4.2 SBF Block Definitions

4.2.1 Measurement Blocks

GNSS observables are available in the following SBF blocks:

- the legacy `MeasEpoch` block, possibly complemented by `MeasExtra`.
- the `Meas3Ranges` block, possibly complemented by `Meas3Doppler` and `Meas3CN0HiRes`.

The `MeasEpoch` block contains pseudorange, carrier phase, C/N0 and Doppler observables. The `Meas3Ranges` block contains pseudoranges, carrier phases and C/N0, while Doppler is available in the companion `Meas3Doppler` block. The observable resolution is shown in the table below.

	`MeasEpoch`	`Meas3Ranges`
Pseudorange	1mm	1mm
Carrier phase	0.001cycles	0.001cycles
C/N0	0.25dB-Hz 0.03125dB-Hz with `MeasExtra`	1dB-Hz 0.0625dB-Hz with `Meas3CN0HiRes`
Doppler	0.0001Hz	No Doppler in `Meas3Ranges` 1mm/s with `Meas3Doppler`

The main advantage of the `Meas3` blocks is their reduced size compared to the `MeasEpoch` blocks. As an illustration, the following table shows the disk space required to log the different measurement-related blocks over one day at a 1-s interval. In this example, measurements from all GPS L1/L2/L5, GLONASS L1/L2, Galileo E1/E6/E5a/E5b and BeiDou B1/B2/B3 signals have been logged (constellation status as of beginning of 2017).

SBF Block	Disk space (1 day, 1 Hz)
`MeasEpoch`	104MB
`MeasExtra`	110MB
`Meas3Ranges`	28MB
`Meas3Doppler`	10MB
`Meas3CN0HiRes`	5MB

MeasEpoch	Number: 4027 "OnChange" interval: internal measurement rate (receiver-type dependent)

This block contains all the GNSS measurements (observables) taken at the time given by the TOW and WNc fields.

For each tracked signal, the following measurement set is available:

- the pseudorange
- the carrier phase
- the Doppler
- the C/N0
- the lock-time.

To decrease the block size, all the measurements from a given satellite are referenced to one master measurement set. For instance, the L2 pseudorange (C2) is not much different from the L1 pseudorange (C1), such that the difference between C2 and C1 is encoded, instead of the absolute value of C2.

This is done by using a two-level sub-block structure. All the measurements from a given satellite are stored in a MeasEpochChannelType1 sub-block. The first part of this sub-block contains the master measurements, encoded as absolute values. The second part contains slave measurements, for which only the delta values are encoded in smaller MeasEpochChannelType2 sub-blocks.

Every MeasEpochChannelType1 sub-block contains a field "N2", which gives the number of nested MeasEpochChannelType2 sub-blocks. If there is only one signal tracked for a given satellite, there are no slave measurements and N2 is set to 0.

Decoding is done as follows:

1. Decode the master measurements and the N2 value from the MeasEpochChannelType1 sub-block.
2. If N2 is not 0, decode the N2 nested MeasEpochChannelType2 sub-blocks.
3. Go back to 1 till the N1 MeasEpochChannelType1 sub-blocks have been decoded.

Note that measurements in this block are scrambled if the "Measurement Availability" permission is not granted on your receiver. See also bit 7 of the CommonFlags field.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
N1	u1			Number of MeasEpochChannelType1 sub-blocks in this MeasEpoch block.
SB1Length	u1	1 byte		Length of a MeasEpochChannelType1 sub-block, excluding the nested MeasEpochChannelType2 sub-blocks
SB2Length	u1	1 byte		Length of a MeasEpochChannelType2 sub-block
CommonFlags	u1			Bit field containing flags common to all measurements. Bit 0: Multipath mitigation: if this bit is set, multipath mitigation is enabled. (see the **setMultipathMitigation** command). Bit 1: Smoothing of code: if this bit is set, at least one of the code measurements are smoothed values (see **setSmoothingInterval** command). Bit 2: Carrier phase align: if this bit is set, the fractional part of the carrier phase measurements from different modulations on the same carrier frequency (e.g. GPS L2C and L2P) are aligned, i.e. multiplexing biases (0.25 or 0.5 cycles) are corrected. Aligned carrier phase measurements can be directly included in RINEX files. If this bit is unset, this block contains raw carrier phase measurements. This bit is always set in the current firmware version. Bit 3: Clock steering: this bit is set if clock steering is active (see **setClockSyncThreshold** command). Bit 4: Not applicable. Bit 5: High dynamics: this bit is set when the receiver is in high-dynamics mode (see the **setReceiverDynamics** command). Bit 6: Reserved Bit 7: Scrambling: bit set when the measurements are scrambled. Scrambling is applied when the "Measurement Availability" permission is not granted (see the **lif,Permissions** command).
CumClkJumps	u1	0.001 s		Cumulative millisecond clock jumps since start-up, with an ambiguity of k*256 ms. For example, if two clock jumps of -1 ms have occurred since startup, this field contains the value 254.
Reserved	u1			Reserved for future use, to be ignored by decoding software
Type1	...	...		*A succession of N1 MeasEpochChannelType1 sub-blocks, see definition below*
Padding	u1[..]			Padding bytes, see 4.1.5

Rev 1

MeasEpochChannelType1 sub-block definition:

Parameter	Type	Units	Do-Not-Use	Description
RxChannel	u1			Receiver channel on which this satellite is currently tracked (see 4.1.11).
Type	u1			Bit field indicating the signal type and antenna ID: Bits 0-4: SigIdxLo: if not 31, this is the signal number (see 4.1.10), otherwise the signal number can be found in the ObsInfo field below. Bits 5-7: Antenna ID: 0 for main, 1 for *Aux1* and 2 for *Aux2*

SVID	u1			Satellite ID, see 4.1.9
Misc	u1	4294967.296 m	0 (1)	Bit field containing the MSB of the pseudorange. Bits 0-3: CodeMSB: MSB of the pseudorange (this is an unsigned value). Bits 4-7: Reserved
CodeLSB	u4	0.001 m	0 (1)	LSB of the pseudorange. The pseudorange expressed in meters is computed as follows: PR_{type1}[m] = (CodeMSB*4294967296+CodeLSB)*0.001 where CodeMSB is part of the Misc field.
Doppler	i4	0.0001 Hz	−2147483648	Carrier Doppler (positive for approaching satellites). To compute the Doppler in Hz, use: D_{type1}[Hz] = Doppler*0.0001
CarrierLSB	u2	0.001 cycles	0 (2)	LSB of the carrier phase relative to the pseudorange
CarrierMSB	i1	65.536 cycles	−128 (2)	MSB of the carrier phase relative to the pseudorange. The full carrier phase can be computed by: L[cycles] = PR_{type1}[m]/λ +(CarrierMSB*65536+CarrierLSB)*0.001 where λ is the carrier wavelength corresponding to the frequency of the signal type in the Type field above: λ=299792458/f_L m, with f_L the carrier frequency as listed in section 4.1.10.
CN0	u1	0.25 dB-Hz	255	The C/N0 in dB-Hz is computed as follows, depending on the signal type in the Type field: C/N_0[dB-Hz] = CN0*0.25 if the signal number is 1 or 2 C/N_0[dB-Hz] = CN0*0.25+10 otherwise Users requiring a higher C/N0 resolution can use the MeasExtra SBF block. The Misc field of that block allows to extend the resolution to 0.03125dB-Hz.
LockTime	u2	1 s	65535	Duration of continuous carrier phase. The lock-time is reset at the initial lock of the phase-locked-loop, and whenever a loss of lock condition occurs. If the lock-time is longer than 65534s, it is clipped to 65534s. If the carrier phase measurement is not available, this field is set to its Do-Not-Use value.
ObsInfo	u1			Bit field: Bit 0: if set, the pseudorange measurement is smoothed Bit 1: Reserved Bit 2: this bit is set when the carrier phase (L) has a half-cycle ambiguity Bits 3-7: The interpretation of these bits depends on the value of SigIdxLo from the Type field. If SigIdxLo equals 31, these bits contain the signal number with an offset of 32 (see 4.1.10). For example, a value of 1 corresponds to signal number 33 (QZSS L1S). If SigIdxLo is 8, 9, 10 or 11, these bits contain the GLONASS frequency number with an offset of 8. For example, a value of 1 corresponds to frequency number -7. Otherwise, these bits are reserved.
N2	u1			Number of MeasEpochChannelType2 sub-blocks contained in this MeasEpochChannelType1 sub-block.

(1) The pseudorange is invalid if both CodeMSB is 0 and CodeLSB is 0.
(2) The carrier phase is invalid if both CarrierMSB is -128 and CarrierLSB is 0.

Padding	u1[..]			Padding bytes, see 4.1.5
Type2	...	...		*A succession of N2 MeasEpochChannelType2 sub-blocks, see definition below*

MeasEpochChannelType2 sub-block definition:

Parameter	Type	Units	Do-Not-Use	Description
Type	u1			Bit field indicating the signal type and antenna ID: Bits 0-4: SigIdxLo: if not 31, this is the signal number (see 4.1.10), otherwise the signal number can be found in the ObsInfo field below. Bits 5-7: Antenna ID: 0 for main, 1 for *Aux1* and 2 for *Aux2*
LockTime	u1	1 s	255	See corresponding field in the MeasEpochChannelType1 sub-block above, except that the value is clipped to 254 instead of 65534.
CN0	u1	0.25 dB-Hz	255	See corresponding field in the MeasEpochChannelType1 sub-block above.
OffsetsMSB	u1	 65.536 m 6.5536 Hz	 −4 (3) −16 (4)	Bit field containing the MSB of the code and of the Doppler offsets with respect to the MeasEpochChannelType1 sub-block. Bits 0-2: CodeOffsetMSB: MSB of the code offset. Bits 3-7: DopplerOffsetMSB: MSB of the Doppler offset. CodeOffsetMSB and DopplerOffsetMSB are coded as two's complement. Refer to the CodeOffsetLSB and DopplerOffsetLSB fields to see how to use this field.
CarrierMSB	i1	65.536 cycles	−128 (5)	MSB of the carrier phase relative to the pseudorange.
ObsInfo	u1			Bit field: Bit 0: if set, the pseudorange measurement is smoothed Bit 1: Reserved Bit 2: this bit is set when the carrier phase (L) has a half-cycle ambiguity Bits 3-7: If SigIdxLo from the Type field of this sub-block equals 31, these bits contain the signal number with an offset of 32 (see 4.1.10), e.g. 1 corresponds to signal number 33 (QZSS L1S). Otherwise they are reserved and must be ignored by the decoding software.
CodeOffsetLSB	u2	0.001 m	0 (3)	LSB of the code offset with respect to pseudorange in the MeasEpochChannelType1 sub-block. To compute the pseudorange, use: PR_{type2} [m] = PR_{type1}[m] + (CodeOffsetMSB*65536+CodeOffsetLSB)*0.001
CarrierLSB	u2	0.001 cycles	0 (5)	LSB of the carrier phase relative to the pseudorange. The full carrier phase can be computed by: L[cycles]= PR_{type2}[m]/λ +(CarrierMSB*65536+CarrierLSB)*0.001 where λ is the carrier wavelength corresponding to the signal type in the Type field.

(3) The pseudorange is invalid if both CodeOffsetMSB is -4 and CodeOffsetLSB is 0.
(4) The Doppler is invalid if both DopplerOffsetMSB is -16 and DopplerOffsetLSB is 0.
(5) The carrier phase is invalid if both CarrierMSB is -128 and CarrierLSB is 0.

DopplerOffsetLSB	u2	0.0001 Hz	0 (4)	LSB of the Doppler offset relative to the Doppler in the MeasEpochChannelType1 sub-block. To compute the Doppler, use: D_{type2}[Hz] = D_{type1}[Hz]*α +(DopplerOffsetMSB*65536+DopplerOffsetLSB) *1e-4, where α is the ratio of the carrier frequency corresponding to the observable type in this MeasEpochChannelType2 sub-block, and that of the master observable type in the parent MeasEpochChannelType1 sub-block (see section 4.1.10 for a list of all carrier frequencies).
Padding	u1[..]			Padding bytes, see 4.1.5

MeasExtra	Number: 4000 "OnChange" interval: internal measurement rate (receiver-type dependent)

This block contains extra information associated with the measurements contained in the MeasEpoch block, such as the internal corrections parameters applied during the measurement pre-processing, and the noise variances.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
N	u1			Number of sub-blocks in this MeasExtra block.
SBLength	u1	1 byte		Length of a sub-block
DopplerVarFactor	f4	1 Hz^2 / $cycle^2$		Factor to be used to compute the Doppler variance from the carrier phase variance. More specifically, the Doppler variance in mHz^2 can be computed by: $\sigma^2_{\text{Doppler}}[\text{mHz}^2]$ = CarrierVariance * DopplerVarFactor, Where CarrierVariance can be found for each measurement type in the MeasExtraChannelSub sub-blocks.
ChannelSub	...	...		*A succession of N MeasExtraChannelSub sub-blocks, see definition below*
Padding	u1[..]			Padding bytes, see 4.1.5

`MeasExtraChannelSub` sub-block definition:

	Parameter	Type	Units	Do-Not-Use	Description
	`RxChannel`	u1			Receiver channel on which this satellite is currently tracked (see 4.1.11).
	`Type`	u1			Bit field indicating the signal type and antenna ID: Bits 0-4: `SigIdxLo`: if not 31, this is the signal number (see 4.1.10), otherwise the signal number can be found in the `Misc` field below. A value of 31 can only happen on block revision 3 or above. Bits 5-7: Antenna ID: 0 for main, 1 for *Aux1* and 2 for *Aux2*
	`MPCorrection`	i2	0.001 m		Multipath correction applied to the pseudorange. This number has to be added to the pseudorange to recover the raw pseudo-range as it would be if multipath mitigation was not used.
	`SmoothingCorr`	i2	0.001 m		Smoothing correction applied to the pseudorange. This number has to be added to the pseudorange to recover the raw pseudo-range as it would be if smoothing was disabled.
	`CodeVar`	u2	0.0001 m^2	65535	Estimated code tracking noise variance. If the variance is larger than 65534 cm^2, it is clipped to 65534 cm^2.
	`CarrierVar`	u2	1 $mcycle^2$	65535	Estimated carrier tracking noise variance. This value can be multiplied by `DopplerVarFactor` to compute the Doppler measurement variance. If the variance is larger than 65534 $mcycles^2$, it is clipped to 65534 $mcycles^2$.
	`LockTime`	u2	1 s	65535	Duration of continuous carrier phase. The lock-time is reset at the initial lock after a signal (re)acquisition. If the lock-time is longer than 65534s, it is clipped to 65534s. If the carrier phase measurement is not available, this field is set to its Do-Not-Use value.
Rev 1	`CumLossCont`	u1			Carrier phase cumulative loss-of-continuity counter (modulo 256) for the signal type, antenna and satellite this sub-block refers to. This counter starts at zero at receiver start-up, and is incremented at each initial lock after signal (re)acquisition, or when a cycle slip is detected.
Rev 1	`CarMPCorr`	i1	1.953125 mcycle		Multipath correction applied to the carrier phase, in units of 1/512 cycles. This number has to be added to the carrier phase to recover the raw phase as it would be if multipath mitigation was not used.
Rev 2	`Info`	u1			Bit field: Bits 0-3: Reserved. Bits 4-7: Reserved.
Rev 3	`Misc`	u1	0.03125 dB-Hz		Bit field: Bits 0-2: `CN0HighRes`: high-resolution extension of the C/N0 (unsigned value from 0 to 7). The C/N0 value in the `MeasEpoch` SBF block has a resolution of 0.25dB-Hz. `CN0HighRes` can be used to extend the resolution to 0.03125dB-Hz. The high-resolution C/N0, in dB-Hz, is computed as follows: $C/N_{0,\mathrm{HighRes}} = C/N_{0,\mathrm{MeasEpoch}} + \mathrm{CN0HighRes} * 0.03125$. where $C/N_{0,\mathrm{MeasEpoch}}$ is the C/N0 value coming from the `MeasEpoch` SBF block. Bits 3-7: If `SigIdxLo` from the `Type` field equals 31, these bits contain the signal number with an offset of 32 (see 4.1.10). Otherwise they are reserved.

Padding	u1[..]			Padding bytes, see 4.1.5

Meas3Ranges	Number: 4109 "OnChange" interval: internal measurement rate (receiver-type dependent)

This block contains all the code, carrier phase and C/N0 observables at a given measurement epoch. The resolution is 0.001m, 0.001cycles and 1dB-Hz for the code, carrier and C/N0 measurements respectively.

Applications requiring Doppler measurements can log the Meas3Doppler SBF block in addition to the Meas3Ranges block. Applications requiring extended C/N0 resolution (1/16dB-Hz) can log the Meas3CN0HiRes SBF block in addition to the Meas3Ranges block.

The advantage of this block compared to the MeasEpoch SBF block is its reduced size while offering the full resolution for the code and carrier measurements. One of the techniques used to reduce the size is to only encode full measurements (reference epochs) every N epochs. Between these reference epochs, Meas3Ranges contains delta epochs where the difference between the current measurements and the ones at the applicable reference epoch is encoded. The decoder must have received and stored the applicable reference epoch to be able to decode delta epochs. When streaming SBF over an unreliable communication link, if the reference epoch is lost, subsequent Meas3Ranges blocks cannot be decoded until the next reference epoch is received. The interval at which reference epochs are encoded can be controlled with the **setMeas3MaxRefInterval** command. A longer interval generally reduces the average block size, at the expense of a longer data gap in case a reference epoch is lost.

See also page 238 for additional information.

The format of this block and of the other Meas3 blocks is complex and is not provided here. Details can be obtained from Septentrio Support. The RxTools installation contains the complete source code of a decoder in C language, together with sbf2asc, a small application showing how to use it. All C files can be found under the sbf2asc folder in the RxTools installation. The main measurement decoding function is sbfread_MeasCollectAndDecode() in the sbfread_meas.c file. Users interested in decoding the Meas3 blocks are strongly advised to use the provided source code instead of writing their own decoder.

The detailed definition of this block is not available in this document.

Meas3CN0HiRes	Number: 4110 "OnChange" interval: internal measurement rate (receiver-type dependent)

The Meas3CN0HiRes block is an extension of the Meas3Ranges block containing the fractional part of the C/N0 values. The resolution of the C/N0 value in the Meas3Ranges SBF block is 1dB-Hz. Applications requiring a finer C/N0 resolution (0.0625dB-Hz) must log the Meas3CN0HiRes block together with the Meas3Ranges block.

The detailed definition of this block is not available in this document.

Meas3Doppler	Number: 4111 "OnChange" interval: internal measurement rate (receiver-type dependent)

The Meas3Doppler block is an extension of the Meas3Ranges block containing the range-rate (Doppler) values. Applications requiring range-rate or Doppler observables must log the Meas3Doppler block together with the Meas3Ranges block.

The detailed definition of this block is not available in this document.

Meas3PP	Number: 4112 "OnChange" interval: internal measurement rate (receiver-type dependent)

The Meas3PP block is an extension of the Meas3Ranges block containing various Septentrio-proprietary flags and values needed for accurate post-processing or re-processing of the PVT from the measurements in the Meas3Ranges SBF block. This block must be logged together with Meas3Ranges.

The detailed definition of this block is not available in this document.

Meas3MP	Number: 4113 "OnChange" interval: internal measurement rate (receiver-type dependent)

The Meas3MP block is an extension of the Meas3Ranges block containing the multipath correction applied by the receiver. It can be used for research purposes to undo the receiver multipath mitigation and revert to unmitigated data. This block must be logged together with Meas3Ranges.

The detailed definition of this block is not available in this document.

EndOfMeas	Number: 5922 "OnChange" interval: internal measurement rate (receiver-type dependent)

This block marks the end of the transmission of all measurement-related blocks belonging to a given epoch.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	

4.2.2 Navigation Page Blocks

GPSRawCA	Number: 4017 "OnChange" interval: 6s

This block contains the 300 bits of a GPS C/A subframe. It is generated each time a new subframe is received, i.e. every 6 seconds.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
SVID	u1			Satellite ID, see 4.1.9
CRCPassed	u1			Status of the CRC or parity check: 0: CRC or parity check failed 1: CRC or parity check passed
ViterbiCnt	u1			Not applicable
Source	u1			Bit field: Bits 0-4: Signal type from which the bits have been received, as defined in 4.1.10 Bits 5-7: Reserved
FreqNr	u1			Not applicable
RxChannel	u1			Receiver channel (see 4.1.11).
NAVBits	u4[10]			NAVBits contains the 300 bits of a GPS C/A subframe. Encoding: For easier parsing, the bits are stored as a succession of 10 32-bit words. Since the actual words in the subframe are 30-bit long, two unused bits are inserted in each 32-bit word. More specifically, each 32-bit word has the following format: Bits 0-5: 6 parity bits (referred to as D_{25} to D_{30} in the GPS ICD), XOR-ed with the last transmitted bit of the previous word (D^*_{30})). Bits 6-29: source data bits (referred to as d_n in the GPS ICD). The first received bit is the MSB. Bits 30-31: Reserved
Padding	u1[..]			Padding bytes, see 4.1.5

GPSRawL2C	Number: 4018 "OnChange" interval: 12s

This block contains the 300 bits of a GPS L2C CNAV subframe (the so-called $D_c(t)$ data stream).

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
SVID	u1			Satellite ID, see 4.1.9
CRCPassed	u1			Status of the CRC or parity check: 0: CRC or parity check failed 1: CRC or parity check passed
ViterbiCnt	u1			Viterbi decoder error count over the subframe
Source	u1			Bit field: Bits 0-4: Signal type from which the bits have been received, as defined in 4.1.10 Bits 5-7: Reserved
FreqNr	u1			Not applicable
RxChannel	u1			Receiver channel (see 4.1.11).
NAVBits	u4[10]			NAVBits contains the 300 bits of a GPS CNAV subframe. Encoding: NAVBits contains all the bits of the frame, including the preamble. The first received bit is stored as the MSB of NAVBits[0]. The unused bits in NAVBits[9] must be ignored by the decoding software.
Padding	u1[..]			Padding bytes, see 4.1.5

GPSRawL5	Number: 4019 "OnChange" interval: 6s

This block contains the 300 bits of a GPS L5 CNAV subframe (the so-called $D_c(t)$ data stream).

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
SVID	u1			Satellite ID, see 4.1.9
CRCPassed	u1			Status of the CRC or parity check: 0: CRC or parity check failed 1: CRC or parity check passed
ViterbiCnt	u1			Viterbi decoder error count over the subframe
Source	u1			Bit field: Bits 0-4: Signal type from which the bits have been received, as defined in 4.1.10 Bits 5-7: Reserved
FreqNr	u1			Not applicable
RxChannel	u1			Receiver channel (see 4.1.11).
NAVBits	u4[10]			NAVBits contains the 300 bits of a GPS CNAV subframe. Encoding: NAVBits contains all the bits of the frame, including the preamble. The first received bit is stored as the MSB of NAVBits[0]. The unused bits in NAVBits[9] must be ignored by the decoding software.
Padding	u1[..]			Padding bytes, see 4.1.5

GLORawCA	Number: 4026 "OnChange" interval: 2s

This block contains the 85 bits of a GLONASS L1CA or L2CA navigation string.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
SVID	u1			Satellite ID, see 4.1.9
CRCPassed	u1			Status of the CRC or parity check: 0: CRC or parity check failed 1: CRC or parity check passed
ViterbiCnt	u1			Not applicable
Source	u1			Bit field: Bits 0-4: Signal type from which the bits have been received, as defined in 4.1.10 Bits 5-7: Reserved
FreqNr	u1			Frequency number, with an offset of 8. See 4.1.9
RxChannel	u1			Receiver channel (see 4.1.11).
NAVBits	u4[3]			NAVBits contains the first 85 bits of a GLONASS C/A string (i.e. all bits of the string with the exception of the time mark). Encoding: The first received bit is stored as the MSB of NAVBits[0]. The unused bits in NAVBits[2] must be ignored by the decoding software.
Padding	u1[..]			Padding bytes, see 4.1.5

GALRawFNAV	Number: 4022 "OnChange" interval: 10s

This block contains the 244 bits of a Galileo F/NAV navigation page, after deinterleaving and Viterbi decoding.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
SVID	u1			Satellite ID, see 4.1.9
CRCPassed	u1			Status of the CRC or parity check: 0: CRC or parity check failed 1: CRC or parity check passed
ViterbiCnt	u1			Viterbi decoder error count over the page
Source	u1			Bit field: Bits 0-4: Signal type from which the bits have been received, as defined in 4.1.10 Bits 5-6: Reserved Bit 7: Reserved
FreqNr	u1			Not applicable
RxChannel	u1			Receiver channel (see 4.1.11).
NAVBits	u4[8]			NavBits contains the 244 bits of a Galileo F/NAV page. Encoding: NAVBits contains all the bits of the frame, with the exception of the synchronization field. The first received bit is stored as the MSB of NAVBits[0]. The unused bits in NAVBits[7] must be ignored by the decoding software.
Padding	u1[..]			Padding bytes, see 4.1.5

GALRawINAV	Number: 4023 "OnChange" interval: 2s

This block contains the 234 bits of a Galileo I/NAV navigation page, after deinterleaving and Viterbi decoding.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
SVID	u1			Satellite ID, see 4.1.9
CRCPassed	u1			Status of the CRC or parity check: 0: CRC or parity check failed 1: CRC or parity check passed
ViterbiCnt	u1			Viterbi decoder error count over the page
Source	u1			Bit field: Bits 0-4: Signal type from which the bits have been received, as defined in 4.1.10 Bit 5: Set when the nav page is the concatenation of a sub-page received from E5b, and a sub-page received from L1BC. In that case, bits 0-4 are set to L1BC. Bit 6: Reserved Bit 7: Reserved
FreqNr	u1			Not applicable
RxChannel	u1			Receiver channel (see 4.1.11).
NAVBits	u4[8]			NAVBits contains the 234 bits of an I/NAV navigation page (in nominal or alert mode). Note that the I/NAV page is transmitted as two sub-pages (the so-called even and odd pages) of duration 1 second each (120 bits each). In this block, the even and odd pages are concatenated, even page first and odd page last. The 6 tails bits at the end of the even page are removed (hence a total of 234 bits). If the even and odd pages have been received from two different carriers (E5b and L1), bit 5 of the Source field is set. Encoding: NAVBits contains all the bits of the frame, with the exception of the synchronization field. The first received bit is stored as the MSB of NAVBits[0]. The unused bits in NAVBits[7] must be ignored by the decoding software.
Padding	u1[..]			Padding bytes, see 4.1.5

GEORawL1	Number: 4020 "OnChange" interval: 1s

This block contains the 250 bits of a SBAS L1 navigation frame, after Viterbi decoding.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
SVID	u1			Satellite ID, see 4.1.9
CRCPassed	u1			Status of the CRC or parity check: 0: CRC or parity check failed 1: CRC or parity check passed
ViterbiCnt	u1			Viterbi decoder error count over the navigation frame
Source	u1			Bit field: Bits 0-4: Signal type from which the bits have been received, as defined in 4.1.10 Bits 5-7: Reserved
FreqNr	u1			Not applicable
RxChannel	u1			Receiver channel (see 4.1.11).
NAVBits	u4[8]			NAVBits contains the 250 bits of a SBAS navigation frame. Encoding: NAVBits contains all the bits of the frame, including the preamble. The first received bit is stored as the MSB of NAVBits[0]. The unused bits in NAVBits[7] must be ignored by the decoding software.
Padding	u1[..]			Padding bytes, see 4.1.5

GEORawL5	Number: 4021 "OnChange" interval: 1s

This block contains the 250 bits of a SBAS L5 navigation frame, after Viterbi decoding.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
SVID	u1			Satellite ID, see 4.1.9
CRCPassed	u1			Status of the CRC or parity check: 0: CRC or parity check failed 1: CRC or parity check passed
ViterbiCnt	u1			Viterbi decoder error count over the navigation frame
Source	u1			Bit field: Bits 0-4: Signal type from which the bits have been received, as defined in 4.1.10 Bits 5-7: Reserved
FreqNr	u1			Not applicable
RxChannel	u1			Receiver channel (see 4.1.11).
NAVBits	u4[8]			NAVBits contains the 250 bits of a SBAS navigation frame. Encoding: NAVBits contains all the bits of the frame, including the preamble. The first received bit is stored as the MSB of NAVBits[0]. The unused bits in NAVBits[7] must be ignored by the decoding software.
Padding	u1[..]			Padding bytes, see 4.1.5

BDSRaw	Number: 4047 "OnChange" interval: 6 seconds (non GEOs), 0.6 s (GEOs)

This block contains the 300 bits of a BeiDou navigation page, as received from the B1I, B2I or B3I signal.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
SVID	u1			Satellite ID, see 4.1.9
CRCPassed	u1			Status of the CRC or parity check: 0: CRC or parity check failed 1: CRC or parity check passed
ViterbiCnt	u1			Not applicable
Source	u1			Signal type from which the bits have been received, as defined in 4.1.10
Reserved	u1			Reserved for future use, to be ignored by decoding software.
RxChannel	u1			Receiver channel (see 4.1.11).
NAVBits	u4[10]			NAVBits contains the 300 deinterleaved bits of a BeiDou navigation subframe. Encoding: NAVBits contains all the bits of the subframe, including the preamble and the parity bits. The first received bit is stored as the MSB of NAVBits[0]. The 20 unused bits in NAVBits[9] must be ignored by the decoding software. The bits are deinterleaved.
Padding	u1[..]			Padding bytes, see 4.1.5

BDSRawB1C	Number: 4218 "OnChange" interval: 18s

This block contains the 1800 symbols of a BeiDou B-CNAV1 navigation frame (itself containing three subframes), as received from the B1C signal.

