CHANGE NOTICE

Affected Document:	IRN/SCN Number	Date:
IS-GPS-200 Rev N	XXX-XXXX-XXX	DD-MMM-YYYY
Authority: RFC-000544	**Proposed Change Notice** PCN-IS-200N_RFC544	**Date:** 30-SEP-2025

Document Title: NAVSTAR GPS Space Segment/Navigation User Segment Interfaces

RFC Title: Eccentric Anomaly Rate Fix and No Cost Items

Reason For Change (Driver):

1. The Eccentric Anomaly Rate formula in all documents that describe this CNAV formula are incorrect
2. There are requirements and description changes from RFC-495A and RFC-502 which did not make it into the requirements baseline but are still correct and would help civil user equipment engineers make better civil receivers. This includes a number of Core CEI description changes that were worked out, but did not make it into RFC-502.
3. PRAT Item 2020-03 to normalize the use of scientific notation across the Public GPS interface documents has only been partially implemented
4. During the last Public ICWG, it became apparent that the Public interface documents do not use a uniform method of documenting multiplication in formulas
5. RFC-515 made a number of changes to XML which still need to be made to ICD-GPS-870 to ensure that Public users of XML are executing XML correctly

Description of Change:

1. The Eccentric Anomaly Rate formula will be corrected in all CNAV Public documents (PRAT 2025-02, Pre-RFC-1445)
2. The changes from RFCs-495A and 502 would be added into the requirements baseline (PRAT 2021-03)
3. The changes needed to normalize the use of scientific notation in the Public GPS interface documents will be completed (PRAT 2020-03)
4. The few places that used “*” or “x” to denote multiplication of scalar values would be normalized to what is used across the Public Signal-In-Space documents
5. The XML to ICD-GPS-870 would be completed so it describes the as-built XML system (Pre-RFC-1354)
6. There is one vetted change in IS-GPS-200 which should be included in this RFC

Authored By: RE: Tony Anthony **Checked By: RE:** Vincent Quan

AUTHORIZED SIGNATURES	REPRESENTING	DATE
	PNT Technical Director, MilComm & PNT Directorate, Space Systems Command (SSC)	

THIS DOCUMENT SPECIFIES TECHNICAL REQUIREMENTS AND NOTHING HEREIN CONTAINED SHALL BE DEEMED TO ALTER THE TERMS OF ANY CONTRACT OR PURCHASE ORDER BETWEEN ALL PARTIES AFFECTED.	Interface Control Contractor: SAIC (GPS SE&I) 200 N. Pacific Coast Highway, Suite 1700 El Segundo, CA 90245
	CODE IDENT 66RP1

IS200-18:

Section Number:
3.1.0-1

WAS:
The interface between the GPS Space Segment (SS) and the GPS navigation User Segment (US) includes two RF links, L1 and L2. Utilizing these links, the space vehicles (SVs) of the SS shall provide continuous earth coverage signals that provide to the US the ranging codes and the system data needed to accomplish the GPS navigation (NAV) mission. These signals shall be available to a suitably equipped user with RF visibility to an SV.

Redlines:
The interface between the GPS Space Segment (SS) and the GPS navigation User Segment (US) includes two RF links, L1 and L2. Utilizing these links, the space vehicles (SVs) of the SS shall provide continuous earth coverage signals that provide to the US the ranging codes and the system data needed to accomplish the GPS navigation (NAV) mission.~~ These signals shall be available to a suitably equipped user with RF visibility to an SV.~~

IS:
The interface between the GPS Space Segment (SS) and the GPS navigation User Segment (US) includes two RF links, L1 and L2. Utilizing these links, the space vehicles (SVs) of the SS shall provide continuous earth coverage signals that provide to the US the ranging codes and the system data needed to accomplish the GPS navigation (NAV) mission.

