6.6 Observation

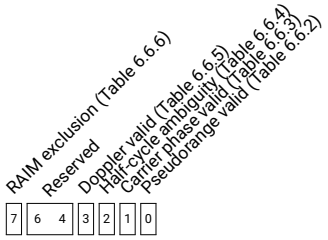
Satellite observation messages from the device. The SBP sender ID of 0 indicates remote observations from a GNSS base station, correction network, or Skylark, Swift's cloud GNSS correction product.

MSG_OBS — 0x004A — 74

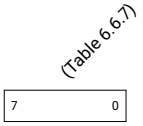
The GPS observations message reports all the raw pseudorange and carrier phase observations for the satellites being tracked by the device. Carrier phase observation here is represented as a 40-bit fixed point number with Q32.8 layout (i.e. 32-bits of whole cycles and 8-bits of fractional cycles). The observations are be interoperable with 3rd party receivers and conform with typical RTCMv3 GNSS observations.

Offset (bytes)	Size (bytes)	Format	Units	Name	Description
0	4	u32	ms	`header.t.tow`	Milliseconds since start of GPS week
4	4	s32	ns	`header.t.ns_residual`	Nanosecond residual of millisecond-rounded TOW (ranges from -500000 to 500000)
8	2	u16	week	`header.t.wn`	GPS week number
10	1	u8		`header.n_obs`	Total number of observations. First nibble is the size of the sequence (n), second nibble is the zero-indexed counter (ith packet of n)
17N + 11	4	u32	2 cm	`obs[N].P`	Pseudorange observation
17N + 15	4	s32	cycles	`obs[N].L.i`	Carrier phase whole cycles
17N + 19	1	u8	cycles / 256	`obs[N].L.f`	Carrier phase fractional part
17N + 20	2	s16	Hz	`obs[N].D.i`	Doppler whole Hz
17N + 22	1	u8	Hz / 256	`obs[N].D.f`	Doppler fractional part
17N + 23	1	u8	dB Hz / 4	`obs[N].cn0`	Carrier-to-Noise density. Zero implies invalid cn0.
17N + 24	1	u8		`obs[N].lock`	Lock timer. This value gives an indication of the time for which a signal has maintained continuous phase lock. Whenever a signal has lost and regained lock, this value is reset to zero. It is encoded according to DF402 from the RTCM 10403.2 Amendment 2 specification. Valid values range from 0 to 15 and the most significant nibble is reserved for future use.
17N + 25	1	u8		`obs[N].flags`	Measurement status flags. A bit field of flags providing the status of this observation. If this field is 0 it means only the Cn0 estimate for the signal is valid.
17N + 26	1	u8		`obs[N].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]
17N + 27	1	u8		`obs[N].sid.code`	Signal constellation, band and code
	17N + 11				Total Payload Length

Table 6.6.1: MSG_OBS 0x004A message structure



Field 6.6.1: Measurement status flags. A bit field of flags providing the status of this observation. If this field is 0 it means only the Cn0 estimate for the signal is valid. (`flags`)



Field 6.6.2: Signal constellation, band and code (`sid.code`)

Value	Description
0	Invalid pseudorange measurement
1	Valid pseudorange measurement and coarse TOW decoded

Table 6.6.2: Pseudorange valid values (`flags[0]`)

Value	Description
0	Invalid carrier phase measurement
1	Valid carrier phase measurement

Table 6.6.3: Carrier phase valid values (`flags[1]`)

Value	Description
0	Half cycle phase ambiguity unresolved
1	Half cycle phase ambiguity resolved

Table 6.6.4: Half-cycle ambiguity values (`flags[2]`)

Value	Description
0	Invalid doppler measurement
1	Valid doppler measurement

Table 6.6.5: Doppler valid values (`flags[3]`)

Value	Description
0	No exclusion
1	Measurement was excluded by SPP RAIM, use with care

Table 6.6.6: RAIM exclusion values (`flags[7]`)

Value	Description
0	GPS L1CA
1	GPS L2CM
2	SBAS L1CA
3	GLO L1CA
4	GLO L2CA
5	GPS L1P
6	GPS L2P
9	GPS L5I
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I
26	GAL E5I
47	BDS3 B2a

Table 6.6.7: values (`sid.code[0:7]`)

MSG_BASE_POS_ECEF — 0x0048 — 72

The base station position message is the position reported by the base station itself in absolute Earth Centered Earth Fixed coordinates. It is used for pseudo-absolute RTK positioning, and is required to be a high-accuracy surveyed location of the base station. Any error here will result in an error in the pseudo-absolute position output.