The symbols are deinterleaved. The receiver attempts to correct bit errors using the LDPC parity bits, but unrecoverable errors are still possible at low C/N0. It is therefore always needed to check the CRC status before using the navigation bits. A separate CRC check is provided for subframe 2 and 3.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
SVID	u1			Satellite ID, see 4.1.9
CRCSF2	u1			Status of the CRC check of subframe 2: 0: failed 1: passed
CRCSF3	u1			Status of the CRC check of subframe 3: 0: failed 1: passed
Source	u1			Signal type from which the bits have been received, as defined in 4.1.10
Reserved	u1			Reserved for future use, to be ignored by decoding software.
RxChannel	u1			Receiver channel (see 4.1.11).
NAVBits	u4[57]			NAVBits contains the 1800 deinterleaved symbols of a BeiDou B1C (B-CNAV1) navigation frame. Encoding: NAVBits contains all the symbols of the frame. The first received symbol (i.e. the first symbol of subframe 1) is stored as the MSB of NAVBits[0]. The 24 unused bits in NAVBits[56] must be ignored by the decoding software.
Padding	u1[..]			Padding bytes, see 4.1.5

BDSRawB2a	Number: 4219 "OnChange" interval: 3s

This block contains the 576 symbols of a BeiDou B-CNAV2 navigation frame, as received from the B2a signal.

The receiver attempts to correct bit errors using the LDPC parity bits, but unrecoverable errors are still possible at low C/N0. It is therefore always needed to check the CRC status before using the navigation bits.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
SVID	u1			Satellite ID, see 4.1.9
CRCPassed	u1			Status of the CRC or parity check: 0: CRC or parity check failed 1: CRC or parity check passed
ViterbiCnt	u1			Not applicable
Source	u1			Signal type from which the bits have been received, as defined in 4.1.10
Reserved	u1			Reserved for future use, to be ignored by decoding software.
RxChannel	u1			Receiver channel (see 4.1.11).
NAVBits	u4[18]			NAVBits contains the 576 symbols of a BeiDou B2a (B-CNAV2) navigation frame. Encoding: NAVBits contains all the symbols of the frame, excluding the preamble. The first received symbol (i.e. the MSB of the PRN field) is stored as the MSB of NAVBits[0].
Padding	u1[..]			Padding bytes, see 4.1.5

QZSRawL1CA	Number: 4066 "OnChange" interval: 6s

This block contains the 300 bits of a QZSS C/A subframe.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
SVID	u1			Satellite ID, see 4.1.9
CRCPassed	u1			Status of the CRC or parity check: 0: CRC or parity check failed 1: CRC or parity check passed
Reserved	u1			Reserved
Source	u1			Bit field: Bits 0-4: Signal type from which the bits have been received, as defined in 4.1.10 Bits 5-7: Reserved
Reserved2	u1			Reserved for future use, to be ignored by decoding software.
RxChannel	u1			Receiver channel (see 4.1.11).
NAVBits	u4[10]			NAVBits contains the 300 bits of a QZSS C/A subframe. Encoding: Same as GPSRawCA block.
Padding	u1[..]			Padding bytes, see 4.1.5

QZSRawL2C	Number: 4067 "OnChange" interval: 12s

This block contains the 300 bits of a QZSS L2C CNAV subframe.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
SVID	u1			Satellite ID, see 4.1.9
CRCPassed	u1			Status of the CRC or parity check: 0: CRC or parity check failed 1: CRC or parity check passed
ViterbiCnt	u1			Viterbi decoder error count over the subframe
Source	u1			Bit field: Bits 0-4: Signal type from which the bits have been received, as defined in 4.1.10 Bits 5-7: Reserved
Reserved	u1			Reserved for future use, to be ignored by decoding software.
RxChannel	u1			Receiver channel (see 4.1.11).
NAVBits	u4[10]			NAVBits contains the 300 bits of a QZSS CNAV subframe. Encoding: NAVBits contains all the bits of the frame, including the preamble. The first received bit is stored as the MSB of NAVBits[0]. The unused bits in NAVBits[9] must be ignored by the decoding software.
Padding	u1[..]			Padding bytes, see 4.1.5

QZSRawL5	Number: 4068 "OnChange" interval: 6s

This block contains the 300 bits of a QZSS L5 CNAV subframe.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
SVID	u1			Satellite ID, see 4.1.9
CRCPassed	u1			Status of the CRC or parity check: 0: CRC or parity check failed 1: CRC or parity check passed
ViterbiCnt	u1			Viterbi decoder error count over the subframe
Source	u1			Bit field: Bits 0-4: Signal type from which the bits have been received, as defined in 4.1.10 Bits 5-7: Reserved
Reserved	u1			Reserved for future use, to be ignored by decoding software.
RxChannel	u1			Receiver channel (see 4.1.11).
NAVBits	u4[10]			NAVBits contains the 300 bits of a QZSS CNAV subframe. Encoding: NAVBits contains all the bits of the frame, including the preamble. The first received bit is stored as the MSB of NAVBits[0]. The unused bits in NAVBits[9] must be ignored by the decoding software.
Padding	u1[..]			Padding bytes, see 4.1.5

NAVICRaw	Number: 4093 "OnChange" interval: 12s

This block contains the 292 bits of a NavIC/IRNSS subframe.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
SVID	u1			Satellite ID, see 4.1.9
CRCPassed	u1			Status of the CRC or parity check: 0: CRC or parity check failed 1: CRC or parity check passed
ViterbiCnt	u1			Viterbi decoder error count over the subframe
Source	u1			Signal type from which the bits have been received, as defined in 4.1.10
Reserved	u1			Reserved for future use, to be ignored by decoding software.
RxChannel	u1			Receiver channel (see 4.1.11).
NAVBits	u4[10]			NavBits contains the 292 bits of a NavIC/IRNSS subframe. Encoding: NAVBits contains all the bits of the frame, with the exception of the preamble. The first received bit is stored as the MSB of NAVBits[0]. The unused bits in NAVBits[9] must be ignored by the decoding software.
Padding	u1[..]			Padding bytes, see 4.1.5

4.2.3 GPS Decoded Message Blocks

GPSNav	Number: 5891
	"OnChange" interval: block generated each time a new navigation data set is received from a GPS satellite

The GPSNav block contains the decoded navigation data for one GPS satellite. These data are conveyed in subframes 1 to 3 of the satellite navigation message. Refer to GPS ICD for further details.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
PRN	u1			ID of the GPS satellite of which the ephemeris is given in this block (see 4.1.9)
Reserved	u1			Reserved for future use, to be ignored by decoding software
WN	u2	1 week	65535	Week number (10 bits from subframe 1, word 3)
CAorPonL2	u1			Code(s) on L2 channel (2 bits from subframe 1, word 3)
URA	u1			User Range accuracy index (4 bits from subframe 1 word 3)
health	u1			6-bit health from subframe 1, word 3 (6 bits from subframe 1, word 3)
L2DataFlag	u1			Data flag for L2 P-code (1 bit from subframe 1, word 4)
IODC	u2			Issue of data, clock (10 bits from subframe 1)
IODE2	u1			Issue of data, ephemeris (8 bits from subframe 2)
IODE3	u1			Issue of data, ephemeris (8 bits from subframe 3)
FitIntFlg	u1			Curve Fit Interval, (1 bit from subframe 2, word 10)
Reserved2	u1			unused, to be ignored by decoding software
T_gd	f4	1 s		Estimated group delay differential
t_oc	u4	1 s		clock data reference time
a_f2	f4	1 s / s^2		SV clock aging
a_f1	f4	1 s / s		SV clock drift
a_f0	f4	1 s		SV clock bias
C_rs	f4	1 m		Amplitude of the sine harmonic correction term to the orbit radius
DEL_N	f4	1 semi-circle / s		Mean motion difference from computed value
M_0	f8	1 semi-circle		Mean anomaly at reference time
C_uc	f4	1 rad		Amplitude of the cosine harmonic correction term to the argument of latitude
e	f8			Eccentricity
C_us	f4	1 rad		Amplitude of the sine harmonic correction term to the argument of latitude
SQRT_A	f8	1 $m^{1/2}$		Square root of the semi-major axis
t_oe	u4	1 s		Reference time ephemeris

C_ic	f4	1 rad		Amplitude of the cosine harmonic correction term to the angle of inclination
OMEGA_0	f8	1 semi-circle		Longitude of ascending node of orbit plane at weekly epoch
C_is	f4	1 rad		Amplitude of the sine harmonic correction term to the angle of inclination
i_0	f8	1 semi-circle		Inclination angle at reference time
C_rc	f4	1 m		Amplitude of the cosine harmonic correction term to the orbit radius
omega	f8	1 semi-circle		Argument of perigee
OMEGADOT	f4	1 semi-circle / s		Rate of right ascension
IDOT	f4	1 semi-circle / s		Rate of inclination angle
WNt_oc	u2	1 week		WN associated with t_oc, modulo 1024
WNt_oe	u2	1 week		WN associated with t_oe, modulo 1024
Padding	u1[..]			Padding bytes, see 4.1.5

GPSAlm	Number: 5892 "OnChange" interval: block generated each time a new almanac data set is received from a GPS satellite

The GPSAlm block contains the decoded almanac data for one GPS satellite. These data are conveyed in subframes 4 and 5 of the satellite navigation message. Refer to GPS ICD for further details.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
PRN	u1			ID of the GPS satellite of which the almanac is given in this block (see 4.1.9)
Reserved	u1			Reserved for future use, to be ignored by decoding software
e	f4			Eccentricity
t_oa	u4	1 s		almanac reference time of week
delta_i	f4	1 semi-circle		Inclination angle at reference time, relative to i_0 = 0.3 semi-circles
OMEGADOT	f4	1 semi-circle / s		Rate of right ascension
SQRT_A	f4	1 $m^{1/2}$		Square root of the semi-major axis
OMEGA_0	f4	1 semi-circle		Longitude of ascending node of orbit plane at weekly epoch
omega	f4	1 semi-circle		Argument of perigee
M_0	f4	1 semi-circle		Mean anomaly at reference time
a_f1	f4	1 s / s		SV clock drift
a_f0	f4	1 s		SV clock bias
WN_a	u1	1 week		Almanac reference week, to which t_oa is referenced
config	u1			Anti-spoofing and satellite configuration (4 bits from subframe 4, page 25)
health8	u1			health on 8 bits from the almanac page
health6	u1			health summary on 6 bits (from subframe 4, page 25 and subframe 5 page 25)
Padding	u1[..]			Padding bytes, see 4.1.5

GPSIon	Number: 5893 "OnChange" interval: block generated each time subframe 4, page 18, is received from a GPS satellite

The GPSIon block contains the decoded ionosphere data (the Klobuchar coefficients). These data are conveyed in subframes 4, page 18 of the satellite navigation message. Refer to GPS ICD for further details.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
PRN	u1			ID of the GPS satellite from which the coefficients have been received (see 4.1.9)
Reserved	u1			Reserved for future use, to be ignored by decoding software
alpha_0	f4	1 s		vertical delay coefficient 0
alpha_1	f4	1 s / semi-circle		vertical delay coefficient 1
alpha_2	f4	1 s / semi-circle^2		vertical delay coefficient 2
alpha_3	f4	1 s / semi-circle^3		vertical delay coefficient 3
beta_0	f4	1 s		model period coefficient 0
beta_1	f4	1 s / semi-circle		model period coefficient 1
beta_2	f4	1 s / semi-circle^2		model period coefficient 2
beta_3	f4	1 s / semi-circle^3		model period coefficient 3
Padding	u1[..]			Padding bytes, see 4.1.5

GPSUtc	Number: 5894 "OnChange" interval: block generated each time subframe 4, page 18, is received from a GPS satellite

The GPSUtc block contains the decoded UTC data. These data are conveyed in subframes 4, page 18 of the satellite navigation message. Refer to GPS ICD for further details.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
PRN	u1			ID of the GPS satellite from which these UTC parameters have been received (see 4.1.9)
Reserved	u1			Reserved for future use, to be ignored by decoding software
A_1	f4	1 s / s		first order term of polynomial
A_0	f8	1 s		constant term of polynomial
t_ot	u4	1 s		reference time for UTC data
WN_t	u1	1 week		UTC reference week number, to which t_ot is referenced
DEL_t_LS	i1	1 s		Delta time due to leap seconds whenever the effectivity time is not in the past
WN_LSF	u1	1 week		Effectivity time of leap second (week)
DN	u1	1 day		Effectivity time of leap second (day, from 1 to 7)
DEL_t_LSF	i1	1 s		Delta time due to leap seconds whenever the effectivity time is in the past

4.2.4 GLONASS Decoded Message Blocks

GLONav	Number: 4004 "OnChange" interval: block generated each time a new navigation data set is received from a GLONASS satellite

The GLONav block contains the decoded ephemeris data for one GLONASS satellite.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
SVID	u1			ID of the GLONASS satellite for which ephemeris is provided in this block (see 4.1.9).
FreqNr	u1			Frequency number of the GLONASS satellite for which ephemeris is provided in this block (see 4.1.9).
X	f8	1000 m		x-component of satellite position in PZ-90.02
Y	f8	1000 m		y-component of satellite position in PZ-90.02
Z	f8	1000 m		z-component of satellite position in PZ-90.02
Dx	f4	1000 m / s		x-component of satellite velocity in PZ-90.02
Dy	f4	1000 m / s		y-component of satellite velocity in PZ-90.02
Dz	f4	1000 m / s		z-component of satellite velocity in PZ-90.02
Ddx	f4	1000 m / s^2		x-component of satellite acceleration in PZ-90.02
Ddy	f4	1000 m / s^2		y-component of satellite acceleration in PZ-90.02
Ddz	f4	1000 m / s^2		z-component of satellite acceleration in PZ-90.02
gamma	f4	1 Hz / Hz		$\gamma_n(t_b)$:relative deviation of predicted carrier frequency
tau	f4	1 s		$\tau_n(t_b)$: time correction to GLONASS time
dtau	f4	1 s		$\Delta\tau_n$: time difference between L2 and L1 sub-band
t_oe	u4	1 s		reference time-of-week in GPS time frame
WN_toe	u2	1 week		reference week number in GPS time frame (modulo 1024)
P1	u1	1 minute		time interval between adjacent values of t_b
P2	u1			1-bit odd/even flag of t_b
E	u1	1 day		age of data
B	u1			3-bit health flag, satellite unhealthy if MSB set
tb	u2	1 minute		time of day (center of validity interval)
M	u1			2-bit GLONASS-M satellite identifier (01, otherwise 00)
P	u1			2-bit mode of computation of time parameters
l	u1			1-bit health flag, 0=healthy, 1=unhealthy
P4	u1			1-bit 'updated' flag of ephemeris data
N_T	u2	1 day		current day number within 4-year interval
F_T	u2	0.01 m		predicted user range accuracy at time t_b
Padding	u1[..]			Padding bytes, see 4.1.5

GLOAlm	Number: 4005 "OnChange" interval: block generated each time a new almanac data set is received from a GLONASS satellite

The GLOAlm block contains the decoded navigation data for one GLONASS satellite.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
SVID	u1			ID of the GLONASS satellite for which almanac is provided in this block (see 4.1.9).
FreqNr	u1			Frequency number of the GLONASS satellite for which almanac is provided in this block (see 4.1.9). This number corresponds to the H_n^A parameter in the GLONASS ICD.
epsilon	f4			ϵ_n^A: orbit eccentricity
t_oa	u4	1 s		Reference time-of-week in GPS time frame
Delta_i	f4	1 semi-circle		Δ i_n^A: correction to inclination
lambda	f4	1 semi-circle		λ_n^A: Longitude of first ascending node
t_ln	f4	1 s		$t_{\lambda\ n}^A$: time of first ascending node passage
omega	f4	1 semi-circle		ω_n^A: argument of perigee
Delta_T	f4	1 s / orbit-period		Δ T_n^A: correction to mean Draconian period
dDelta_T	f4	1 s / orbit-period^2		dΔ T_n^A: rate of change correction to mean Draconian period
tau	f4	1 s		τ_n^A: coarse correction to satellite time
WN_a	u1	1 week		Reference week in GPS time frame (modulo 256)
C	u1			$C_n{}^A$: 1-bit general health flag (1 indicates healthy)
N	u2	1 day		N^A: calendar day number within 4 year period
M	u1			$M_n{}^A$: 2-bit GLONASS-M satellite identifier
N_4	u1			N_4: 4 year interval number, starting from 1996
Padding	u1[..]			Padding bytes, see 4.1.5

GLOTime	Number: 4036 "OnChange" interval: block generated at the end of each GLONASS super-frame, i.e. every 2.5 minutes.

The GLOTime block contains the decoded non-immediate data related to the difference between GLONASS and GPS, UTC and UT1 time scales.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
SVID	u1			ID of the GLONASS satellite from which the data in this block has been decoded (see 4.1.9).
FreqNr	u1			Frequency number of the GLONASS satellite from which the data in this block has been decoded (see 4.1.9).
N_4	u1			4 year interval number, starting from 1996
KP	u1			notification of leap second
N	u2	1 day		calendar day number within 4 year period
tau_GPS	f4	$1 \cdot 10^9$ ns		difference with respect to GPS time
tau_c	f8	$1 \cdot 10^9$ ns		GLONASS time scale correction to UTC(SU)
B1	f4	1 s		difference between UT1 and UTC(SU)
B2	f4	1 s / msd		daily change of B1
Padding	u1[..]			Padding bytes, see 4.1.5

4.2.5 Galileo Decoded Message Blocks

GALNav	Number: 4002 "OnChange" interval: output each time a new navigation data batch is decoded.

The GalNav block contains the following decoded navigation data for one Galileo satellite:

- orbital elements and clock corrections
- health, Signal-In-Space Accuracy (SISA) indexes and Broadcast Group Delays (BGDs) for each carrier or carrier combinations.

The interpretation of the clock correction parameters (t_oc, a_f0, a_f1, a_f2) depends on the value of the Source field:

Source	Message type	Applicable Clock Model
2	I/NAV	(L1,E5b)
16	F/NAV	(L1,E5a)

If the receiver is decoding both the I/NAV and the F/NAV data stream, it will output a GalNav block for the I/NAV stream, containing the (L1, E5b) clock model, and a different GalNav block for the F/NAV stream, containing the (L1, E5a) clock model.

Depending on the message type being decoded, some health, SISA or BGD values may not be available (in that case they are set to their respective Do-Not-Use values). The following health, SISA and BGD values are guaranteed to be available for a given value of the Source field:

Source	Health, SISA and BGD availability
2 (I/NAV)	At least L1-B_{DVS}, L1-B_{HS}, E5b_{DVS},E5b_{HS}, SISA_L1E5b and BGD_L1E5b are available
16 (F/NAV)	At least E5a_{DVS},E5a_{HS}, SISA_L1E5a and BGD_L1E5a are available

The IODNav field identifies the issue of data. All orbital elements, clock parameters and SISA values in the block are guaranteed to refer to the same data batch identified by IODNav. The fields Health_OSSOL, BGD_L1E5a, BGD_L1E5b and CNAVenc are not covered by the issue of data, and the block simply contains the latest received value.

Please refer to the Galileo Signal-In-Space ICD for the interpretation and usage of the parameters contained in this SBF block.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
SVID	u1			SVID of the Galileo satellite (see 4.1.9)

Source	u1			See table above: this field indicates how to interpret the clock correction parameters.
SQRT_A	f8	1 $m^{1/2}$		Square root of the semi-major axis
M_0	f8	1 semi-circle		Mean anomaly at reference time
e	f8			Eccentricity
i_0	f8	1 semi-circle		Inclination angle at reference time
omega	f8	1 semi-circle		Argument of perigee
OMEGA_0	f8	1 semi-circle		Longitude of ascending node of orbit plane at weekly epoch
OMEGADOT	f4	1 semi-circle / s		Rate of right ascension
IDOT	f4	1 semi-circle / s		Rate of inclination angle
DEL_N	f4	1 semi-circle / s		Mean motion difference from computed value
C_uc	f4	1 rad		Amplitude of the cosine harmonic correction term to the argument of latitude
C_us	f4	1 rad		Amplitude of the sine harmonic correction term to the argument of latitude
C_rc	f4	1 m		Amplitude of the cosine harmonic correction term to the orbit radius
C_rs	f4	1 m		Amplitude of the sine harmonic correction term to the orbit radius
C_ic	f4	1 rad		Amplitude of the sine harmonic correction term to the angle of inclination
C_is	f4	1 rad		Amplitude of the cosine harmonic correction term to the angle of inclination
t_oe	u4	1 s		Reference time, ephemeris
t_oc	u4	1 s		Reference time, clock. The Source field indicates which clock model t_oc refers to.
a_f2	f4	1 s / s^2		SV clock aging. The Source field indicates which clock model a_f2 refers to.
a_f1	f4	1 s / s		SV clock drift. The Source field indicates which clock model a_f1 refers to.
a_f0	f8	1 s		SV clock bias. The Source field indicates which clock model a_f0 refers to.
WNt_oe	u2	1 week		WN associated with t_oe, in GPS time frame, modulo 4096
WNt_oc	u2	1 week		WN associated with t_oc, in GPS time frame, modulo 4096
IODnav	u2			Issue of data, navigation (10 bits)
Health_OSSOL	u2			Bit field indicating the last received Health Status (HS) and Data Validity Status (DVS) of the E5a, E5b and L1-B signals: Bit 0: If set, bits 1 to 3 are valid, otherwise they must be ignored. Bit 1: 1-bit L1-B_{DVS} Bits 2-3: 2-bit L1-B_{HS} Bit 4: If set, bits 5 to 7 are valid, otherwise they must be ignored. Bit 5: 1-bit E5b_{DVS} Bits 6-7: 2-bit E5b_{HS} Bit 8: If set, bits 9 to 11 are valid, otherwise they must be ignored. Bit 9: 1-bit E5a_{DVS} Bits 10-11: 2-bit E5a_{HS} Bits 12-15: Reserved
Health_PRS	u1			Reserved

SISA_L1E5a	u1		255	Signal-In-Space Accuracy Index (L1, E5a)
SISA_L1E5b	u1		255	Signal-In-Space Accuracy Index (L1, E5b)
SISA_L1AE6A	u1		255	Reserved
BGD_L1E5a	f4	1 s	$-2 \cdot 10^{10}$	Last received broadcast group delay (L1, E5a)
BGD_L1E5b	f4	1 s	$-2 \cdot 10^{10}$	Last received broadcast group delay (L1, E5b)
BGD_L1AE6A	f4	1 s	$-2 \cdot 10^{10}$	Reserved
CNAVenc	u1		255	2-bit C/NAV encryption status.

GALAlm	Number: 4003 "OnChange" interval: output each time a new almanac set is received for a satellite.

The GalAlm block contains the decoded almanac data for one Galileo satellite.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
SVID	u1			SVID of the Galileo satellite from which these almanac parameters have been received (see 4.1.9)
Source	u1			See corresponding field in the GalNav block. Source can take the value 18 to indicate that the almanac data contained in this block has been merged from INAV and FNAV pages.
e	f4			Eccentricity
t_oa	u4	1 s		almanac reference time of week
delta_i	f4	1 semi-circle		Inclination angle at reference time, relative to nominal
OMEGADOT	f4	1 semi-circle / s		Rate of right ascension
SQRT_A	f4	1 $m^{1/2}$		Square root of the semi-major axis, relative to nominal
OMEGA_0	f4	1 semi-circle		Longitude of ascending node of orbit plane at weekly epoch
omega	f4	1 semi-circle		Argument of perigee
M_0	f4	1 semi-circle		Mean anomaly at reference time
a_f1	f4	1 s / s		SV clock drift
a_f0	f4	1 s		SV clock bias
WN_a	u1	1 week		2-bit almanac reference week
SVID_A	u1			SVID of the Galileo satellite of which the almanac parameters are provided in this block (see 4.1.9 for the SVID numbering convention).
health	u2			Bit field indicating the health status (HS) of the E5a, E5b, L1-B, L1-A and E6-A signals: Bit 0: If set, bits 1 and 2 are valid, otherwise they must be ignored. Bits 1-2: 2-bit L1-B_{HS} Bit 3: If set, bits 4 and 5 are valid, otherwise they must be ignored. Bits 4-5: 2-bit E5b_{HS} Bit 6: If set, bits 7 and 8 are valid, otherwise they must be ignored. Bits 7-8: 2-bit E5a_{HS} Bit 9: Not applicable Bits 10-11: Not applicable Bit 12: Not applicable Bits 13-14: Not applicable Bit 15: Reserved

IODa	u1			4-bit Issue of Data for the almanac.

GALIon	Number: 4030 "OnChange" interval: output each time the ionospheric parameters are received from a Galileo satellite.

The GalIon block contains the decoded ionosphere model parameters of the Galileo system.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
SVID	u1			SVID of the Galileo satellite from which these parameters have been received (see 4.1.9)
Source	u1			Message type from which the data has been decoded: 2: I/NAV 16: F/NAV
a_i0	f4	$1 \cdot 10^{-22}$ W / (m^2 Hz)		Effective ionization level, a_{i0}
a_i1	f4	$1 \cdot 10^{-22}$ W / (m^2 Hz) / deg		Effective ionization level, a_{i1}
a_i2	f4	$1 \cdot 10^{-22}$ W / (m^2 Hz) / deg^2		Effective ionization level, a_{i2}
StormFlags	u1			Bit field containing the five ionospheric storm flags: Bit 0: SF5 Bit 1: SF4 Bit 2: SF3 Bit 3: SF2 Bit 4: SF1 Bits 5-7: Reserved

GALUtc	Number: 4031 "OnChange" interval: output each time the UTC offset parameters are received from a Galileo satellite.

The GalUtc block contains the decoded UTC parameter information.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
SVID	u1			SVID of the Galileo satellite from which these parameters have been received (see 4.1.9)
Source	u1			Message type from which the data has been decoded: 2: I/NAV 16: F/NAV
A_1	f4	1 s / s	$-2 \cdot 10^{10}$	first order term of polynomial
A_0	f8	1 s	$-2 \cdot 10^{10}$	constant term of polynomial
t_ot	u4	1 s		reference time of week for UTC data
WN_ot	u1	1 week		UTC reference week number, to which t_ot is referenced
DEL_t_LS	i1	1 s		Delta time due to leap seconds whenever the effectivity time is not in the past
WN_LSF	u1	1 week		Effectivity time of leap second (week)
DN	u1	1 day		Effectivity time of leap second (day, from 1 to 7)
DEL_t_LSF	i1	1 s		Delta time due to leap seconds whenever the effectivity time is in the past

GALGstGps	Number: 4032 "OnChange" interval: output each time valid GST-GPS offset parameters are received from a Galileo satellite.

This block contains the decoded GPS to Galileo System Time offset parameters. This block is only output if these parameters are valid in the navigation page (i.e. if they are not set to "all ones").