Rationale:
CRM #86 10/30/2022: Remove duplicate sentence that had been moved to next paragraph. This is a correction to an administrative requirement "split" that accidentally hadn't been completed. (T. Anthony)

IS200-2041:

Section Number:
3.3.1.1.0-2

WAS:
The carrier frequencies for the L1 and L2 signals shall be coherently derived from a common frequency source within the SV. The nominal frequency of this source -- as it appears to an observer on the ground -- is 10.23 MHz. The SV carrier frequency and clock rates -- as they would appear to an observer located in the SV -- are offset to compensate for relativistic effects. The clock rates are offset by Δf/f = -4.4647E-10, equivalent to a change in the P-code chipping rate of 10.23 MHz offset by a Δf = -4.5674E-3 Hz. This is equal to 10.2299999954326 MHz.

Redlines:
The carrier frequencies for the L1 and L2 signals shall be coherently derived from a common frequency source within the SV. The nominal frequency of this source -- as it appears to an observer on the ground -- is 10.23 MHz. The SV carrier frequency and clock rates -- as they would appear to an observer located in the SV -- are offset to compensate for relativistic effects. The clock rates are offset by ~~ f~~Δf/f = -4.~~4647E~~4647 × 10^{-10}, equivalent to a change in the P-code chipping rate of 10.23 MHz offset by a~~- f~~Δf = -4.~~5674E~~5674 × 10^{-3} Hz. This is equal to 10.2299999954326 MHz.

IS:
The carrier frequencies for the L1 and L2 signals shall be coherently derived from a common frequency source within the SV. The nominal frequency of this source -- as it appears to an observer on the ground -- is 10.23 MHz. The SV carrier frequency and clock rates -- as they would appear to an observer located in the SV -- are offset to compensate for relativistic effects. The clock rates are offset by Δf/f = -4.4647 × 10^{-10}, equivalent to a change in the P-code chipping rate of 10.23 MHz offset by a Δf = -4.5674 × 10^{-3} Hz. This is equal to 10.2299999954326 MHz.

Rationale:
9/10/2025: Converted the exponential notation to CSE Manual standard. (T. Anthony)
Also, replaced bit image delta characters with the Unicode delta character. (T. Anthony)

IS200-97:

Section Number:
3.3.2.1.0-1

WAS:
For PRN codes 1 through 37, the $P_i(t)$ pattern (P-code) is generated by the modulo-2 summation of two PRN codes, X1(t) and X2(t - iT), where T is the period of one P-code chip and equals $(1.023E7)^{-1}$ seconds, while i is an integer from 1 through 37. This allows the generation of 37 unique P(t) code phases (identified in Table 3-Ia) using the same basic code generator.

Expanded P-code PRN sequences, $P_i(t)$ where $38 \leq i \leq 63$, are described as follows:

$P_i(t) = P_{i-37}(t + T)$ (where T will equal 24 hours)

therefore, the equation is

$P_i(t) = P_{i-37x}(t + i * 24 \text{ hours})$,

where i is an integer from 64 to 210, x is an integer portion of (i-1)/37.

As an example, the P-code sequence for PRN 38 is the same sequence as PRN 1 shifted 24 hours into a week (i.e. 1st chip of PRN 38 at beginning of week is the same chip for PRN 1 at 24 hours after beginning of week). The list of expanded P-code PRN assignments is identified in Table 3-Ib.

Redlines:
For PRN codes 1 through 37, the Pi(t) pattern (P-code) is generated by the modulo-2 summation of two PRN codes, X1(t) and X2(t - iT), where T is the period of one P-code chip~~ and equals (1.023E7)-1 seconds~~, while i is an integer from 1 through 37. This allows the generation of 37 unique P(t) code phases (identified in Table 3-Ia) using the same basic code generator.

Expanded P-code PRN sequences, Pi(t) where 38 ≤ i ≤ 63, are described as follows:

Pi(t) = Pi-37(t + T) (where T will equal 24 hours)

therefore, the equation is

Pi(t) = Pi-37x(t + i~~ *~~ (24 hours)),

where i is an integer from 64 to 210, x is an integer portion of (i-1)/37.

As an example, the P-code sequence for PRN 38 is the same sequence as PRN 1 shifted 24 hours into a week (i.e. 1st chip of PRN 38 at beginning of week is the same chip for PRN 1 at 24 hours after beginning of week). The list of expanded P-code PRN assignments is identified in Table 3-Ib.