Offset (bytes)	Size (bytes)	Format	Units	Name	Description
0	8	double	m	x	ECEF X coodinate
8	8	double	m	y	ECEF Y coordinate
16	8	double	m	z	ECEF Z coordinate
	24				Total Payload Length

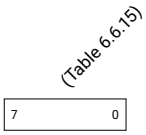
Table 6.6.9: MSG_BASE_POS_ECEF 0x0048 message structure

MSG_EPHEMERIS_GPS — 0x008A — 138

The ephemeris message returns a set of satellite orbit parameters that is used to calculate GPS satellite position, velocity, and clock offset. Please see the Navstar GPS Space Segment/Navigation user interfaces (ICD-GPS-200, Table 20-III) for more details.

Offset (bytes)	Size (bytes)	Format	Units	Name	Description
0	1	u8		common.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		common.sid.code	Signal constellation, band and code
2	4	u32	s	common.toe.tow	Seconds since start of GPS week
6	2	u16	week	common.toe.wn	GPS week number
8	4	float	m	common.ura	User Range Accuracy
12	4	u32	s	common.fit_interval	Curve fit interval
16	1	u8		common.valid	Status of ephemeris, 1 = valid, 0 = invalid
17	1	u8		common.health_bits	Satellite health status. GPS: ICD-GPS-200, chapter 20.3.3.3.1.4 SBAS: 0 = valid, non-zero = invalid GLO: 0 = valid, non-zero = invalid
18	4	float	s	tgd	Group delay differential between L1 and L2
22	4	float	m	c_rs	Amplitude of the sine harmonic correction term to the orbit radius
26	4	float	m	c_rc	Amplitude of the cosine harmonic correction term to the orbit radius
30	4	float	rad	c_uc	Amplitude of the cosine harmonic correction term to the argument of latitude
34	4	float	rad	c_us	Amplitude of the sine harmonic correction term to the argument of latitude
38	4	float	rad	c_ic	Amplitude of the cosine harmonic correction term to the angle of inclination
42	4	float	rad	c_is	Amplitude of the sine harmonic correction term to the angle of inclination
46	8	double	rad/s	dn	Mean motion difference
54	8	double	rad	m0	Mean anomaly at reference time
62	8	double		ecc	Eccentricity of satellite orbit
70	8	double	mˆ(1/2)	sqrta	Square root of the semi-major axis of orbit
78	8	double	rad	omega0	Longitude of ascending node of orbit plane at weekly epoch
86	8	double	rad/s	omegadot	Rate of right ascension
94	8	double	rad	w	Argument of perigee
102	8	double	rad	inc	Inclination
110	8	double	rad/s	inc_dot	Inclination first derivative
118	4	float	s	af0	Polynomial clock correction coefficient (clock bias)
122	4	float	s/s	af1	Polynomial clock correction coefficient (clock drift)
126	4	float	s/sˆ2	af2	Polynomial clock correction coefficient (rate of clock drift)
130	4	u32	s	toc.tow	Seconds since start of GPS week
134	2	u16	week	toc.wn	GPS week number
136	1	u8		iode	Issue of ephemeris data
137	2	u16		iodc	Issue of clock data
	139				Total Payload Length

Table 6.6.14: MSG_EPHEMERIS_GPS 0x008A message structure



Field 6.6.5: Signal constellation, 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
9	GPS L5I
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I
26	GAL E5I
47	BDS3 B2a

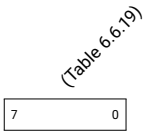
Table 6.6.15: values (`common.sid.code[0:7]`)

MSG_EPHEMERIS_BDS — 0x0089 — 137

The ephemeris message returns a set of satellite orbit parameters that is used to calculate BDS satellite position, velocity, and clock offset. Please see the BeiDou Navigation Satellite System SIS-ICD Version 2.1, Table 5-9 for more details.