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
SVID	u1			SVID of the Galileo satellite from which these parameters have been received (see 4.1.9)
Source	u1			Message type from which the data has been decoded: 2: I/NAV 16: F/NAV
A_1G	f4	$1 \cdot 10^9$ ns / s		Rate of change of the offset
A_0G	f4	$1 \cdot 10^9$ ns		Constant term of the offset
t_oG	u4	1 s		Reference time of week
WN_oG	u1	1 week		6-bit reference week number.

GALSARRLM	Number: 4034 "OnChange" interval: generated each time a SAR RLM message is decoded.

This block contains a decoded Galileo search-and-rescue (SAR) return link message (RLM).

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
SVID	u1			SVID of the Galileo satellite from which this RLM has been received.
Source	u1			Message type from which the data has been decoded: 2: I/NAV 16: F/NAV
RLMLength	u1			Length of the RLM message in bits. RLMLength can be either 80 for a short message or 160 for a long message.
Reserved	u1[3]			Reserved for future use, to be ignored by decoding software
RLMBits	u4[*N*]			Bits in the RLM message, with the first bit being the MSB of RLMBits[0]. *N* is 3 for a short message (i.e. if RLMLength is 80), and 5 for a long message (i.e. if RLMLength is 160). The 16 unused bits of a short message are set to 0. These bits correspond to the 16 LSBs of RLMBits[2].
Padding	u1[..]			Padding bytes, see 4.1.5

4.2.6 BeiDou Decoded Message Blocks

BDSNav	Number: 4081 "OnChange" interval: block generated each time a new navigation data set is received from a BeiDou satellite

The BDSNav block contains the decoded navigation data for one BeiDou satellite, as received from the D1 or D2 nav message.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
PRN	u1			ID of the BeiDou satellite of which the ephemeris is given in this block (see 4.1.9)
Reserved	u1			Reserved for future use, to be ignored by decoding software
WN	u2	1 week		BeiDou week number as received from the navigation message (from 0 to 8191)
URA	u1			User range accuracy index (4-bit value)
SatH1	u1			1-bit autonomous health
IODC	u1			Age of data, clock (5 bits)
IODE	u1			Age of data, ephemeris (5 bits)
Reserved2	u2			unused, to be ignored by decoding software
T_GD1	f4	1 s		B1I equipment group delay differential
T_GD2	f4	1 s	$-2 \cdot 10^{10}$	B2I equipment group delay differential (set to the Do-Not-Use value when unknown)
t_oc	u4	1 s		clock data reference time, in BeiDou system time (lagging GPS time by 14 seconds).
a_f2	f4	1 s / s^2		SV clock aging
a_f1	f4	1 s / s		SV clock drift
a_f0	f4	1 s		SV clock bias
C_rs	f4	1 m		Amplitude of the sine harmonic correction term to the orbit radius
DEL_N	f4	1 semi-circle / s		Mean motion difference from computed value
M_0	f8	1 semi-circle		Mean anomaly at reference time
C_uc	f4	1 rad		Amplitude of the cosine harmonic correction term to the argument of latitude
e	f8			Eccentricity
C_us	f4	1 rad		Amplitude of the sine harmonic correction term to the argument of latitude
SQRT_A	f8	1 $m^{1/2}$		Square root of the semi-major axis
t_oe	u4	1 s		Reference time ephemeris, in BeiDou system time (lagging GPS time by 14 seconds).
C_ic	f4	1 rad		Amplitude of the cosine harmonic correction term to the angle of inclination
OMEGA_0	f8	1 semi-circle		Longitude of ascending node of orbit plane at weekly epoch

C_is	f4	1 rad		Amplitude of the sine harmonic correction term to the angle of inclination
i_0	f8	1 semi-circle		Inclination angle at reference time
C_rc	f4	1 m		Amplitude of the cosine harmonic correction term to the orbit radius
omega	f8	1 semi-circle		Argument of perigee
OMEGADOT	f4	1 semi-circle / s		Rate of right ascension
IDOT	f4	1 semi-circle / s		Rate of inclination angle
WNt_oc	u2	1 week		BeiDou week number associated with t_oc, modulo 8192. Note that this value relates to the BeiDou system time.
WNt_oe	u2	1 week		BeiDou week number associated with t_oe, modulo 8192. Note that this values relates to the BeiDou system time.
Padding	u1[..]			Padding bytes, see 4.1.5

BDSAlm	Number: 4119 "OnChange" interval: block generated each time a new almanac data set is received from a BeiDou satellite

The BDSAlm block contains the decoded almanac data for one BeiDou satellite.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
PRN	u1			ID of the BeiDou satellite of which the almanac is given in this block (see 4.1.9)
WN_a	u1	1 week		Almanac week number
t_oa	u4	1 s		Almanac reference time
SQRT_A	f4	1 $m^{1/2}$		Square root of the semi-major axis
e	f4			Eccentricity
omega	f4	1 semi-circle		Argument of perigee
M_0	f4	1 semi-circle		Mean anomaly at reference time
OMEGA_0	f4	1 semi-circle		Longitude of ascending node of orbital plane computed according to reference time
OMEGADOT	f4	1 semi-circle / s		Rate of right ascension
delta_i	f4	1 semi-circle		Correction of orbit reference inclination at reference time
a_f0	f4	1 s		Satellite clock bias
a_f1	f4	1 s / s		Satellite clock drift
Health	u2			Satellite health information (9 bits)
Reserved	u1[2]			Reserved for future use, to be ignored by decoding software
Padding	u1[..]			Padding bytes, see 4.1.5

BDSIon	Number: 4120 "OnChange" interval: output each time the ionospheric parameters are received from a BeiDou satellite

The BDSIon block contains the BeiDou ionosphere data (the Klobuchar coefficients), as received from the D1 or D2 nav message.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
PRN	u1			ID of the BeiDou satellite from which the coefficients have been received (see 4.1.9)
Reserved	u1			Reserved for future use, to be ignored by decoding software
alpha_0	f4	1 s		vertical delay coefficient 0
alpha_1	f4	1 s / semi-circle		vertical delay coefficient 1
alpha_2	f4	1 s / semi-circle^2		vertical delay coefficient 2
alpha_3	f4	1 s / semi-circle^3		vertical delay coefficient 3
beta_0	f4	1 s		model period coefficient 0
beta_1	f4	1 s / semi-circle		model period coefficient 1
beta_2	f4	1 s / semi-circle^2		model period coefficient 2
beta_3	f4	1 s / semi-circle^3		model period coefficient 3
Padding	u1[..]			Padding bytes, see 4.1.5

BDSUtc	Number: 4121 "OnChange" interval: output each time the UTC offset parameters are received from a BeiDou satellite

The BDSUtc block contains the BeiDou UTC data, as received from the D1 or D2 nav message.

Note that BDT (BeiDou time) started on January 1st, 2006 (GPS week 1356). Therefore the delta time between BDT and UTC due to leap seconds is 14 less than the value in GPSUtc.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
PRN	u1			ID of the BeiDou satellite from which the coefficients have been received (see 4.1.9)
Reserved	u1			Reserved for future use, to be ignored by decoding software
A_1	f4	1 s / s		first order term of polynomial
A_0	f8	1 s		constant term of polynomial
DEL_t_LS	i1	1 s		Delta time due to leap seconds whenever the effectivity time is not in the past
WN_LSF	u1	1 week		Effectivity time of leap second (week)
DN	u1	1 day		Effectivity time of leap second (day, from 0 to 6)
DEL_t_LSF	i1	1 s		Delta time due to leap seconds whenever the effectivity time is in the past
Padding	u1[..]			Padding bytes, see 4.1.5

4.2.7 QZSS Decoded Message Blocks

QZSNav	Number: 4095
	"OnChange" interval: block generated each time a new navigation data set is received from a QZSS satellite

The QZSNav block contains the decoded navigation data for one QZSS satellite. The data is decoded from the navigation message transmitted in the L1 C/A signal. Refer to the QZSS ICD for further details.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
PRN	u1			ID of the QZSS satellite of which the ephemeris is given in this block (see 4.1.9)
Reserved	u1			Reserved for future use, to be ignored by decoding software
WN	u2	1 week	65535	Week number (10 bits from subframe 1, word 3)
CAorPonL2	u1			Code(s) on L2 channel (2 bits from subframe 1, word 3). Always 2 for QZSS satellites.
URA	u1			User Range accuracy index (4 bits from subframe 1 word 3)
health	u1			6-bit health from subframe 1, word 3 (6 bits from subframe 1, word 3)
L2DataFlag	u1			Data flag for L2 P-code (1 bit from subframe 1, word 4). Always 1 for QZSS satellites.
IODC	u2			Issue of data, clock (10 bits from subframe 1)
IODE2	u1			Issue of data, ephemeris (8 bits from subframe 2)
IODE3	u1			Issue of data, ephemeris (8 bits from subframe 3)
FitIntFlg	u1			Curve Fit Interval, (1 bit from subframe 2, word 10)
Reserved2	u1			unused, to be ignored by decoding software
T_gd	f4	1 s	$-2 \cdot 10^{10}$	Estimated group delay differential
t_oc	u4	1 s		clock data reference time
a_f2	f4	1 s / s^2		SV clock aging
a_f1	f4	1 s / s		SV clock drift
a_f0	f4	1 s		SV clock bias
C_rs	f4	1 m		Amplitude of the sine harmonic correction term to the orbit radius
DEL_N	f4	1 semi-circle / s		Mean motion difference from computed value
M_0	f8	1 semi-circle		Mean anomaly at reference time
C_uc	f4	1 rad		Amplitude of the cosine harmonic correction term to the argument of latitude
e	f8			Eccentricity
C_us	f4	1 rad		Amplitude of the sine harmonic correction term to the argument of latitude
SQRT_A	f8	1 $m^{1/2}$		Square root of the semi-major axis

t_oe	u4	1 s		Reference time ephemeris
C_ic	f4	1 rad		Amplitude of the cosine harmonic correction term to the angle of inclination
OMEGA_0	f8	1 semi-circle		Longitude of ascending node of orbit plane at weekly epoch
C_is	f4	1 rad		Amplitude of the sine harmonic correction term to the angle of inclination
i_0	f8	1 semi-circle		Inclination angle at reference time
C_rc	f4	1 m		Amplitude of the cosine harmonic correction term to the orbit radius
omega	f8	1 semi-circle		Argument of perigee
OMEGADOT	f4	1 semi-circle / s		Rate of right ascension
IDOT	f4	1 semi-circle / s		Rate of inclination angle
WNt_oc	u2	1 week		WN associated with t_oc, modulo 1024
WNt_oe	u2	1 week		WN associated with t_oe, modulo 1024
Padding	u1[..]			Padding bytes, see 4.1.5

QZSAlm	Number: 4116 "OnChange" interval: block generated each time a new almanac data set is received from a QZSS satellite

The QZSAlm block contains the decoded almanac data for one QZSS satellite. These data are conveyed in subframes 4 and 5 of the satellite navigation message. Refer to QZSS ICD for further details.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
PRN	u1			ID of the QZSS satellite of which the almanac is given in this block (see 4.1.9)
Reserved	u1			Reserved for future use, to be ignored by decoding software
e	f4			Difference from reference eccentricity
t_oa	u4	1 s		almanac reference time of week
delta_i	f4	1 semi-circle		Difference from reference angle of inclination
OMEGADOT	f4	1 semi-circle / s		Rate of right ascension
SQRT_A	f4	1 $m^{1/2}$		Square root of the semi-major axis
OMEGA_0	f4	1 semi-circle		Longitude of ascending node of orbit plane at weekly epoch
omega	f4	1 semi-circle		Argument of perigee
M_0	f4	1 semi-circle		Mean anomaly at reference time
a_f1	f4	1 s / s		SV clock drift
a_f0	f4	1 s		SV clock bias
WN_a	u1	1 week		Almanac reference week, to which t_oa is referenced
Reserved2	u1			Reserved for future use, to be ignored by decoding software
health8	u1			health on 8 bits from the almanac page
health6	u1			health summary on 6 bits (from subframe 4, page 25 and subframe 5 page 25)
Padding	u1[..]			Padding bytes, see 4.1.5

4.2.8 SBAS L1 Decoded Message Blocks

GEOMT00	Number:	5925
	"OnChange" interval:	block generated each time an empty MT00 is received from an SBAS satellite on the L1 signal

This block is sent to indicate that an empty SBAS message type 0 has been received.

Depending on the SBAS operational mode, message type 0 can contain the contents of message type 2. Upon reception of a message type 0, the receiver checks whether the message is empty (it contains only 0's) or whether it contains the message type 2 contents. In the former case, a GEOMT00 block will be generated. In the latter case, a GEOFastCorr block will be generated. Refer to section A.4.4.1 of the DO 229 standard for further details.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
PRN	u1			ID of the SBAS satellite from which the message has been received (see 4.1.9)

GEOPRNMask	Number: 5926 "OnChange" interval: block generated each time MT01 is received from an SBAS satellite

This block contains the decoded PRN mask transmitted in SBAS message type 1. Refer to section A.4.4.2 of the DO 229 standard for further details.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
PRN	u1			ID of the SBAS satellite from which the message has been received (see 4.1.9)
IODP	u1			Issue of data - PRN.
NbrPRNs	u1			Number of PRNs designated in the mask.
PRNMask	u1[NbrPRNs]			List of the PRNs in the PRN mask. PRNMask[0] is the first PRN designated in the PRN mask (from 1 to 210), PRNMask[1] is the 2nd PRN designated in the PRN mask, etc...
Padding	u1[..]			Padding bytes, see 4.1.5

GEOFastCorr	Number: 5927 "OnChange" interval: block generated each time MT02, MT03, MT04, MT05, MT24 and possibly MT00 is received from an SBAS satellite

This block contains the decoded fast corrections transmitted in the SBAS message types 2, 3, 4, 5, 24 and possibly 0 if the type 0 message contains the type 2 contents. Refer to section A.4.4.3 and A.4.4.8 of the DO 229 standard for further details.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
PRN	u1			ID of the SBAS satellite from which the message has been received (see 4.1.9)
MT	u1			Message type from which these fast corrections come, either 0, 2, 3, 4, 5 or 24.
IODP	u1			Issue of data - PRN.
IODF	u1			Issue of data - fast corrections.
N	u1			Number of fast correction sets in this message. This is the number of FastCorr sub-blocks. N depends on the message type as follows. Message type / N MT00, MT02, MT03, MT04 / 13 MT05 / 12 MT24 / 6
SBLength	u1			Length of the FastCorr sub-blocks in bytes
FastCorr	...	...		*A succession of N FastCorr sub-blocks, see definition below*
Padding	u1[..]			Padding bytes, see 4.1.5

FastCorr sub-block definition:

Parameter	Type	Units	Description
PRNMaskNo	u1		Sequence number in the PRN mask. This field may be set to zero. In that case, all following fields in this sub-block must be discarded.
UDREI	u1		User Differential Range Error Indicator for the PRN at index PRNMaskNo.
Reserved	u1[2]		Reserved for future use, to be ignored by decoding software
PRC	f4	1 m	Pseudorange correction for the PRN at index PRNMaskNo.
Padding	u1[..]		Padding bytes, see 4.1.5

GEOIntegrity	Number: 5928 "OnChange" interval: block generated each time MT06 is received from an SBAS satellite

This block contains the decoded integrity information transmitted in SBAS message type 6. Refer to section A.4.4.4 of the DO-229 standard for further details.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
PRN	u1			ID of the SBAS satellite from which the message has been received (see 4.1.9)
Reserved	u1			Reserved for future use, to be ignored by decoding software
IODF	u1[4]			Issue of data - fast corrections for MT02, MT03, MT04 and MT05.
UDREI	u1[51]			User Differential Range Error Indicator for each of the 51 slots in the PRN mask.

GEOFastCorrDegr	Number: 5929 "OnChange" interval: block generated each time MT07 is received from an SBAS satellite

This block contains the decoded fast correction degradation factors transmitted in SBAS message type 7. Refer to section A.4.4.5 of the DO-229 standard for further details.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
PRN	u1			ID of the SBAS satellite from which the message has been received (see 4.1.9)
IODP	u1			Issue of data - PRN.
t_lat	u1	1 s		System latency.
ai	u1[51]			Degradation factor indicator (from 0 to 15) for each of the 51 slots in the PRN mask.
Padding	u1[..]			Padding bytes, see 4.1.5

GEONav	Number: 5896 "OnChange" interval: block generated each time MT09 is received from an SBAS satellite

This block contains the decoded navigation data transmitted in SBAS message type 9. Refer to section A.4.4.11 of the DO-229 standard for further details.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
PRN	u1			ID of the SBAS satellite of which the navigation data is provided here (see 4.1.9)
Reserved	u1			Reserved for future use, to be ignored by decoding software
IODN	u2			Issue of data - navigation (DO 229-B) Spare (DO 229-C)
URA	u2			Accuracy exponent
t0	u4	1 s		Time of applicability (time-of-day)
Xg	f8	1 m		X position at time-of-day t0
Yg	f8	1 m		Y position at time-of-day t0
Zg	f8	1 m		Z position at time-of-day t0
Xgd	f8	1 m / s		X velocity at time-of-day t0
Ygd	f8	1 m / s		Y velocity at time-of-day t0
Zgd	f8	1 m / s		Z velocity at time-of-day t0
Xgdd	f8	1 m / s^2		X acceleration at time-of-day t0
Ygdd	f8	1 m / s^2		Y acceleration at time-of-day t0
Zgdd	f8	1 m / s^2		Z acceleration at time-of-day t0
aGf0	f4	1 s		Time offset with respect to SBAS network time
aGf1	f4	1 s / s		Time drift with respect to SBAS network time
Padding	u1[..]			Padding bytes, see 4.1.5

GEODegrFactors	Number: 5930 "OnChange" interval: block generated each time MT10 is received from an SBAS satellite

This block contains the decoded degradation factors transmitted in SBAS message type 10. Refer to section A.4.5 of the DO-229 standard for further details.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
PRN	u1			ID of the SBAS satellite from which the message has been received (see 4.1.9)
Reserved	u1			Reserved for future use, to be ignored by decoding software
Brrc	f8	1 m		A parameter associated with the relative estimation noise and round-off error.
Cltc_lsb	f8	1 m		Maximum round-off error due to the LSB resolution of the orbit and clock information.
Cltc_v1	f8	1 m / s		Velocity error bound on the maximum range rate difference of missed messages due to clock and orbit rate differences.
Iltc_v1	u4	1 s		Update interval for long term corrections when the velocity code is 1.
Cltc_v0	f8	1 m		Bound on the update delta between successive long term corrections.
Iltc_v0	u4	1 s		Minimum update interval for long term messages when the velocity code is 0.
Cgeo_lsb	f8	1 m		Maximum round-off error due to the LSB resolution of the orbit and clock information.
Cgeo_v	f8	1 m / s		Velocity error bound on the maximum range rate difference of missed messages due to clock and orbit rate differences.
Igeo	u4	1 s		Update interval for GEO navigation messages.
Cer	f4	1 m		A degradation parameter.
Ciono_step	f8	1 m		Bound on the difference between successive ionospheric grid delay values.
Iiono	u4	1 s		Minimum update interval for ionospheric correction messages.
Ciono_ramp	f8	1 m / s		Rate of change of the ionospheric corrections.
RSSudre	u1			Root-sum-square flag (UDRE)
RSSiono	u1			Root-sum-square flag (IONO)
Reserved2	u1[2]			Reserved for future use, to be ignored by decoding software
Ccovariance	f8			A parameter used to compensate for the errors introduced by quantization (introduced in DO 229-C). To be multiplied by the SF parameter from the GEOClockEphCovMatrix block.
Padding	u1[..]			Padding bytes, see 4.1.5

GEONetworkTime	Number: 5918 "OnChange" interval: block generated each time MT12 is received from an SBAS satellite

This block contains the decoded network time offset parameters transmitted in SBAS message type 12. Refer to section A.4.4.15 of the DO-229 standard for further details.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
PRN	u1			ID of the SBAS satellite from which this Network Time data was received (see 4.1.9)
Reserved	u1			Reserved for future use, to be ignored by decoding software
A_1	f4	1 s / s		first order term of polynomial
A_0	f8	1 s		constant term of polynomial
t_ot	u4	1 s		reference time for UTC data (time of week)
WN_t	u1	1 week		UTC reference week number, to which t_ot is referenced
DEL_t_LS	i1	1 s		Delta time due to leap seconds whenever the effectivity time is not in the past
WN_LSF	u1	1 week		Effectivity time of leap second (week)
DN	u1	1 day		Effectivity time of leap second (day)
DEL_t_LSF	i1	1 s		Delta time due to leap seconds whenever the effectivity time is in the past
UTC_std	u1			UTC Standard Identifier
GPS_WN	u2	1 week		GPS week number (modulo 1024)
GPS_TOW	u4	1 s		GPS time-of-week
GlonassID	u1			Glonass Indicator
Padding	u1[..]			Padding bytes, see 4.1.5

GEOAlm	Number: 5897 "OnChange" interval: block generated each time MT17 is received from an SBAS satellite

This block contains the decoded almanac data for one SBAS satellite, as transmitted in SBAS message type 17. A different GEOAlm block is generated for each of the up to three almanac data sets in MT17. Refer to section A.4.4.12 of the DO-229 standard for further details.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
PRN	u1			ID of the SBAS satellite of which the almanac is provided here (see 4.1.9)
Reserved0	u1			Reserved for future use, to be ignored by decoding software
DataID	u1			Data ID
Reserved1	u1			Reserved for future use, to be ignored by decoding software
Health	u2			Health bits
t_oa	u4	1 s		Time of applicability with the day ambiguity resolved. This is the time in GPS seconds from Jan 6th, 1980.
Xg	f8	1 m		X position at t_oa
Yg	f8	1 m		Y position at t_oa
Zg	f8	1 m		Z position at t_oa
Xgd	f8	1 m / s		X velocity at t_oa
Ygd	f8	1 m / s		Y velocity at t_oa
Zgd	f8	1 m / s		Z velocity at t_oa
Padding	u1[..]			Padding bytes, see 4.1.5

GEOIGPMask	Number: 5931 "OnChange" interval: block generated each time MT18 is received from an SBAS satellite

This block contains the decoded ionospheric grid point mask transmitted in SBAS message type 18. Refer to section A.4.4.9 of the DO-229 standard for further details.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
PRN	u1			ID of the SBAS satellite from which the message has been received (see 4.1.9)
NbrBands	u1			Number of bands being broadcast.
BandNbr	u1			Band number.
IODI	u1			Issue of data - ionosphere.
NbrIGPs	u1			Number of ionospheric grid points (IGP) designated in the mask.
IGPMask	u1[NbrIGPs]			List of the IGPs in the IGP mask. IGPMask[0] is the first IGP designated in the IGP mask (from 1 to 201), IGPMask[1] is the 2nd IGP designated in the IGP mask, etc...
Padding	u1[..]			Padding bytes, see 4.1.5

GEOLongTermCorr	Number: 5932 "OnChange" interval: block generated each time MT24 or MT25 is received from an SBAS satellite

This block contains the decoded long term corrections transmitted in SBAS message types 24 and 25. Refer to section A.4.4.7 and A.4.4.8 of the DO-229 standard for further details.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
PRN	u1			ID of the SBAS satellite from which the message has been received (see 4.1.9)
N	u1			Number of long-term corrections in this message. This is the number of LTCorr sub-blocks. N can be 0, 1, 2, 3 or 4.
SBLength	u1	1 byte		Length of the LTCorr sub-blocks in bytes
Reserved	u1[3]			Reserved for future use, to be ignored by decoding software
LTCorr	...	...		*A succession of N LTCorr sub-blocks, see definition below*
Padding	u1[..]			Padding bytes, see 4.1.5

LTCorr sub-block definition:

Parameter	Type	Units	Description
VelocityCode	u1		Velocity code (0 or 1)
PRNMaskNo	u1		Sequence in the PRN mask, from 1 to 51. Note that if the PRN mask No. from the original message is 0, the corresponding long term corrections are ignored, and hence not included in the GEOLongTermCorr block.
IODP	u1		Issue of data - PRN.
IODE	u1		Issue of data - ephemeris.
dx	f4	1 m	Satellite position offset (x).
dy	f4	1 m	Satellite position offset (y).
dz	f4	1 m	Satellite position offset (z).
dxRate	f4	1 m / s	Satellite velocity offset (x), or 0.0 if VelocityCode is 0.
dyRate	f4	1 m / s	Satellite velocity offset (y), or 0.0 if VelocityCode is 0.
dzRate	f4	1 m / s	Satellite velocity offset (z), or 0.0 if VelocityCode is 0.
da_f0	f4	1 s	Satellite clock offset.
da_f1	f4	1 s / s	Satellite drift correction, or 0.0 if VelocityCode is 0.
t_oe	u4	1 s	Time-of-day of applicability, or 0 if VelocityCode is 0.
Padding	u1[..]		Padding bytes, see 4.1.5

GEOIonoDelay	Number: 5933 "OnChange" interval: block generated each time MT26 is received from an SBAS satellite

This block contains the decoded ionospheric delays transmitted in SBAS message type 26. Refer to section A.4.4.10 of the DO-229 standard for further details.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
PRN	u1			ID of the SBAS satellite from which the message has been received (see 4.1.9)
BandNbr	u1			Band number
IODI	u1			Issue of data - ionosphere.
N	u1			Number of ionospheric delay corrections in this message. This is the number of IDC sub-blocks. N is always 15.
SBLength	u1	1 byte		Length of the IDC sub-blocks in bytes.
Reserved	u1			Reserved for future use, to be ignored by decoding software
IDC	...	...		*A succession of N IDC sub-blocks, see definition below*
Padding	u1[..]			Padding bytes, see 4.1.5

IDC sub-block definition:

Parameter	Type	Units	Description
IGPMaskNo	u1		Sequence number in the IGP mask (see GEOIGPMask block), from 1 to 201.
GIVEI	u1		Grid Ionospheric Vertical Error Indicator, from 0 to 15
Reserved	u1[2]		Reserved for future use, to be ignored by decoding software
VerticalDelay	f4	1 m	IGP vertical delay estimate.
Padding	u1[..]		Padding bytes, see 4.1.5

GEOServiceLevel	Number: 5917 "OnChange" interval: block generated each time MT27 is received from an SBAS satellite

This block contains a decoded service level message for a geostationary SBAS satellite as sent in message type 27. Refer to section A.4.4.13 of the DO-229 standard for further details.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
PRN	u1			ID of the SBAS satellite from which this service level message was received (see 4.1.9)
Reserved	u1			Reserved for future use, to be ignored by decoding software
IODS	u1			Issue of Data Service level, ranging from 0 to 7
nrMessages	u1			Number of service messages (MT27), from 1 to 8
MessageNR	u1			Service message number, from 1 to 8
PriorityCode	u1			Priority Code, from 0 to 3
dUDREI_In	u1			δUDRE Indicator for users inside the service region, from 0 to 15
dUDREI_Out	u1			δUDRE Indicator for users outside the service region, from 0 to 15
N	u1			Number of Regions in this message. This is the number of ServiceRegion sub-blocks. Ranging from 0 to 7
SBLength	u1	1 byte		Length of the ServiceRegion sub-blocks in bytes
Regions	...	...		*A succession of N ServiceRegion sub-blocks, see definition below*
Padding	u1[..]			Padding bytes, see 4.1.5

ServiceRegion sub-block definition:

Parameter	Type	Units	Description
Latitude1	i1	1 degree	Coordinate 1 latitude, from -90 to +90
Latitude2	i1	1 degree	Coordinate 2 latitude, from -90 to +90
Longitude1	i2	1 degree	Coordinate 1 longitude, from -180 to +180
Longitude2	i2	1 degree	Coordinate 2 longitude, from -180 to +180
RegionShape	u1		Region Shape: 0=triangular, 1=square
Padding	u1[..]		Padding bytes, see 4.1.5

GEOClockEphCovMatrix	Number: 5934 "OnChange" interval: block generated each time MT28 is received from an SBAS satellite

This block contains the decoded clock-ephemeris covariance Cholesky factor matrix transmitted in SBAS message type 28. Refer to section A.4.4.16 of the DO-229 standard for further details.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	SIS time stamp, see 4.1.3
WNc	u2	1 week	65535	
PRN	u1			Satellite ID, see 4.1.9
IODP	u1			Issue of data - PRN.
N	u1			Number of covariance matrices in this message. This is the number of CovMatrix sub-blocks. N can be 1 or 2.
SBLength	u1	1 byte		Length of the CovMatrix sub-blocks in bytes
Reserved	u1[2]			Reserved for future use, to be ignored by decoding software
CovMatrix	...	...		*A succession of N CovMatrix sub-blocks, see definition below*
Padding	u1[..]			Padding bytes, see 4.1.5

CovMatrix sub-block definition:

Parameter	Type	Units	Description
PRNMaskNo	u1		Sequence number in the PRN mask, from 1 to 51. Note that if the PRN mask No. from the original message is 0, the corresponding matrix is ignored, and hence not included in the GEOClockEphCovMatrix block.
Reserved	u1[2]		Reserved for future use, to be ignored by decoding software
ScaleExp	u1		Scale exponent; scale factor (= $2^{(\text{scale exponent} - 5)}$)
E11	u2		$E_{1,1}$
E22	u2		$E_{2,2}$
E33	u2		$E_{3,3}$
E44	u2		$E_{4,4}$
E12	i2		$E_{1,2}$
E13	i2		$E_{1,3}$
E14	i2		$E_{1,4}$
E23	i2		$E_{2,3}$
E24	i2		$E_{2,4}$
E34	i2		$E_{3,4}$
Padding	u1[..]		Padding bytes, see 4.1.5

4.2.9 GNSS Position, Velocity and Time Blocks

PVTCartesian	Number: 4006 "OnChange" interval: default PVT output rate (see 4.1.8)

This block contains the GNSS-based position, velocity and time (PVT) solution at the time specified in the TOW and WNc fields. The time of applicability is specified in the receiver time frame.