IS:
For PRN codes 1 through 37, the $P_i(t)$ pattern (P-code) is generated by the modulo-2 summation of two PRN codes, X1(t) and X2(t - iT), where T is the period of one P-code chip, while i is an integer from 1 through 37. This allows the generation of 37 unique P(t) code phases (identified in Table 3-Ia) using the same basic code generator.

Expanded P-code PRN sequences, $P_i(t)$ where $38 \leq i \leq 63$, are described as follows:

$P_i(t) = P_{i-37}(t + T)$ (where T will equal 24 hours)

therefore, the equation is

$P_i(t) = P_{i-37x}(t + i\ (24\ \text{hours}))$,

where i is an integer from 64 to 210, x is an integer portion of (i-1)/37.

As an example, the P-code sequence for PRN 38 is the same sequence as PRN 1 shifted 24 hours into a week (i.e. 1st chip of PRN 38 at beginning of week is the same chip for PRN 1 at 24 hours after beginning of week). The list of expanded P-code PRN assignments is identified in Table 3-Ib.

Rationale:
8/21/2025: At TIM #1 SMEs requested that the rate for the P-code chip be deleted since this version was confusing but defined clearly elsewhere. This removed the need for dealing with power of 10 notation (T. Anthony)
8/5/2025 Normalize the notation for scalar value multiply, use only implied multiply. (T. Anthony)

IS200-157:

Section Number:
6.2.1.0-1

WAS:
User Range Accuracy (URA) is a statistical indicator of the GPS ranging accuracy obtainable with a specific signal and SV. URA provides a conservative RMS estimate of the user range error (URE) in the associated navigation data for the transmitting SV. It includes all errors for which the Space and Control Segments are responsible. Whether the integrity status flag is “0” or ”1”, 4.42 times URA bounds the instantaneous URE with 1-(1e-5) per hour probability (‘legacy’ level of integrity assurance). When the integrity status flag is set to "1", 5.73 times URA bounds the instantaneous URE with 1-(1e-8) per hour probability (‘enhanced’ level of integrity assurance). Integrity properties of the URA are specified with respect to the scaled (multiplied by either 4.42 or 5.73 as appropriate) upper bound values of the URA index or to the scaled composite of the upper bound values of all component URA indexes.

Redlines:
User Range Accuracy (URA) is a statistical indicator of the GPS ranging accuracy obtainable with a specific signal and SV for all errors for which the Space and Control Segments are responsible. There is a URA for LNAV and a second URA for CNAV. Nominal URA provides a conservative RMS estimate of the user range error (URE) in the associated navigation data for the ~~transmitting~~specific signal and SV. ~~It~~Integrity ~~includes~~Assured ~~all~~URA ~~errors~~(IAURA) is a statistical indicator for ~~which~~ bounding the ~~Space~~instantaneous ~~and~~URE ~~Control~~obtainable ~~Segments~~with ~~are~~a ~~responsible.~~specific signal and SV. Whether the integrity status flag is “0” or ”1”, 4.42 times ~~URA~~IAURA bounds the instantaneous URE with 1-(~~1e~~ 1×10^{-5}) per hour probability (‘legacy’ level of integrity assurance).~~-~~ When the integrity status flag is set to "1", 5.73 times ~~URA~~IAURA bounds the instantaneous URE with 1-(~~1e~~ 1×10^{-8}) per hour probability (‘enhanced’ level of integrity assurance).~~-~~ Integrity properties of the ~~URA~~IAURA are specified with respect to the scaled (multiplied by either 4.42 or 5.73 as appropriate) upper bound values of the URA index when using the LNAV Clock, Ephemeris, Integrity (CEI) data set or ~~to~~ the ~~scaled~~RSS ~~composite~~of the of an elevation-dependent URA and a non-elevation dependent URA developed using the upper bound values of ~~all~~the ~~component~~associated URA indexes when using the CNAV CEI data set.