Offset (bytes)	Size (bytes)	Format	Units	Name	Description
0	1	u8		common.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		common.sid.code	Signal constellation, band and code
2	4	u32	s	common.toe.tow	Seconds since start of GPS week
6	2	u16	week	common.toe.wn	GPS week number
8	4	float	m	common.ura	User Range Accuracy
12	4	u32	s	common.fit_interval	Curve fit interval
16	1	u8		common.valid	Status of ephemeris, 1 = valid, 0 = invalid
17	1	u8		common.health_bits	Satellite health status. GPS: ICD-GPS-200, chapter 20.3.3.3.1.4 SBAS: 0 = valid, non-zero = invalid GLO: 0 = valid, non-zero = invalid
18	4	float	s	tgd1	Group delay differential for B1
22	4	float	s	tgd2	Group delay differential for B2
26	4	float	m	c_rs	Amplitude of the sine harmonic correction term to the orbit radius
30	4	float	m	c_rc	Amplitude of the cosine harmonic correction term to the orbit radius
34	4	float	rad	c_uc	Amplitude of the cosine harmonic correction term to the argument of latitude
38	4	float	rad	c_us	Amplitude of the sine harmonic correction term to the argument of latitude
42	4	float	rad	c_ic	Amplitude of the cosine harmonic correction term to the angle of inclination
46	4	float	rad	c_is	Amplitude of the sine harmonic correction term to the angle of inclination
50	8	double	rad/s	dn	Mean motion difference
58	8	double	rad	m0	Mean anomaly at reference time
66	8	double		ecc	Eccentricity of satellite orbit
74	8	double	mˆ(1/2)	sqrta	Square root of the semi-major axis of orbit
82	8	double	rad	omega0	Longitude of ascending node of orbit plane at weekly epoch
90	8	double	rad/s	omegadot	Rate of right ascension
98	8	double	rad	w	Argument of perigee
106	8	double	rad	inc	Inclination
114	8	double	rad/s	inc_dot	Inclination first derivative
122	8	double	s	af0	Polynomial clock correction coefficient (clock bias)
130	4	float	s/s	af1	Polynomial clock correction coefficient (clock drift)
134	4	float	s/sˆ2	af2	Polynomial clock correction coefficient (rate of clock drift)
138	4	u32	s	toc.tow	Seconds since start of GPS week
142	2	u16	week	toc.wn	GPS week number
144	1	u8		iode	Issue of ephemeris data Calculated from the navigation data parameter t_oe per RTCM/CSNO recommendation: IODE = mod (t_oe / 720, 240)
145	2	u16		iodc	Issue of clock data Calculated from the navigation data parameter t_oe per RTCM/CSNO recommendation: IODE = mod (t_oc / 720, 240)
	147				Total Payload Length

Table 6.6.18: MSG_EPHEMERIS_BDS 0x0089 message structure



Field 6.6.7: Signal constellation, 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
9	GPS L5I
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I
26	GAL E5I
47	BDS3 B2a

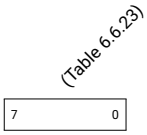
Table 6.6.19: values (`common.sid.code[0:7]`)

MSG_EPHEMERIS_GAL — 0x008D — 141

The ephemeris message returns a set of satellite orbit parameters that is used to calculate Galileo satellite position, velocity, and clock offset. Please see the Signal In Space ICD OS SIS ICD, Issue 1.3, December 2016 for more details.

Offset (bytes)	Size (bytes)	Format	Units	Name	Description
0	1	u8		common.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		common.sid.code	Signal constellation, band and code
2	4	u32	s	common.toe.tow	Seconds since start of GPS week
6	2	u16	week	common.toe.wn	GPS week number
8	4	float	m	common.ura	User Range Accuracy
12	4	u32	s	common.fit_interval	Curve fit interval
16	1	u8		common.valid	Status of ephemeris, 1 = valid, 0 = invalid
17	1	u8		common.health_bits	Satellite health status. GPS: ICD-GPS-200, chapter 20.3.3.3.1.4 SBAS: 0 = valid, non-zero = invalid GLO: 0 = valid, non-zero = invalid
18	4	float	s	bgd_e1e5a	E1-E5a Broadcast Group Delay
22	4	float	s	bgd_e1e5b	E1-E5b Broadcast Group Delay
26	4	float	m	c_rs	Amplitude of the sine harmonic correction term to the orbit radius
30	4	float	m	c_rc	Amplitude of the cosine harmonic correction term to the orbit radius
34	4	float	rad	c_uc	Amplitude of the cosine harmonic correction term to the argument of latitude
38	4	float	rad	c_us	Amplitude of the sine harmonic correction term to the argument of latitude
42	4	float	rad	c_ic	Amplitude of the cosine harmonic correction term to the angle of inclination
46	4	float	rad	c_is	Amplitude of the sine harmonic correction term to the angle of inclination
50	8	double	rad/s	dn	Mean motion difference
58	8	double	rad	m0	Mean anomaly at reference time
66	8	double		ecc	Eccentricity of satellite orbit
74	8	double	mˆ(1/2)	sqrta	Square root of the semi-major axis of orbit
82	8	double	rad	omega0	Longitude of ascending node of orbit plane at weekly epoch
90	8	double	rad/s	omegadot	Rate of right ascension
98	8	double	rad	w	Argument of perigee
106	8	double	rad	inc	Inclination
114	8	double	rad/s	inc_dot	Inclination first derivative
122	8	double	s	af0	Polynomial clock correction coefficient (clock bias)
130	8	double	s/s	af1	Polynomial clock correction coefficient (clock drift)
138	4	float	s/sˆ2	af2	Polynomial clock correction coefficient (rate of clock drift)
142	4	u32	s	toc.tow	Seconds since start of GPS week
146	2	u16	week	toc.wn	GPS week number
148	2	u16		iode	Issue of data (IODnav)
150	2	u16		iodc	Issue of data (IODnav). Always equal to iode
152	1	u8		source	0=I/NAV, 1=F/NAV
	153				Total Payload Length

