
ID
0x42.
An
ex-
am-
ple
string
that
could
be
sent
to
a
de-
vice
is
"so-
lu-
tion\0soln_freq\010\0".

Offset	Size (bytes)	Field Name	Description
0	N	string setting	A NULL-terminated and NULL-delimited string with contents "SECTION_SETTING\0SETTING\0VALUE\0"
	N		Total Payload Length

Table 6.7.2:
MSG_SETTINGS_WRITE
0x00A0
mes-
sage
struc-
ture

MSG_SETTINGS_WRITE_RESP

0x00AF

175

Return the status of a write request with the new value of the setting. If the requested value is rejected, the current value will be returned. The

string
field
is
a
NULL-
terminated
and
NULL-
delimited
string
with
con-
tents
"SEC-
TION_SETTING\0SETTING\0VALUE\0"
where
the
'\0'
es-
cape
se-
quence
de-
notes
the
NULL
char-
ac-
ter
and
where
quo-
ta-
tion
marks
are
omit-
ted.
An

ex-
am-
ple
string
that
could
be
sent
from
de-
vice
is
"so-
lu-
tion\0soln_freq\010\0".

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	1	u8	status	Write sta- tus
1	N	string	setting	String NULL- terminated and de- lim- ited string with con- tents "SEC- TION_SETTING\0SETTING\0VALUE\0"
N+ 1				Total Pay- load Length

Table 6.7.3:
MSG_SETTINGS_WRITE_RESP
0x00AF
mes-
sage
struc-
ture

Write
sta-
tus
(Ta-
ble 6.7.4)20

Field
6.7.1:
Write
sta-
tus
(status)

Value	Description
0	Accepted; value updated
1	Rejected; value unparsable or out-of-range
2	Rejected; requested setting does not exist
3	Rejected; setting name could not be parsed
4	Rejected; setting is read only
5	Rejected; modification is temporarily disabled
6	Rejected; unspecified error

Table 6.7.4:
Write
sta-
tus
val-
ues
(status[0:1])

MSG_SETTINGS_READ_REQ

0x00A4

164

The
set-
ting
mes-
sage
that
reads
the
de-
vice
con-
fig-
u-
ra-
tion.
The
string
field
is
a
NULL-
terminated
and
NULL-
delimited
string
with
con-
tents
"SEC-
TION_SETTING\0SETTING\0"
where
the
'\0'

es-
cape
se-
quence
de-
notes
the
NULL
char-
ac-
ter
and
where
quo-
ta-
tion
marks
are
omit-
ted.
An
ex-
am-
ple
string
that
could
be
sent
to
a
de-
vice
is
"so-
lu-
tion\0soln_freq\0".
A
de-

vice
will
only
re-
spond
to
this
mes-
sage
when
it
is
re-
ceived
from
sender
ID
0x42.
A
de-
vice
should
re-
spond
with
a
MSG_SETTINGS_READ_RESP
mes-
sage
(msg_id
0x00A5).

Offset	Size (bytes)	Field Name	Description
0	N	string setting	NULL-terminated and NULL-delimited string with contents "SECTION_SETTING\0SETTING\0"
	N		Total Payload Length

Table 6.7.5:
MSG_SETTINGS_READ_REQ
0x00A4
mes-
sage
struc-
ture

MSG_SETTINGS_READ_RESP

0x00A5

165

The
set-
ting
mes-
sage
with
which
the
de-
vice
re-
sponds
af-
ter
a

MSG_SETTING_READ_REQ

is
sent
to
de-
vice.
The
string
field
is
a
NULL-
terminated
and
NULL-
delimited
string
with
con-

tents
"SEC-
TION_SETTING\0SETTING\0VALUE\0"
where
the
'\0'
es-
cape
se-
quence
de-
notes
the
NULL
char-
ac-
ter
and
where
quo-
ta-
tion
marks
are
omit-
ted.
An
ex-
am-
ple
string
that
could
be
sent
from
de-
vice
is

”so-
lu-
tion\0soln_freq\010\0”.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	N	string	setting	A NULL-terminated and NULL-delimited string with con- tents ”SEC- TION_SETTING\0SETTING\0VALUE\0”
	N		Total Pay- load Length	

Table 6.7.6:
MSG_SETTINGS_READ_RESP
0x00A5
mes-
sage
struc-
ture

MSG_SETTINGS_READ_BY_INDEX_REQ

0x00A2

162

The
set-
tings
mes-
sage
for
it-
er-
at-
ing
through
the
set-
tings
val-
ues.
A
de-
vice
will
re-
spond
to
this
mes-
sage
with
a
"MSG_SETTINGS_READ_BY_INDEX_RESP".

Offset	Size	Unit	Field Name	Description
	(bytes)	(bytes)		
0	2	u16	index	index into the device settings, with values ranging from 0 to length(settings)
	2			Total Payload Length

Table 6.7.7:
MSG_SETTINGS_READ_BY_INDEX_REQ
0x00A2
mes-
sage
struc-
ture

MSG_SETTINGS_READ_BY_INDEX_RESP

0x00A7

167

The
set-
tings
mes-
sage
that
re-
ports
the
value
of
a
set-
ting
at
an
in-
dex.

 In
the
string
field,
it
re-
ports
NULL-
terminated
and
de-
lim-
ited
string
with
con-

tents
”SEC-
TION_SETTING\0SETTING\0VALUE\0FORMAT_TYPE\0”.
where
the
’\0’
es-
cape
se-
quence
de-
notes
the
NULL
char-
ac-
ter
and
where
quo-
ta-
tion
marks
are
omit-
ted.
The
FOR-
MAT_TYPE
field
is
op-
tional
and
de-
notes
pos-
si-
ble

string
val-
ues
of
the
set-
ting
as
a
hint
to
the
user.
If
in-
cluded,
the
for-
mat
type
por-
tion
of
the
string
has
the
for-
mat
"enum:value1,value2,value3".
An
ex-
am-
ple
string
that
could
be
sent

from
the
de-
vice
is
”sim-
u-
la-
tor\0enabled\0True\0enum:True,False\0”

Offset	Size	Field Name	Description
(bytes)	(bytes)		
0	2	u16 index	index into the device settings, with values ranging from 0 to length(settings)
2	N	string settings	NULL-terminated and delimited string with contents "SECTION.SETTING\0SETTING\0VALUE\0FORMAT_TYPE\0"
N+			Total
2			Payload Length

Table 6.7.8:
MSG_SETTINGS_READ_BY_INDEX_RESP
0x00A7
mes-
sage
struc-
ture

MSG_SETTINGS_READ_BY_INDEX_DONE

0x00A6

166

The
set-
tings
mes-
sage
for
in-
di-
cat-
ing
end
of
the
set-
tings
val-
ues.

Offset	Size	Unit	Description
(by	(in	bytes)	
0			Total Pay- load Length

Table 6.7.9:
MSG_SETTINGS_READ_BY_INDEX_DONE
0x00A6
mes-
sage
struc-
ture

6.8 System

Standardized
sys-
tem
mes-
sages
from
Swift
Nav-
i-
ga-
tion
de-
vices.

MSG_STARTUP

—
0xFF00

—
65280

The
sys-
tem
start-
up
mes-
sage
is
sent
once
on
sys-
tem
start-
up.
It
no-
ti-
fies
the

host
or
other
at-
tached
de-
vices
that
the
sys-
tem
has
started
and
is
now
ready
to
re-
spond
to
com-
mands
or
con-
fig-
u-
ra-
tion
re-
quests.

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	1	u8	cause	Cause of startup
1	1	u8	startype	Startup type
2	2	u16	reserved	Reserved
4				Total Payload Length

Table 6.8.1:
MSG_STARTUP
0xFF00
mes-
sage
struc-
ture

Cause
of
startup
(Table 6.8.2)90

Field
6.8.1:
Cause
of
startup
(cause)

Value	Description
0	Power on
1	Software reset
2	Watchdog reset

Table 6.8.2:
Cause
of
startup
values
(cause[0:8])

(Table 6.8.3)90

Field
6.8.2:
Startup
type
(startup_type)

Value	Description
0	Cold start
1	Warm start
2	Hot start

Table 6.8.3:
values
(startup_type[0:8])

MSG_DGNSS_STATUS

0xFF02

65282

This
mes-
sage
pro-
vides
in-
for-
ma-
tion
about
the
re-
ceipt
of
Dif-
fer-
en-
tial
cor-
rec-
tions.
It
is
ex-
pected
to
be
sent
with
each
re-
ceipt
of
a

com-
plete
cor-
rec-
tions
packet.