The computed position (x, y, z) and velocity (v_x, v_y, v_z) are reported in a Cartesian coordinate system using the datum indicated in the Datum field. The position is that of the marker. The ARP-to-marker offset is set through the command **setAntennaOffset**.

The PVT solution is also available in ellipsoidal form in the PVTGeodetic block.

The variance-covariance information associated with the reported PVT solution can be found in the PosCovCartesian and VelCovCartesian blocks.

If no PVT solution is available, the Error field indicates the cause of the unavailability and all fields after the Error field are set to their respective Do-Not-Use values.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
Mode	u1			Bit field indicating the GNSS PVT mode, as follows: Bits 0-3: type of PVT solution: 0: No GNSS PVT available (the Error field indicates the cause of the absence of the PVT solution) 1: Stand-Alone PVT 2: Differential PVT 3: Fixed location 4: RTK with fixed ambiguities 5: RTK with float ambiguities 6: SBAS aided PVT 7: moving-base RTK with fixed ambiguities 8: moving-base RTK with float ambiguities 10: Precise Point Positioning (PPP) 12: Reserved Bits 4-5: Reserved Bit 6: Set if the user has entered the command **setPVTMode,Static,auto** and the receiver is still in the process of determining its fixed position. Bit 7: 2D/3D flag: set in 2D mode (height assumed constant and not computed).
Error	u1			PVT error code. The following values are defined: 0: No Error 1: Not enough measurements 2: Not enough ephemerides available 3: DOP too large (larger than 15) 4: Sum of squared residuals too large 5: No convergence 6: Not enough measurements after outlier rejection 7: Position output prohibited due to export laws 8: Not enough differential corrections available 9: Base station coordinates unavailable 10: Ambiguities not fixed and user requested to only output RTK-fixed positions
X	f8	1 m	$-2\cdot10^{10}$	X coordinate in coordinate frame specified by Datum
Y	f8	1 m	$-2\cdot10^{10}$	Y coordinate in coordinate frame specified by Datum
Z	f8	1 m	$-2\cdot10^{10}$	Z coordinate in coordinate frame specified by Datum
Undulation	f4	1 m	$-2\cdot10^{10}$	Geoid undulation. See the **setGeoidUndulation** command.
Vx	f4	1 m / s	$-2\cdot10^{10}$	Velocity in the X direction
Vy	f4	1 m / s	$-2\cdot10^{10}$	Velocity in the Y direction
Vz	f4	1 m / s	$-2\cdot10^{10}$	Velocity in the Z direction

COG	f4	1 degree	$-2 \cdot 10^{10}$	Course over ground: this is defined as the angle of the vehicle with respect to the local level North, ranging from 0 to 360, and increasing towards east. Set to the Do-Not-Use value when the speed is lower than 0.1m/s.
RxClkBias	f8	1 ms	$-2 \cdot 10^{10}$	Receiver clock bias relative to the GNSS system time reported in the TimeSystem field. Positive when the receiver time is ahead of the system time. To transfer the receiver time to the system time, use: $t_{GPS/GST} = t_{rx}$ - RxClkBias
RxClkDrift	f4	1 ppm	$-2 \cdot 10^{10}$	Receiver clock drift relative to the GNSS system time (relative frequency error). Positive when the receiver clock runs faster than the system time.
TimeSystem	u1		255	Time system of which the offset is provided in this sub-block: 0: GPS time 1: Galileo time 3: GLONASS time 4: BeiDou time 5: QZSS time
Datum	u1		255	This field defines in which datum the coordinates are expressed: 0: WGS84/ITRS 19: Datum equal to that used by the DGNSS/RTK base station 30: ETRS89 (ETRF2000 realization) 31: NAD83(2011), North American Datum (2011) 32: NAD83(PA11), North American Datum, Pacific plate (2011) 33: NAD83(MA11), North American Datum, Marianas plate (2011) 34: GDA94(2010), Geocentric Datum of Australia (2010) 35: GDA2020, Geocentric Datum of Australia 2020 250: First user-defined datum 251: Second user-defined datum
NrSV	u1		255	Total number of satellites used in the PVT computation.
WACorrInfo	u1		0	Bit field providing information about which wide area corrections have been applied: Bit 0: set if orbit and satellite clock correction information is used Bit 1: set if range correction information is used Bit 2: set if ionospheric information is used Bit 3: set if orbit accuracy information is used (UERE/SISA) Bit 4: set if DO229 Precision Approach mode is active Bits 5-7: Reserved
ReferenceID	u2		65535	This field indicates the reference ID of the differential information used. In case of DGPS or RTK operation, this field is to be interpreted as the base station identifier. In SBAS operation, this field is to be interpreted as the PRN of the geostationary satellite used (from 120 to 158). If multiple base stations or multiple geostationary satellites are used the value is set to 65534.
MeanCorrAge	u2	0.01 s	65535	In case of DGPS or RTK, this field is the mean age of the differential corrections. In case of SBAS operation, this field is the mean age of the 'fast corrections' provided by the SBAS satellites.
SignalInfo	u4		0	Bit field indicating the type of GNSS signals having been used in the PVT computations. If a bit *i* is set, the signal type having index *i* has been used. The signal numbers are listed in section 4.1.10. Bit 0 (GPS-C/A) is the LSB of SignalInfo.

	AlertFlag	u1		0	Bit field indicating integrity related information: Bits 0-1: RAIM integrity flag: 0: RAIM not active (integrity not monitored) 1: RAIM integrity test successful 2: RAIM integrity test failed 3: Reserved Bit 2: set if integrity has failed as per Galileo HPCA (HMI Probability Computation Algorithm) Bit 3: set if Galileo ionospheric storm flag is active Bit 4: Reserved Bits 5-7: Reserved
Rev 1	NrBases	u1		0	Number of base stations used in the PVT computation.
Rev 1	PPPInfo	u2	1 s	0	Bit field containing PPP-related information: Bits 0-11: Age of the last seed, in seconds. The age is clipped to 4091s. This field must be ignored when the seed type is 0 (see bits 13-15 below). Bit 12: Reserved Bits 13-15: Type of last seed: 0: Not seeded or not in PPP positioning mode 1: Manual seed 2: Seeded from DGPS 3: Seeded from RTKFixed
Rev 2	Latency	u2	0.0001 s	65535	Time elapsed between the time of applicability of the position fix and the generation of this SBF block by the receiver. This time includes the receiver processing time, but not the communication latency.
Rev 2	HAccuracy	u2	0.01 m	65535	2DRMS horizontal accuracy: twice the root-mean-square of the horizontal distance error. The horizontal distance between the true position and the computed position is expected to be lower than HAccuracy with a probability of at least 95%. The value is clipped to 65534 =655.34m
Rev 2	VAccuracy	u2	0.01 m	65535	2-sigma vertical accuracy. The vertical distance between the true position and the computed position is expected to be lower than VAccuracy with a probability of at least 95%. The value is clipped to 65534 =655.34m.
Rev 2	Misc	u1			Bit field containing miscellaneous flags: Bit 0: In DGNSS or RTK mode, set if the baseline points to the base station ARP. Unset if it points to the antenna phase center, or if unknown. Bit 1: Set if the phase center offset is compensated for at the rover, unset if not or unknown. Bit 2: Proprietary. Bit 3: Proprietary. Bits 4-5: Proprietary. Bits 6-7: Flag indicating whether the marker position reported in this block is also the ARP position (i.e. whether the ARP-to-marker offset provided with the **setAntennaOffset** command is zero or not) 0: Unknown 1: The ARP-to-marker offset is zero 2: The ARP-to-marker offset is not zero
	Padding	u1[..]			Padding bytes, see 4.1.5

PVTGeodetic	Number: 4007 "OnChange" interval: default PVT output rate (see 4.1.8)

This block contains the GNSS-based position, velocity and time (PVT) solution at the time specified in the TOW and WNc fields. The time of applicability is specified in the receiver time frame.

The computed position (ϕ,λ,h) and velocity (v_n, v_e, v_u) are reported in an ellipsoidal coordinate system using the datum indicated in the Datum field. The velocity vector is expressed relative to the local-level Cartesian coordinate frame with north-, east-, up-unit vectors. The position is that of the marker. The ARP-to-marker offset is set through the command **setAntennaOffset**.

The PVT solution is also available in Cartesian form in the PVTCartesian block.

The variance-covariance information associated with the reported PVT solution can be found in the PosCovGeodetic and VelCovGeodetic blocks.

If no PVT solution is available, the Error field indicates the cause of the unavailability and all fields after the Error field are set to their respective Do-Not-Use values.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
Mode	u1			Bit field indicating the GNSS PVT mode, as follows: Bits 0-3: type of PVT solution: 0: No GNSS PVT available (the Error field indicates the cause of the absence of the PVT solution) 1: Stand-Alone PVT 2: Differential PVT 3: Fixed location 4: RTK with fixed ambiguities 5: RTK with float ambiguities 6: SBAS aided PVT 7: moving-base RTK with fixed ambiguities 8: moving-base RTK with float ambiguities 10: Precise Point Positioning (PPP) 12: Reserved Bits 4-5: Reserved Bit 6: Set if the user has entered the command **setPVTMode,Static,auto** and the receiver is still in the process of determining its fixed position. Bit 7: 2D/3D flag: set in 2D mode (height assumed constant and not computed).
Error	u1			PVT error code. The following values are defined: 0: No Error 1: Not enough measurements 2: Not enough ephemerides available 3: DOP too large (larger than 15) 4: Sum of squared residuals too large 5: No convergence 6: Not enough measurements after outlier rejection 7: Position output prohibited due to export laws 8: Not enough differential corrections available 9: Base station coordinates unavailable 10: Ambiguities not fixed and user requested to only output RTK-fixed positions
Latitude	f8	1 rad	$-2\cdot10^{10}$	Latitude, from $-\pi/2$ to $+\pi/2$, positive North of Equator
Longitude	f8	1 rad	$-2\cdot10^{10}$	Longitude, from $-\pi$ to $+\pi$, positive East of Greenwich
Height	f8	1 m	$-2\cdot10^{10}$	Ellipsoidal height (with respect to the ellipsoid specified by Datum)
Undulation	f4	1 m	$-2\cdot10^{10}$	Geoid undulation. See the **setGeoidUndulation** command.
Vn	f4	1 m / s	$-2\cdot10^{10}$	Velocity in the North direction
Ve	f4	1 m / s	$-2\cdot10^{10}$	Velocity in the East direction
Vu	f4	1 m / s	$-2\cdot10^{10}$	Velocity in the 'Up' direction

COG	f4	1 degree	$-2 \cdot 10^{10}$	Course over ground: this is defined as the angle of the vehicle with respect to the local level North, ranging from 0 to 360, and increasing towards east. Set to the Do-Not-Use value when the speed is lower than 0.1m/s.
RxClkBias	f8	1 ms	$-2 \cdot 10^{10}$	Receiver clock bias relative to the GNSS system time reported in the TimeSystem field. Positive when the receiver time is ahead of the system time. To transfer the receiver time to the system time, use: $t_{GPS/GST} = t_{rx}$ - RxClkBias
RxClkDrift	f4	1 ppm	$-2 \cdot 10^{10}$	Receiver clock drift relative to the GNSS system time (relative frequency error). Positive when the receiver clock runs faster than the system time.
TimeSystem	u1		255	Time system of which the offset is provided in this sub-block: 0: GPS time 1: Galileo time 3: GLONASS time 4: BeiDou time 5: QZSS time
Datum	u1		255	This field defines in which datum the coordinates are expressed: 0: WGS84/ITRS 19: Datum equal to that used by the DGNSS/RTK base station 30: ETRS89 (ETRF2000 realization) 31: NAD83(2011), North American Datum (2011) 32: NAD83(PA11), North American Datum, Pacific plate (2011) 33: NAD83(MA11), North American Datum, Marianas plate (2011) 34: GDA94(2010), Geocentric Datum of Australia (2010) 35: GDA2020, Geocentric Datum of Australia 2020 250: First user-defined datum 251: Second user-defined datum
NrSV	u1		255	Total number of satellites used in the PVT computation.
WACorrInfo	u1		0	Bit field providing information about which wide area corrections have been applied: Bit 0: set if orbit and satellite clock correction information is used Bit 1: set if range correction information is used Bit 2: set if ionospheric information is used Bit 3: set if orbit accuracy information is used (UERE/SISA) Bit 4: set if DO229 Precision Approach mode is active Bits 5-7: Reserved
ReferenceID	u2		65535	This field indicates the reference ID of the differential information used. In case of DGPS or RTK operation, this field is to be interpreted as the base station identifier. In SBAS operation, this field is to be interpreted as the PRN of the geostationary satellite used (from 120 to 158). If multiple base stations or multiple geostationary satellites are used the value is set to 65534.
MeanCorrAge	u2	0.01 s	65535	In case of DGPS or RTK, this field is the mean age of the differential corrections. In case of SBAS operation, this field is the mean age of the 'fast corrections' provided by the SBAS satellites.
SignalInfo	u4		0	Bit field indicating the type of GNSS signals having been used in the PVT computations. If a bit *i* is set, the signal type having index *i* has been used. The signal numbers are listed in section 4.1.10. Bit 0 (GPS-C/A) is the LSB of SignalInfo.

	AlertFlag	u1		0	Bit field indicating integrity related information: Bits 0-1: RAIM integrity flag: 0: RAIM not active (integrity not monitored) 1: RAIM integrity test successful 2: RAIM integrity test failed 3: Reserved Bit 2: set if integrity has failed as per Galileo HPCA (HMI Probability Computation Algorithm) Bit 3: set if Galileo ionospheric storm flag is active Bit 4: Reserved Bits 5-7: Reserved
Rev 1	NrBases	u1		0	Number of base stations used in the PVT computation.
Rev 1	PPPInfo	u2	1 s	0	Bit field containing PPP-related information: Bits 0-11: Age of the last seed, in seconds. The age is clipped to 4091s. This field must be ignored when the seed type is 0 (see bits 13-15 below). Bit 12: Reserved Bits 13-15: Type of last seed: 0: Not seeded or not in PPP positioning mode 1: Manual seed 2: Seeded from DGPS 3: Seeded from RTKFixed
Rev 2	Latency	u2	0.0001 s	65535	Time elapsed between the time of applicability of the position fix and the generation of this SBF block by the receiver. This time includes the receiver processing time, but not the communication latency.
Rev 2	HAccuracy	u2	0.01 m	65535	2DRMS horizontal accuracy: twice the root-mean-square of the horizontal distance error. The horizontal distance between the true position and the computed position is expected to be lower than HAccuracy with a probability of at least 95%. The value is clipped to 65534 =655.34m
Rev 2	VAccuracy	u2	0.01 m	65535	2-sigma vertical accuracy. The vertical distance between the true position and the computed position is expected to be lower than VAccuracy with a probability of at least 95%. The value is clipped to 65534 =655.34m.
Rev 2	Misc	u1			Bit field containing miscellaneous flags: Bit 0: In DGNSS or RTK mode, set if the baseline points to the base station ARP. Unset if it points to the antenna phase center, or if unknown. Bit 1: Set if the phase center offset is compensated for at the rover, unset if not or unknown. Bit 2: Proprietary. Bit 3: Proprietary. Bits 4-5: Proprietary. Bits 6-7: Flag indicating whether the marker position reported in this block is also the ARP position (i.e. whether the ARP-to-marker offset provided with the **setAntennaOffset** command is zero or not) 0: Unknown 1: The ARP-to-marker offset is zero 2: The ARP-to-marker offset is not zero
	Padding	u1[..]			Padding bytes, see 4.1.5

PosCovCartesian	Number: 5905 "OnChange" interval: default PVT output rate (see 4.1.8)

This block contains the elements of the symmetric variance-covariance matrix of the position expressed relative to the Cartesian axes of the coordinate system datum requested by the user:

$$\begin{pmatrix} \sigma_x^2 & \sigma_{xy} & \sigma_{xz} & \sigma_{xb} \\ \sigma_{yx} & \sigma_y^2 & \sigma_{yz} & \sigma_{yb} \\ \sigma_{zx} & \sigma_{zy} & \sigma_z^2 & \sigma_{zb} \\ \sigma_{bx} & \sigma_{by} & \sigma_{bz} & \sigma_b^2 \end{pmatrix}$$

This variance-covariance matrix contains an indication of the accuracy of the estimated parameters (see diagonal elements) and the correlation between these estimates (see off-diagonal elements). Note that the variances and covariances are estimated: they are not necessarily indicative of the actual scatter of the position estimates at a given site.

The position variance results from the propagation of all pseudorange variances using the observation geometry. The receiver implements a stochastic error model for individual measurements, based on parameters such as the C/N_0, the satellite elevation, the pseudorange type, the URA of the broadcast ephemeris and the ionospheric model.

If the ellipsoidal height is not estimated (2D-mode), all components of the variance-covariance matrix are undefined and set to their Do-Not-Use value.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
Mode	u1			Bit field indicating the GNSS PVT mode, as follows: Bits 0-3: type of PVT solution: 0: No GNSS PVT available (the Error field indicates the cause of the absence of the PVT solution) 1: Stand-Alone PVT 2: Differential PVT 3: Fixed location 4: RTK with fixed ambiguities 5: RTK with float ambiguities 6: SBAS aided PVT 7: moving-base RTK with fixed ambiguities 8: moving-base RTK with float ambiguities 10: Precise Point Positioning (PPP) 12: Reserved Bits 4-5: Reserved Bit 6: Set if the user has entered the command **setPVTMode,Static,auto** and the receiver is still in the process of determining its fixed position. Bit 7: 2D/3D flag: set in 2D mode (height assumed constant and not computed).
Error	u1			PVT error code. The following values are defined: 0: No Error 1: Not enough measurements 2: Not enough ephemerides available 3: DOP too large (larger than 15) 4: Sum of squared residuals too large 5: No convergence 6: Not enough measurements after outlier rejection 7: Position output prohibited due to export laws 8: Not enough differential corrections available 9: Base station coordinates unavailable 10: Ambiguities not fixed and user requested to only output RTK-fixed positions
Cov_xx	f4	1 m^2	$-2 \cdot 10^{10}$	Variance of the x estimate
Cov_yy	f4	1 m^2	$-2 \cdot 10^{10}$	Variance of the y estimate
Cov_zz	f4	1 m^2	$-2 \cdot 10^{10}$	Variance of the z estimate
Cov_bb	f4	1 m^2	$-2 \cdot 10^{10}$	Variance of the clock bias estimate
Cov_xy	f4	1 m^2	$-2 \cdot 10^{10}$	Covariance between the x and y estimates
Cov_xz	f4	1 m^2	$-2 \cdot 10^{10}$	Covariance between the x and z estimates
Cov_xb	f4	1 m^2	$-2 \cdot 10^{10}$	Covariance between the x and clock bias estimates
Cov_yz	f4	1 m^2	$-2 \cdot 10^{10}$	Covariance between the y and z estimates
Cov_yb	f4	1 m^2	$-2 \cdot 10^{10}$	Covariance between the y and clock bias estimates

Cov_zb	f4	1 m^2	$-2 \cdot 10^{10}$	Covariance between the z and clock bias estimates
Padding	u1[..]			Padding bytes, see 4.1.5

PosCovGeodetic	Number: 5906 "OnChange" interval: default PVT output rate (see 4.1.8)

This block contains the elements of the symmetric variance-covariance matrix of the position expressed in the geodetic coordinates in the datum requested by the user:

$$\begin{pmatrix} \sigma_\phi^2 & \sigma_{\phi\lambda} & \sigma_{\phi h} & \sigma_{\phi b} \\ \sigma_{\lambda\phi} & \sigma_\lambda^2 & \sigma_{\lambda h} & \sigma_{\lambda b} \\ \sigma_{h\phi} & \sigma_{h\lambda} & \sigma_h^2 & \sigma_{hb} \\ \sigma_{b\phi} & \sigma_{b\lambda} & \sigma_{bh} & \sigma_b^2 \end{pmatrix}$$

Please refer to the PosCovCartesian block description for a general explanation of the contents.

Note that the units of measure for all the variances and covariances, for height as well as for latitude and longitude, are m^2 for ease of interpretation.

If the ellipsoidal height is not estimated (2D-mode), all height related components of the variance-covariance matrix are undefined and set to their Do-Not-Use value.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
Mode	u1			Bit field indicating the GNSS PVT mode, as follows: Bits 0-3: type of PVT solution: 0: No GNSS PVT available (the Error field indicates the cause of the absence of the PVT solution) 1: Stand-Alone PVT 2: Differential PVT 3: Fixed location 4: RTK with fixed ambiguities 5: RTK with float ambiguities 6: SBAS aided PVT 7: moving-base RTK with fixed ambiguities 8: moving-base RTK with float ambiguities 10: Precise Point Positioning (PPP) 12: Reserved Bits 4-5: Reserved Bit 6: Set if the user has entered the command **setPVTMode,Static,auto** and the receiver is still in the process of determining its fixed position. Bit 7: 2D/3D flag: set in 2D mode (height assumed constant and not computed).
Error	u1			PVT error code. The following values are defined: 0: No Error 1: Not enough measurements 2: Not enough ephemerides available 3: DOP too large (larger than 15) 4: Sum of squared residuals too large 5: No convergence 6: Not enough measurements after outlier rejection 7: Position output prohibited due to export laws 8: Not enough differential corrections available 9: Base station coordinates unavailable 10: Ambiguities not fixed and user requested to only output RTK-fixed positions
Cov_latlat	f4	1 m^2	$-2\cdot10^{10}$	Variance of the latitude estimate
Cov_lonlon	f4	1 m^2	$-2\cdot10^{10}$	Variance of the longitude estimate
Cov_hgthgt	f4	1 m^2	$-2\cdot10^{10}$	Variance of the height estimate
Cov_bb	f4	1 m^2	$-2\cdot10^{10}$	Variance of the clock-bias estimate
Cov_latlon	f4	1 m^2	$-2\cdot10^{10}$	Covariance between the latitude and longitude estimates
Cov_lathgt	f4	1 m^2	$-2\cdot10^{10}$	Covariance between the latitude and height estimates
Cov_latb	f4	1 m^2	$-2\cdot10^{10}$	Covariance between the latitude and clock-bias estimates
Cov_lonhgt	f4	1 m^2	$-2\cdot10^{10}$	Covariance between the longitude and height estimates

Cov_lonb	f4	1 m^2	$-2 \cdot 10^{10}$	Covariance between the longitude and clock-bias estimates
Cov_hb	f4	1 m^2	$-2 \cdot 10^{10}$	Covariance between the height and clock-bias estimates
Padding	u1[..]			Padding bytes, see 4.1.5

VelCovCartesian	Number: 5907 "OnChange" interval: default PVT output rate (see 4.1.8)

This block contains the elements of the symmetric variance-covariance matrix of the velocity expressed in the Cartesian coordinates of the coordinate system datum requested by the user:

$$\begin{pmatrix} \sigma^2_{v_x} & \sigma_{v_x v_y} & \sigma_{v_x v_z} & \sigma_{v_x d} \\ \sigma_{v_y v_x} & \sigma^2_{v_y} & \sigma_{v_y v_z} & \sigma_{v_y d} \\ \sigma_{v_z v_x} & \sigma_{v_z v_y} & \sigma^2_{v_z} & \sigma_{v_z d} \\ \sigma_{d v_x} & \sigma_{d v_y} & \sigma_{d v_z} & \sigma^2_{d} \end{pmatrix}$$

Please refer to the PosCovCartesian block description for a general explanation of the contents.

If the up-velocity is not estimated (2D-mode), all components of the variance-covariance matrix are undefined and set to their Do-Not-Use value.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
Mode	u1			Bit field indicating the GNSS PVT mode, as follows: Bits 0-3: type of PVT solution: 0: No GNSS PVT available (the Error field indicates the cause of the absence of the PVT solution) 1: Stand-Alone PVT 2: Differential PVT 3: Fixed location 4: RTK with fixed ambiguities 5: RTK with float ambiguities 6: SBAS aided PVT 7: moving-base RTK with fixed ambiguities 8: moving-base RTK with float ambiguities 10: Precise Point Positioning (PPP) 12: Reserved Bits 4-5: Reserved Bit 6: Set if the user has entered the command **setPVTMode,Static,auto** and the receiver is still in the process of determining its fixed position. Bit 7: 2D/3D flag: set in 2D mode (height assumed constant and not computed).
Error	u1			PVT error code. The following values are defined: 0: No Error 1: Not enough measurements 2: Not enough ephemerides available 3: DOP too large (larger than 15) 4: Sum of squared residuals too large 5: No convergence 6: Not enough measurements after outlier rejection 7: Position output prohibited due to export laws 8: Not enough differential corrections available 9: Base station coordinates unavailable 10: Ambiguities not fixed and user requested to only output RTK-fixed positions
Cov_VxVx	f4	1 m^2 / s^2	$-2 \cdot 10^{10}$	Variance of the x-velocity estimate
Cov_VyVy	f4	1 m^2 / s^2	$-2 \cdot 10^{10}$	Variance of the y-velocity estimate
Cov_VzVz	f4	1 m^2 / s^2	$-2 \cdot 10^{10}$	Variance of the z-velocity estimate
Cov_DtDt	f4	1 m^2 / s^2	$-2 \cdot 10^{10}$	Variance of the clock drift estimate
Cov_VxVy	f4	1 m^2 / s^2	$-2 \cdot 10^{10}$	Covariance between the x- and y-velocity estimates
Cov_VxVz	f4	1 m^2 / s^2	$-2 \cdot 10^{10}$	Covariance between the x- and z-velocity estimates
Cov_VxDt	f4	1 m^2 / s^2	$-2 \cdot 10^{10}$	Covariance between the x-velocity and the clock drift estimates
Cov_VyVz	f4	1 m^2 / s^2	$-2 \cdot 10^{10}$	Covariance between the y- and z-velocity estimates

Cov_VyDt	f4	1 m^2 / s^2	$-2 \cdot 10^{10}$	Covariance between the y-velocity and the clock drift estimates
Cov_VzDt	f4	1 m^2 / s^2	$-2 \cdot 10^{10}$	Covariance between the z-velocity and the clock drift estimates
Padding	u1[..]			Padding bytes, see 4.1.5

VelCovGeodetic	Number: 5908 "OnChange" interval: default PVT output rate (see 4.1.8)

This block contains the elements of the symmetric variance-covariance matrix of the velocity expressed in the geodetic coordinates in the datum requested by the user:

$$\begin{pmatrix} \sigma^2_{v_N} & \sigma_{v_N v_E} & \sigma_{v_N v_U} & \sigma_{v_N d} \\ \sigma_{v_E v_N} & \sigma^2_{v_E} & \sigma_{v_E v_U} & \sigma_{v_E d} \\ \sigma_{v_U v_N} & \sigma_{v_U v_E} & \sigma^2_{v_U} & \sigma_{v_U d} \\ \sigma_{d v_N} & \sigma_{d v_E} & \sigma_{d v_U} & \sigma^2_{d} \end{pmatrix}$$

Please refer to the PosCovCartesian block description for a general explanation of the contents.