IS:
User Range Accuracy (URA) is a statistical indicator of the GPS ranging accuracy obtainable with a specific signal and SV for all errors for which the Space and Control Segments are responsible. There is a URA for LNAV and a second URA for CNAV. Nominal URA provides a conservative RMS estimate of the user range error (URE) in the associated navigation data for the specific signal and SV. Integrity Assured URA (IAURA) is a statistical indicator for bounding the instantaneous URE obtainable with a specific signal and SV. Whether the integrity status flag is “0” or ”1”, 4.42 times IAURA bounds the instantaneous URE with 1-(1×10^{-5}) per hour probability (‘legacy’ level of integrity assurance). When the integrity status flag is set to "1", 5.73 times IAURA bounds the instantaneous URE with 1-(1×10^{-8}) per hour probability (‘enhanced’ level of integrity assurance). Integrity properties of the IAURA are specified with respect to the scaled (multiplied by either 4.42 or 5.73 as appropriate) upper bound values of the URA index when using the LNAV Clock, Ephemeris, Integrity (CEI) data set or the RSS of the of an elevation-dependent URA and a non-elevation dependent URA developed using the upper bound values of the associated URA indexes when using the CNAV CEI data set.

Rationale:
9/3/2025: Added IAURA definition and expanded on URA definition. (T. Anthony)
8/27/2025: Converted the exponential notation to CSE Manual standard. (T. Anthony)

IS200-158:

Section Number:
6.2.1.0-2

WAS:
Note #1: URA applies over the transmission interval that is applicable to the LNAV/CNAV data from which the URA is read, for the worst-case location within the satellite footprint.

Redlines:
Note #1: URA applies over the ~~transmission~~curve fit interval that is applicable to the LNAV/CNAV data from which the URA index or indexes are read. IAURA applies over the curve fit interval that is applicable to the LNAV/CNAV data from which the URA index or indexes are read~~,~~ for the worst-case location within the satellite footprint.

IS:
Note #1: URA applies over the curve fit interval that is applicable to the LNAV/CNAV data from which the URA index or indexes are read. IAURA applies over the curve fit interval that is applicable to the LNAV/CNAV data from which the URA index or indexes are read for the worst-case location within the satellite footprint.

Rationale:
9/3/2025: Redefines NOTE 1 in terms of IAURA. (T. Anthony)

IS200-159:

Section Number:
6.2.1.0-3

WAS:
Note #2: The URA for a particular signal may be represented by a single index in the LNAV data and by a composite of more than one index representing components of the total URA in the CNAV data. Specific URA indexes and formulae for calculating the total URA for each signal are defined in Appendix II for the LNAV message and Appendix III for the CNAV message.

Redlines:
Note #2: The URA for a particular signal ~~may be~~is represented by a single index in the LNAV data and by a composite of ~~more than one~~ ~~index~~indexes representing components of the total URA in the CNAV data.~~ ~~ Specific URA indexes and formulae for calculating the ~~total~~nominal URA/IAURA for each signal are defined in Appendix II for the LNAV ~~message~~CEI data set and Appendix III for the CNAV ~~message~~CEI data set.

IS:
Note #2: The URA for a particular signal is represented by a single index in the LNAV data and by a composite of indexes representing components of the total URA in the CNAV data. Specific URA indexes and formulae for calculating the nominal URA/IAURA for each signal are defined in Appendix II for the LNAV CEI data set and Appendix III for the CNAV CEI data set.

Rationale:
9/23/2025: At TIM #3 reworded "may be" to "is" and simplified "more than one index" to "indexes" (T. Anthony)
9/3/2025: Redefines NOTE 2 in terms of IAURA. (T. Anthony)

IS200-2140:
Insertion after object IS200-159
Section Number:
6.2.1.0-4

WAS:
<INSERTED OBJECT>

Redlines:
Note #3: The LNAV URA index should be applied when using the LNAV Clock, Ephemeris, Integrity (CEI) data set. The CNAV URA indexes should be applied when using the CNAV CEI data set. See Section 6.2.9 for information on CEI data sets.
Object Type: Info-Only