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	1	u8	status	status
			flags	flags
1	2	ul64	latency	latency
			seconds of	seconds of
			ob-	ob-
			ser-	ser-
			va-	va-
			tion	tion
			re-	re-
			ceipt	receipt
3	1	u8	numSignals	Number
			of	of
			sig-	sig-
			nals	nals
			from	from
			base	base
			sta-	sta-
			tion	tion
4	N	string	source	Corrections
			source	source
			string	string
	N+			Total
	4			Pay-
				load
				Length

Table 6.8.4:
MSG_DGNSS_STATUS
0xFF02
mes-
sage
struc-
ture

Reserved44

Dif-

fer-

en-

tial

type

(Ta-

ble 6.8.5)40

Field

6.8.3:

Sta-

tus

flags

(**flags**)

Value	Description
0	Invalid
1	Code Difference
2	RTK

Table 6.8.5:

Dif-

fer-

en-

tial

type

val-

ues

(**flags**[0:3])

MSG_HEARTBEAT

0xFFFF

65535

The heart-beat message is sent periodically to inform the host or other attached devices that the system is running. It is used to

mon-
i-
tor
sys-
tem
mal-
func-
tions.
It
also
con-
tains
sta-
tus
flags
that
in-
di-
cate
to
the
host
the
sta-
tus
of
the
sys-
tem
and
whether
it
is
op-
er-
at-
ing
cor-
rectly.

Cur-
rently,
the
ex-
pected
heart-
beat
in-
ter-
val
is
1
sec.

 The
sys-
tem
er-
ror
flag
is
used
to
in-
di-
cate
that
an
er-
ror
has
oc-
curred
in
the
sys-
tem.
To
de-
ter-

mine
the
source
of
the
er-
ror,
the
re-
main-
ing
er-
ror
flags
should
be
in-
spected.

Offset (by bytes)	Size (bytes)	Unit	Name	Description
0	4	u32	flags	Status flags
	4			Total Pay- load Length

Table 6.8.6:
MSG_HEARTBEAT
0xFFFF
mes-
sage
struc-
ture

External
an-
tenna
present
(Ta-
ble 6.8.11)131
Ex-
ter-
nal
an-
tenna
short
(Ta-
ble 6.8.10)130
Re-
served624
SBP
ma-
jor
pro-
to-
col
ver-
sion
num-
ber816
SBP
mi-
nor
pro-
to-
col
ver-
sion
num-
ber88
Re-
served53
Swift-
NAP
Er-
ror
(Ta-
ble 6.8.9)12
IO
Er-
ror
(Ta-
ble 6.8.8)11
Sys-
tem
Er-
ror
Flag
(Ta-
ble 6.8.7)10
Field

MSG_INS_STATUS

0xFF03

65283

The
INS
sta-
tus
mes-
sage
de-
scribes
the
state
of
the
op-
er-
a-
tion
and
ini-
tial-
iza-
tion
of
the
in-
er-
tial
nav-
i-
ga-
tion
sys-
tem.

Offset (bytes)	Size (bytes)	Field Name	Description
0	4	u32 flags	Status flags
	4		Total Pay- load Length

Table 6.8.12:
MSG_INS_STATUS
0xFF03
mes-
sage
struc-
ture

Reserved248

INS

Er-

ror

(Ta-

ble 6.8.15)44

GNSS

Fix

(Ta-

ble 6.8.14)13

Mode

(Ta-

ble 6.8.13)30

Field

6.8.5:

Sta-

tus

flags

(flags)

Value	Description
0	Awaiting initialization
1	Dynamically aligning
2	Ready
3	GNSS Outage exceeds max duration

Table 6.8.13:

Mode

val-

ues

(flags[0:2])

Value	Description
0	No GNSS fix available
1	GNSS fix

Table 6.8.14:

GNSS

Fix

val-

ues

(flags[3])

Value	Description
0	Reserved
1	IMU Data Error
2	INS License Error
3	IMU Calibration Data Error

Table 6.8.15:

INS

Er-

ror

val-

7 Draft Mes- sage Def- i- ni- tions

7.1 Acquisition

Satellite
ac-
qui-
si-
tion
mes-
sages
from
the
de-
vice.

**MSG
ACQ
RE-
SULT**

—
0x002F

—
47

This
mes-
sage
de-
scribes
the
re-
sults
from
an
at-
tempted
GPS
sig-
nal
ac-
qui-
si-
tion
search
for
a
satel-
lite
PRN
over
a
code
phase/carrier
fre-
quency
range.
It

~~con-~~
tains

the
pa-
ram-
e-
ters
of
the

(Table 7.1.2)80

Field

7.1.1:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(`sid.code`)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 7.1.2:

val-

ues

(`sid.code[0:7]`)

Offset (bytes)	Size (bytes)	Name	Description
0	1	Protocol	Identifies the start of frame transmission. Always 0x55.
1	2	MessageType	Identifies the payload contents.
3	2	Sender	A unique identifier of the sender. On the Piksi, this is set to the 2 least significant bytes of the device serial number. A stream of SBP messages

Name	Size (bytes)	Description
------	-----------------	-------------

s8	1	Signed 8- bit in- te- ger
----	---	--

s16	2	Signed 16- bit in- te- ger
-----	---	---

s32	4	Signed 32- bit in- te- ger
-----	---	---

s64	8	Signed 64- bit in- te- ger
-----	---	---

u8	1	Unsigned 8- bit in- te- ger
----	---	--

u16	2	Unsigned 16- bit in- te- ger
-----	---	---

u32	4	Unsigned 32- bit in- te- ger
-----	---	---

u64	8	Unsigned 64- bit
-----	---	------------------------

Version 2.5.1	4	May 3, 2019
---------------	---	-------------

275

float	4	Single- precision float (IEEE- 754)
-------	---	---

double	8	Double- precision
--------	---	----------------------

Field Name	Type	Value	Bytestring Segment
Preamble	u8	0x55	55
Message Type	u16	MSG_BASELINE_ECEF	02 02
Sender	u16	1228	cc 04
Length	u8	20	14
Payload		—	70 3d d0 18 cf ef ff ff ef e8 ff ff f0 18 00 00 00 00 05 00
MSG_BASELINE_ECEF			
.tow	u32	416300400 msec	70 3d d0 18
.x	s32	−4145 mm	cf ef ff ff
.y	s32	−5905 mm	ef e8 ff ff
.z	s32	6384 mm	f0 18 00 00
.accuracy	u16	0	00 00
.nsats	u8	5	05
.flags	u8	0	00
CRC	u16	0x9443	43 94

Table 4.0.2:

SBP

break-

down

for

MSG_BASELINE_ECEF

Offset (bytes)	Size (bytes)	Field Name	Description
0	4	float B cn0 Hz	CN/0 of best point
4	4	float phi sp	Code phase of best point
8	4	float f cf	Carrier fre- quency of best point
12	1	u8 sid.sat	Constellation- specific satel- lite iden- ti- fier. This field for Glonass can ei- ther be (100+FCN) where FCN is in [- 7,+6] or the Slot ID in [1,28]
13	1	u8 sid.code	Signal con-

Version 2.5.4, May 3, 2019

277

14

Total
Pay-
load

MSG**ACQ****SV****PRO-****FILE**

—

0x002E

—

46

The
mes-
sage
de-
scribes
all
SV
pro-
files
dur-
ing
ac-
qui-
si-
tion
time.
The
mes-
sage
is
used
to
de-
bug
and
mea-
sure
the
per-
for-
mance.