Table 6.6.22: MSG_EPHEMERIS_GAL 0x008D message structure



Field 6.6.9: Signal constellation, 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
9	GPS L5I
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I
26	GAL E5I
47	BDS3 B2a

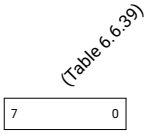
Table 6.6.23: values (`common.sid.code[0:7]`)

MSG_EPHEMERIS_GLO — 0x008B — 139

The ephemeris message returns a set of satellite orbit parameters that is used to calculate GLO satellite position, velocity, and clock offset. Please see the GLO ICD 5.1 "Table 4.5 Characteristics of words of immediate information (ephemeris parameters)" for more details.

Offset (bytes)	Size (bytes)	Format	Units	Name	Description
0	1	u8		common.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		common.sid.code	Signal constellation, band and code
2	4	u32	s	common.toe.tow	Seconds since start of GPS week
6	2	u16	week	common.toe.wn	GPS week number
8	4	float	m	common.ura	User Range Accuracy
12	4	u32	s	common.fit_interval	Curve fit interval
16	1	u8		common.valid	Status of ephemeris, 1 = valid, 0 = invalid
17	1	u8		common.health_bits	Satellite health status. GPS: ICD-GPS-200, chapter 20.3.3.3.1.4 SBAS: 0 = valid, non-zero = invalid GLO: 0 = valid, non-zero = invalid
18	4	float		gamma	Relative deviation of predicted carrier frequency from nominal
22	4	float	s	tau	Correction to the SV time
26	4	float	s	d_tau	Equipment delay between L1 and L2
30	24	double[3]	m	pos	Position of the SV at tb in PZ-90.02 coordinates system
54	24	double[3]	m/s	vel	Velocity vector of the SV at tb in PZ-90.02 coordinates system
78	12	float[3]	m/s^2	acc	Acceleration vector of the SV at tb in PZ-90.02 coordinates sys
90	1	u8		fcn	Frequency slot. FCN+8 (that is [1..14]). 0 or 0xFF for invalid
91	1	u8		iod	Issue of data. Equal to the 7 bits of the immediate data word t_b
	92				Total Payload Length

Table 6.6.38: MSG_EPHEMERIS_GLO 0x008B message structure



Field 6.6.17: Signal constellation, 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
9	GPS L5I
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I
26	GAL E5I
47	BDS3 B2a

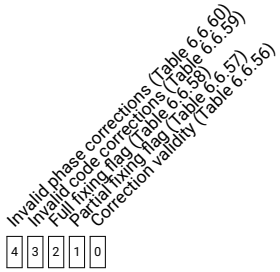
Table 6.6.39: values (common.sid.code[0:7])

MSG_OSR — 0x0640 — 1600

The OSR message contains network corrections in an observation-like format

Offset (bytes)	Size (bytes)	Format	Units	Name	Description
0	4	u32	ms	`header.t.tow`	Milliseconds since start of GPS week
4	4	s32	ns	`header.t.ns_residual`	Nanosecond residual of millisecond-rounded TOW (ranges from -500000 to 500000)
8	2	u16	week	`header.t.wn`	GPS week number
10	1	u8		`header.n_obs`	Total number of observations. First nibble is the size of the sequence (n), second nibble is the zero-indexed counter (ith packet of n)
$19N + 11$	4	u32	2 cm	`obs[N].P`	Pseudorange observation
$19N + 15$	4	s32	cycles	`obs[N].L.i`	Carrier phase whole cycles
$19N + 19$	1	u8	cycles / 256	`obs[N].L.f`	Carrier phase fractional part
$19N + 20$	1	u8		`obs[N].lock`	Lock timer. This value gives an indication of the time for which a signal has maintained continuous phase lock. Whenever a signal has lost and regained lock, this value is reset to zero. It is encoded according to DF402 from the RTCM 10403.2 Amendment 2 specification. Valid values range from 0 to 15 and the most significant nibble is reserved for future use.
$19N + 21$	1	u8		`obs[N].flags`	Correction flags.
$19N + 22$	1	u8		`obs[N].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]
$19N + 23$	1	u8		`obs[N].sid.code`	Signal constellation, band and code
$19N + 24$	2	u16	5 mm	`obs[N].iono_std`	Slant ionospheric correction standard deviation
$19N + 26$	2	u16	5 mm	`obs[N].tropo_std`	Slant tropospheric correction standard deviation
$19N + 28$	2	u16	5 mm	`obs[N].range_std`	Orbit/clock/bias correction projected on range standard deviation
	$19N + 11$				Total Payload Length