If the up-velocity is not estimated (2D-mode), all up-velocity related components of the variance-covariance matrix are undefined and set to their Do-Not-Use value.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
Mode	u1			Bit field indicating the GNSS PVT mode, as follows: Bits 0-3: type of PVT solution: 0: No GNSS PVT available (the Error field indicates the cause of the absence of the PVT solution) 1: Stand-Alone PVT 2: Differential PVT 3: Fixed location 4: RTK with fixed ambiguities 5: RTK with float ambiguities 6: SBAS aided PVT 7: moving-base RTK with fixed ambiguities 8: moving-base RTK with float ambiguities 10: Precise Point Positioning (PPP) 12: Reserved Bits 4-5: Reserved Bit 6: Set if the user has entered the command **setPVTMode,Static,auto** and the receiver is still in the process of determining its fixed position. Bit 7: 2D/3D flag: set in 2D mode (height assumed constant and not computed).
Error	u1			PVT error code. The following values are defined: 0: No Error 1: Not enough measurements 2: Not enough ephemerides available 3: DOP too large (larger than 15) 4: Sum of squared residuals too large 5: No convergence 6: Not enough measurements after outlier rejection 7: Position output prohibited due to export laws 8: Not enough differential corrections available 9: Base station coordinates unavailable 10: Ambiguities not fixed and user requested to only output RTK-fixed positions
Cov_VnVn	f4	1 m^2/s^2	$-2\cdot10^{10}$	Variance of the north-velocity estimate
Cov_VeVe	f4	1 m^2/s^2	$-2\cdot10^{10}$	Variance of the east-velocity estimate
Cov_VuVu	f4	1 m^2/s^2	$-2\cdot10^{10}$	Variance of the up-velocity estimate
Cov_DtDt	f4	1 m^2/s^2	$-2\cdot10^{10}$	Variance of the clock drift estimate
Cov_VnVe	f4	1 m^2/s^2	$-2\cdot10^{10}$	Covariance between the north- and east-velocity estimates
Cov_VnVu	f4	1 m^2/s^2	$-2\cdot10^{10}$	Covariance between the north- and up-velocity estimates
Cov_VnDt	f4	1 m^2/s^2	$-2\cdot10^{10}$	Covariance between the north-velocity and clock drift estimates
Cov_VeVu	f4	1 m^2/s^2	$-2\cdot10^{10}$	Covariance between the east- and up-velocity estimates

Cov_VeDt	f4	1 m^2 / s^2	$-2 \cdot 10^{10}$	Covariance between the east-velocity and clock drift estimates
Cov_VuDt	f4	1 m^2 / s^2	$-2 \cdot 10^{10}$	Covariance between the up-velocity and clock drift estimates
Padding	u1[..]			Padding bytes, see 4.1.5

DOP	Number: 4001 "OnChange" interval: default PVT output rate (see 4.1.8)

This block contains both Dilution of Precision (DOP) values and SBAS protection levels. The DOP values result from a trace of the unit position variance-covariance matrices:

$$\text{Position Dilution of Precision:} \quad PDOP = \sqrt{\mathbf{Q}_{xx} + \mathbf{Q}_{yy} + \mathbf{Q}_{zz}}$$
$$\text{Time Dilution of Precision:} \quad TDOP = \sqrt{\mathbf{Q}_{bb}}$$
$$\text{Horizontal Dilution of Precision:} \quad HDOP = \sqrt{\mathbf{Q}_{\lambda\lambda} + \mathbf{Q}_{\phi\phi}}$$
$$\text{Vertical Dilution of Precision:} \quad VDOP = \sqrt{\mathbf{Q}_{hh}}$$

In these equations, the matrix **Q** is the inverse of the unweighted normal matrix used for the computation of the position. The normal matrix equals the product of the geometry matrix A with its transpose (A^tA). The term "unweighted" implies that the DOP factor only addresses the effect of the geometric factors on the quality of the position.

The DOP values can be used to interpret the current constellation geometry. This is an important parameter for the quality of the position fix: the DOP parameter is the propagation factor of the pseudorange variance. For example, if an error of 5 m is present in the pseudorange, it will propagate into the horizontal plane with a factor expressed by the HDOP. Hence a low DOP value indicates that the satellites used for the position fix result in a low multiplication of the systematic ranging errors. A value of six (6) for the PDOP is generally considered as the maximum value allowed for an acceptable position computation.

The horizontal and vertical protection levels (HPL and VPL) indicate the integrity of the computed horizontal and vertical position components as per the DO 229 specification. In SBAS-aided PVT mode (see the `Mode` field of the `PVTCartesian` SBF block), HPL and VPL are based upon the error estimates provided by SBAS. Otherwise they are based upon internal position-mode dependent error estimates.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
NrSV	u1		0	Total number of satellites used in the DOP computation, or 0 if the DOP information is not available (in that case, the xDOP fields are all set to 0)
Reserved	u1			Reserved for future use, to be ignored by decoding software
PDOP	u2	0.01	0	If 0, PDOP not available, otherwise divide by 100 to obtain PDOP.
TDOP	u2	0.01	0	If 0, TDOP not available, otherwise divide by 100 to obtain TDOP.
HDOP	u2	0.01	0	If 0, HDOP not available, otherwise divide by 100 to obtain HDOP.
VDOP	u2	0.01	0	If 0, VDOP not available, otherwise divide by 100 to obtain VDOP.
HPL	f4	1 m	$-2\cdot10^{10}$	Horizontal Protection Level (see the DO 229 standard).
VPL	f4	1 m	$-2\cdot10^{10}$	Vertical Protection Level (see the DO 229 standard).
Padding	u1[..]			Padding bytes, see 4.1.5

PosCart	Number: 4044 "OnChange" interval: default PVT output rate (see 4.1.8)

This block contains the absolute and relative (relative to the nearest base station) position at the time specified in the TOW and WNc fields. The time of applicability is specified in the receiver time frame.

The absolute position (X, Y, Z) is reported in a Cartesian coordinate system using the datum indicated in the Datum field. The position is that of the marker. The ARP-to-marker offset is set through the command **setAntennaOffset**.

For highest accuracy, the receiver tries to compute the baseline (Base2RoverX, Base2RoverY, Base2RoverZ) from rover ARP to base ARP. See the description of the BaseVectorCart block for details.

Accurate ARP-to-ARP baseline is guaranteed only if both bits 0 and 1 of the Misc field are set. Otherwise, centimeter-level offsets may arise because the receiver cannot make the distinction between phase center and ARP positions. See section 2.5 for a discussion on the phase center and ARP positions.

This block also contains the variance-covariance information and DOP factors associated with the position.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
Mode	u1			Bit field indicating the GNSS PVT mode, as follows: Bits 0-3: type of PVT solution: 0: No GNSS PVT available (the Error field indicates the cause of the absence of the PVT solution) 1: Stand-Alone PVT 2: Differential PVT 3: Fixed location 4: RTK with fixed ambiguities 5: RTK with float ambiguities 6: SBAS aided PVT 7: moving-base RTK with fixed ambiguities 8: moving-base RTK with float ambiguities 10: Precise Point Positioning (PPP) 12: Reserved Bits 4-5: Reserved Bit 6: Set if the user has entered the command **setPVTMode,Static,auto** and the receiver is still in the process of determining its fixed position. Bit 7: 2D/3D flag: set in 2D mode (height assumed constant and not computed).
Error	u1			PVT error code. The following values are defined: 0: No Error 1: Not enough measurements 2: Not enough ephemerides available 3: DOP too large (larger than 15) 4: Sum of squared residuals too large 5: No convergence 6: Not enough measurements after outlier rejection 7: Position output prohibited due to export laws 8: Not enough differential corrections available 9: Base station coordinates unavailable 10: Ambiguities not fixed and user requested to only output RTK-fixed positions
X	f8	1 m	$-2\cdot10^{10}$	X coordinate in coordinate frame specified by Datum
Y	f8	1 m	$-2\cdot10^{10}$	Y coordinate in coordinate frame specified by Datum
Z	f8	1 m	$-2\cdot10^{10}$	Z coordinate in coordinate frame specified by Datum
Base2RoverX	f8	1 m	$-2\cdot10^{10}$	X baseline component (from base to rover)
Base2RoverY	f8	1 m	$-2\cdot10^{10}$	Y baseline component (from base to rover)
Base2RoverZ	f8	1 m	$-2\cdot10^{10}$	Z baseline component (from base to rover)
Cov_xx	f4	1 m^2	$-2\cdot10^{10}$	Variance of the x estimate
Cov_yy	f4	1 m^2	$-2\cdot10^{10}$	Variance of the y estimate

Cov_zz	f4	1 m^2	$-2 \cdot 10^{10}$	Variance of the z estimate
Cov_xy	f4	1 m^2	$-2 \cdot 10^{10}$	Covariance between the x and y estimates
Cov_xz	f4	1 m^2	$-2 \cdot 10^{10}$	Covariance between the x and z estimates
Cov_yz	f4	1 m^2	$-2 \cdot 10^{10}$	Covariance between the y and z estimates
PDOP	u2	0.01	0	If 0, PDOP not available, otherwise divide by 100 to obtain PDOP.
HDOP	u2	0.01	0	If 0, HDOP not available, otherwise divide by 100 to obtain HDOP.
VDOP	u2	0.01	0	If 0, VDOP not available, otherwise divide by 100 to obtain VDOP.
Misc	u1			Bit field containing miscellaneous flags: Bit 0: In DGNSS or RTK mode, set if the baseline points to the base station ARP. Unset if it points to the antenna phase center, or if unknown. Bit 1: Set if the phase center offset is compensated for at the rover, unset if not or unknown. Bit 2: Proprietary. Bit 3: Proprietary. Bits 4-5: Proprietary. Bits 6-7: Flag indicating whether the marker position reported in this block is also the ARP position (i.e. whether the ARP-to-marker offset provided with the **setAntennaOffset** command is zero or not) 0: Unknown 1: The ARP-to-marker offset is zero 2: The ARP-to-marker offset is not zero
Reserved	u1			Reserved for future use.
AlertFlag	u1		0	Bit field indicating integrity related information: Bits 0-1: RAIM integrity flag: 0: RAIM not active (integrity not monitored) 1: RAIM integrity test successful 2: RAIM integrity test failed 3: Reserved Bit 2: set if integrity has failed as per Galileo HPCA (HMI Probability Computation Algorithm) Bit 3: set if Galileo ionospheric storm flag is active Bit 4: Reserved Bits 5-7: Reserved
Datum	u1		255	This field defines in which datum the coordinates are expressed: 0: WGS84/ITRS 19: Datum equal to that used by the DGNSS/RTK base station 30: ETRS89 (ETRF2000 realization) 31: NAD83(2011), North American Datum (2011) 32: NAD83(PA11), North American Datum, Pacific plate (2011) 33: NAD83(MA11), North American Datum, Marianas plate (2011) 34: GDA94(2010), Geocentric Datum of Australia (2010) 35: GDA2020, Geocentric Datum of Australia 2020 250: First user-defined datum 251: Second user-defined datum
NrSV	u1		255	Total number of satellites used in the PVT computation.

WACorrInfo	u1		0	Bit field providing information about which wide area corrections have been applied: Bit 0: set if orbit and satellite clock correction information is used Bit 1: set if range correction information is used Bit 2: set if ionospheric information is used Bit 3: set if orbit accuracy information is used (UERE/SISA) Bit 4: set if DO229 Precision Approach mode is active Bits 5-7: Reserved
ReferenceId	u2		65535	This field indicates the reference ID of the differential information used. In case of DGPS or RTK operation, this field is to be interpreted as the base station identifier. In SBAS operation, this field is to be interpreted as the PRN of the geostationary satellite used (from 120 to 158). If multiple base stations or multiple geostationary satellites are used the value is set to 65534.
MeanCorrAge	u2	0.01 s	65535	In case of DGPS or RTK, this field is the mean age of the differential corrections. In case of SBAS operation, this field is the mean age of the 'fast corrections' provided by the SBAS satellites.
SignalInfo	u4		0	Bit field indicating the type of GNSS signals having been used in the PVT computations. If a bit *i* is set, the signal type having index *i* has been used. The signal numbers are listed in section 4.1.10. Bit 0 (GPS-C/A) is the LSB of SignalInfo.
Padding	u1[..]			Padding bytes, see 4.1.5

PosLocal	Number: 4052 "OnChange" interval: default PVT output rate (see 4.1.8)

This block contains the position at the time specified in the TOW and WNc fields. The time of applicability is specified in the receiver time frame.

The position (Lat, Lon, Alt) relates to the local datum identified with the Datum field. The coordinate transformation to the local datum is done using parameters transmitted by the RTK service provider in RTCM message types MT1021 to MT1023.

The position is that of the marker. The ARP-to-marker offset is set through the command **setAntennaOffset**.

If no position is available, the Error field indicates the cause of the unavailability and all fields after the Error field are set to their respective Do-Not-Use values.

To be able to output a position in the PosLocal block, the receiver needs to have received the relevant RTCM transformation messages (at least either MT1021 or MT1022 is required). If they have not been received yet, the local position is not available and the Error field is set to value 17. See also section 2.4.6.

The corresponding RTCMDatum block provides information on the local datum name and transformation quality indicators. The corresponding RTCMDatum block is the one of which the Datum field matches the Datum field in the PosLocal block.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
Mode	u1			Bit field indicating the GNSS PVT mode, as follows: Bits 0-3: type of PVT solution: 0: No GNSS PVT available (the Error field indicates the cause of the absence of the PVT solution) 1: Stand-Alone PVT 2: Differential PVT 3: Fixed location 4: RTK with fixed ambiguities 5: RTK with float ambiguities 6: SBAS aided PVT 7: moving-base RTK with fixed ambiguities 8: moving-base RTK with float ambiguities 10: Precise Point Positioning (PPP) 12: Reserved Bits 4-5: Reserved Bit 6: Set if the user has entered the command **setPVTMode,Static,auto** and the receiver is still in the process of determining its fixed position. Bit 7: 2D/3D flag: set in 2D mode (height assumed constant and not computed).

Error	u1			PVT error code. The following values are defined: 0: No Error 1: Not enough measurements 2: Not enough ephemerides available 3: DOP too large (larger than 15) 4: Sum of squared residuals too large 5: No convergence 6: Not enough measurements after outlier rejection 7: Position output prohibited due to export laws 8: Not enough differential corrections available 9: Base station coordinates unavailable 10: Ambiguities not fixed and user requested to only output RTK-fixed positions 17: Datum transformation parameters unknown
Lat	f8	1 rad	$-2 \cdot 10^{10}$	Latitude, from $-\pi/2$ to $+\pi/2$, positive North of Equator
Lon	f8	1 rad	$-2 \cdot 10^{10}$	Longitude, from $-\pi$ to $+\pi$, positive East of Greenwich
Alt	f8	1 m	$-2 \cdot 10^{10}$	Height. See the HeightType field of the corresponding RTCMDatum block for the interpretation of the height.
Datum	u1			Reference frame to which the position relate. If the value is in the 20 to 24 range, the corresponding datum parameters can be found in the RTCMDatum block having a matching Datum field. Value 25 corresponds to the local coordinate reference system selected with the **setLocalCoordOperation** command.
Padding	u1[..]			Padding bytes, see 4.1.5

PosProjected	Number: 4094 "OnChange" interval: default PVT output rate (see 4.1.8)

This block contains the projected coordinates at the time specified in the TOW and WNc fields. The time of applicability is specified in the receiver time frame.

The coordinates (Northing, Easting, Alt) relate to the local datum identified with the Datum field. The coordinate transformation and projection is done using parameters transmitted by the RTK service provider in RTCM message types MT1021 to MT1027.

The position is that of the marker. The ARP-to-marker offset is set through the command **setAntennaOffset**.

If no position is available, the Error field indicates the cause of the unavailability and all fields after the Error field are set to their respective Do-Not-Use values.

To be able to output a position in the PosProjected block, the receiver needs to have received at least one RTCM message in the MT1025 to MT1027 range. If none of these messages is sent out by the service provider, or if they have not been received yet, the projected position is not available and the Error field is set to value 17. See also section 2.4.6.

The corresponding RTCMDatum block provides information on the local datum name and transformation/projection quality indicators. The corresponding RTCMDatum block is the one of which the Datum field matches the Datum field in the PosProjected block.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
Mode	u1			Bit field indicating the GNSS PVT mode, as follows: Bits 0-3: type of PVT solution: 0: No GNSS PVT available (the Error field indicates the cause of the absence of the PVT solution) 1: Stand-Alone PVT 2: Differential PVT 3: Fixed location 4: RTK with fixed ambiguities 5: RTK with float ambiguities 6: SBAS aided PVT 7: moving-base RTK with fixed ambiguities 8: moving-base RTK with float ambiguities 10: Precise Point Positioning (PPP) 12: Reserved Bits 4-5: Reserved Bit 6: Set if the user has entered the command **setPVTMode,Static,auto** and the receiver is still in the process of determining its fixed position. Bit 7: 2D/3D flag: set in 2D mode (height assumed constant and not computed).
Error	u1			PVT error code. The following values are defined: 0: No Error 1: Not enough measurements 2: Not enough ephemerides available 3: DOP too large (larger than 15) 4: Sum of squared residuals too large 5: No convergence 6: Not enough measurements after outlier rejection 7: Position output prohibited due to export laws 8: Not enough differential corrections available 9: Base station coordinates unavailable 10: Ambiguities not fixed and user requested to only output RTK-fixed positions 17: Datum transformation parameters unknown
Northing	f8	1 m	$-2\cdot10^{10}$	Northing coordinate in the plane grid representation.
Easting	f8	1 m	$-2\cdot10^{10}$	Easting coordinate in the plane grid representation.
Alt	f8	1 m	$-2\cdot10^{10}$	Height. If the Datum field is in the 20 to 24 range, see the HeightType field of the corresponding RTCMDatum block for the interpretation of the height.
Datum	u1			Reference frame to which the position relate. If the value is in the 20 to 24 range, the corresponding datum parameters can be found in the RTCMDatum block having a matching Datum field. Value 25 corresponds to the local coordinate reference system selected with the **setLocalCoordOperation** command.
Padding	u1[..]			Padding bytes, see 4.1.5

BaseVectorCart	Number: 4043 "OnChange" interval: default PVT output rate (see 4.1.8)

The BaseVectorCart block contains the relative position and orientation of one or more base stations, as seen from the rover (i.e. this receiver). The relative position is expressed in the Cartesian X, Y, Z directions.

For highest accuracy, the receiver tries to compute the baseline from rover antenna reference point (ARP) to base ARP. This requires to compensate for the phase center offset at both the base and the rover antennas. This is possible if two conditions are met:

- the base station must transmit its antenna parameters in RTCM2 message types 23 and 24 or in RTCM3 message types 1005/1006 and 1007/1008. Older RTCM2 messages and CMR do not allow phase center offset compensation.
- the base and rover antenna types must belong to the list returned by the command **lstAntennaInfo, overview**. (see the description of the commands **setAntennaOffset** and **lstAntennaInfo** for details).

Accurate ARP-to-ARP baseline is guaranteed only if both bits 0 and 1 of the Misc field are set. Otherwise, centimeter-level offsets may arise because the receiver cannot make the distinction between phase center and ARP positions. See section 2.5 for a discussion on the phase center and ARP positions.

The block supports multi-base operation. It contains as many sub-blocks as available base stations, each sub-block containing the baseline relative to a single base station identified by the ReferenceID field.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
N	u1			Number of baselines for which relative position, velocity and direction are provided in this SBF block, i.e. number of VectorInfoCart sub-blocks. If N is 0, there are no baseline available for this epoch.
SBLength	u1	1 byte		Length of one sub-block
VectorInfoCart	...	...		*A succession of N VectorInfoCart sub-blocks, see definition below*
Padding	u1[..]			Padding bytes, see 4.1.5

`VectorInfoCart` sub-block definition:

Parameter	Type	Units	Do-Not-Use	Description
`nrSV`	u1			Number of satellites for which corrections are available from the base station identified by the `ReferenceID` field.
`Error`	u1			PVT error code. The following values are defined: 0: No Error 1: Not enough measurements 2: Not enough ephemerides available 3: DOP too large (larger than 15) 4: Sum of squared residuals too large 5: No convergence 6: Not enough measurements after outlier rejection 7: Position output prohibited due to export laws 8: Not enough differential corrections available 9: Base station coordinates unavailable 10: Ambiguities not fixed and user requested to only output RTK-fixed positions
`Mode`	u1			Bit field indicating the GNSS PVT mode, as follows: Bits 0-3: type of PVT solution: 0: No GNSS PVT available (the `Error` field indicates the cause of the absence of the PVT solution) 1: Stand-Alone PVT 2: Differential PVT 3: Fixed location 4: RTK with fixed ambiguities 5: RTK with float ambiguities 6: SBAS aided PVT 7: moving-base RTK with fixed ambiguities 8: moving-base RTK with float ambiguities 10: Precise Point Positioning (PPP) 12: Reserved Bits 4-5: Reserved Bit 6: Set if the user has entered the command **`setPVTMode,Static,auto`** and the receiver is still in the process of determining its fixed position. Bit 7: 2D/3D flag: set in 2D mode (height assumed constant and not computed).
`Misc`	u1			Bit field containing miscellaneous flags: Bit 0: Set if the baseline points to the base station ARP. Unset if it points to the antenna phase center, or if unknown. Bit 1: Set if the phase center offset is compensated for at the rover (i.e. the baseline starts from the antenna ARP), unset if not or unknown. Bit 2: Proprietary. Bit 3: Proprietary. Bits 4-5: Proprietary. Bits 6-7: Reserved
`DeltaX`	f8	1 m	$-2\cdot10^{10}$	X baseline component (from rover to base)
`DeltaY`	f8	1 m	$-2\cdot10^{10}$	Y baseline component (from rover to base)
`DeltaZ`	f8	1 m	$-2\cdot10^{10}$	Z baseline component (from rover to base)

DeltaVx	f4	1 m / s	$-2 \cdot 10^{10}$	X velocity of base with respect to rover
DeltaVy	f4	1 m / s	$-2 \cdot 10^{10}$	Y velocity of base with respect to rover
DeltaVz	f4	1 m / s	$-2 \cdot 10^{10}$	Z velocity of base with respect to rover
Azimuth	u2	0.01 degrees	65535	Azimuth of the base station (from 0 to 360°, increasing towards east)
Elevation	i2	0.01 degrees	−32768	Elevation of the base station (from -90° to 90°)
ReferenceID	u2			Base station ID
CorrAge	u2	0.01 s	65535	Age of the oldest differential correction used for this baseline computation.
SignalInfo	u4		0	Bit field indicating the GNSS signals for which differential corrections are available from the base station identified by ReferenceID. If bit *i* is set, corrections for the signal type having index *i* are available. The signal numbers are listed in section 4.1.10. Bit 0 (GPS-C/A) is the LSB of SignalInfo.
Padding	u1[..]			Padding bytes, see 4.1.5

BaseVectorGeod	Number: 4028 "OnChange" interval: default PVT output rate (see 4.1.8)

The BaseVectorGeod block contains the relative position and orientation of one or more base stations, as seen from the rover (i.e. this receiver). The relative position is expressed in the East-North-Up directions.

For highest accuracy, the receiver tries to compute the baseline from rover antenna reference point (ARP) to base ARP. See the description of the BaseVectorCart block for details.

Accurate ARP-to-ARP baseline is guaranteed only if both bits 0 and 1 of the Misc field are set. Otherwise, centimeter-level offsets may arise because the receiver cannot make the distinction between phase center and ARP positions. See section 2.5 for a discussion on the phase center and ARP positions.

The block supports multi-base operation. It contains as many sub-blocks as available base stations, each sub-block containing the baseline coordinates relative to a single base station identified by the ReferenceID field.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
N	u1			Number of baselines for which relative position, velocity and direction are provided in this SBF block, i.e. number of VectorInfoGeod sub-blocks. If N is 0, there are no baseline available for this epoch.
SBLength	u1	1 byte		Length of one sub-block
VectorInfoGeod	...	...		*A succession of N VectorInfoGeod sub-blocks, see definition below*
Padding	u1[..]			Padding bytes, see 4.1.5

`VectorInfoGeod` sub-block definition:

Parameter	Type	Units	Do-Not-Use	Description
`NrSV`	u1			Number of satellites for which corrections are available from the base station identified by the `ReferenceID` field.
`Error`	u1			PVT error code. The following values are defined: 0: No Error 1: Not enough measurements 2: Not enough ephemerides available 3: DOP too large (larger than 15) 4: Sum of squared residuals too large 5: No convergence 6: Not enough measurements after outlier rejection 7: Position output prohibited due to export laws 8: Not enough differential corrections available 9: Base station coordinates unavailable 10: Ambiguities not fixed and user requested to only output RTK-fixed positions
`Mode`	u1			Bit field indicating the GNSS PVT mode, as follows: Bits 0-3: type of PVT solution: 0: No GNSS PVT available (the `Error` field indicates the cause of the absence of the PVT solution) 1: Stand-Alone PVT 2: Differential PVT 3: Fixed location 4: RTK with fixed ambiguities 5: RTK with float ambiguities 6: SBAS aided PVT 7: moving-base RTK with fixed ambiguities 8: moving-base RTK with float ambiguities 10: Precise Point Positioning (PPP) 12: Reserved Bits 4-5: Reserved Bit 6: Set if the user has entered the command **`setPVTMode,Static,auto`** and the receiver is still in the process of determining its fixed position. Bit 7: 2D/3D flag: set in 2D mode (height assumed constant and not computed).
`Misc`	u1			Bit field containing miscellaneous flags: Bit 0: Set if the baseline points to the base station ARP. Unset if it points to the antenna phase center, or if unknown. Bit 1: Set if the phase center offset is compensated for at the rover (i.e. the baseline starts from the antenna ARP), unset if not or unknown. Bit 2: Proprietary. Bit 3: Proprietary. Bits 4-5: Proprietary. Bits 6-7: Reserved
`DeltaEast`	f8	1 m	$-2\cdot10^{10}$	East baseline component (from rover to base)
`DeltaNorth`	f8	1 m	$-2\cdot10^{10}$	North baseline component (from rover to base)
`DeltaUp`	f8	1 m	$-2\cdot10^{10}$	Up baseline component (from rover to base)

DeltaVe	f4	1 m / s	$-2 \cdot 10^{10}$	East velocity of base with respect to rover
DeltaVn	f4	1 m / s	$-2 \cdot 10^{10}$	North velocity of base with respect to rover
DeltaVu	f4	1 m / s	$-2 \cdot 10^{10}$	Up velocity of base with respect to rover
Azimuth	u2	0.01 degrees	65535	Azimuth of the base station (from 0 to 360°, increasing towards east)
Elevation	i2	0.01 degrees	−32768	Elevation of the base station (from -90° to 90°)
ReferenceID	u2			Base station ID
CorrAge	u2	0.01 s	65535	Age of the oldest differential correction used for this baseline computation.
SignalInfo	u4		0	Bit field indicating the GNSS signals for which differential corrections are available from the base station identified by ReferenceID. If bit *i* is set, corrections for the signal type having index *i* are available. The signal numbers are listed in section 4.1.10. Bit 0 (GPS-C/A) is the LSB of SignalInfo.
Padding	u1[..]			Padding bytes, see 4.1.5

PVTSupport	Number: 4076 "OnChange" interval: default PVT output rate (see 4.1.8)

This block contains various internal parameters that can be used for maintenance and support.

The detailed definition of this block is not available in this document.

PVTSupportA	Number: 4079 "OnChange" interval: default PVT output rate (see 4.1.8)

This block contains various internal parameters that can be used for maintenance and support.

The detailed definition of this block is not available in this document.

EndOfPVT	Number: 5921 "OnChange" interval: default PVT output rate (see 4.1.8)

This block marks the end of transmission of all PVT related blocks belonging to the same epoch.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
Padding	u1[..]			Padding bytes, see 4.1.5

4.2.10 GNSS Attitude Blocks

AttEuler	Number: 5938 "OnChange" interval: default PVT output rate (see 4.1.8)

The AttEuler block contains the Euler angles (pitch, roll and heading) at the time specified in the TOW and WNc fields (in the receiver time frame).