(Table 7.1.4)80

Field

7.1.2:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(acq_sv_profile[N].sid.code)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 7.1.4:

val-

ues

(acq_sv_profile[N].sid.code[0:7])

Offset (bytes)	Size (bytes)	Unit	Name	Description
33M+ 0	u8		<code>acq_sv_profile[N].job_type</code>	SV search job type (deep, fall- back, etc)
33M+ 1	u8		<code>acq_sv_profile[N].status</code>	Acquisition sta- tus 1 is Suc- cess, 0 is Fail- ure
33M+ 2	u16	dB- Hz*10	<code>acq_sv_profile[N].cn0</code>	CN0 value. Only valid if sta- tus is '1'
33M+ 4	u8	ms	<code>acq_sv_profile[N].int_time</code>	Acquisition in- te- gra- tion time
33M+ 5	u8		<code>acq_sv_profile[N].sid.sat</code>	Constellation- specific satel- lite iden- ti- fier. This field for Glonass

7.2 File IO

Messages

for

us-

ing

de-

vice's

on-

board

flash

filesys-

tem

func-

tion-

al-

ity.

This

al-

lows

data

to

be

stored

per-

sis-

tently

in

the

de-

vice's

pro-

gram

flash

with

wear-

levelling

us-

ing

a
sim-
ple
file-
sys-
tem
in-
ter-
face.

The
file
sys-
tem
in-
ter-
face
(CFS)
de-
fines

an
ab-
stract
API
for
read-
ing
di-
rec-
to-
ries
and
for
read-
ing
and
writ-
ing
files.

Note
that

some
of
these
mes-
sages
share
the
same
mes-
sage
type
ID
for
both
the
host
re-
quest
and
the
de-
vice
re-
sponse.

**MSG
FILEIO
READ
REQ**

—
0x00A8

—
168

The
file
read
mes-
sage
reads
a
cer-
tain
length
(up
to
255
bytes)
from
a
given
off-
set
into
a
file,
and
re-
turns
the
data
in
a

MSG_FILEIO_READ_RESP

mes-
sage
where

the
mes-

sage
length
field
in-
di-
cates
how

Offset (bytes)	Size (bytes)	Format	Name	Description
0	4	u32	<code>sequence</code>	Read se- quence num- ber
4	4	u32	<code>offset</code>	File off- set
8	1	u8	<code>chunk_size</code>	Chunk size to read
9	N	string	<code>filename</code>	Name of the file to read from
$N+9$				Total Pay- load Length

Table 7.2.1:
MSG_FILEIO_READ_REQ
0x00A8
mes-
sage
struc-
ture

MSG
FILEIO
READ
RESP

—
0x00A3

—
163
The
file
read
mes-
sage
reads
a
cer-
tain
length
(up
to
255
bytes)
from
a
given
off-
set
into
a
file,
and
re-
turns
the
data
in
a
mes-
sage
where
the

mes-
Version 2.5.4, May 3, 2019
sage

length
field
in-
di-
cates
how
many

Offset (by 4 bytes)	Size (bytes)	Format	FieldName	Description
0	4	u32	sequence	Read sequence number
4	N	u8[N]	contents	Contents of read file
$N+4$				Total Payload Length

Table 7.2.2:
MSG_FILEIO_READ_RESP
0x00A3
message
structure

MSG
FILEIO
READ
DIR
REQ

—
0x00A9

—
169
The
read
di-
rec-
tory
mes-
sage
lists
the
files
in
a
di-
rec-
tory
on
the
de-
vice's
on-
board
flash
file
sys-
tem.
The
off-
set
pa-
ram-
e-
ter
can

Version 2.5.4, May 3, 2019

be
used
to
skip
the
first
n
el-

Offset (by bytes)	Size (bytes)	Unit	Name	Description
0	4	u32	sequence	Read sequence number
4	4	u32	offset	The offset to skip the first n el- e- ments of the file list
8	<i>N</i>	string	dirname	Name of the di- rec- tory to list
<i>N</i> + 8				Total Pay- load Length

Table 7.2.3:
MSG_FILEIO_READ_DIR_REQ
0x00A9
mes-
sage
struc-
ture

MSG
FILEIO
READ
DIR
RESP

—
0x00AA

—
170

The
read
di-
rec-
tory
mes-
sage
lists
the
files
in
a
di-
rec-
tory
on
the
de-
vice's
on-
board
flash
file
sys-
tem.
Mes-
sage
con-
tains
the
di-
rec-
tory

Version 2.5.4, May 3, 2019

294

list-
ings
as
a
NULL
de-
lim-
ited

Offset (by bytes)	Size (bytes)	Field Name	Description
0	4	u32 sequence	Read sequence number
4	N	u8[N] contents	Contents of read di- rec- tory
$N+4$			Total Pay- load Length

Table 7.2.4:
MSG_FILEIO_READ_DIR_RESP
0x00AA
mes-
sage
struc-
ture

**MSG
FILEIO
RE-
MOVE**

—
0x00AC

—
172

The
file
re-
move
mes-
sage
deletes

a
file
from
the
file
sys-
tem.

If
the
mes-
sage
is
in-
valid,

a
fol-
lowup

MSG_PRINT

mes-
sage
will
print
"In-
valid
fileio
re-

move

Version 2.5.4, May 3, 2019

mes-
sage".

A
de-
vice
will
only
pro-

Offset	Size	Format	Name	Description
	(bytes)			
0	N	string	filename	Name of the file to delete
	N			Total Payload Length

Table 7.2.5:
MSG_FILEIO_REMOVE
0x00AC
mes-
sage
struc-
ture

**MSG
FILEIO
WRITE
REQ**

0x00AD

173

The
file
write
mes-
sage
writes
a
cer-
tain
length
(up
to
255
bytes)
of
data
to
a
file
at
a
given
off-
set.
Re-
turns
a
copy
of
the
orig-
i-
nal

MSG_FILEIO_WRITE_RESP

Version 2.5.4, May 3, 2019

300

mes-
sage
to
check
in-
tegrity
of
the

Offset (bytes)	Size (bytes)	Unit Name	Description
0	4	u32 sequence	Write sequence number
4	4	u32 offset	Offset into the file at which to start writing in bytes
8	<i>N</i>	string filename	Name of the file to write to
9	<i>N</i>	u8[<i>N</i>] data	Variable- length array of data to write
<i>N</i> + 9			Total Payload Length

Table 7.2.6:
MSG_FILEIO_WRITE_REQ
0x00AD
mes-
sage
struc-
ture

**MSG
FILEIO
WRITE
RESP**

—
0x00AB

—
171
The
file
write
mes-
sage
writes
a
cer-
tain
length
(up
to
255
bytes)
of
data
to
a
file
at
a
given
off-
set.
The
mes-
sage
is
a
copy
of
the
orig-
i-

nal
Version 2.5.4, May 3, 2019

MSG_FILEIO_WRITE_REQ

mes-
sage
to
check
in-
tegrity

Offset	Size	Format	Field Name	Description
(bytes)	(bytes)			
0	4	u32	sequence	Write sequence number
	4			Total Payload Length

Table 7.2.7:
MSG_FILEIO_WRITE_RESP
0x00AB
mes-
sage
struc-
ture

MSG
FILEIO
CON-
FIG
REQ

—
0x1001

—
4097

Requests

ad-

vice

on

the

op-

ti-

mal

con-

fig-

u-

ra-

tion

for

a

FileIO

trans-

fer.

Newer

ver-

sion

of

FileIO

can

sup-

port

greater

through-

put

by

sup-

port-

ing

Version 2.5.4, May 3, 2019

large

win-

dow

of

FileIO

data

that

Offset (by bytes)	Size (bytes)	Format	FieldName	Description
0	4	u32	sequence	Advice se- quence num- ber
	4			Total Pay- load Length

Table 7.2.8:
MSG_FILEIO_CONFIG_REQ
0x1001
mes-
sage
struc-
ture

**MSG
FILEIO
CON-
FIG
RESP**

—
0x1002

—
4098

The
ad-
vice
on
the
op-
ti-
mal
con-
fig-
u-
ra-
tion
for
a
FileIO
trans-
fer.
Newer
ver-
sion
of
FileIO
can
sup-
port
greater
through-
put
by
sup-
port-
ing

Version 2.5.4, May 3, 2019

large
win-
dow
of
FileIO
data
that

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	4	u32	sequence	Advice sequence number
4	4	u32	window_size	The number of SBP pack- ets in the data in- flight win- dow
8	4	u32	batch_size	The num- ber of SBP pack- ets sent in one PDU
12	4	u32	fileio_version	The ver- sion of FileIO that is sup- ported
16				Total Pay- load Length

Table 7.2.9:
Version 2.5.4, May 3, 2019
MSG_FILEIO_CONFIG_RESP
0x1002
mes-
sage
struc-
ture

7.3 Linux

Linux
state
mon-
i-
tor-
ing.