Table 6.6.55: MSG_OSR 0x0640 message structure



Field 6.6.23: Correction flags. (`flags`)

Value	Description
0	Do not use signal
1	Valid signal

Table 6.6.56: Correction validity values (`flags[0]`)

Value	Description
0	Partial fixing unavailable
1	Partial fixing available

Table 6.6.57: Partial fixing flag values (`flags[1]`)

Value	Description
0	Full fixing unavailable
1	Full fixing available

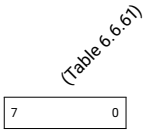
Table 6.6.58: Full fixing flag values (`flags[2]`)

Value	Description
0	Valid code corrections
1	Do not use code corrections

Table 6.6.59: Invalid code corrections values (`flags[3]`)

Value	Description
0	Valid phase corrections
1	Do not use phase corrections

Table 6.6.60: Invalid phase corrections values (`flags[4]`)



Field 6.6.24: Signal constellation, 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
9	GPS L5I
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I
26	GAL E5I
47	BDS3 B2a

Table 6.6.61: values (`sid.code[0:7]`)

7.6 Ssr

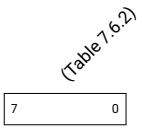
Precise State Space Representation (SSR) corrections format

MSG SSR ORBIT CLOCK — 0x05DD — 1501

The precise orbit and clock correction message is to be applied as a delta correction to broadcast ephemeris and is an equivalent to the 1060 /1066 RTCM message types

Offset (bytes)	Size (bytes)	Format	Units	Name	Description
0	4	u32	s	time.tow	Seconds since start of GPS week
4	2	u16	week	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		update_interval	Update interval between consecutive corrections. Encoded following RTCM DF391 specification.
9	1	u8		iod_ssr	IOD of the SSR correction. A change of Issue Of Data SSR is used to indicate a change in the SSR generating configuration
10	4	u32		iod	Issue of broadcast ephemeris data or IODCRC (Beidou)
14	4	s32	0.1 mm	radial	Orbit radial delta correction
18	4	s32	0.4 mm	along	Orbit along delta correction
22	4	s32	0.4 mm	cross	Orbit along delta correction
26	4	s32	0.001 mm/s	dot_radial	Velocity of orbit radial delta correction
30	4	s32	0.004 mm/s	dot_along	Velocity of orbit along delta correction
34	4	s32	0.004 mm/s	dot_cross	Velocity of orbit cross delta correction
38	4	s32	0.1 mm	c0	C0 polynomial coefficient for correction of broadcast satellite clock
42	4	s32	0.001 mm/s	c1	C1 polynomial coefficient for correction of broadcast satellite clock
46	4	s32	0.00002 mm/sˆ-2	c2	C2 polynomial coefficient for correction of broadcast satellite clock
	50				Total Payload Length

Table 7.6.1: MSG_SSR_ORBIT_CLOCK 0x05DD message structure



Field 7.6.1: Signal constellation, 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
9	GPS L5I
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I
26	GAL E5I
47	BDS3 B2a

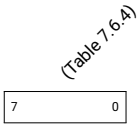
Table 7.6.2: values (`sid.code[0:7]`)

MSG SSR CODE BIASES — 0x05E1 — 1505

The precise code biases message is to be added to the pseudorange of the corresponding signal to get corrected pseudorange. It is an equivalent to the 1059 / 1065 RTCM message types

Offset (bytes)	Size (bytes)	Format	Units	Name	Description
0	4	u32	s	time.tow	Seconds since start of GPS week
4	2	u16	week	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		update_interval	Update interval between consecutive corrections. Encoded following RTCM DF391 specification.
9	1	u8		iod_ssr	IOD of the SSR correction. A change of Issue Of Data SSR is used to indicate a change in the SSR generating configuration
3N + 10	1	u8		biases[N].code	Signal encoded following RTCM specifications (DF380, DF381, DF382 and DF467).
3N + 11	2	s16	0.01 m	biases[N].value	Code bias value
	3N + 10				Total Payload Length