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
NrSV	u1		255	The average over all antennas of the number of satellites currently included in the attitude calculations.
Error	u1			Bit field providing error information. For each antenna baseline, two bits are used to provide error information: Bits 0-1: Error code for Main-Aux1 baseline: 0: No error 1: Not enough measurements 2: Reserved 3: Reserved Bits 2-3: Error code for Main-Aux2 baseline, same definition as bit 0-1. Bits 4-6: Reserved Bit 7: Set when GNSS-based attitude not requested by user. In that case, the other bits are all zero.
Mode	u2			Attitude mode code: 0: No attitude 1: Heading, pitch (roll = 0), aux antenna positions obtained with float ambiguities 2: Heading, pitch (roll = 0), aux antenna positions obtained with fixed ambiguities 3: Heading, pitch, roll, aux antenna positions obtained with float ambiguities 4: Heading, pitch, roll, aux antenna positions obtained with fixed ambiguities
Reserved	u2			Reserved for future use, to be ignored by decoding software
Heading	f4	1 degree	$-2\cdot10^{10}$	Heading
Pitch	f4	1 degree	$-2\cdot10^{10}$	Pitch
Roll	f4	1 degree	$-2\cdot10^{10}$	Roll
PitchDot	f4	1 degree / s	$-2\cdot10^{10}$	Rate of change of the pitch angle
RollDot	f4	1 degree / s	$-2\cdot10^{10}$	Rate of change of the roll angle
HeadingDot	f4	1 degree / s	$-2\cdot10^{10}$	Rate of change of the heading angle
Padding	u1[..]			Padding bytes, see 4.1.5

AttCovEuler	Number: 5939 "OnChange" interval: default PVT output rate (see 4.1.8)

This block contains the elements of the symmetric variance-covariance matrix of the attitude angles reported in the AttEuler block

$$\begin{pmatrix} \sigma_\phi^2 & \sigma_{\phi\theta} & \sigma_{\phi\psi} \\ \sigma_{\theta\phi} & \sigma_\theta^2 & \sigma_{\theta\psi} \\ \sigma_{\psi\phi} & \sigma_{\psi\theta} & \sigma_\psi^2 \end{pmatrix}$$

This variance-covariance matrix contains an indication of the accuracy of the estimated parameters (see diagonal elements) and the correlation between these estimates (see off-diagonal elements).

In case the receiver is in heading and pitch mode only, only the heading and pitch variance values will be valid. All other components of the variance-covariance matrix are set to their Do-Not-Use value.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
Reserved	u1			Reserved for future use, to be ignored by decoding software
Error	u1			Bit field providing error information. For each antenna baseline, two bits are used to provide error information: Bits 0-1: Error code for Main-Aux1 baseline: 0: No error 1: Not enough measurements 2: Reserved 3: Reserved Bits 2-3: Error code for Main-Aux2 baseline, same definition as bit 0-1. Bits 4-6: Reserved Bit 7: Set when GNSS-based attitude not requested by user. In that case, the other bits are all zero.
Cov_HeadHead	f4	1 degree^2	$-2\cdot10^{10}$	Variance of the heading estimate
Cov_PitchPitch	f4	1 degree^2	$-2\cdot10^{10}$	Variance of the pitch estimate
Cov_RollRoll	f4	1 degree^2	$-2\cdot10^{10}$	Variance of the roll estimate
Cov_HeadPitch	f4	1 degree^2	$-2\cdot10^{10}$	Covariance between Euler angle estimates. Future functionality. The values are currently set to their Do-Not-Use values.
Cov_HeadRoll	f4	1 degree^2	$-2\cdot10^{10}$	Covariance between Euler angle estimates. Future functionality. The values are currently set to their Do-Not-Use values.
Cov_PitchRoll	f4	1 degree^2	$-2\cdot10^{10}$	Covariance between Euler angle estimates. Future functionality. The values are currently set to their Do-Not-Use values.
Padding	u1[..]			Padding bytes, see 4.1.5

AuxAntPositions	Number: 5942 "OnChange" interval: default PVT output rate (see 4.1.8)

The AuxAntPositions block contains the relative position and velocity of the different antennas in a multi-antenna receiver. The coordinates are expressed in the local-level ENU reference frame.

When the antenna positions cannot be estimated, the baseline vectors are set to their Do-Not-Use value.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
N	u1			Number of AuxAntPositionSub sub-blocks in this AuxAntPositions block
SBLength	u1	1 byte		Length of one sub-block in bytes
AuxAntPosition	...	...		*A succession of N AuxAntPositionSub sub-blocks, see definition below*
Padding	u1[..]			Padding bytes, see 4.1.5

AuxAntPositionSub sub-block definition:

Parameter	Type	Units	Do-Not-Use	Description
NrSV	u1		255	Total number of satellites tracked by the antenna identified by the AuxAntID field and used in the attitude computation.
Error	u1			Aux antenna position error code: 0: No error 1: Not enough measurements 2: Reserved 3: Reserved If error is not 0, the coordinates reported later in this block are all set to their Do-Not-Use value.
AmbiguityType	u1		255	Aux antenna positions obtained with 0: Fixed ambiguities 1: Float ambiguities
AuxAntID	u1			Auxiliary antenna ID: 1 for the first auxiliary antenna, 2 for the second, etc...
DeltaEast	f8	1 m	$-2\cdot10^{10}$	Position in East direction (relative to main antenna)
DeltaNorth	f8	1 m	$-2\cdot10^{10}$	Position in North direction (relative to main antenna)
DeltaUp	f8	1 m	$-2\cdot10^{10}$	Position in Up direction (relative to main antenna)
EastVel	f8	1 m / s	$-2\cdot10^{10}$	Velocity in East direction (relative to main antenna)
NorthVel	f8	1 m / s	$-2\cdot10^{10}$	Velocity in North direction (relative to main antenna)
UpVel	f8	1 m / s	$-2\cdot10^{10}$	Velocity in Up direction (relative to main antenna)
Padding	u1[..]			Padding bytes, see 4.1.5

EndOfAtt	Number: 5943 "OnChange" interval: default PVT output rate (see 4.1.8)

This block marks the end of transmission of all GNSS-attitude related blocks belonging to the same epoch.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
Padding	u1[..]			Padding bytes, see 4.1.5

4.2.11 Receiver Time Blocks

ReceiverTime	Number: 5914 "OnChange" interval: 1s

The ReceiverTime block provides the current time with a 1-second resolution in the receiver time scale and UTC.

The level of synchronization of the receiver time with the satellite system time is provided in the SyncLevel field.

UTC time is provided if the UTC parameters have been received from at least one GNSS satellite. If the UTC time is not available, the corresponding fields are set to their Do-Not-Use value.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
UTCYear	i1	1 year	−128	Current year in the UTC time scale (2 digits). From 0 to 99, or -128 if not available
UTCMonth	i1	1 month	−128	Current month in the UTC time scale. From 1 to 12, or -128 if not available
UTCDay	i1	1 day	−128	Current day in the UTC time scale. From 1 to 31, or -128 if not available
UTCHour	i1	1 hour	−128	Current hour in the UTC time scale. From 0 to 23, or -128 if not available
UTCMin	i1	1 minute	−128	Current minute in the UTC time scale. From 0 to 59, or -128 if not available
UTCSec	i1	1 s	−128	Current second in the UTC time scale. From 0 to 59, or -128 if not available
DeltaLS	i1	1 s	−128	Integer second difference between UTC time and GPS system time. Positive if GPS time is ahead of UTC. Set to -128 if not available.
SyncLevel	u1			Bit field indicating the synchronization level of the receiver time. If bits 0 to 2 are set, full synchronization is achieved: Bit 0: WNSET: if this bit is set, the receiver week number is set. Bit 1: TOWSET: if this bit is set, the receiver time-of-week is set to within 20ms. Bit 2: FINETIME: if this bit is set, the receiver time-of-week is within the limit specified by the **setClockSyncThreshold** command. Bit 3: Reserved Bit 4: i Reserved Bits 5-7: Reserved
Padding	u1[..]			Padding bytes, see 4.1.5

xPPSOffset	Number: 5911 "OnChange" interval: PPS rate

The xPPSOffset block contains the offset between the true xPPS pulse and the actual pulse output by the receiver. It is output right after each xPPS pulse.

On receivers with more than one independent PPS outputs, this block always refers to the first PPS output.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
SyncAge	u1	1 s		Age of the last synchronization to system time. The xPPS pulse is regularly resynchronized with system time. This field indicates the number of seconds elapsed since the last resynchronization. SyncAge is constrained to the 0-255s range. If the age is higher than 255s, SyncAge is set to 255. If the PPS is synchronized with the internal receiver time (Timescale = 3), SyncAge is always set to 0.
TimeScale	u1			Time scale to which the xPPS pulse is referenced, as set with the **setPPSParameters** command: 1: GPS time 2: UTC 3: Receiver time 4: GLONASS time 5: Galileo time 6: BeiDou time
Offset	f4	$1 \cdot 10^{-9}$ s		Offset of the xPPS output by the receiver with respect to its true position. Offset is negative when the xPPS pulse is in advance with respect to its true position. See also section 1.19 for an explanation of the xPPS generation principle, and for a description of the xPPS offset.
Padding	u1[..]			Padding bytes, see 4.1.5

4.2.12 External Event Blocks

These blocks report the state of the receiver applicable at the instant of a level transition on one of its “Event” pins. The receiver time is reported in the `ExtEvent` SBF block, and the receiver position is reported in the `ExtEventPVTCartesian` and the `ExtEventPVTGeodetic` blocks.

If enabled, upon detection of an event, these three blocks are output in the following order, with no other SBF blocks in between them:

1. `ExtEvent`;
2. `ExtEventPVTCartesian`;
3. `ExtEventPVTGeodetic`.

All blocks referring to the same event contain the same time stamp in the `TOW` and `WNc` fields.

ExtEvent	Number: 5924 "OnChange" interval: each time an event is detected

The ExtEvent block contains the time tag of a voltage transition on one of the "Event" input pins.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	External time stamp, see 4.1.3
WNc	u2	1 week	65535	
Source	u1			Input pin where this external event has been detected. The following values are defined: 1: EventA 2: EventB
Polarity	u1			0: rising edge event 1: falling edge event
Offset	f4	1 s		Event time offset with respect to TOW, including the potential delay specified with the **setEventParameters** command. The time of week of the external event is given by: $t_{ext,rx}$ [s] = TOW/1000 + Offset $t_{ext,rx}$ refers to the receiver system time scale. Use the RxClkBias field to convert this time to the GNSS time scale.
RxClkBias	f8	1 s	$-2 \cdot 10^{10}$	Receiver clock bias at the time of event. The clock bias is relative to the time system of the last PVT computation (see the TimeSystem field of the PVTCartesian or PVTGeodetic blocks). To get the time of week of the external event in GNSS time, use: $t_{ext,GNSS}$ [s] = TOW/1000 + Offset - RxClkBias. The accuracy of the clock bias is dependent on the age of the last PVT solution. When the receiver has been unable to compute a PVT during the last 10 minutes, this field is set to its Do-Not-Use value.
PVTAge	u2	1 s		Age of the last PVT solution. If the PVT age is larger than 10 minutes (600s), this value is clipped to 600.
Padding	u1[..]			Padding bytes, see 4.1.5

Rev 1

ExtEventPVTCartesian	Number: 4037 "OnChange" interval: each time an external event is detected

This block contains the position, velocity and time (PVT) solution applicable at the time of an external event, in a Cartesian coordinate system.

This block has the same structure and description as the PVTCartesian block, except that the TOW and WNc fields refer to the time at which the electrical transition on the event pin has been detected (with a millisecond resolution), and that the position is computed at the event time, taking into account a possible user-defined delay set by the **setEventParameters** command.

A user needing the sub-millisecond part of the event time must refer to the Offset field of the corresponding ExtEvent block. The corresponding ExtEvent block is the last of the ExtEvent blocks having been output by the receiver.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	External time stamp, see 4.1.3
WNc	u2	1 week	65535	
Mode	u1			Bit field indicating the GNSS PVT mode, as follows: Bits 0-3: type of PVT solution: 0: No GNSS PVT available (the Error field indicates the cause of the absence of the PVT solution) 1: Stand-Alone PVT 2: Differential PVT 3: Fixed location 4: RTK with fixed ambiguities 5: RTK with float ambiguities 6: SBAS aided PVT 7: moving-base RTK with fixed ambiguities 8: moving-base RTK with float ambiguities 10: Precise Point Positioning (PPP) 12: Reserved Bits 4-5: Reserved Bit 6: Set if the user has entered the command **setPVTMode,Static,auto** and the receiver is still in the process of determining its fixed position. Bit 7: 2D/3D flag: set in 2D mode (height assumed constant and not computed).
Error	u1			PVT error code. The following values are defined: 0: No Error 1: Not enough measurements 2: Not enough ephemerides available 3: DOP too large (larger than 15) 4: Sum of squared residuals too large 5: No convergence 6: Not enough measurements after outlier rejection 7: Position output prohibited due to export laws 8: Not enough differential corrections available 9: Base station coordinates unavailable 10: Ambiguities not fixed and user requested to only output RTK-fixed positions
X	f8	1 m	$-2 \cdot 10^{10}$	X coordinate in coordinate frame specified by Datum
Y	f8	1 m	$-2 \cdot 10^{10}$	Y coordinate in coordinate frame specified by Datum
Z	f8	1 m	$-2 \cdot 10^{10}$	Z coordinate in coordinate frame specified by Datum
Undulation	f4	1 m	$-2 \cdot 10^{10}$	Geoid undulation. See the **setGeoidUndulation** command.
Vx	f4	1 m / s	$-2 \cdot 10^{10}$	Not applicable
Vy	f4	1 m / s	$-2 \cdot 10^{10}$	Not applicable
Vz	f4	1 m / s	$-2 \cdot 10^{10}$	Not applicable

COG	f4	1 degree	$-2 \cdot 10^{10}$	Course over ground: this is defined as the angle of the vehicle with respect to the local level North, ranging from 0 to 360, and increasing towards east. Set to the Do-Not-Use value when the speed is lower than 0.1m/s.
RxClkBias	f8	1 ms	$-2 \cdot 10^{10}$	Receiver clock bias relative to the GNSS system time reported in the TimeSystem field. Positive when the receiver time is ahead of the system time. To transfer the receiver time to the system time, use: $t_{GPS/GST} = t_{rx}$ - RxClkBias
RxClkDrift	f4	1 ppm	$-2 \cdot 10^{10}$	Receiver clock drift relative to the GNSS system time (relative frequency error). Positive when the receiver clock runs faster than the system time.
TimeSystem	u1		255	Time system of which the offset is provided in this sub-block: 0: GPS time 1: Galileo time 3: GLONASS time 4: BeiDou time 5: QZSS time
Datum	u1		255	This field defines in which datum the coordinates are expressed: 0: WGS84/ITRS 19: Datum equal to that used by the DGNSS/RTK base station 30: ETRS89 (ETRF2000 realization) 31: NAD83(2011), North American Datum (2011) 32: NAD83(PA11), North American Datum, Pacific plate (2011) 33: NAD83(MA11), North American Datum, Marianas plate (2011) 34: GDA94(2010), Geocentric Datum of Australia (2010) 35: GDA2020, Geocentric Datum of Australia 2020 250: First user-defined datum 251: Second user-defined datum
NrSV	u1		255	Total number of satellites used in the PVT computation.
WACorrInfo	u1		0	Bit field providing information about which wide area corrections have been applied: Bit 0: set if orbit and satellite clock correction information is used Bit 1: set if range correction information is used Bit 2: set if ionospheric information is used Bit 3: set if orbit accuracy information is used (UERE/SISA) Bit 4: set if DO229 Precision Approach mode is active Bits 5-7: Reserved
ReferenceID	u2		65535	This field indicates the reference ID of the differential information used. In case of DGPS or RTK operation, this field is to be interpreted as the base station identifier. In SBAS operation, this field is to be interpreted as the PRN of the geostationary satellite used (from 120 to 158). If multiple base stations or multiple geostationary satellites are used the value is set to 65534.
MeanCorrAge	u2	0.01 s	65535	In case of DGPS or RTK, this field is the mean age of the differential corrections. In case of SBAS operation, this field is the mean age of the 'fast corrections' provided by the SBAS satellites.
SignalInfo	u4		0	Bit field indicating the type of GNSS signals having been used in the PVT computations. If a bit *i* is set, the signal type having index *i* has been used. The signal numbers are listed in section 4.1.10. Bit 0 (GPS-C/A) is the LSB of SignalInfo.

	AlertFlag	u1		0	Bit field indicating integrity related information: Bits 0-1: RAIM integrity flag: 0: RAIM not active (integrity not monitored) 1: RAIM integrity test successful 2: RAIM integrity test failed 3: Reserved Bit 2: set if integrity has failed as per Galileo HPCA (HMI Probability Computation Algorithm) Bit 3: set if Galileo ionospheric storm flag is active Bit 4: Reserved Bits 5-7: Reserved
Rev 1	NrBases	u1		0	Number of base stations used in the PVT computation.
Rev 1	PPPInfo	u2	1 s	0	Bit field containing PPP-related information: Bits 0-11: Age of the last seed, in seconds. The age is clipped to 4091s. This field must be ignored when the seed type is 0 (see bits 13-15 below). Bit 12: Reserved Bits 13-15: Type of last seed: 0: Not seeded or not in PPP positioning mode 1: Manual seed 2: Seeded from DGPS 3: Seeded from RTKFixed
Rev 2	Latency	u2	0.0001 s	65535	Time elapsed between the time of applicability of the position fix and the generation of this SBF block by the receiver. This time includes the receiver processing time, but not the communication latency.
Rev 2	HAccuracy	u2	0.01 m	65535	2DRMS horizontal accuracy: twice the root-mean-square of the horizontal distance error. The horizontal distance between the true position and the computed position is expected to be lower than HAccuracy with a probability of at least 95%. The value is clipped to 65534 =655.34m
Rev 2	VAccuracy	u2	0.01 m	65535	2-sigma vertical accuracy. The vertical distance between the true position and the computed position is expected to be lower than VAccuracy with a probability of at least 95%. The value is clipped to 65534 =655.34m.
Rev 2	Misc	u1			Bit field containing miscellaneous flags: Bit 0: In DGNSS or RTK mode, set if the baseline points to the base station ARP. Unset if it points to the antenna phase center, or if unknown. Bit 1: Set if the phase center offset is compensated for at the rover, unset if not or unknown. Bit 2: Proprietary. Bit 3: Proprietary. Bits 4-5: Proprietary. Bits 6-7: Flag indicating whether the marker position reported in this block is also the ARP position (i.e. whether the ARP-to-marker offset provided with the **setAntennaOffset** command is zero or not) 0: Unknown 1: The ARP-to-marker offset is zero 2: The ARP-to-marker offset is not zero
	Padding	u1[..]			Padding bytes, see 4.1.5

ExtEventPVTGeodetic	Number: 4038 "OnChange" interval: each time an external event is detected

This block contains the position, velocity and time (PVT) solution applicable at the time of an external event, in an ellipsoidal coordinate system.

This block has the same structure and description as the PVTGeodetic block, except that the TOW and WNc fields refer to the time at which the electrical transition on the event pin has been detected (with a millisecond resolution), and that the position is computed at the event time, taking into account a possible user-defined delay set by the **setEventParameters** command.

A user needing the sub-millisecond part of the event time must refer to the Offset field of the corresponding ExtEvent block. The corresponding ExtEvent block is the last of the ExtEvent blocks having been output by the receiver.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	External time stamp, see 4.1.3
WNc	u2	1 week	65535	
Mode	u1			Bit field indicating the GNSS PVT mode, as follows: Bits 0-3: type of PVT solution: 0: No GNSS PVT available (the Error field indicates the cause of the absence of the PVT solution) 1: Stand-Alone PVT 2: Differential PVT 3: Fixed location 4: RTK with fixed ambiguities 5: RTK with float ambiguities 6: SBAS aided PVT 7: moving-base RTK with fixed ambiguities 8: moving-base RTK with float ambiguities 10: Precise Point Positioning (PPP) 12: Reserved Bits 4-5: Reserved Bit 6: Set if the user has entered the command **setPVTMode,Static,auto** and the receiver is still in the process of determining its fixed position. Bit 7: 2D/3D flag: set in 2D mode (height assumed constant and not computed).
Error	u1			PVT error code. The following values are defined: 0: No Error 1: Not enough measurements 2: Not enough ephemerides available 3: DOP too large (larger than 15) 4: Sum of squared residuals too large 5: No convergence 6: Not enough measurements after outlier rejection 7: Position output prohibited due to export laws 8: Not enough differential corrections available 9: Base station coordinates unavailable 10: Ambiguities not fixed and user requested to only output RTK-fixed positions
Latitude	f8	1 rad	$-2\cdot10^{10}$	Latitude, from $-\pi/2$ to $+\pi/2$, positive North of Equator
Longitude	f8	1 rad	$-2\cdot10^{10}$	Longitude, from $-\pi$ to $+\pi$, positive East of Greenwich
Height	f8	1 m	$-2\cdot10^{10}$	Ellipsoidal height (with respect to the ellipsoid specified by Datum)
Undulation	f4	1 m	$-2\cdot10^{10}$	Geoid undulation. See the **setGeoidUndulation** command.
Vn	f4	1 m / s	$-2\cdot10^{10}$	Not applicable
Ve	f4	1 m / s	$-2\cdot10^{10}$	Not applicable
Vu	f4	1 m / s	$-2\cdot10^{10}$	Not applicable

COG	f4	1 degree	$-2 \cdot 10^{10}$	Course over ground: this is defined as the angle of the vehicle with respect to the local level North, ranging from 0 to 360, and increasing towards east. Set to the Do-Not-Use value when the speed is lower than 0.1m/s.
RxClkBias	f8	1 ms	$-2 \cdot 10^{10}$	Receiver clock bias relative to the GNSS system time reported in the TimeSystem field. Positive when the receiver time is ahead of the system time. To transfer the receiver time to the system time, use: $t_{GPS/GST} = t_{rx}$ - RxClkBias
RxClkDrift	f4	1 ppm	$-2 \cdot 10^{10}$	Receiver clock drift relative to the GNSS system time (relative frequency error). Positive when the receiver clock runs faster than the system time.
TimeSystem	u1		255	Time system of which the offset is provided in this sub-block: 0: GPS time 1: Galileo time 3: GLONASS time 4: BeiDou time 5: QZSS time
Datum	u1		255	This field defines in which datum the coordinates are expressed: 0: WGS84/ITRS 19: Datum equal to that used by the DGNSS/RTK base station 30: ETRS89 (ETRF2000 realization) 31: NAD83(2011), North American Datum (2011) 32: NAD83(PA11), North American Datum, Pacific plate (2011) 33: NAD83(MA11), North American Datum, Marianas plate (2011) 34: GDA94(2010), Geocentric Datum of Australia (2010) 35: GDA2020, Geocentric Datum of Australia 2020 250: First user-defined datum 251: Second user-defined datum
NrSV	u1		255	Total number of satellites used in the PVT computation.
WACorrInfo	u1		0	Bit field providing information about which wide area corrections have been applied: Bit 0: set if orbit and satellite clock correction information is used Bit 1: set if range correction information is used Bit 2: set if ionospheric information is used Bit 3: set if orbit accuracy information is used (UERE/SISA) Bit 4: set if DO229 Precision Approach mode is active Bits 5-7: Reserved
ReferenceID	u2		65535	This field indicates the reference ID of the differential information used. In case of DGPS or RTK operation, this field is to be interpreted as the base station identifier. In SBAS operation, this field is to be interpreted as the PRN of the geostationary satellite used (from 120 to 158). If multiple base stations or multiple geostationary satellites are used the value is set to 65534.
MeanCorrAge	u2	0.01 s	65535	In case of DGPS or RTK, this field is the mean age of the differential corrections. In case of SBAS operation, this field is the mean age of the 'fast corrections' provided by the SBAS satellites.
SignalInfo	u4		0	Bit field indicating the type of GNSS signals having been used in the PVT computations. If a bit *i* is set, the signal type having index *i* has been used. The signal numbers are listed in section 4.1.10. Bit 0 (GPS-C/A) is the LSB of SignalInfo.

	AlertFlag	u1		0	Bit field indicating integrity related information: Bits 0-1: RAIM integrity flag: 0: RAIM not active (integrity not monitored) 1: RAIM integrity test successful 2: RAIM integrity test failed 3: Reserved Bit 2: set if integrity has failed as per Galileo HPCA (HMI Probability Computation Algorithm) Bit 3: set if Galileo ionospheric storm flag is active Bit 4: Reserved Bits 5-7: Reserved
Rev 1	NrBases	u1		0	Number of base stations used in the PVT computation.
Rev 1	PPPInfo	u2	1 s	0	Bit field containing PPP-related information: Bits 0-11: Age of the last seed, in seconds. The age is clipped to 4091s. This field must be ignored when the seed type is 0 (see bits 13-15 below). Bit 12: Reserved Bits 13-15: Type of last seed: 0: Not seeded or not in PPP positioning mode 1: Manual seed 2: Seeded from DGPS 3: Seeded from RTKFixed
Rev 2	Latency	u2	0.0001 s	65535	Time elapsed between the time of applicability of the position fix and the generation of this SBF block by the receiver. This time includes the receiver processing time, but not the communication latency.
Rev 2	HAccuracy	u2	0.01 m	65535	2DRMS horizontal accuracy: twice the root-mean-square of the horizontal distance error. The horizontal distance between the true position and the computed position is expected to be lower than HAccuracy with a probability of at least 95%. The value is clipped to 65534 =655.34m
Rev 2	VAccuracy	u2	0.01 m	65535	2-sigma vertical accuracy. The vertical distance between the true position and the computed position is expected to be lower than VAccuracy with a probability of at least 95%. The value is clipped to 65534 =655.34m.
Rev 2	Misc	u1			Bit field containing miscellaneous flags: Bit 0: In DGNSS or RTK mode, set if the baseline points to the base station ARP. Unset if it points to the antenna phase center, or if unknown. Bit 1: Set if the phase center offset is compensated for at the rover, unset if not or unknown. Bit 2: Proprietary. Bit 3: Proprietary. Bits 4-5: Proprietary. Bits 6-7: Flag indicating whether the marker position reported in this block is also the ARP position (i.e. whether the ARP-to-marker offset provided with the **setAntennaOffset** command is zero or not) 0: Unknown 1: The ARP-to-marker offset is zero 2: The ARP-to-marker offset is not zero
	Padding	u1[..]			Padding bytes, see 4.1.5

ExtEventBaseVectGeod	Number: 4217 "OnChange" interval: each time an external event is detected

...