MSG
LINUX
CPU
STATE

—
0x7F00

—
32512

This
mes-
sage
in-
di-
cates
the
pro-
cess
state
of
the
top
10
heav-
i-
est
con-
sumers
of
CPU
on
the
sys-
tem.

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	1	u8	index	sequence of this status message, values from 0-9
1	2	u16	pid	the PID of the process
3	1	u8	pcpu	percent of cpu used, expressed as a fraction of 256
4	15	string	tname	fixed length string representing the thread name
19	N	string	cmdline	the command line (as much as it fits in the remaining 100 bytes)

MSG
LINUX
MEM
STATE

—
0x7F01

—
32513

This
mes-
sage
in-
di-
cates
the
pro-
cess
state
of
the
top
10
heav-
i-
est
con-
sumers
of
mem-
ory
on
the
sys-
tem.

Offset (by bytes)	Size (bytes)	Field Type	Field Name	Description
0	1	u8	index	sequence of this status message, values from 0-9
1	2	u16	pid	the PID of the process
3	1	u8	pmem	percent of memory used, expressed as a fraction of 256
4	15	string	tname	fixed length string representing the thread name
19	N	string	cmdline	the command line
Version 2.5.4, May 3, 2019				(as much as it fits in the remain-

MSG
LINUX
SYS
STATE

—
0x7F02

—
32514

This
presents
a
sum-
mary
of
CPU
and
mem-
ory
uti-
liza-
tion.

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	2	u16	mem_total	total sys- tem mem- ory
2	1	u8	pcpu	percent of to- tal cpu cur- rently uti- lized
3	1	u8	pmem	percent of to- tal mem- ory cur- rently uti- lized
4	2	u16	procs_starting	number of pro- cesses that started dur- ing col- lec- tion phase
6	2	u16	procs_stopping	number of pro- cesses that stopped dur- ing col- lec- tion phase
8	2	u16	pid_count	the count of pro- cesses on the

**MSG
LINUX
PRO-
CESS
SOCKET
COUNTS**

—

0x7F03

—

32515

Top

10

list

of

pro-

cesses

with

high

socket

counts.

Offset (by bytes)	Size (bytes)	Unit	Name	Description
0	1	u8	index	sequence of this status message, values from 0-9
1	2	u16	pid	the PID of the process in question
3	2	u16	socket_count	the number of sockets the process is using
5	2	u16	socket_types	A bit-field indicating the socket types used:
				0x1
				(tcp),
				0x2
				(udp),
				0x4
				(unix stream),
				0x8
				(unix dgram),
				0x10

**MSG
LINUX
PRO-
CESS
SOCKET
QUEUES**

—

0x7F04

—

32516

Top

10

list

of

sock-

ets

with

deep

queues.

Offset	Size (bytes)	Field Name	Description
0	1	u8 index	sequence of this status message, values from 0-9
1	2	u16 pid	the PID of the process in question
3	2	u16 recv_queued	the total amount of receive data queued for this process
5	2	u16 send_queued	the total amount of send data queued for this process
Version 2.5.4, May 3, 2019			323
7	2	u16 socket_types	A bit-field indicating the

MSG
LINUX
SOCKET
US-
AGE

—
0x7F05

—
32517

Summaries
the
socket
us-
age
across
the
sys-
tem.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	4	u32	avg_queue_depth	average socket queue depths across all sock- ets on the sys- tem
4	4	u32	max_queue_depth	the max queue depth seen within the re- port- ing pe- riod
8	32	u16[16]	socket_state_counts	A count for each socket type re- ported in the 'socket_types_reported' field, the first en- try cor- re- sponds to the first en- abled bit in 'types_reported'.
40	32	u16[16]	socket_type_counts	A count for

**MSG
LINUX
PRO-
CESS
FD
COUNT**

—
0x7F06
—

32518

Top
10
list
of
pro-
cesses
with
a
large
num-
ber
of
open
file
de-
scrip-
tors.

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	1	u8	index	sequence of this status message, values from 0-9
1	2	u16	pid	the PID of the process in question
3	2	u16	fd_count	a count of the number of file descriptors opened by the process
5	N	string	cmdline	the command line of the process
Version 2.5.4, May 3, 2019				in question
N+5				Total Payload Length

Table 7.3.7:

**MSG
LINUX
PRO-
CESS
FD
SUM-
MARY**

—
0x7F07

—
32519

Summary
of
open
file
de-
scrip-
tors
on
the
sys-
tem.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	4	u32	<code>sys_fd_count</code>	count of total FDs open on the system
4	N	string	<code>most_opened</code>	A null delimited list of strings which alternates between a string representation of the process count and the file name whose count it being reported. That is, in C string syntax

7.4 Orientation

Orientation
Mes-
sages

**MSG
BASE-
LINE
HEAD-
ING**

—
0x020F

—
527

This
mes-
sage
re-
ports
the
base-
line
head-
ing
point-
ing
from
the
base
sta-
tion
to
the
rover
rel-
a-
tive
to
True
North.
The
full
GPS
time
is
given
by

the Version 2.5.4, May 3, 2019

pre-
ced-
ing
MSG_GPS_TIME
with
the
match-

Offset (by bytes)	Size (bytes)	Unit	Field Name	Description
0	4	u32	time tow	GPS Time of Week
4	4	u32	heading	Heading
8	1	u8	n_sats	Number of satel- lites used in so- lu- tion
9	1	u8	flags	Status flags
10				Total Pay- load Length

Table 7.4.1:
MSG_BASELINE_HEADING
0x020F
mes-
sage
struc-
ture

Reserved53

Fix

mode

(Ta-

ble 7.4.2)30

Field

7.4.1:

Sta-

tus

flags

(**flags**)

Value	Description
0	Invalid
1	Reserved
2	Differential GNSS (DGNSS)
3	Float RTK
4	Fixed RTK

Table 7.4.2:

Fix

mode

val-

ues

(**flags**[0:2])

**MSG
ORI-
ENT
QUAT**

0x0220

544

This
mes-
sage
re-
ports
the
quater-
nion
vec-
tor
de-
scrib-
ing
the
ve-
hi-
cle
body
frame's
ori-
en-
ta-
tion
with
re-
spect
to
a
local-
level
NED
frame.
The

com-
Version 2.5.4, May 3, 2019
po-

nents
of
the
vec-
tor
should
sum

Reserved53
INS
Nav-
i-
ga-
tion
mode
(Ta-
ble 7.4.4)30

Field
7.4.2:
Sta-
tus
flags
(**flags**)

Value	Description
0	Invalid
1	Valid

Table 7.4.4:

INS
Nav-
i-
ga-
tion
mode
val-
ues
(**flags**[0:2])

Offset (bytes)	Size (bytes)	Format	Unit Name	Description
0	4	u32	time_tow	GPS Time of Week
4	4	s32 ² -w		Real com- po- nent
8	4	s32 ² -x		1st imag- i- nary com- po- nent
12	4	s32 ² -y		2nd imag- i- nary com- po- nent
16	4	s32 ² -z		3rd imag- i- nary com- po- nent
20	4	float	N/A accuracy	Estimated stan- dard de- vi- a- tion of w
24	4	float	N/A accuracy	Estimated stan- dard de- vi- a- tion
Version 2.5.4, May 3, 2019				of
28	4	float	N/A accuracy	x Estimated stan- dard de- vi- a- tion

**MSG
ORI-
ENT
EU-
LER**

0x0221

545

This
mes-
sage
re-
ports
the
yaw,
pitch,
and
roll
an-
gles
of
the
ve-
hi-
cle
body
frame.
The
ro-
ta-
tions
should
ap-
plied
in-
trin-
si-
cally
in
the

~~or-~~

Version 2.5.4, May 3, 2019

der
yaw,
pitch,
and
roll
in
or-
der

Reserved53
INS
Nav-
i-
ga-
tion
mode
(Ta-
ble 7.4.6)30

Field
7.4.3:
Sta-
tus
flags
(**flags**)

Value	Description
0	Invalid
1	Valid

Table 7.4.6:

INS
Nav-
i-
ga-
tion
mode
val-
ues
(**flags**[0:2])

Offset (bytes)	Size (bytes)	Unit Name	Description
0	4	u32ms tow	GPS Time of Week
4	4	s32microroll	rotation about the for- ward axis of the ve- hi- cle
8	4	s32micropitch	rotation about the right- ward axis of the ve- hi- cle
12	4	s32microyaw	rotation about the down- ward axis of the ve- hi- cle
16	4	floatroll_accuracy	Estimated stan- dard de- vi- a- tion of roll
20	4	floatpitch_accuracy	Estimated stan- dard de- vi- a- tion of pitch

**MSG
AN-
GU-
LAR
RATE**

0x0222

546

This
mes-
sage
re-
ports
the
ori-
en-
ta-
tion
rates
in
the
ve-
hi-
cle
body
frame.
The
val-
ues
rep-
re-
sent
the
mea-
sure-
ments
a
strapped
down
gy-

~~FO-~~

Scope

would
make
and
are
not
equiv-
a-

Reserved62
INS
Nav-
i-
ga-
tion
mode
(Ta-
ble 7.4.8)30

Field
7.4.4:
Sta-
tus
flags
(**flags**)

Value	Description
0	Invalid
1	Valid

Table 7.4.8:
INS
Nav-
i-
ga-
tion
mode
val-
ues
(**flags**[0:2])

Offset (bytes)	Size (bytes)	Format	Unit Name	Description
0	4	u32	time tow	GPS Time of Week
4	4	s32	microradians	angular rate about x axis
8	4	s32	microradians	angular rate about y axis
12	4	s32	microradians	angular rate about z axis
16	1	u8	flags	Status flags
17				Total Pay- load Length

Table 7.4.7:
MSG_ANGULAR_RATE
0x0222
mes-
sage
struc-
ture

7.5 Piksi

System
health,
con-
fig-
u-
ra-
tion,
and
di-
ag-
nos-
tic
mes-
sages
spe-
cific
to
the
Piksi
L1
re-
ceiver,
in-
clud-
ing
a
va-
ri-
ety
of
legacy
mes-
sages
that
may
no
longer
be

used.

MSG
AL-
MANAC

—
0x0069

—
105

This
is
a
legacy
mes-
sage
for
send-
ing
and
load-
ing
a
satel-
lite
ala-
manac
onto
the
Piksi's
flash
mem-
ory
from
the
host.

Offset (bytes)	Size (bytes)	Field Name	Description
0			Total Pay- load Length

Table 7.5.1:
MSG_ALMANAC
0x0069
mes-
sage
struc-
ture

**MSG
SET
TIME**

—

0x0068

—

104

This
mes-
sage
sets
up
tim-
ing
func-
tion-
al-
ity
us-
ing
a
coarse
GPS
time
es-
ti-
mate
sent
by
the
host.

Offset (bytes)	Size (bytes)	Field Name	Description
0			Total Pay- load Length

Table 7.5.2:
MSG_SET_TIME
0x0068
mes-
sage
struc-
ture

MSG RE- SET

—
0x00B6

—
182

This
mes-
sage
from
the
host
re-
sets
the
Piksi
back
into
the
boot-
loader.

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	4	u32	flags	Reset flags
	4			Total Pay- load Length

Table 7.5.3:
MSG_RESET
0x00B6
mes-
sage
struc-
ture

Reserved311

De-
fault

set-
tings.

(Ta-
ble 7.5.4)10

Field

7.5.1:

Re-
set

flags

(**flags**)

Value	Description
0	Preserve existing settings.
1	Resore default settings.

Table 7.5.4:

De-
fault

set-
tings.

val-
ues

(**flags**[0])

**MSG
RE-
SET
DEP**
—
0x00B2
—
178
This
mes-
sage
from
the
host
re-
sets
the
Piksi
back
into
the
boot-
loader.

Offset (bytes)	Size (bytes)	FieldName	Description
0			Total Pay- load Length

Table 7.5.5:
MSG_RESET_DEP
0x00B2
mes-
sage
struc-
ture

**MSG
CW
RE-
SULTS**

0x00C0

192

This
is
an
un-
used
legacy
mes-
sage
for
re-
sult
re-
port-
ing
from
the
CW
in-
ter-
fer-
ence
chan-
nel
on
the
Swift-
NAP.
This
mes-
sage
will
be
re-

~~moved~~

in Version 2.5.4, May 3, 2019

a
fu-
ture
re-
lease.

Offset (by bytes)	Size (bytes)	FieldName	Description
0			Total Pay- load Length

Table 7.5.6:
MSG_CW_RESULTS
0x00C0
mes-
sage
struc-
ture

MSG
CW
START

—
0x00C1
—

193

This
is
an
un-
used
legacy
mes-
sage
from
the
host
for
start-
ing
the
CW
in-
ter-
fer-
ence
chan-
nel
on
the
Swift-
NAP.
This
mes-
sage
will
be
re-
moved
in

a
Version 2.5.4, May 3, 2019
fu-

ture
re-
lease.

Offset (by bytes)	Size (bytes)	FieldName	Description
0			Total Pay- load Length

Table 7.5.7:
MSG_CW_START
0x00C1
mes-
sage
struc-
ture

MSG**RE-****SET****FIL-****TERS**

—

0x0022

—

34

This

mes-

sage

re-

sets

ei-

ther

the

DGNSS

Kalman

fil-

ters

or

In-

te-

ger

Am-

bi-

gu-

ity

Res-

o-

lu-

tion

(IAR)

pro-

cess.

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	1	u8	filter	Filter flags
	1			Total Payload Length

Table 7.5.8:
MSG_RESET_FILTERS
0x0022
mes-
sage
struc-
ture

Reserved62
Fil-
ter
or
pro-
cess
to
re-
set
(Ta-
ble 7.5.9)20

Field 7.5.2: Filter flags (filter)	
Value	Description
0	DGNSS filter
1	IAR process
2	Inertial filter

Table 7.5.9:
Fil-
ter
or
pro-
cess

**MSG
INIT
BASE****0x0023****35**

This
mes-
sage
ini-
tial-
izes
the
in-
te-
ger
am-
bi-
gu-
ity
res-
o-
lu-
tion
(IAR)
pro-
cess
on
the
Piksi
to
use
an
as-
sumed
base-
line
po-
si-
tion

be-
Version 2.5.4, May 3, 2019
tween

the
base
sta-
tion
and
rover
re-

Offset (by bytes)	Size (bytes)	FieldName	Description
0			Total Pay- load Length

Table 7.5.10:
MSG_INIT_BASE
0x0023
mes-
sage
struc-
ture

**MSG
THREAD
STATE**

0x0017

23

The
thread

us-
age
mes-
sage
from
the
de-
vice
re-
ports
real-
time

op-
er-
at-
ing
sys-
tem
(RTOS)
thread

us-
age
statis-
tics
for
the
named
thread.

The
re-
ported
per-

cent-
Version 2.5.4, May 3, 2019
age

val-
ues
must
be
nor-
mal-
ized

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	20	string	name	Thread name (NULL terminated)
20	2	u16	cpu	Percentage cpu use for this thread. Values range from 0 - 1000 and needs to be renormalized to 100
22	4	u32	stack_free	Free stack space for this thread
26				Total Payload Length

Table 7.5.11:
MSG_THREAD_STATE
0x0017
mes-
sage
structure
Version 2.5.4, May 3, 2019

**MSG
UART
STATE**

0x001D

29

The
UART
mes-
sage
re-
ports
data
la-
tency
and
through-
put
of
the
UART
chan-
nels
pro-
vid-
ing
SBP
I/O.
On
the
de-
fault
Piksi
con-
fig-
u-
ra-
tion,
UARTs
A

and
B

are
used
for
teleme-
try
ra-
dios

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	4	floatB/s	uart_a.tx_throughput	UART trans- mit through- put
4	4	floatB/s	uart_a.rx_throughput	UART re- ceive through- put
8	2	u16	uart_a.crc_error_count	UART CRC er- ror count
10	2	u16	uart_a.io_error_count	UART IO er- ror count
12	1	u8	uart_a.tx_buffer_level	UART trans- mit buffer per- cent- age uti- liza- tion (ranges from 0 to 255)
13	1	u8	uart_a.rx_buffer_level	UART re- ceive buffer per- cent- age uti- liza- tion (ranges from 0 to 255)
14	4	floatB/s	uart_b.tx_throughput	UART trans- mit through-