Table 7.6.3: MSG_SSR_CODE_BIASES 0x05E1 message structure



Field 7.6.2: Signal constellation, 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
9	GPS L5I
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I
26	GAL E5I
47	BDS3 B2a

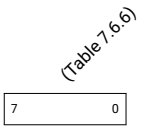
Table 7.6.4: values (sid.code[0:7])

MSG SSR PHASE BIASES — 0x05E6 — 1510

The precise phase biases message contains the biases to be added to the carrier phase of the corresponding signal to get corrected carrier phase measurement, as well as the satellite yaw angle to be applied to compute the phase wind-up correction. It is typically an equivalent to the 1265 RTCM message types

Offset (bytes)	Size (bytes)	Format	Units	Name	Description
0	4	u32	s	time.tow	Seconds since start of GPS week
4	2	u16	week	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		update_interval	Update interval between consecutive corrections. Encoded following RTCM DF391 specification.
9	1	u8		iod_ssr	IOD of the SSR correction. A change of Issue Of Data SSR is used to indicate a change in the SSR generating configuration
10	1	u8		dispersive_bias	Indicator for the dispersive phase biases property.
11	1	u8		mw_consistency	Consistency indicator for Melbourne-Wubbena linear combinations
12	2	u16	1 / 256 semi-circle	yaw	Satellite yaw angle
14	1	s8	1 / 8192 semi-circle / s	yaw_rate	Satellite yaw angle rate
8N + 15	1	u8		biases[N].code	Signal encoded following RTCM specifications (DF380, DF381, DF382 and DF467)
8N + 16	1	u8		biases[N].integer_indicator	Indicator for integer property
8N + 17	1	u8		biases[N].widelane_integer_indicator	Indicator for two groups of Wide-Lane(s) integer property
8N + 18	1	u8		biases[N].discontinuity_counter	Signal phase discontinuity counter. Increased for every discontinuity in phase.
8N + 19	4	s32	0.1 mm	biases[N].bias	Phase bias for specified signal
	8N + 15				Total Payload Length

Table 7.6.5: MSG_SSR_PHASE_BIASES 0x05E6 message structure



Field 7.6.3: Signal constellation, 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
9	GPS L5I
12	BDS2 B1
13	BDS2 B2
14	GAL E1B
20	GAL E7I
26	GAL E5I
47	BDS3 B2a

Table 7.6.6: values (`sid.code[0:7]`)

MSG SSR STEC CORRECTION — 0x05FB — 1531

The Slant Total Electron Content per space vehicle, given as polynomial approximation for a given tile. This should be combined with the MSG_SSR_GRIDDED_CORRECTION message to get the state space representation of the atmospheric delay.
It is typically equivalent to the QZSS CLAS Sub Type 8 messages.

Offset (bytes)	Size (bytes)	Format	Units	Name	Description
0	2	u16		header.tile_set_id	Unique identifier of the tile set this tile belongs to.
2	2	u16		header.tile_id	Unique identifier of this tile in the tile set.
4	4	u32	s	header.time.tow	Seconds since start of GPS week
8	2	u16	week	header.time.wn	GPS week number
10	1	u8		header.num_msgs	Number of messages in the dataset
11	1	u8		header.seq_num	Position of this message in the dataset
12	1	u8		header.update_interval	Update interval between consecutive corrections. Encoded following RTCM DF391 specification.
13	1	u8		header.iod_atmo	IOD of the SSR atmospheric correction
11N + 14	1	u8		stec_sat_list[N].sv_id.satId	ID of the space vehicle within its constellation
11N + 15	1	u8		stec_sat_list[N].sv_id.constellation	Constellation ID to which the SV belongs
11N + 16	1	u8		stec_sat_list[N].stec_quality_indicator	Quality of the STEC data. Encoded following RTCM DF389 specification but in units of TECU instead of m.
11N + 17	8	s16[4]	C00 = 0.05 TECU, C01/C10 = 0.02 TECU/deg, C11 0.02 TECU/deg^2	stec_sat_list[N].stec_coeff	Coefficents of the STEC polynomial in the order of C00, C01, C10, C11
	11N + 14				Total Payload Length

Table 7.6.7: MSG_SSR_STEC_CORRECTION 0x05FB message structure

MSG SSR GRIDDED CORRECTION — 0x05FC — 1532

STEC residuals are per space vehicle, troposphere is not.
It is typically equivalent to the QZSS CLAS Sub Type 9 messages