IS:
Note #3: The LNAV URA index should be applied when using the LNAV Clock, Ephemeris, Integrity (CEI) data set. The CNAV URA indexes should be applied when using the CNAV CEI data set. See Section 6.2.9 for information on CEI data sets.
Object Type: Info-Only

Rationale:
9/23/2025 At TIM #3 decided the notes would be more logical if this came before Note 33. So this is now Note #3 and IS200-1292 becomes Note #4 (T. Anthony)
9/3/2025: Redefines this Note in terms of applicability. (T. Anthony)
PRAT 2021-03 8/5/2023 Incorporate Core CEI changes from RFC-502 (T. Anthony)

IS200-1292:

Section Number:
6.2.1.0-5

WAS:
Note #3: The URA is not required to bound the instantaneous URE when: (a) an alert is issued to the users before the instantaneous URE exceeds either of the scaled URA bounds; or (b) if the integrity status flag is "0", an alert is issued to the users no more than 8.0 seconds after the instantaneous URE exceeds the 4.42 times URA bound; or (c) if the integrity status flag is "1", an alert is issued to the users no more than 8.0 seconds after the instantaneous URE exceeds the 4.42 times URA bound; or (d) if the integrity status flag is "1", an alert is issued to users no more than 5.2 seconds after the instantaneous URE exceeds the 5.73 times URA bound. In this context, an "alert" is defined as any indication or characteristic of the conveying signal, as specified elsewhere in this document, which signifies to users that the conveying signal may be invalid or should not be used, such as the health bits not indicating operational-healthy, broadcasting non-standard code, parity error, etc.

Redlines:
Note #~~3~~4: The ~~URA~~LNAV IAURA is not required to bound the instantaneous URE using the LNAV CEI data and the CNAV IAURA is not required to bound the instantaneous URE using the CNAV CEI data when:
(a) an alert is issued to the users before the instantaneous URE exceeds ~~either~~4.42 ~~of~~times the~~ scaled~~ ~~URA~~IAURA ~~bounds~~; or
(b) if the integrity status flag is "0", an alert is issued to the users no more than 8.0 seconds after the instantaneous URE exceeds~~ the~~ 4.42 times ~~URA~~the ~~bound~~IAURA ; or
(c) if the integrity status flag is "1", both an alert is issued to the users no more than 8.0 seconds after the instantaneous URE exceeds the 4.42 times~~ URA bound; or~~ ~~(d)~~either ~~if~~of the~~ integrity status~~ ~~flag~~IAURA ~~is~~values; ~~"1",~~and an alert is issued to users no more than 5.2 seconds after the instantaneous URE exceeds the 5.73 times ~~URA~~the ~~bound~~IAURA.
In this context, an "alert" is defined as any indication or characteristic of the conveying signal, as specified elsewhere in this document, which signifies to users that the conveying signal may be invalid or should not be used, such as the health bits not indicating operational-healthy, broadcasting non-standard code, parity error, etc.

IS:
Note #4: The LNAV IAURA is not required to bound the instantaneous URE using the LNAV CEI data and the CNAV IAURA is not required to bound the instantaneous URE using the CNAV CEI data when:

(a) an alert is issued to the users before the instantaneous URE exceeds 4.42 times the IAURA ; or

(b) if the integrity status flag is "0", an alert is issued to the users no more than 8.0 seconds after the instantaneous URE exceeds 4.42 times the IAURA ; or

(c) if the integrity status flag is "1", both an alert is issued to the users no more than 8.0 seconds after the instantaneous URE exceeds the 4.42 times either of the IAURA values; and an alert is issued to users no more than 5.2 seconds after the instantaneous URE exceeds the 5.73 times the IAURA.

In this context, an "alert" is defined as any indication or characteristic of the conveying signal, as specified elsewhere in this document, which signifies to users that the conveying signal may be invalid or should not be used, such as the health bits not indicating operational-healthy, broadcasting non-standard code, parity error, etc.