MSG
UART
STATE
DEPA

—
0x0018

—
24
Deprecated

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	4	floatB/s	uart_a.tx_throughput	UART trans- mit through- put
4	4	floatB/s	uart_a.rx_throughput	UART re- ceive through- put
8	2	u16	uart_a.crc_error_count	UART CRC er- ror count
10	2	u16	uart_a.io_error_count	UART IO er- ror count
12	1	u8	uart_a.tx_buffer_level	UART trans- mit buffer per- cent- age uti- liza- tion (ranges from 0 to 255)
13	1	u8	uart_a.rx_buffer_level	UART re- ceive buffer per- cent- age uti- liza- tion (ranges from 0 to 255)
14	4	floatB/s	uart_b.tx_throughput	UART trans- mit through-

MSG
IAR
STATE

—
0x0019

—
25
This
mes-
sage
re-
ports
the
state
of
the
In-
te-
ger
Am-
bi-
gu-
ity
Res-
o-
lu-
tion
(IAR)
pro-
cess,
which
re-
solves
un-
known
in-
te-
ger
am-
bi-
gu-

—
Version 2.5.4, May 3, 2019
ties

from
double-
differenced
carrier-
phase
mea-
sure-

Offset (by bytes)	Size (bytes)	Format	FieldName	Description
0	4	u32	num_hyps	Number of in- te- ger am- bi- gu- ity hy- pothe- ses re- main- ing
4				Total Pay- load Length

Table 7.5.14:
MSG_IAR_STATE
0x0019
mes-
sage
struc-
ture

MSG
MASK
SATEL-
LITE

—

0x002B

—

43
This
mes-
sage
al-
lows
set-
ting
a
mask
to
pre-
vent
a
par-
tic-
u-
lar
satel-
lite
from
be-
ing
used
in
var-
i-
ous
Piksi
sub-
sys-
tems.

Reserved62
 Track-
 ing
 chan-
 nels
 (Ta-
 ble 7.5.17)11
 Ac-
 qui-
 si-
 tion
 chan-
 nel
 (Ta-
 ble 7.5.16)10

Field
 7.5.3:
 Mask
 of
 sys-
 tems
 that
 should
 ig-
 nore
 this
 satel-
 lite.
 (mask)

Value	Description
0	Enabled
1	Skip this satellite on future acquisitions

Table 7.5.16:
 Ac-
 qui-
 si-
 tion
 chan-
 nel
 val-
 ues
 (mask[0])

Value	Description
0	Enabled
1	Drop this PRN if currently tracking

Table 7.5.17:
 Track-
 ing
 chan-
 nels
 val-
 ues

(Table 7.5.18)80

Field

7.5.4:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(`sid.code`)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 7.5.18:

val-

ues

(`sid.code[0:7]`)

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	1	u8	mask	Mask of systems that should ignore this satellite.
1	1	u8	sid.sat	Constellation-specific satellite identifier. This field for Glonass can either be (100+FCN) where FCN is in [-7,+6] or the Slot ID in [1,28]
2	1	u8	sid.code	Signal constellation, band and code
Version 2.5.4, May 3, 2019				381
3				Total Payload Length

Table 7.5.15:
MSG_MASK_SATELLITE

**MSG
DE-
VICE
MON-
I-
TOR**

—
0x00B5

—
181

This
mes-
sage
con-
tains
tem-
per-
a-
ture
and
volt-
age
level
mea-
sure-
ments
from
the
pro-
ces-
sor's
mon-
i-
tor-
ing
sys-
tem
and
the
RF
fron-
tend

Version 2.5.4, May 3, 2019

tem-
per-
a-
ture
if
avail-
able.

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	2	s16V	dev_vin	Device V _{in}
		/		
		1000		
2	2	s16V	cpu_vint	Processor V _{int}
		/		
		1000		
4	2	s16V	cpu_vaux	Processor V _{aux}
		/		
		1000		
6	2	s16degC	cpu_temperature	Processor tem- per- a- ture
		/		
		100		
8	2	s16degC	fe_temperature	Frontend tem- per- a- ture (if avail- able)
		/		
		100		
10				Total Pay- load Length

Table 7.5.19:
MSG_DEVICE_MONITOR
0x00B5
mes-
sage
struc-
ture

**MSG
COM-
MAND
REQ**

—
0x00B8

—
184

Request

the

re-

cip-

i-

ent

to

ex-

e-

cute

an

com-

mand.

Out-

put

will

be

sent

in

MSG_LOG

mes-

sages,

and

the

exit

code

will

be

re-

turned

with

MSG_COMMAND_RESP.

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	4	u32	sequence	Sequence number
4	N	string	command	Command line to execute
	N+4			Total Payload Length

Table 7.5.20:
MSG_COMMAND_REQ
0x00B8
mes-
sage
struc-
ture

**MSG
COM-
MAND
RESP**

—
0x00B9

—
185

The
re-
sponse
to
MSG_COMMAND_REQ
with
the
re-
turn
code
of
the
com-
mand.
A
re-
turn
code
of
zero
in-
di-
cates
suc-
cess.

Offset (by- tes)	Size (bytes)	Format	Field Name	Description
0	4	u32	sequence	Sequence num- ber
4	4	s32	code	Exit code
8				Total Pay- load Length

Table 7.5.21:
MSG_COMMAND_RESP
0x00B9
mes-
sage
struc-
ture

**MSG
COM-
MAND
OUT-
PUT****—
0x00BC****—
188**

Returns
the
stan-
dard
out-
put
and
stan-
dard
er-
ror
of
the
com-
mand
re-
quested
by
MSG_COMMAND_REQ.

The
se-
quence
num-
ber
can
be
used
to
fil-
ter
for
fil-
ter

Version 2.5.4, May 3, 2019

the
cor-
rect
com-
mand.

Offset (by bytes)	Size (bytes)	Field Name	Description
0	4	u32 sequence	Sequence number
4	N	string line	Line of standard output or standard error
$N+4$			Total Payload Length

Table 7.5.22:
MSG_COMMAND_OUTPUT
0x00BC
mes-
sage
struc-
ture

**MSG
NET-
WORK
STATE
REQ**

—
0x00BA

—
186

Request

state

of

Piksi

net-

work

in-

ter-

faces.

Out-

put

will

be

sent

in

MSG_NETWORK_STATE_RESP

mes-

sages

Offset (bytes)	Size (bytes)	Field Name	Description
0			Total Pay- load Length

Table 7.5.23:
MSG_NETWORK_STATE_REQ
0x00BA
mes-
sage
struc-
ture

MSG
NET-
WORK
STATE
RESP

—

0x00BB

—

187

The
state
of
a
net-
work
in-
ter-
face
on
the
Piksi.
Data
is
made
to
re-
flect
out-
put
of
ifad-
drs
struct
re-
turned
by
geti-
fad-
drs
in
c.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	4	u8[4]	<code>ipv4_address</code>	IPv4 ad- dress (all zero when un- avail- able)
4	1	u8	<code>ipv4_mask_size</code>	IPv4 net- mask CIDR no- ta- tion
5	16	u8[16]	<code>ipv6_address</code>	IPv6 ad- dress (all zero when un- avail- able)
21	1	u8	<code>ipv6_mask_size</code>	IPv6 net- mask CIDR no- ta- tion
22	4	u32	<code>rx_bytes</code>	Number of Rx bytes
26	4	u32	<code>tx_bytes</code>	Number of Tx bytes
30	16	string	<code>interface_name</code>	Interface Name
46	4	u32	<code>flags</code>	Interface flags
				from
Version 2.5.4, May 3, 2019				SIOCGIF- FLAGS
50				Total Pay- load Length

Table 7.5.24:
MSG_NETWORK_STATE_RESP

**MSG
NET-
WORK
BAND-
WIDTH
US-
AGE**

—
0x00BD
—

189

The
band-
width
us-
age,
a
list
of
us-
age
by
in-
ter-
face.