Offset (bytes)	Size (bytes)	Format	Units	Name	Description
0	2	u16		header.tile_set_id	Unique identifier of the tile set this tile belongs to.
2	2	u16		header.tile_id	Unique identifier of this tile in the tile set.
4	4	u32	s	header.time.tow	Seconds since start of GPS week
8	2	u16	week	header.time.wn	GPS week number
10	2	u16		header.num_msgs	Number of messages in the dataset
12	2	u16		header.seq_num	Position of this message in the dataset
14	1	u8		header.update_interval	Update interval between consecutive corrections. Encoded following RTCM DF391 specification.
15	1	u8		header.iod_atmo	IOD of the SSR atmospheric correction
16	1	u8		header.tropo_quality_indicator	Quality of the troposphere data. Encoded following RTCM DF389 specification in units of m.
17	2	u16		element.index	Index of the grid point
19	2	s16	4 mm	element.tropo_delay_correction.hydro	Hydrostatic vertical delay (add 2.3 m to get actual vertical hydro delay)
21	1	s8	4 mm	element.tropo_delay_correction.wet	Wet vertical delay (add 0.252 m to get actual vertical wet delay)
22	1	u8		element.tropo_delay_correction.stddev	stddev; modified DF389 scale; class is upper 3 bits, value is lower 5; stddev <= (3^class * (1 + value/16) - 1) mm
$5N + 23$	1	u8		element.stec_residuals[N].sv_id.satId	ID of the space vehicle within its constellation
$5N + 24$	1	u8		element.stec_residuals[N].sv_id.constellation	Constellation ID to which the SV belongs
$5N + 25$	2	s16	0.04 TECU	element.stec_residuals[N].residual	STEC residual
$5N + 27$	1	u8		element.stec_residuals[N].stddev	stddev; modified DF389 scale; class is upper 3 bits, value is lower 5; stddev <= (3^class * (1 + value/16) - 1) * 10 TECU
	$5N + 23$				Total Payload Length

Table 7.6.8: MSG_SSR_GRIDDED_CORRECTION 0x05FC message structure

MSG SSR TILE DEFINITION — 0x05F6 — 1526

Provides the correction point coordinates for the atmospheric correction values in the MSG_SSR_STEC_CORRECTION and MSG_SSR_GRIDDED_CORRECTION messages.
Based on ETSI TS 137 355 V16.1.0 (LTE Positioning Protocol) information element GNSS-SSR-CorrectionPoints. SBP only supports gridded arrays of correction points, not lists of points.

Offset (bytes)	Size (bytes)	Format	Units	Name	Description
0	2	u16		tile_set_id	Unique identifier of the tile set this tile belongs to.
2	2	u16		tile_id	Unique identifier of this tile in the tile set. See GNSS-SSR-ArrayOfCorrectionPoints field correctionPointSetID.
4	2	s16	encoded degrees	corner_nw_lat	North-West corner correction point latitude. The relation between the latitude X in the range [-90, 90] and the coded number N is: N = floor((X / 90) * 2^14) See GNSS-SSR-ArrayOfCorrectionPoints field referencePointLatitude.
6	2	s16	encoded degrees	corner_nw_lon	North-West corner correction point longtitude. The relation between the longtitude X in the range [-180, 180] and the coded number N is: N = floor((X / 180) * 2^15) See GNSS-SSR-ArrayOfCorrectionPoints field referencePointLongitude.
8	2	u16	0.01 degrees	spacing_lat	Spacing of the correction points in the latitude direction. See GNSS-SSR-ArrayOfCorrectionPoints field stepOfLatitude.
10	2	u16	0.01 degrees	spacing_lon	Spacing of the correction points in the longtitude direction. See GNSS-SSR-ArrayOfCorrectionPoints field stepOfLongtitude.
12	2	u16		rows	Number of steps in the latitude direction. See GNSS-SSR-ArrayOfCorrectionPoints field numberOfStepsLatitude.
14	2	u16		cols	Number of steps in the longtitude direction. See GNSS-SSR-ArrayOfCorrectionPoints field numberOfStepsLongtitude.
16	8	u64		bitmask	Specifies the availability of correction data at the correction points in the array. If a specific bit is enabled (set to 1), the correction is not available. Only the first rows * cols bits are used, the remainder are set to 0. If there are more then 64 correction points the remaining corrections are always available. Starting with the northwest corner of the array (top left on a north oriented map) the correction points are enumerated with row precedence - first row west to east, second row west to east, until last row west to east - ending with the southeast corner of the array. See GNSS-SSR-ArrayOfCorrectionPoints field bitmaskOfGrids but note the definition of the bits is inverted.
	24				Total Payload Length