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	External time stamp, see 4.1.3
WNc	u2	1 week	65535	
N	u1			Number of baselines for which relative position, velocity and direction are provided in this SBF block, i.e. number of ExtEventVectorInfoGeod sub-blocks. If N is 0, there are no baseline available for this epoch.
SBLength	u1	1 byte		Length of one sub-block
ExtEventVectorInfoGeod	...	...		*A succession of N ExtEventVectorInfoGeod sub-blocks, see definition below*
Padding	u1[..]			Padding bytes, see 4.1.5

`ExtEventVectorInfoGeod` sub-block definition:

Parameter	Type	Units	Do-Not-Use	Description
`NrSV`	u1			Number of satellites for which corrections are available from the base station identified by the `ReferenceID` field.
`Error`	u1			PVT error code. The following values are defined: 0: No Error 1: Not enough measurements 2: Not enough ephemerides available 3: DOP too large (larger than 15) 4: Sum of squared residuals too large 5: No convergence 6: Not enough measurements after outlier rejection 7: Position output prohibited due to export laws 8: Not enough differential corrections available 9: Base station coordinates unavailable 10: Ambiguities not fixed and user requested to only output RTK-fixed positions
`Mode`	u1			Bit field indicating the GNSS PVT mode, as follows: Bits 0-3: type of PVT solution: 0: No GNSS PVT available (the `Error` field indicates the cause of the absence of the PVT solution) 1: Stand-Alone PVT 2: Differential PVT 3: Fixed location 4: RTK with fixed ambiguities 5: RTK with float ambiguities 6: SBAS aided PVT 7: moving-base RTK with fixed ambiguities 8: moving-base RTK with float ambiguities 10: Precise Point Positioning (PPP) 12: Reserved Bits 4-5: Reserved Bit 6: Set if the user has entered the command **`setPVTMode,Static,auto`** and the receiver is still in the process of determining its fixed position. Bit 7: 2D/3D flag: set in 2D mode (height assumed constant and not computed).
`Misc`	u1			Bit field containing miscellaneous flags: Bit 0: Set if the baseline points to the base station ARP. Unset if it points to the antenna phase center, or if unknown. Bit 1: Set if the phase center offset is compensated for at the rover (i.e. the baseline starts from the antenna ARP), unset if not or unknown. Bit 2: Proprietary. Bit 3: Proprietary. Bits 4-5: Proprietary. Bits 6-7: Reserved
`DeltaEast`	f8	1 m	$-2\cdot10^{10}$	East baseline component (from rover to base)
`DeltaNorth`	f8	1 m	$-2\cdot10^{10}$	North baseline component (from rover to base)
`DeltaUp`	f8	1 m	$-2\cdot10^{10}$	Up baseline component (from rover to base)

DeltaVe	f4	1 m / s	$-2 \cdot 10^{10}$	East velocity of base with respect to rover
DeltaVn	f4	1 m / s	$-2 \cdot 10^{10}$	North velocity of base with respect to rover
DeltaVu	f4	1 m / s	$-2 \cdot 10^{10}$	Up velocity of base with respect to rover
Azimuth	u2	0.01 degrees	65535	Azimuth of the base station (from 0 to 360°, increasing towards east)
Elevation	i2	0.01 degrees	−32768	Elevation of the base station (from -90° to 90°)
ReferenceID	u2			Base station ID
CorrAge	u2	0.01 s	65535	Age of the oldest differential correction used for this baseline computation.
SignalInfo	u4		0	Bit field indicating the GNSS signals for which differential corrections are available from the base station identified by ReferenceID. If bit *i* is set, corrections for the signal type having index *i* are available. The signal numbers are listed in section 4.1.10. Bit 0 (GPS-C/A) is the LSB of SignalInfo.
Padding	u1[..]			Padding bytes, see 4.1.5

ExtEventAttEuler	Number: 4237 "OnChange" interval: each time an external event is detected

This block contains the Euler angles (pitch, roll and heading) applicable at the time of an external event.

This block has the same structure and description as the AttEuler block, except that the TOW and WNc fields refer to the time at which the electrical transition on the event pin has been detected (with a millisecond resolution), and that the position is computed at the event time, taking into account a possible user-defined delay set by the **setEventParameters** command.

A user needing the sub-millisecond part of the event time must refer to the Offset field of the corresponding ExtEvent block. The corresponding ExtEvent block is the last of the ExtEvent blocks having been output by the receiver.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	External time stamp, see 4.1.3
WNc	u2	1 week	65535	
NrSV	u1		255	The average over all antennas of the number of satellites currently included in the attitude calculations.
Error	u1			Bit field providing error information. For each antenna baseline, two bits are used to provide error information: Bits 0-1: Error code for Main-Aux1 baseline: 0: No error 1: Not enough measurements 2: Reserved 3: Reserved Bits 2-3: Error code for Main-Aux2 baseline, same definition as bit 0-1. Bits 4-6: Reserved Bit 7: Set when GNSS-based attitude not requested by user. In that case, the other bits are all zero.
Mode	u2			Attitude mode code: 0: No attitude 1: Heading, pitch (roll = 0), aux antenna positions obtained with float ambiguities 2: Heading, pitch (roll = 0), aux antenna positions obtained with fixed ambiguities 3: Heading, pitch, roll, aux antenna positions obtained with float ambiguities 4: Heading, pitch, roll, aux antenna positions obtained with fixed ambiguities
Reserved	u2			Reserved for future use, to be ignored by decoding software
Heading	f4	1 degree	$-2\cdot10^{10}$	Heading
Pitch	f4	1 degree	$-2\cdot10^{10}$	Pitch
Roll	f4	1 degree	$-2\cdot10^{10}$	Roll
PitchDot	f4	1 degree / s	$-2\cdot10^{10}$	Not applicable

RollDot	f4	1 degree / s	$-2 \cdot 10^{10}$	Not applicable
HeadingDot	f4	1 degree / s	$-2 \cdot 10^{10}$	Not applicable
Padding	u1[..]			Padding bytes, see 4.1.5

4.2.13 Differential Correction Blocks

DiffCorrIn	Number: 5919 "OnChange" interval: each time a RTCM or CMR message is received

The DiffCorrIn block contains incoming RTCM or CMR messages. The length of the block depends on the message type and contents.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
Mode	u1			0: RTCMv2 1: CMRv2 2: RTCMv3 3: RTCMV (a proprietary variant of RTCM2) 4: SPARTN 5: Reserved
Source	u1		255	Indicates the receiver connection from which the message has been received: 0: COM1 1: COM2 2: COM3 3: COM4 4: USB1 5: USB2 6: IP connection 7: SBF file 8: L-Band (message decoded by the built-in L-band demodulator) 9: NTRIP 10: OTG1 11: OTG2 12: Bluetooth 15: UHF modem 16: IPR connection 17: Direct call port 18: IPS connection
If the Mode field is 0 then this field is available:				
RTCM2Words	u4[*N*]			30-bit words of the RTCM2 message. The Data Word Length (number of 32 bit words) is variable and depends on the RTCM2 message contents. It can be computed by the following piece of C code: `N = 2 + ((RTCM2Words[1]»9) & 0x1f);` *N* can range from 2 to 33. The first two words are the RTCM2 message header and they are always present. Each of the words is organized as follows: Bits 0-5: 6 parity bits. They are provided for the sake of completeness. Parity doesn't need to be checked, since the DiffCorrIn block only contains valid words. Bits 6-29: 24 information-containing bits of the word. The first received bit is the MSB. Bits 30-31: bit 0 and 1 of the preceding word
If the Mode field is 1 then this field is available:				
CMRMessage	u1[*N*]			*N* depends on the CMR message type.
If the Mode field is 2 then this field is available:				
RTCM3Message	u1[*N*]			*N* depends on the RTCM 3 message type.

If the `Mode` field is 3 then this field is available:				
`RTCMVMessage`	u1[*N*]			*N* depends on the RTCMV message type.
`Padding`	u1[..]			Padding bytes, see 4.1.5

BaseStation	Number:	5949
	"OnChange" interval:	block generated each time a differential correction message related to the base station coordinates is received

The BaseStation block contains the ECEF coordinates of the base station the receiver is currently connected to. This block helps users accessing the base station coordinates via SBF instead of having to decode the specific differential correction message (see the DiffCorrIn SBF block above).

The interpretation to give to the X, Y, Z ECEF coordinates is dependent on the value of the Source field:

Value of Source	Interpretation of X, Y, Z
0, 4 or 10	Coordinate of the L1 phase center
2 or 8	Antenna reference point
9	Proprietary

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
BaseStationID	u2			The base station ID
BaseType	u1			Base station type: 0: Fixed 1: Moving (reserved for future use) 255: Unknown
Source	u1			Source of the base station coordinates: 0: RTCM 2.x (Msg 3) 2: RTCM 2.x (Msg 24) 4: CMR 2.x (Msg 1) 8: RTCM 3.x (Msg 1005 or 1006) 9: RTCMV (Msg 3) 10: CMR+ (Type 2)
Datum	u1		255	Not applicable
Reserved	u1			Reserved for future use, to be ignored by decoding software
X	f8	1 m		Antenna X coordinate expressed in the datum specified by the Datum field
Y	f8	1 m		Antenna Y coordinate
Z	f8	1 m		Antenna Z coordinate
Padding	u1[..]			Padding bytes, see 4.1.5

RTCMDatum	Number: 4049 "OnChange" interval: block generated each time a set of transformation parameters is received

This block reports the source and target datum names as transmitted in RTCM 3.x message types 1021 or 1022. It also reports the corresponding height and quality indicators.

If a service provider only sends out message types 1021 or 1022, this block is transmitted immediately after reception of MT1021 or MT1022. If message types 1023 or 1024 are also sent out, this block is transmitted after the reception of these messages and the QualityInd field is set accordingly.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
SourceCRS	c1[32]			Name of the source Coordinate Reference System, right-padded with zeros.
TargetCRS	c1[32]			Name of the target Coordinate Reference System, right-padded with zeros.
Datum	u1			See the Datum field in the PosLocal and PosProjected SBF blocks. Datum is set to 255 if this SourceCRS/TargetCRS pair is currently not used by the receiver.
HeightType	u1			Height Indicator field from MT1021 and MT1022. This field indicates how to interpret the height reported in the PosLocal and the PosProjected SBF blocks: 0: Geometrical height 1: Physical height (height definition in target CRS) 2: Physical height (height definition in source CRS)
QualityInd	u1			Bit field indicating the maximum approximation error after applying the transformation: Bits 0-3: horizontal quality indicator: 0: Unknown quality 1: Quality better than 21 mm (from MT1021/1022) 2: Quality 21 to 50 mm (from MT1021/1022) 3: Quality 51 to 200 mm (from MT1021/1022) 4: Quality 201 to 500 mm (from MT1021/1022) 5: Quality 501 to 2000 mm (from MT1021/1022) 6: Quality 2001 to 5000 mm (from MT1021/1022) 7: Quality worse than 5001 mm (from MT1021/1022) 9: Quality 0 to 10 mm (from MT1023/1024) 10: Quality 11 to 20 mm (from MT1023/1024) 11: Quality 21 to 50 mm (from MT1023/1024) 12: Quality 51 to 100 mm (from MT1023/1024) 13: Quality 101 to 200 mm (from MT1023/1024) 14: Quality 201 to 500 mm (from MT1023/1024) 15: Quality worse than 501 mm (from MT1023/1024) Bits 4-7: vertical quality indicator, same definition as bits 0-3.
Padding	u1[..]			Padding bytes, see 4.1.5

4.2.14 L-Band Demodulator Blocks

LBandTrackerStatus	Number: 4201 "OnChange" interval: 1s

The LBandTrackerStatus block provides general information on the tracking status of the L-band signals.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
N	u1			Number of L-band trackers for which data is provided in this SBF block, i.e. number of TrackData sub-blocks.
SBLength	u1	1 byte		Length of one sub-block
TrackData	...	...		*A succession of N TrackData sub-blocks, see definition below*
Padding	u1[..]			Padding bytes, see 4.1.5

`TrackData` sub-block definition:

	Parameter	Type	Units	Do-Not-Use	Description
	`Frequency`	u4	1 Hz	0	Nominal frequency of the beam for which data is provided in this sub-block.
	`Baudrate`	u2	1 baud	0	Baudrate of the beam
	`ServiceID`	u2			Service ID of the beam. Set to 0 for the LBAS1 beam. Set to 1 for the LBAS2 beam when received through an NTRIP connection. This field must be ignored if the `Status` field is set to anything else than 3 (Locked).
	`FreqOffset`	f4	1 Hz	$-2 \cdot 10^{10}$	Frequency offset of the demodulator, if available
	`CN0`	u2	0.01 dB-Hz	0	Current C/N_0 value
	`AvgPower`	i2	0.01 dB	−32768	Not applicable.
	`AGCGain`	i1	1 dB	−128	Not applicable.
	`Mode`	u1			Current operation mode: 0: normal
	`Status`	u1			Current status: 0: Idle 1: Search 2: FrameSearch 3: Locked
Rev 2	`SVID`	u1			Satellite ID, see 4.1.9
Rev 1	`LockTime`	u2	1 s		Lock time to the L-band signal, clipped to 65535 seconds.
Rev 3	`Source`	u1			L-band tracking module: 0: Unknown 1: Internal 2: LBR board 3: NTRIP. L-band data received over NTRIP. In that case, the other fields in this sub-block are not applicable and set to their Do-Not-Use value.
	`Padding`	u1[..]			Padding bytes, see 4.1.5

LBandBeams	Number: 4204 "OnChange" interval: Block generated each time beam status data is decoded

This block contains the name, longitude and beam frequency of the L-band geostationary satellites known by the receiver.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
N	u1			Number of L-band beams for which data is provided in this SBF block, i.e. number of BeamInfo sub-blocks.
SBLength	u1	1 byte		Length of one sub-block
BeamInfo	...	...		*A succession of N BeamInfo sub-blocks, see definition below*
Padding	u1[..]			Padding bytes, see 4.1.5

BeamInfo sub-block definition:

Parameter	Type	Units	Do-Not-Use	Description
SVID	u1			SVID associated to the satellite for which information is provided in this sub-block. SVID ranges from 107 to 119. See also section 4.1.9.
SatName	c1[9]			Satellite Name, right padded with zeros
SatLongitude	i2	0.01 degrees	−32768	Satellite Longitude (positive east of Greenwich)
BeamFreq	u4	1 Hz	0	L-band beam center frequency
Padding	u1[..]			Padding bytes, see 4.1.5

4.2.15 Status Blocks

ChannelStatus	Number: 4013 "OnChange" interval: default PVT output rate (see 4.1.8)

This block describes the current satellite allocation and tracking status of the active receiver channels. Active channels are channels to which a satellite has been allocated.

This block uses a two-level sub-block structure analogous to that of the MeasEpoch block. For each active channel, a ChannelSatInfo sub-block contains all satellite-dependent information such as health, azimuth and elevation. Each of these sub-blocks contains N2 ChannelStateInfo sub-blocks, N2 being the number of active antennas in a given channel (for single-antenna receivers, N2 is one). The ChannelStateInfo reports information such as the tracking status and PVT usage of a given signal type tracked on a given antenna.

Inactive channels are not contained in the ChannelStatus block.

Health, tracking and PVT status fields are available for each satellite. These status fields consist of a sequence of up to 8 two-bit fields. Each 2-bit field contains the status of one of the signals transmitted by the satellite. The position of the 2 bits corresponding to a given signal is dependent on the constellation, but is otherwise fixed. It is indicated in the tables below.

GPS:

Reserved		Reserved		L1C		L5		L2C		P2(Y)		P1(Y)		L1CA	
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

GLONASS:

Reserved		Reserved		Reserved		L3		L2CA		L2P		L1P		L1CA	
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Galileo:

Reserved		E5-AltBOC		E5b		E5a		E6BC		E6A		L1BC		L1A	
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

SBAS:

Reserved		Reserved		Reserved		Reserved		Reserved		Reserved		L5		L1	
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

BeiDou:

Reserved		Reserved		B2b		B2a		B1C		B3I		B2I		B1I	
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

QZSS:

Reserved		Reserved		L1S		L1C		L6		L5		L2C		L1CA	
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

NavIC/IRNSS:

Reserved		Reserved		Reserved		Reserved		Reserved		Reserved		Reserved		L5	
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
N	u1			Number of channels for which status are provided in this SBF block, i.e. number of ChannelSatInfo sub-blocks. If N is 0, there are no active channels available for this epoch.
SB1Length	u1	1 byte		Length of a ChannelSatInfo sub-block, excluding the nested ChannelStateInfo sub-blocks
SB2Length	u1	1 byte		Length of a ChannelStateInfo sub-block
Reserved	u1[3]			Reserved for future use, to be ignored by decoding software
SatInfo	...	...		*A succession of N ChannelSatInfo sub-blocks, see definition below*
Padding	u1[..]			Padding bytes, see 4.1.5

ChannelSatInfo sub-block definition:

Parameter	Type	Units	Do-Not-Use	Description
SVID	u1			Satellite ID, see 4.1.9
FreqNr	u1		0	For GLONASS FDMA signals, this is the frequency number, with an offset of 8. It ranges from 1 (corresponding to an actual frequency number of -7) to 21 (corresponding to an actual frequency number of 13). Otherwise, FreqNr is reserved and must be ignored by the decoding software.
Reserved1	u1[2]			Reserved for future use, to be ignored by decoding software
Azimuth/RiseSet	u2	1 degree	511 3	bit field: Bits 0-8: Azimuth [0,359]. 0 is North, and Azimuth increases towards East. Bits 9-13: Reserved Bits 14-15: Rise/Set Indicator: 0: Satellite setting 1: Satellite rising 3: Elevation rate unknown
HealthStatus	u2			Sequence of 2-bit health status fields, each of them taking one of the following values: 0 : health unknown, or not applicable 1 : healthy 3 : unhealthy The 2-bit health status is a condensed version of the health status as sent by the satellite. For SBAS, the health status is set from the almanac data (MT17).
Elevation	i1	1 degree	−128	Elevation [-90,90] relative to local horizontal plane
N2	u1			Number of ChannelStateInfo blocks following this ChannelSatInfo block. There is one ChannelStateInfo sub-block per antenna.
RxChannel	u1			Channel number, see section 4.1.11.
Reserved2	u1			Reserved for future use, to be ignored by decoding software
Padding	u1[..]			Padding bytes, see 4.1.5

StateInfo	...	...		*A succession of N2* `ChannelStateInfo` *sub-blocks, see definition below*

`ChannelStateInfo` sub-block definition:

Parameter	Type	Units	Description
`Antenna`	u1		Antenna number (0 for main antenna)
`Reserved`	u1		Reserved for future use, to be ignored by decoding software
`TrackingStatus`	u2		Sequence of 2-bit tracking status fields, each of them taking one of the following values: 0: idle or not applicable 1: Search 2: Sync 3: Tracking
`PVTStatus`	u2		Sequence of 2-bit PVT status fields, each of them taking one of the following values: 0: not used 1: waiting for ephemeris 2: used 3: rejected
`PVTInfo`	u2		Internal info
`Padding`	u1[..]		Padding bytes, see 4.1.5

ReceiverStatus	Number: 4014 "OnChange" interval: 1s

The ReceiverStatus block provides general information on the status of the receiver.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
CPULoad	u1	1 %	255	Load on the receiver's CPU. The load should stay below 80% in normal operation. Higher loads might result in data loss.
ExtError	u1			Bit field reporting external errors, i.e. errors detected in external data. Upon detection of an error, the corresponding bit is set for a duration of one second, and then resets. Bit 0: SISERROR: set if a violation of the signal-in-space ICD has been detected for at least one satellite while that satellite is reported as healthy. Use the command "**lif,SisError**" for details. Bit 1: DIFFCORRERROR: set when an anomaly has been detected in an incoming differential correction stream, causing the receiver to fail to decode the corrections. Use the command "**lif,DiffCorrError**" for details. Bit 2: EXTSENSORERROR: set when a malfunction has been detected on at least one of the external sensors connected to the receiver. Use the command "**lif, ExtSensorError**" for details. Bit 3: SETUPERROR: set when a configuration/setup error has been detected. An example of such error is when a remote NTRIP Caster is not reachable. Use the command "**lif, SetupError**" for details. Bits 4-7: Reserved
UpTime	u4	1 s		Number of seconds elapsed since the start-up of the receiver, or since the last reset.

RxState	u4			Bit field indicating the status of key components of the receiver: Bit 0: Reserved Bit 1: ACTIVEANTENNA: this bit is set when an active antenna is sensed at the main antenna connector. This functionality is only available on certain receiver models. Bit 2: EXT_FREQ: this bit is set if an external frequency reference is detected at the 10 MHz input, and cleared if the receiver uses its own internal clock. Bit 3: EXT_TIME: this bit is set if a pulse has been detected on the TimeSync input. Bit 4: WNSET: see corresponding bit in the SyncLevel field of the ReceiverTime block. Bit 5: TOWSET: see corresponding bit in the SyncLevel field of the ReceiverTime block. Bit 6: FINETIME: see corresponding bit in the SyncLevel field of the ReceiverTime block. Bit 7: INTERNALDISK_ACTIVITY: this bit is set for one second each time data is logged to the internal disk (DSK1). If the logging rate is larger than 1 Hz, set continuously. Bit 8: INTERNALDISK_FULL: this bit is set when the internal disk (DSK1) is full. A disk is full when it is filled to 95% of its total capacity. Bit 9: INTERNALDISK_MOUNTED: this bit is set when the internal disk (DSK1) is mounted. Bit 10: INT_ANT: this bit is set when the GNSS RF signal is taken from the internal antenna input, and cleared when it comes from the external antenna input (only applicable on receiver models featuring an internal antenna input). Bit 11: REFOUT_LOCKED: if set, the 10-MHz frequency provided at the REF OUT connector is locked to GNSS time. Otherwise it is free-running. Bit 12: LBAND_ANT: this bit is set when the L-band signal is tracked from the dedicated L-band antenna, and cleared when it is tracked from the same antenna as the GNSS signals, or when the receiver does not support L-band tracking. Bit 13: EXTERNALDISK_ACTIVITY: this bit is set for one second each time data is logged to the external disk (DSK2). If the logging rate is larger than 1 Hz, set continuously. Bit 14: EXTERNALDISK_FULL: this bit is set when the external disk (DSK2) is full. A disk is full when it is filled to 95% of its total capacity. Bit 15: EXTERNALDISK_MOUNTED: this bit is set when the external disk (DSK2) is mounted. Bit 16: PPS_IN_CAL: this bit is set when PPS IN delay calibration is on-going. Only applicable to PolaRx5TR receivers. Bit 17: DIFFCORR_IN: this bit is set for one second each time differential corrections are decoded. If the input rate is larger than 1 Hz, set continuously. Bit 18: INTERNET: this bit is set when the receiver has internet access. If not set, there is either no internet access, or the receiver could not reliably determine the status. Bits 19-31: Reserved

Rev 1	RxError	u4			Bit field indicating whether an error occurred previously. If this field is not equal to zero, at least one error has been detected. Bit 0: Reserved Bit 1: Reserved Bit 2: Reserved Bit 3: SOFTWARE: set upon detection of a software warning or error. This bit is reset by the command "**lif, error**". Bit 4: WATCHDOG: set when the watchdog expired at least once since the last power-on. Bit 5: ANTENNA: set when antenna overcurrent condition is detected. Bit 6: CONGESTION: set when an output data congestion has been detected on at least one of the communication ports of the receiver during the last second. Bit 7: Reserved Bit 8: MISSEDEVENT: set when an external event congestion has been detected during the last second. It indicates that the receiver is receiving too many events on its EVENTx pins. Bit 9: CPUOVERLOAD: set when the CPU load is larger than 90%. Bit 10: INVALIDCONFIG: set if one or more configuration file (e.g. permissions) is invalid or absent. Bit 11: OUTOFGEOFENCE: set if the receiver is currently out of its permitted region of operation (geofencing). Bit 12: Reserved Bit 13: Reserved Bit 14: Reserved Bit 15: Reserved Bit 16: Reserved Bits 17-31: Reserved
	N	u1			Number of AGCState sub-blocks this block contains.
	SBLength	u1	1 byte		Length of a AGCState sub-block.
	CmdCount	u1		0	Command cyclic counter, incremented each time a command is entered that changes the receiver configuration. After the counter has reached 255, it resets to 1.
	Temperature	u1	1 °C	0	Not applicable.
	AGCState	...	...		*A succession of N AGCState sub-blocks, see definition below*
	Padding	u1[..]			Padding bytes, see 4.1.5

`AGCState` sub-block definition:

Parameter	Type	Units	Do-Not-Use	Description
`FrontEndID`	u1			Bit field indicating the frontend code and antenna ID: Bits 0-4: frontend code: 0: GPSL1/E1 1: GLOL1 2: E6 3: GPSL2 4: GLOL2 5: L5/E5a 6: E5b/B2I 7: E5(a+b) 8: Combined GPS/GLONASS/SBAS/Galileo L1 9: Combined GPS/GLONASS L2 10: MSS/L-band 11: B1I 12: B3I 13: S-band Bits 5-7: Antenna ID: 0 for main, 1 for *Aux1* and 2 for *Aux2*
`Gain`	i1	1 dB	−128	AGC gain, in dB. The Do-Not-Use value is used to indicate that the frontend PLL is not locked.
`SampleVar`	u1		0	Normalized variance of the IF samples. The nominal value for this variance is 100.
`BlankingStat`	u1	1 %		Current percentage of samples being blanked by the pulse blanking unit. This field is always 0 for receiver without pulse blanking unit.
`Padding`	u1[..]			Padding bytes, see 4.1.5

SatVisibility	Number: 4012 "OnChange" interval: 1s

This block contains the azimuth and elevation of all the satellites above the horizon for which the ephemeris or almanac is available.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
N	u1			Number of satellites for which information is provided in this SBF block, i.e. number of SatInfo sub-blocks.
SBLength	u1	1 byte		Length of one SatInfo sub-block
SatInfo	...	...		*A succession of N SatInfo sub-blocks, see definition below*
Padding	u1[..]			Padding bytes, see 4.1.5

SatInfo sub-block definition:

Parameter	Type	Units	Do-Not-Use	Description
SVID	u1			Satellite ID, see 4.1.9
FreqNr	u1		0	For GLONASS FDMA signals, this is the frequency number, with an offset of 8. It ranges from 1 (corresponding to an actual frequency number of -7) to 21 (corresponding to an actual frequency number of 13). Otherwise, FreqNr is reserved and must be ignored by the decoding software.
Azimuth	u2	0.01 degrees	65535	Azimuth. 0 is North, and azimuth increases towards East.
Elevation	i2	0.01 degrees	−32768	Elevation relative to local horizontal plane.
RiseSet	u1			Rise/set indicator: 0: satellite setting 1: satellite rising 255: elevation rate unknown
SatelliteInfo	u1			Satellite visibility info based on: 1: almanac 2: ephemeris 255: unknown
Padding	u1[..]			Padding bytes, see 4.1.5

InputLink	Number: 4090 "OnChange" interval: 1s

The InputLink block reports statistics of the number of bytes and messages received and accepted on each active connection descriptor.

Per connection descriptor, the receiver maintains two byte counters (NrBytesReceived and NrBytesAccepted) and two message counters (NrMsgReceived and NrMsgAccepted), which are reported in the sub-blocks. These counters provide useful information on the quality of the transmission link, and of the bandwidth efficiency.

These counters (as well as the age of the last message) are reset simultaneously on the following events:

- start-up of the receiver
- overflow of one of the counters
- change of input type
- deactivation of a connection descriptor, e.g. on disconnection of USB or IP ports.

There is one sub-block per connection descriptor for which statistics is available.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
N	u1			Number of connection descriptors for which communication link statistics are included
SBLength	u1	1 byte		Length of one InputStatsSub sub-block.
InputStats	...	...		*A succession of N InputStatsSub sub-blocks, see definition below*
Padding	u1[..]			Padding bytes, see 4.1.5

`InputStatsSub` sub-block definition:

<table>
<tr><th>Parameter</th><th>Type</th><th>Units</th><th>Do-Not-Use</th><th>Description</th></tr>
<tr><td>CD</td><td>u1</td><td></td><td></td><td>Identifier of the connection to which this information applies:
<table>
<tr><th>Value of CD</th><th>Connection type</th><th>Example</th></tr>
<tr><td>0-31</td><td>COMx, with x=CD</td><td>1: COM1</td></tr>
<tr><td>32-47</td><td>USBx, with x=CD-32</td><td>33: USB1</td></tr>
<tr><td>48-63</td><td>OTGx, with x=CD-48</td><td>49: OTG1</td></tr>
<tr><td>64-95</td><td>IPx, with x=CD-54</td><td>64:IP10</td></tr>
<tr><td>96-127</td><td>DSKx, with x=CD-96</td><td>97:DSK1</td></tr>
<tr><td>128-159</td><td>NTRx, with x=CD-128 (NTRIP connections)</td><td>129:NTR1</td></tr>
<tr><td>160-191</td><td>IPSx, with x=CD-160 (IP server connections)</td><td>161:IPS1</td></tr>
<tr><td>192</td><td>BT01 (Bluetooth connection)</td><td></td></tr>
<tr><td>193</td><td>BT02 (Bluetooth connection)</td><td></td></tr>
<tr><td>196</td><td>UHF1 (UHF Modem)</td><td></td></tr>
<tr><td>200-205</td><td>IPRx, with x=CD-200 (IP receive connections)</td><td>201:IPR1</td></tr>
<tr><td>210</td><td>DCL1 (cellular data-call connection)</td><td></td></tr>
<tr><td>214</td><td>CAN1 (CAN stream interface)</td><td></td></tr>
<tr><td>215-219</td><td>Reserved</td><td></td></tr>
<tr><td>220</td><td>SPI1 (SPI interface)</td><td></td></tr>
<tr><td>221-255</td><td>Reserved</td><td></td></tr>
</table></td></tr>
</table>

Type	u1			Type of data: 0: none 1: DaisyChain (includes "echo" messages) 32: CMD 33: SBF 34: AsciiDisplay (see **setDataInOut** command) 35: RINEX 36: CGGTTS 40: BINEX 64: NMEA 96: RTCMv2 97: RTCMv3 98: CMRv2 99: RTCMV (a proprietary variant of RTCMv2) 100: SPARTN 101: LBMP 110: raw LBAS1 from e.g. NTRIP 111: raw LBAS2 from e.g. NTRIP 118: raw LBAND data from Beam1 119: raw LBAND data from Beam2 120: raw LBAND data from Beam3 121: raw LBAND data from Beam4 128: Reserved 129: Reserved 130: Reserved 131: SBG (IMU sensor) 132: Reserved 133: Reserved 134: Reserved 135: Reserved 136: Reserved 137: ADIS 160: ASCIIIn
AgeOfLastMessage	u2	1 s	65535	Age of the last accepted message. If the age is older than 65534s, it is clipped to 65534s.
NrBytesReceived	u4	1 byte	4294967295	Total number of bytes received [6]
NrBytesAccepted	u4	1 byte	4294967295	Total number of bytes [6] in messages that passed the check for this type of input (CRC, parity check, ...). The ratio of NrBytesAccepted to NrBytesReceived gives an indication of the quality of the communication link.
NrMsgReceived	u4	1 message		Total number of messages of type Type received.
NrMsgAccepted	u4	1 message		Total number of messages of type Type that were interpreted and used by the receiver. The ratio of NrMsgAccepted to NrMsgReceived gives an indication of the bandwidth usage efficiency
Padding	u1[..]			Padding bytes, see 4.1.5

[6] Note that, for RTCM 2.x, one 8-bit byte contains 6 RTCM data bits.