Offset (bytes)	Size (bytes)	Unit	Name	Description
40M+ 0	8	u64	<code>interfaces[N].duration</code>	Duration over which the measurement was collected
40M+ 8	8	u64	<code>interfaces[N].total_bytes</code>	Number of bytes handled in total within period
40M+ 16	4	u32	<code>interfaces[N].rx_bytes</code>	Number of bytes transmitted within period
40M+ 20	4	u32	<code>interfaces[N].tx_bytes</code>	Number of bytes received within period
24	16	string	<code>interfaces[N].interface_name</code>	Interface Name
40N				Total Payload Length

MSG
CELL
MO-
DEM
STA-
TUS

—
0x00BE

—
190
If
a
cell
mo-
dem
is
present

on
a
piksi
de-
vice,
this
mes-
sage
will
be
send
pe-
ri-
od-
i-
cally
to
up-
date
the
host
on
the
sta-
tus

Version 2.5.4, May 3, 2019

the
mo-
dem
and
its
var-
i-

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	1	s8	<code>signal_strength</code>	Received cell signal strength in dBm, zero translates to unknown
1	4	float	<code>signal_error_rate</code>	BER as reported by the modem, zero translates to unknown
5	N	u8[N]	<code>reserved</code>	Unspecified data TBD for this schema
$N + 5$				Total Payload Length

Table 7.5.26:
MSG_CELL_MODEM_STATUS
0x00BE
mes-
sage
struc-

MSG**SPECAN**

—

0x0051

—

81

Spectrum

an-

a-

lyzer

packet.

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	2	u16	<code>channel_tag</code>	Channel ID
2	4	u32	<code>ns t.tow</code>	Milliseconds since start of GPS week
6	4	s32	<code>ns t.ns_residual</code>	Nanosecond residual of millisecond-rounded TOW (ranges from -500000 to 500000)
10	2	u16	<code>week.k.wn</code>	GPS week number
12	4	float	<code>MHz freq.ref</code>	Reference frequency of this packet
16	4	float	<code>MHz freq.step</code>	Frequency step of points in this packet
20	4	float	<code>dB amplitude.ref</code>	Reference amplitude of this packet
24	4	float	<code>dB amp 2019</code>	Amplitude unit value of points in this packet
28	N	u8[N]	<code>amplitude.value</code>	Amplitude

MSG
FRONT
END
GAIN

—
0x00BF

—
191

This
mes-
sage
de-
scribes
the
gain
of
each
chan-
nel
in
the
re-
ceiver
fron-
tend.
Each
gain
is
en-
coded
as
a
non-
dimensional
per-
cent-
age
rel-
a-
tive
to
the
max-
i-
mum
range
pos-
si-
ble
for

Offset (by bytes)	Size (bytes)	Field Name	Description
0	8	s8[8]rf_gain	RF gain for each fron- tend chan- nel
8	8	s8[8]if_gain	Intermediate fre- quency gain for each fron- tend chan- nel
16			Total Pay- load Length

Table 7.5.28:
MSG_FRONT_END_GAIN
0x00BF
mes-
sage
struc-
ture

7.6 Sbas

SBAS
data

MSG
SBAS
RAW

—
0x7777

—
30583

This
mes-
sage
is
sent
once
per
sec-
ond
per
SBAS
satel-
lite.
ME
checks
the
par-
ity
of
the
data
block
and
sends
only
blocks
that
pass
the
check.

(Table 7.6.2)80

Field

7.6.1:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(sid.code)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 7.6.2:

val-

ues

(sid.code[0:7])

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	1	u8	sid.sat	Constellation-specific satellite identifier. This field for Glonass can either be (100+FCN) where FCN is in [-7,+6] or the Slot ID in [1,28]
1	1	u8	sid.code	Signal constellation, band and code
2	4	u32	ns tow	GPS time-of-week at the start of the
Version 2.5.4, May 3, 2019				data block.
6	1	u8	message_type	SBAS message type (0-63)
7	27	u8[27]	data	Raw SBAS

7.7 Ssr

Precise
State
Space
Rep-
re-
sen-
ta-
tion
(SSR)
cor-
rec-
tions
for-
mat

MSG
SSR
OR-
BIT
CLOCK

—
0x05DD

—
1501

The
pre-
cise
or-
bit
and
clock
cor-
rec-
tion
mes-
sage
is
to
be
ap-
plied
as
a
delta
cor-
rec-
tion
to
broad-
cast
ephemeris
and
is
typ-
i-
cally
an

equiv-
a-
lent
to
the
1060
and
1066

(Table 7.7.2)80

Field

7.7.1:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(`sid.code`)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 7.7.2:

val-

ues

(`sid.code[0:7]`)

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	4	u32	<code>time.tow</code>	Seconds since start of GPS week
4	2	u16	<code>time.wn</code>	GPS week number
6	1	u8	<code>sid.sat</code>	Constellation-specific satellite identifier. This field for Glonass can either be (100+FCN) where FCN is in [-7,+6] or the Slot ID in [1,28]
7	1	u8	<code>sid.code</code>	Signal constellation, band and code
8	1	u8 s	<code>update_interval</code>	Update interval between consecutive

MSG
SSR
OR-
BIT
CLOCK
DEP
A

—
0x05DC

—
1500

The
pre-
cise
or-
bit
and
clock
cor-
rec-
tion
mes-
sage
is
to
be
ap-
plied
as
a
delta
cor-
rec-
tion
to
broad-
cast
ephemeris
and
is
typ-
i-

version 2.5.4, May 3, 2019

ally
an
equiv-
a-
lent
to
the
1060

(Table 7.7.4)80

Field

7.7.2:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(`sid.code`)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 7.7.4:

val-

ues

(`sid.code[0:7]`)

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	4	u32	<code>time.tow</code>	Seconds since start of GPS week
4	2	u16	<code>time.wn</code>	GPS week number
6	1	u8	<code>sid.sat</code>	Constellation-specific satellite identifier. This field for Glonass can either be (100+FCN) where FCN is in [-7,+6] or the Slot ID in [1,28]
7	1	u8	<code>sid.code</code>	Signal constellation, band and code
8	1	u8 s	<code>update_interval</code>	Update interval between consecutive

**MSG
SSR
CODE
BI-
ASES**

—
0x05E1

—
1505

The
pre-
cise
code
bi-
ases
mes-
sage
is
to
be
added
to
the
pseu-
do-
r-
ange
of
the
cor-
re-
spond-
ing
sig-
nal
to
get
cor-
rected
pseu-
do-

~~r-~~

ange.
Version 2.5.4, May 3, 2019

It
is
typ-
i-
cally
an
equiv-

(Table 7.7.6)80

Field

7.7.3:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(`sid.code`)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 7.7.6:

val-

ues

(`sid.code[0:7]`)

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	4	u32	<code>time.tow</code>	Seconds since start of GPS week
4	2	u16	<code>time.wn</code>	GPS week number
6	1	u8	<code>sid.sat</code>	Constellation-specific satellite identifier. This field for Glonass can either be (100+FCN) where FCN is in [-7,+6] or the Slot ID in [1,28]
7	1	u8	<code>sid.code</code>	Signal constellation, band and code
8	1	u8 s	<code>update_interval</code>	Update interval between consecutive

MSG
SSR
PHASE
BI-
ASES

—
0x05E6

—
1510

The
pre-
cise
phase
bi-
ases
mes-
sage
con-
tains
the
bi-
ases
to
be
added
to
the
car-
rier
phase
of
the
cor-
re-
spond-
ing
sig-
nal
to
get
cor-
rected

Version 2.5.4, May 3, 2019

427

car-
rier
phase
mea-
sure-
ment,
as
well

(Table 7.7.8)80

Field

7.7.4:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(`sid.code`)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 7.7.8:

val-

ues

(`sid.code[0:7]`)

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	4	u32	time.tow	Seconds since start of GPS week
4	2	u16	time.wn	GPS week number
6	1	u8	sid.sat	Constellation-specific satellite identifier. This field for Glonass can either be (100+FCN) where FCN is in [-7,+6] or the Slot ID in [1,28]
7	1	u8	sid.code	Signal constellation, band and code
8	1	u8 s	update_interval	Update interval between consecutive