Table 7.6.9: MSG_SSR_TILE_DEFINITION 0x05F6 message structure

MSG SSR STEC CORRECTION DEP A — 0x05EB — 1515

Offset (bytes)	Size (bytes)	Format	Units	Name	Description
0	4	u32	s	header.time.tow	Seconds since start of GPS week
4	2	u16	week	header.time.wn	GPS week number
6	1	u8		header.num_msgs	Number of messages in the dataset
7	1	u8		header.seq_num	Position of this message in the dataset
8	1	u8		header.update_interval	Update interval between consecutive corrections. Encoded following RTCM DF391 specification.
9	1	u8		header.iod_atmo	IOD of the SSR atmospheric correction
11N + 10	1	u8		stec_sat_list[N].sv_id.satId	ID of the space vehicle within its constellation
11N + 11	1	u8		stec_sat_list[N].sv_id.constellation	Constellation ID to which the SV belongs
11N + 12	1	u8		stec_sat_list[N].stec_quality_indicator	Quality of the STEC data. Encoded following RTCM DF389 specification but in units of TECU instead of m.
11N + 13	8	s16[4]	C00 = 0.05 TECU, C01/C10 = 0.02 TECU/deg, C11 0.02 TECU/degˆ2	stec_sat_list[N].stec_coeff	Coefficents of the STEC polynomial in the order of C00, C01, C10, C11
	11N + 10				Total Payload Length

Table 7.6.13: MSG_SSR_STEC_CORRECTION_DEP_A 0x05EB message structure

MSG SSR GRIDDED CORRECTION DEP A — 0x05FA — 1530

Offset (bytes)	Size (bytes)	Format	Units	Name	Description
0	4	u32	s	header.time.tow	Seconds since start of GPS week
4	2	u16	week	header.time.wn	GPS week number
6	2	u16		header.num_msgs	Number of messages in the dataset
8	2	u16		header.seq_num	Position of this message in the dataset
10	1	u8		header.update_interval	Update interval between consecutive corrections. Encoded following RTCM DF391 specification.
11	1	u8		header.iod_atmo	IOD of the SSR atmospheric correction
12	1	u8		header.tropo_quality_indicator	Quality of the troposphere data. Encoded following RTCM DF389 specifcation in units of m.
13	2	u16		element.index	Index of the grid point
15	2	s16	4 mm	element.tropo_delay_correction.hydro	Hydrostatic vertical delay (add 2.3 m to get actual vertical hydro delay)
17	1	s8	4 mm	element.tropo_delay_correction.wet	Wet vertical delay (add 0.252 m to get actual vertical wet delay)
18	1	u8		element.tropo_delay_correction.stddev	stddev; modified DF389 scale; class is upper 3 bits, value is lower 5; stddev <= (3^class * (1 + value/16) - 1) mm
$5N + 19$	1	u8		element.stec_residuals[N].sv_id.satId	ID of the space vehicle within its constellation
$5N + 20$	1	u8		element.stec_residuals[N].sv_id.constellation	Constellation ID to which the SV belongs
$5N + 21$	2	s16	0.04 TECU	element.stec_residuals[N].residual	STEC residual
$5N + 23$	1	u8		element.stec_residuals[N].stddev	stddev; modified DF389 scale; class is upper 3 bits, value is lower 5; stddev <= (3^class * (1 + value/16) - 1) * 10 TECU
	$5N + 19$				Total Payload Length

Table 7.6.14: MSG_SSR_GRIDDED_CORRECTION_DEP_A 0x05FA message structure

MSG SSR GRID DEFINITION DEP A — 0x05F5 — 1525

Offset (bytes)	Size (bytes)	Format	Units	Name	Description
0	1	u8	inverse degrees	header.region_size_inverse	region_size (deg) = 10 / region_size_inverse 0 is an invalid value.
1	2	u16		header.area_width	grid height (deg) = grid width (deg) = area_width / region_size 0 is an invalid value.
3	2	u16		header.lat_nw_corner_enc	North-West corner latitude (deg) = region_size * lat_nw_corner_enc - 90
5	2	u16		header.lon_nw_corner_enc	North-West corner longtitude (deg) = region_size * lon_nw_corner_enc - 180
7	1	u8		header.num_msgs	Number of messages in the dataset
8	1	u8		header.seq_num	Postion of this message in the dataset
9	N	u8[N]		rle_list	Run Length Encode list of quadrants that contain valid data. The spec describes the encoding scheme in detail, but essentially the index of the quadrants that contain transitions between valid and invalid (and vice versa) are encoded as u8 integers.
	N + 9				Total Payload Length

Table 7.6.15: MSG_SSR_GRID_DEFINITION_DEP_A 0x05F5 message structure