OutputLink	Number: 4091 "OnChange" interval: 1s

The OutputLink block reports statistics of the number of bytes sent on each active connection descriptor.

Per connection descriptor, the receiver maintains two byte counters NrBytesProduced and NrBytesSent, which are reported in the sub-block. They provide an indication of the amount of data output and data lost on a given connection.

These counters are reset simultaneously on the following events:

- start-up of the receiver
- overflow of one of the counters
- deactivation of a connection descriptor, e.g. on disconnection of USB or IP ports
- change of COM port settings.

There is one OutputStatsSub sub-block per connection descriptor for which statistics is available. Each OutputStatsSub sub-block contains a number of OutputTypeSub sub-blocks. These sub-blocks indicate which data type has been output through the connection in question during the last second. If no output happened during the last second, there is no OutputTypeSub sub-block.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
N1	u1			Number of OutputStatsSub sub-blocks in this OutputLink block.
SB1Length	u1	1 byte		Length of an OutputStatsSub sub-block, excluding the nested OutputTypeSub sub-block
SB2Length	u1	1 byte		Length of an OutputTypeSub sub-block
Reserved	u1[3]			Reserved for future use
OutputStats	...	...		*A succession of N1 OutputStatsSub sub-blocks, see definition below*
Padding	u1[..]			Padding bytes, see 4.1.5

`OutputStatsSub` sub-block definition:

<table>
<tr><th>Parameter</th><th>Type</th><th>Units</th><th>Description</th></tr>
<tr><td>CD</td><td>u1</td><td></td><td>Identifier of the connection to which this information applies:
<table>
<tr><th>Value of CD</th><th>Connection type</th><th>Example</th></tr>
<tr><td>0-31</td><td>COMx, with x=CD</td><td>1: COM1</td></tr>
<tr><td>32-47</td><td>USBx, with x=CD-32</td><td>33: USB1</td></tr>
<tr><td>48-63</td><td>OTGx, with x=CD-48</td><td>49: OTG1</td></tr>
<tr><td>64-95</td><td>IPx, with x=CD-54</td><td>64:IP10</td></tr>
<tr><td>96-127</td><td>DSKx, with x=CD-96</td><td>97:DSK1</td></tr>
<tr><td>128-159</td><td>NTRx, with x=CD-128 (NTRIP connections)</td><td>129:NTR1</td></tr>
<tr><td>160-191</td><td>IPSx, with x=CD-160 (IP server connections)</td><td>161:IPS1</td></tr>
<tr><td>192</td><td>BT01 (Bluetooth connection)</td><td></td></tr>
<tr><td>193</td><td>BT02 (Bluetooth connection)</td><td></td></tr>
<tr><td>196</td><td>UHF1 (UHF Modem)</td><td></td></tr>
<tr><td>200-205</td><td>IPRx, with x=CD-200 (IP receive connections)</td><td>201:IPR1</td></tr>
<tr><td>210</td><td>DCL1 (cellular data-call connection)</td><td></td></tr>
<tr><td>214</td><td>CAN1 (CAN stream interface)</td><td></td></tr>
<tr><td>215-219</td><td>Reserved</td><td></td></tr>
<tr><td>220</td><td>SPI1 (SPI interface)</td><td></td></tr>
<tr><td>221-255</td><td>Reserved</td><td></td></tr>
</table></td></tr>
<tr><td>N2</td><td>u1</td><td></td><td>Number of <code>OutputTypeSub</code> sub-blocks included at the end of this <code>OutputStatsSub</code> sub-block</td></tr>
<tr><td>AllowedRate</td><td>u2</td><td>1 kbyte / s</td><td>Maximum datarate recommended on this connection</td></tr>
<tr><td>NrBytesProduced</td><td>u4</td><td>1 byte</td><td>Total number of bytes produced by the receiver. See also the <code>NrBytesSent</code> field.</td></tr>
<tr><td>NrBytesSent</td><td>u4</td><td>1 byte</td><td>Total number of bytes actually sent (i.e. without congestions or transmission errors).

The ratio of <code>NrBytesSent</code> to <code>NrBytesProduced</code> gives an indication of the amount of bandwidth overload.

<code>NrBytesSent</code> and <code>NrBytesProduced</code> are 32-bit counters. If one of them overflows, both counters are reset to zero.</td></tr>
<tr><td>NrClients</td><td>u1</td><td></td><td>Number of clients currently connected to this connection. Most connection types can only serve one client at a time, but each IP server (IPS) port can serve up to eight simultaneous clients.

Note that when <code>NrClients</code> is more than one, the fields <code>NrBytesProduced</code> and <code>NrBytesSent</code> are the number of bytes produced and sent to each individual client.</td></tr>
<tr><td>Reserved</td><td>u1[3]</td><td></td><td>Reserved for future use</td></tr>
<tr><td>Padding</td><td>u1[..]</td><td></td><td>Padding bytes, see 4.1.5</td></tr>
<tr><td>OutputType</td><td>...</td><td>...</td><td>A succession of N2 <code>OutputTypeSub</code> sub-blocks, see definition below</td></tr>
</table>

Rev 1

`OutputTypeSub` sub-block definition:

Parameter	Type	Units	Description
`Type`	u1		Type of data: 0: none 1: DaisyChain (includes "echo" messages) 32: CMD 33: SBF 34: AsciiDisplay (see **`setDataInOut`** command) 35: RINEX 36: CGGTTS 40: BINEX 64: NMEA 96: RTCMv2 97: RTCMv3 98: CMRv2 99: RTCMV (a proprietary variant of RTCMv2) 118: raw LBAND data from Beam1 119: raw LBAND data from Beam2 120: raw LBAND data from Beam3 121: raw LBAND data from Beam4
`Percentage`	u1	1 %	Percentage of the produced bytes that belong to this type (during the last second)
`Padding`	u1[..]		Padding bytes, see 4.1.5

NTRIPClientStatus	Number: 4053 "OnChange" interval: 1s

This block reports the current status of the NTRIP client connections.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
N	u1			Number of NTRIP client connections for which status is provided in this block, i.e. number of NTRIPClientConnection sub-blocks.
SBLength	u1	1 byte		Length of one NTRIPClientConnection sub-block
NTRIPClientConnection	...	...		*A succession of N NTRIPClientConnection sub-blocks, see definition below*
Padding	u1[..]			Padding bytes, see 4.1.5

`NTRIPClientConnection` sub-block definition:

Parameter	Type	Units	Description
`CDIndex`	u1		Index of the NTRIP connection (1 for NTR1, 2 for NTR2, etc) for which status is provided in this sub-block.
`Status`	u1		NTRIP client status: 0: Connection disabled 1: Initializing 2: Running, differential corrections are being received and the link statistics is available in the `InputLink` block. 3: Error detected, the error code is provided in the next field. 4: Retrying, client encountered an error, we are trying to reconnect. The error code is provided in the next field. 5: Disabled since the settings are a duplicate of another active NTRIP connection.
`ErrorCode`	u1		NTRIP error code: 0: No error 1: Initialization error (e.g. source table retrieval failure) 2: Authentication error 3: Connection error 4: Mountpoint does not exist 5: Mountpoint unavailable 6: Waiting for GGA 7: GGA sending disabled when required by mountpoint 8: Resolving host failed 9: Out of region 10: TLS setup error 11: TLS handshake error 12: TLS fingerprint error 13: TLS time not known 254: Unknown error
`Info`	u1		Bitfield indicating miscellaneous info about the Connection status: Bit 0: TLS was used to make secure NTRIP connection if this bit is set Bits 1-7: Reserved
`Padding`	u1[..]		Padding bytes, see 4.1.5

NTRIPServerStatus	Number: 4122 "OnChange" interval: 1s

This block reports the current status of the NTRIP server connections.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
N	u1			Number of NTRIP server connections for which status is provided in this block, i.e. number of NTRIPServerConnection sub-blocks.
SBLength	u1	1 byte		Length of one NTRIPServerConnection sub-block
NTRIPServerConnection	...	...		*A succession of N NTRIPServerConnection sub-blocks, see definition below*
Padding	u1[..]			Padding bytes, see 4.1.5

NTRIPServerConnection sub-block definition:

Parameter	Type	Units	Description
CDIndex	u1		Index of the NTRIP connection (1 for NTR1, 2 for NTR2, etc) for which status is provided in this sub-block.
Status	u1		NTRIP server status: 0: Connection disabled 1: Initializing 2: Running, differential corrections are being sent and the link statistics is available in the OutputLink block. 3: Error detected, the error code is provided in the next field. 4: Error detected. Currently trying to reconnect. The error code is provided in the next field. 5: Disabled since the settings are a duplicate of another active NTRIP connection.
ErrorCode	u1		NTRIP error code: 0: No error 1: Initialization error 2: Authentication error 3: Connection error 4: Mountpoint does not exist 5: Configuration conflict error 6: Resolving host failed 7: TLS setup error 8: TLS handshake error 9: TLS fingerprint error 10: TLS time not known 254: Unknown error
Info	u1		Bitfield indicating miscellaneous info about the Connection status: Bit 0: TLS was used to make secure NTRIP connection if this bit is set Bits 1-7: Reserved
Padding	u1[..]		Padding bytes, see 4.1.5

IPStatus	Number: 4058 "OnChange" interval: output each time one or more IP parameters change

This block contains information on the receiver's Ethernet interface (hostname, IP address, gateway, netmask and MAC address).

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
MACAddress	u1[6]			MAC address. The first byte corresponds to the MSB of the address.
IPAddress	u1[16]		All elements set to 0	IP address. For future upgradability, this field can contain a 128-bit IPv6 address. In the current firmware version, the first 12 bytes are always set to 0, and the last 4 bytes contain the IPv4 IP address, or are set to zero if the IP address is not known or not applicable.
Gateway	u1[16]		All elements set to 0	Gateway address. For future upgradability, this field can contain a 128-bit IPv6 address. In the current firmware version, the first 12 bytes are always set to 0, and the last 4 bytes contain the IPv4 IP address, or are set to zero if the gateway address is not known or not applicable.
Netmask	u1		255	Number of bits used to identify the network (CIDR notation).
Reserved	u1[3]			Reserved for future use, to be ignored by decoding software.
Rev 1 HostName	c1[32]			Receiver hostname on the Ethernet interface, or empty if not known.
Padding	u1[..]			Padding bytes, see 4.1.5

DynDNSStatus	Number: 4105 "OnChange" interval: 1s

This block contains dynamic DNS (DynDNS) status information.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
Status	u1			DynDNS status: 0: DynDNS disabled 1: Updating IP address 2: IP address updated at the DynDNS server. DynDNS is ready to use. 254: Error detected, the error code is provided in the next field.
ErrorCode	u1			DynDNS error code: 0: No error 1: Unspecified error 2: Abusive update 3: User name and password mismatch 4: Not a credited user 5: Hostname is not a fully-qualified domain name 6: Hostname does not exist in this user account 7: Hostname blocked for update abuse 8: Bad agent 9: DNS error 10: DynDNS server problem or maintenance 11: DynDNS server not reachable
IPAddress	u1[16]		All elements set to 0	IP address that has been registered at the DynDNS server. For future upgradability, this field can contain a 128-bit IPv6 address. In the current firmware version, the first 12 bytes are always set to 0, and the last 4 bytes contain the IPv4 IP address, or are set to zero if the IP address is not known or not applicable (e.g. because registration failed).
Padding	u1[..]			Padding bytes, see 4.1.5

Rev 1

QualityInd	Number: 4082 "OnChange" interval: 1s

The QualityInd block contains quality indicators for the main functions of the receiver. Each quality indicator is a value from 0 to 10, 0 corresponding to poor quality and 10 to very high quality.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
N	u1			Number of quality indicators contained in this block
Reserved	u1			Reserved for future use, to be ignored by decoding software.
Indicators	u2[N]		All elements set to 15	N successive quality indicators, coded as follows: Bits 0-7: Quality indicator type: 0: Overall quality 1: GNSS signals from main antenna 2: GNSS signals from aux1 antenna 11: RF power level from the main antenna 12: RF power level from the aux1 antenna 21: CPU headroom 25: OCXO stability (only available on PolaRx5S receivers) 30: Base station measurements. This indicator is only available in RTK mode. A low value could for example hint at severe multipath or interference at the base station, or also at ionospheric scintillation. 31: RTK post-processing. This indicator is only available when the position mode is not RTK. It indicates the likelihood of getting a cm-accurate RTK position when post-processing the current data. Bits 8-11: Value of this quality indicator (from 0 for low quality to 10 for high quality, or 15 if unknown) Bits 12-15: Reserved for future use, to be ignored by decoding software.
Padding	u1[..]			Padding bytes, see 4.1.5

DiskStatus	Number: 4059 "OnChange" interval: 1s

This block reports the size and usage of the disks mounted on the receiver.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
N	u1			Number of DiskData sub-blocks this block contains.
SBLength	u1	1 byte		Length of one DiskData sub-blocks in bytes.
Reserved	u1[4]			Reserved for future use
DiskData	...	...		*A succession of N DiskData sub-blocks, see definition below*
Padding	u1[..]			Padding bytes, see 4.1.5

`DiskData` sub-block definition:

	Parameter	Type	Units	Do-Not-Use	Description
	`DiskID`	u1			ID of the disk, starting at 1 for the internal SD Memory Card.
Rev 1	`Status`	u1			Bit field: Bit 0: DISK_MOUNTED: bit set when the disk is mounted. Bit 1: DISK_FULL: bit set when the disk is full. A disk is full when it is filled to 95% of its total capacity. Bit 2: DISK_ACTIVITY: bit set for one second each time data is written to the disk. If the logging rate is larger than 1 Hz, set continuously. Bit 3: LOGGING_ENABLED: bit set when at least one file is open on the disk, regardless of the logging rate. Bit 4: MOUNTING: bit set when disk is being mounted. Bit 5: FORMATTING: bit set when disk is being formatted. Bits 6-7: Reserved
	`DiskUsageMSB`	u2		65535 (7)	16 MSB of the total disk usage. The disk usage in bytes is given by `DiskUsageMSB`*4294967296+`DiskUsageLSB`.
	`DiskUsageLSB`	u4		4294967295 (7)	32 LSB of the total disk usage. The disk usage in bytes is given by `DiskUsageMSB`*4294967296+`DiskUsageLSB`.
	`DiskSize`	u4	1 Mbyte	0	Total size of the disk, in megabytes.
	`CreateDeleteCount`	u1			Counter incremented by one each time a file or a folder is created or deleted on this disk. This counter starts at zero at receiver start-up and restarts at zero after having reached 255.
Rev 1	`Error`	u1		255	Disk error: 0: No error 1: Disk partition is too large 2: Disk does not have any partition 3: File system check and recovery failed 4: Disk in use over USB 254: Disk mount failed due to unknown error
	`Padding`	u1[..]			Padding bytes, see 4.1.5

(7) The disk usage is invalid if both `DiskUsageMSB` is 65535 and `DiskUsageLSB` is 4294967295.

RFStatus	Number: 4092 "OnChange" interval: 1s

The RFStatus block provides information on the radio-frequency (RF) bands where interferences have been detected and/or notch filters have been applied.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
N	u1			Number of RF bands for which data is provided in this SBF block, i.e. number of RFBand sub-blocks.
SBLength	u1	1 byte		Length of one sub-block
Flags	u1			Bit field: Bit 0: Set when a spoofing suspicion is determined. Bits 1-7: Reserved
Reserved	u1[3]			Reserved for future use, to be ignored by decoding software.
RFBand	...	...		*A succession of N RFBand sub-blocks, see definition below*
Padding	u1[..]			Padding bytes, see 4.1.5

RFBand sub-block definition:

Parameter	Type	Units	Description
Frequency	u4	1 Hz	Center frequency of the RF band addressed by this sub-block.
Bandwidth	u2	1 kHz	Bandwidth of the RF band.
Info	u1		Info on this RF band: Bits 0-3: Mode: 1: This RF band is suppressed by a notch filter set manually with the command **setNotchFiltering**. 2: The receiver detected interference in this band, and successfully canceled it. 8: The receiver detected interference in this band. No mitigation applied. Bits 4-5: Reserved Bits 6-7: Antenna ID: 0 for main, 1 for *Aux1* and 2 for *Aux2*
Padding	u1[..]		Padding bytes, see 4.1.5

P2PPStatus	Number: 4238 "OnChange" interval: 1s

This block reports the status of the active P2PP (Point-to-Point Protocol) sessions. See the **setPointToPoint** command for details.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
N	u1			Number of active P2PP sessions for which status is provided in this block, i.e. number of P2PPSession sub-blocks.
SBLength	u1	1 byte		Length of one P2PPSession sub-block
P2PPSession	...	...		*A succession of N P2PPSession sub-blocks, see definition below*
Padding	u1[..]			Padding bytes, see 4.1.5

P2PPSession sub-block definition:

Parameter	Type	Units	Description
SessionID	u1		Index of the P2PP session (1 for P2PP1, 2 for P2PP2, etc) for which status is provided in this sub-block.
Port	u1		Index for the COM port the P2PP session is configured on (1 for COM1, 2 for COM2, etc).
Status	u1		Bit field: Bit 0: Mode: Bit set if the P2PP session is in Server mode, and unset if it is in Client mode (future functionality). Bits 1-7: P2PP status: 0: Initializing 1: Waiting for Connection 2: Connected 3: Disconnecting 4: Error, see ErrorCode field below
ErrorCode	u1		P2PP error: 1: No error 2: Configuration 3: Port Acquisition 4: Port Lock 5: Start Daemon 6: Server Authentication 7: Client Authentication 8: Timeout on Activity 9: Timeout on Negotiation 10: Link Negotiation 255: Unspecified
Padding	u1[..]		Padding bytes, see 4.1.5

CosmosStatus	Number: 4243 "OnChange" interval: 1s

The CosmosStatus block provides information on the status of the Cosmos receiver service.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
Status	u1			The status of Cosmos receiver service: 0: Disabled 1: Running
Padding	u1[..]			Padding bytes, see 4.1.5

4.2.16 Miscellaneous Blocks

ReceiverSetup	Number:	5902
	"OnChange" interval:	Block generated each time a user-command is entered to change one or more values in the block (e.g. when entering the **setMarkerParameters** command)

The ReceiverSetup block contains parameters related to the receiver and its installation. When generating RINEX files, this block defines the RINEX file name and the contents of the header.

For all fields containing a string, if the length of the string is lower than the size of the corresponding field, the unused bytes are set to zero.

	Parameter	Type	Units	Do-Not-Use	Description
	Sync1	c1			Block Header, see 4.1.1
	Sync2	c1			
	CRC	u2			
	ID	u2			
	Length	u2	1 byte		
	TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
	WNc	u2	1 week	65535	
	Reserved	u1[2]			2 bytes reserved for future use, to be ignored by decoding software
	MarkerName	c1[60]			Marker name (set with **setMarkerParameters**).
	MarkerNumber	c1[20]			Marker number (set with **setMarkerParameters**).
	Observer	c1[20]			Observer name (set with **setObserverParameters**).
	Agency	c1[40]			Observer agency (set with **setObserverParameters**).
	RxSerialNumber	c1[20]			Receiver serial number.
	RxName	c1[20]			Receiver GNSS engine name.
	RxVersion	c1[20]			Receiver firmware version.
	AntSerialNbr	c1[20]			Serial number of the main antenna (set with **setAntennaOffset**).
	AntType	c1[20]			Type of the main antenna (set with **setAntennaOffset**).
	deltaH	f4	1 m		δH offset of the main antenna (set with **setAntennaOffset**).
	deltaE	f4	1 m		δE offset of the main antenna (set with **setAntennaOffset**).
	deltaN	f4	1 m		δN offset of the main antenna (set with **setAntennaOffset**).
Rev 1	MarkerType	c1[20]			Marker type (set with the **setMarkerParameters** command).
Rev 2	GNSSFWVersion	c1[40]			Version the firmware installed on the receiver.
Rev 3	ProductName	c1[40]			Product name.
Rev 4	Latitude	f8	1 rad	$-2\cdot10^{10}$	Latitude of the reference position, from $-\pi/2$ to $+\pi/2$, positive North of Equator. Use the **setPVTMode** command to set the reference position.
	Longitude	f8	1 rad	$-2\cdot10^{10}$	Longitude of the reference position, from $-\pi$ to $+\pi$, positive East of Greenwich. Use the **setPVTMode** command to set the reference position.
	Height	f4	1 m	$-2\cdot10^{10}$	Ellipsoidal height of the reference position (with respect to WGS84 ellipsoid). Use the **setPVTMode** command to set the reference position.
	StationCode	c1[10]			Station code (set with **setMarkerParameters**). This field can for example contains the four-letter IGS station code assigned to the receiver.
	MonumentIdx	u1			Monument index (set with **setMarkerParameters**). This index is used to identify the monument when there are multiple monuments at the same station.
	ReceiverIdx	u1			Receiver index (set with **setMarkerParameters**). This index is used to identify the receiver when there are multiple receivers at the same monument.
	CountryCode	c1[3]			ISO 3-character country code (set with the **setMarkerParameters** command).
	Reserved1	c1[21]			Reserved.
	Padding	u1[..]			Padding bytes, see 4.1.5

RxMessage	Number: 4103 "OnChange" interval: block generated each time a message needs to be sent

The receiver generates ASCII messages to help users follow the progress of processes such as file logging or FTP push (activity log). These messages are output in the RxMessage block, and they can also be retrieved from the command line using the lif,RxMessages command.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
Type	u1		255	Type of message contained in this block: 1: Asynchronous command reply 2: Message about internal logging 3: Message about FTP push 4: Message about Receiver Status 5: Message from slave GNSS receiver 6: Message about CloudIt
Severity	u1		255	Message severity: 1: Info 2: Warning 3: Error
MessageID	u4		0	A unique value associated to each message. This is a counter starting at 1 for the first message after boot and incrementing at each message.
StringLn	u2			Length of Message in characters, including the terminating \0.
Reserved2	u1[2]			Reserved, contents to be ignored.
Message	c1[StringLn]			Receiver message terminated by \0.
Padding	u1[..]			Padding bytes, see 4.1.5

Commands	Number: 4015 "OnChange" interval: each time a user command is entered

Every time the user sends a command, a Commands block is output on all ports for which this block is enabled. The Commands SBF block is inserted in the SBF stream at the very moment when the command starts to take effect.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
Reserved	u1[2]			Reserved for future use, to be ignored by decoding software.
CmdData	u1[*N*]			Command data, this is the command in the SNMP' format (reserved for maintenance and support only).
Padding	u1[..]			Padding bytes, see 4.1.5

Comment	Number: 5936 "OnChange" interval: block generated each time a comment is entered with **setObserverComment**

The Comment block contains a comment string as entered with the **setObserverComment** command.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
CommentLn	u2			Length of the Comment string, in characters. The maximum length of a comment is 120 characters.
Comment	c1[CommentLn]			Comment string, as entered with the **setObserverComment** command. Note that this string is not terminated by the "\0" character.
Padding	u1[..]			Padding bytes, see 4.1.5

BBSamples	Number: 4040 "OnChange" interval: block generated each time new baseband samples are ready (typically at 2Hz)

The BBSamples block contains a series of successive complex baseband samples. These samples can be used for signal monitoring and for spectral analysis of the GNSS bands supported by the receiver.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	External time stamp, see 4.1.3
WNc	u2	1 week	65535	
N	u2			Number of complex baseband samples contained in this block
Info	u1			Bit field as follows: Bits 0-2: Antenna ID: antenna from which the samples have been taken: 0 for main, 1 for *Aux1* and 2 for *Aux2*. Bits 3-7: Reserved
Reserved	u1[3]			Reserved for future use, to be ignored by decoding software.
SampleFreq	u4	1 Hz		Sampling frequency in Hz.
LOFreq	u4	1 Hz		Frequency of the local oscillator (LO) used to down-convert the RF signal to baseband.
Samples	u2[N]			N successive complex baseband samples (I+jQ), coded as follows: Bits 0-7: 8-bit Q component, two's complement. Bits 8-15: 8-bit I component, two's complement.
Padding	u1[..]			Padding bytes, see 4.1.5

ASCIIIn	Number: 4075 "OnChange" interval: block generated each time an ASCII string is received

The ASCIIIn block contains a string that has been received on one of the receiver's connection ports.

More specifically, this block is output each time an end-of-line character is received on a communication port configured to receive ASCIIIn input (with the **setDataInOut** command). The string reported in this block contains all characters received since the previous occurrence of an end-of-line character.

The maximum length of the string is 2000 characters. If there are more than 2000 characters between the occurrence of two successive end-of-line characters, the string is discarded

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
CD	u1			Identifier of the connection from which the data has been received:

Value of CD	Connection type	Example
0-31	COMx, with *x*=CD	1: COM1
32-47	USBx, with *x*=CD-32	33: USB1
48-63	OTGx, with *x*=CD-48	49: OTG1
64-95	IPx, with *x*=CD-54	64:IP10
128-159	NTRx, with *x*=CD-128 (NTRIP connections)	129:NTR1
192	BT01 (Bluetooth connection)	
193	BT02 (Bluetooth connection)	
196	UHF1 (UHF Modem)	
200-205	IPRx, with *x*=CD-200 (IP receive connections)	201:IPR1
210	DCL1 (cellular data-call connection)	
214	CAN1 (CAN stream interface)	
215-255	Reserved	

Reserved1	u1[3]			Reserved, contents to be ignored.
StringLn	u2			Length of ASCIIString in characters.
SensorModel	c1[20]			Not supported, reserved for future use.
SensorType	c1[20]			Not supported, reserved for future use.
Reserved2	u1[20]			Reserved, contents to be ignored.
ASCIIString	c1[StringLn]			ASCII string. Note that this string is not terminated by the "\0" character. The string does not include the end-of-line character(s) (carrier return and/or line feed).
Padding	u1[..]			Padding bytes, see 4.1.5

EncapsulatedOutput	Number: 4097 "OnChange" interval: output each time an RTCM, CMR, NMEA or ASCIIDisplay message is output

The EncapsulatedOutput block encapsulates non-SBF output messages into SBF. It is enabled with the Encapsulate option of the **setDataInOut** command.

Parameter	Type	Units	Do-Not-Use	Description
Sync1	c1			Block Header, see 4.1.1
Sync2	c1			
CRC	u2			
ID	u2			
Length	u2	1 byte		
TOW	u4	0.001 s	4294967295	Receiver time stamp, see 4.1.3
WNc	u2	1 week	65535	
Mode	u1			Type of the message encapsulated in the Payload field: 0: RTCMv2 1: CMRv2 2: RTCMv3 4: NMEA 5: ASCIIDisplay
Reserved	u1			Reserved for future use, to be ignored by decoding software.
N	u2			Length of Payload in bytes.
ReservedId	u2			Reserved for future use
Payload	u1[N]			Encapsulated message.
Padding	u1[..]			Padding bytes, see 4.1.5