MSG**SSR****OR-****BIT**

—

0x05DB

—

1499

The

pre-

cise

or-

bit

cor-

rec-

tion

mes-

sage

is

to

be

ap-

plied

as

a

delta

cor-

rec-

tion

to

broad-

cast

ephemeris

and

is

typ-

i-

cally

an

equiv-

a-

lent

Version 2.5.4, May 3, 2019

to

the

1057

RTCM

mes-

sage

types

(Table 7.7.10)80

Field

7.7.5:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(`sid.code`)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 7.7.10:

val-

ues

(`sid.code[0:7]`)

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	4	u32	<code>time.tow</code>	Seconds since start of GPS week
4	2	u16	<code>time.wn</code>	GPS week number
6	1	u8	<code>sid.sat</code>	Constellation-specific satellite identifier. This field for Glonass can either be (100+FCN) where FCN is in [-7,+6] or the Slot ID in [1,28]
7	1	u8	<code>sid.code</code>	Signal constellation, band and code
8	1	u8 s	<code>update_interval</code>	Update interval between consecutive

MSG
SSR
CLOCK

—
0x05DA

—
1498

The
pre-
cise
clock
cor-
rec-
tion
mes-
sage
is
to
be
ap-
plied
as
a
delta
cor-
rec-
tion
to
broad-
cast
ephemeris
and
is
typ-
i-
cally
an
equiv-
a-
lent
to

the
1058

RTCM
mes-
sage
types

(Table 7.7.12)80

Field

7.7.6:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(`sid.code`)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 7.7.12:

val-

ues

(`sid.code[0:7]`)

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
0	4	u32	<code>time.tow</code>	Seconds since start of GPS week
4	2	u16	<code>time.wn</code>	GPS week number
6	1	u8	<code>sid.sat</code>	Constellation-specific satellite identifier. This field for Glonass can either be (100+FCN) where FCN is in [-7,+6] or the Slot ID in [1,28]
7	1	u8	<code>sid.code</code>	Signal constellation, band and code
8	1	u8 s	<code>update_interval</code>	Update interval between consecutive

7.8 Tracking

Satellite
code
and
carrier-
phase
track-
ing
mes-
sages
from
the
de-
vice.

**MSG
TRACK-
ING
STATE****0x0041****65**

The track-
ing mes-
sage re-
turns a
variable-
length ar-
ray of
track-
ing chan-
nel
states.
It re-
ports sta-
tus
and carrier-
to-
noise den-
sity mea-
sure-
ments
for all
tracked
satel-
lites.

(Table 7.8.2)80

Field

7.8.1:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(`sid.code`)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 7.8.2:

val-

ues

(`sid.code[0:7]`)

Offset (bytes)	Size (bytes)	Unit	Name	Description
4N+0	1	u8	<code>states[N].sid.sat</code>	Constellation-specific satellite identifier. This field for Glonass can either be (100+FCN) where FCN is in [-7,+6] or the Slot ID in [1,28]
4N+1	1	u8	<code>states[N].sid.code</code>	Signal constellation, band and code
4N+2	1	u8	<code>states[N].fcn</code>	Frequency channel number (GLONASS only)
4N+3	1	u8	<code>states[N].cn0</code>	Carrier-to-Noise density. Zero implies invalid <code>cn0</code> .

**MSG
MEA-
SURE-
MENT
STATE**

0x0061

97

The
track-
ing
mes-
sage
re-
turns
a
variable-
length
ar-
ray
of
track-
ing
chan-
nel
states.
It
re-
ports
sta-
tus
and
carrier-
to-
noise
den-
sity
mea-
sure-
ments
for
all
tracked
satel-
lites.

(Table 7.8.4)80

Field

7.8.2:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(mesid.code)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 7.8.4:

val-

ues

(mesid.code[0:7])

Offset (bytes)	Size (bytes)	Unit	Field Name	Description
3N+0	4	u8	states[N].mesid.sat	Constellation-specific satellite identifier. This field for Glonass can either be (100+FCN) where FCN is in [-7,+6] or the Slot ID in [1,28]
3N+1	4	u8	states[N].mesid.code	Signal constellation, band and code
3N+2	4	dB Hz / 4	states[N].cn0	Carrier-to-Noise density. Zero implies invalid in-
Version 2.5.4, May 3, 2019				valid cn0.
3N				Total Payload Length

Table 7.8.3:
MSG_MEASUREMENT_STATE

**MSG
TRACK-
ING
IQ**

—
0x002D

—
45

When
en-
abled,
a
track-
ing
chan-
nel
can
out-
put
the
cor-
re-
la-
tions
at
each
up-
date
in-
ter-
val.

(Table 7.8.6)80

Field

7.8.3:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(sid.code)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 7.8.6:

val-

ues

(sid.code[0:7])

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	1	u8	channel	Tracking chan- nel of ori- gin
1	1	u8	sid.sat	Constellation- specific satel- lite iden- ti- fier. This field for Glonass can ei- ther be (100+FCN) where FCN is in [- 7,+6] or the Slot ID in [1,28]
2	1	u8	sid.code	Signal con- stel- la- tion, band and code
$4N+3$	2	s16	corrs[N].I	In- phase cor-
Version 2.5.4, May 3, 2019				re- la- tion
$4N+5$	2	s16	corrs[N].Q	Quadrature cor- re- la- tion
$4N+$				Total

**MSG
TRACK-
ING
IQ
DEP
B**

—
0x002C

—
44

When
en-
abled,
a
track-
ing
chan-
nel
can
out-
put
the
cor-
re-
la-
tions
at
each
up-
date
in-
ter-
val.

(Table 7.8.8)80

Field

7.8.4:

Sig-

nal

con-

stel-

la-

tion,

band

and

code

(sid.code)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I

Table 7.8.8:

val-

ues

(sid.code[0:7])

Offset (bytes)	Size (bytes)	Unit	Name	Description
0	1	u8	channel	Tracking chan- nel of ori- gin
1	1	u8	sid.sat	Constellation- specific satel- lite iden- ti- fier. This field for Glonass can ei- ther be (100+FCN) where FCN is in [- 7,+6] or the Slot ID in [1,28]
2	1	u8	sid.code	Signal con- stel- la- tion, band and code
8N+3	4	s32	corrs[N].I	In- phase cor-
Version 2.5.4, May 3, 2019				re- la- tion
8N+7	4	s32	corrs[N].Q	Quadrature cor- re- la- tion
8N+				Total

7.9 User

Messages

re-

served

for

use

by

the

user.

**MSG
USER
DATA**

—

0x0800

—

2048

This
mes-
sage
can
con-
tain
any
ap-
pli-
ca-
tion
spe-
cific
user
data
up
to
a
max-
i-
mum
length
of
255
bytes
per
mes-
sage.

Offset (by bytes)	Size (bytes)	FieldName	Description
0	N	<code>u8[N] contents</code>	User data pay- load
	N		Total Pay- load Length

Table 7.9.1:
MSG_USER_DATA
0x0800
mes-
sage
struc-
ture

7.10 Vehicle

Messages
from
a
ve-
hi-
cle.

MSG
ODOM-
E-
TRY

—
0x0903

—
2307

Message

rep-

re-

sent-

ing

the

x

com-

po-

nent

of

ve-

hi-

cle

ve-

loc-

ity

in

the

user

frame

at

the

odom-

e-

try

ref-

er-

ence

point(s)

spec-

i-

fied

by

Version 2.5.4, May 3, 2019

the

user.

The

off-

set

for

the

odom-

Reserved35

Ve-

loc-

ity

Source

(Ta-

ble 7.10.3)23

Time

source

(Ta-

ble 7.10.2)30

Field

7.10.1:

Sta-

tus

flags

(flags)

Value	Description
0	None (invalid)
1	GPS Solution (ms in week)
2	Processor Time

Table 7.10.2:

Time

source

val-

ues

(flags[0:2])

Value	Description
0	Source 0
1	Source 1
2	Source 2
3	Source 3

Table 7.10.3:

Ve-

loc-

ity

Source

val-

ues

(flags[3:4])

Offset (bytes)	Size (bytes)	Unit Name	Description
0	4	u32ms tow	Time field representing either milliseconds in the GPS Week or local CPU time from the producing system in milliseconds. See the tow_source flag for the exact source of this timestamp.
4	4	s32mmv/velocity	The signed forward component of velocity.