Rationale:
9/23/2025 At TIM #3 decided to clarify exactly how the LNAV and CNAV IAURAs apply and clarify about "instantaneous URA exceeds". Also, reversed Note 3 and Note 4, so this is now Note 4 (T. Anthony)
9/3/2025: Redefines NOTE 3 in terms of IAURA. (T. Anthony)

IS200-1513:

Section Number:
6.2.9.0-1

WAS:
The Clock, Ephemeris, Integrity (CEI) data set is the collection of SV-specific clock correction polynomial parameters, ephemeris parameters, and related parameters (health flags, URA parameters, time tags, etc.) needed to use the SV's broadcast signal(s) in the positioning service. The parameters in the CEI data set are explicitly listed in Table 6-I-1. The entire CEI data set is needed for maximum accuracy. However, the core CEI data set (parameters without NOTE1 in Table 6-I-1) is sufficient for an initial position solution. The t_{op} term provides the epoch time of week of the state data utilized for the core CEI data set.

Redlines:
The Clock, Ephemeris, Integrity (CEI) data set is the collection of SV-specific clock correction polynomial parameters, ephemeris parameters, and related parameters (health flags, URA parameters, time tags, etc.) needed to use the SV's broadcast signal(s) in the positioning service. The parameters in the CEI data set are explicitly listed in Table 6-I-1. The entire CEI data set is needed for maximum accuracy. However, the core CEI data set (parameters without ~~NOTE1~~NOTE3 in Table 6-I-1) is sufficient for an initial position solution. ~~The top term provides the epoch time of week of the state data utilized for the core CEI data set.~~

IS:
The Clock, Ephemeris, Integrity (CEI) data set is the collection of SV-specific clock correction polynomial parameters, ephemeris parameters, and related parameters (health flags, URA parameters, time tags, etc.) needed to use the SV's broadcast signal(s) in the positioning service. The parameters in the CEI data set are explicitly listed in Table 6-I-1. The entire CEI data set is needed for maximum accuracy. However, the core CEI data set (parameters without NOTE3 in Table 6-I-1) is sufficient for an initial position solution.

Rationale:
PRAT 2021-03 8/5/2023 Incorporate Core CEI changes from RFC-502 (T. Anthony)

IS200-1649:

Section Number:
6.2.9.1.0-1

WAS:
A Core CEI Data Set are the CEI parameters necessary for a satellite to be used for a position solution (non-almanac); broadcast to users with the shortest broadcast interval for CNAV -- see 30.3.4.1. The t_{op} term provides the epoch time of week of the state data utilized for CEI data, except for parameters marked with a NOTE1 in Table 6-I-1.

Redlines:
A Core CEI Data Set are the CEI parameters necessary for a satellite to be used for a position solution (non-almanac); broadcast to users with the shortest broadcast interval for CNAV -- see 30.3.4.1. The t_{op} term provides the epoch time of week of the state data utilized for CEI data, except for parameters marked with a ~~NOTE1~~NOTE3 in Table 6-I-1.

IS:
A Core CEI Data Set are the CEI parameters necessary for a satellite to be used for a position solution (non-almanac); broadcast to users with the shortest broadcast interval for CNAV -- see 30.3.4.1. The t_{op} term provides the epoch time of week of the state data utilized for CEI data, except for parameters marked with a NOTE3 in Table 6-I-1.

Rationale:
PRAT 2021-03 8/5/2023 Incorporate Core CEI changes from RFC-502 (T. Anthony)

IS200-1639:

Section Number:
6.2.9.1-2

WAS:

Symbol	**Parameter Name**	**Subframe**	**Message**
SV Health	SV Health (6 bits)	1	N/A
IODC	Issue of Data, Clock	1	N/A
URA	URA Index	1	N/A
WN	Week Number	1	10
T_{GD}	Group Delay Differential	1	30
WN_{OP}	CEI Data Sequence Propagation Week Number	N/A	30
a_{f0}	SV Clock Bias Correction Coefficient	1	30-37
a_{f1}	SV Clock Drift Correction Coefficient	1	30-37
a_{f2}	Drift Rate Correction Coefficient	1	30-37
t_{oc}	Time of Clock	1	30-37
$\sqrt{A}$	Square Root of the Semi-Major Axis	2	N/A
Δn	Mean Motion Difference from Computed Value	2	N/A
Fit Interval Flag	Fit Interval Flag	2	N/A
e	Eccentricity	2	10
M_0	Mean Anomaly at Reference Time	2	10
t_{oe}	Time of Ephemeris	2	10, 11
C_{rs}	Amplitude of the Sine Correction Term to the Orbit Radius	2	11
C_{uc}	Amplitude of Cosine Harmonic Correction Term to the Argument of Latitude	2	11
C_{us}	Amplitude of Sine Harmonic Correction Term to the Argument of Latitude	2	11
IODE	Issue of Data, Ephemeris	2, 3	N/A
ISF	Integrity Status Flag NOTE1	All	10
ω	Argument of Perigee	3	10
$\dot{\Omega}$	Rate of Right Ascension	3	N/A
$\Delta\dot{\Omega}$	Rate of Right Ascension Difference	N/A	11
Ω_0	Longitude of Ascending Node of Orbit Plane at Weekly Epoch	3	11
i_0	Inclination Angle at Reference Time	3	11
IDOT	Rate of Inclination Angle	3	11
C_{ic}	Amplitude of the Cosine Harmonic Correction Term to the Angle of Inclination	3	11
C_{is}	Amplitude of the Sine Harmonic Correction Term to the Angle of Inclination	3	11

Symbol	Parameter Name	Subframe	Message
C_{rc}	Amplitude of the Cosine Harmonic Correction Term to the Orbit Radius	3	11
ΔA	Semi-major Axis Difference at Reference Time	N/A	10
$\dot{A}$	Change Rate in Semi-major Axis	N/A	10
Δn_0	Mean Motion Difference from Computed Value at Reference Time	N/A	10
$\Delta \dot{n}_0$	Rate of Mean Motion Difference from Computed Value	N/A	10
(L1/L2/L5)	Signal Health (3 bits)	N/A	10
URA_{ED}	Elevation Dependent User Range Accuracy	N/A	10
$ISC_{L1C/A}$	Inter-signal Correction	N/A	30
ISC_{L2C}	Inter-signal Correction	N/A	30
ISC_{L5I5}	Inter-signal Correction	N/A	30
ISC_{L5Q5}	Inter-signal Correction	N/A	30
t_{op}	CEI Data Sequence Propagation Time of Week	N/A	10, 30-37
URA_{NED0}	NED Accuracy Index	N/A	30-37
URA_{NED1}	NED Accuracy Change Index	N/A	30-37
URA_{NED2}	NED Accuracy Change Rate Index	N/A	30-37
Alert	Alert Flag ^{NOTE1}	All	All

NOTE1: Parameters so indicated are for CEI Refinement – not limited to curve fit. Parameters not indicated are needed for/limited to curve fit.

Updates to parameters in table shall prompt changes in t_{oe}/t_{oc} for CNAV and t_{oe}/t_{oc}/IODC/IODE for LNAV. Any parameter marked with NOTE1 may be changed with or without a change in t_{oe}/t_{oc}/IODC/IODE.

Redlines:

Symbol	**Parameter Name**	**Subframe**	**Message**
SV Health	SV Health (6 bits)	1	N/A
IODC	Issue of Data, Clock	1	N/A
URA	URA Index	1	N/A
WN	Week Number	1	10
T_{GD}	Group Delay Differential	1	30
WN_{OP}	CEI Data Sequence Propagation Week Number	N/A	30
a_{f0}	SV Clock Bias Correction Coefficient	1	30-37
a_{f1}	SV Clock Drift Correction Coefficient	1	30-37
a_{f2}	Drift Rate Correction Coefficient	1	30-37
t_{oc}	Time of Clock	1	30-37
$\sqrt{A}$	Square Root of the Semi-Major Axis	2	N/A
Δn	Mean Motion Difference from Computed Value	2	N/A
Fit Interval Flag	Fit Interval Flag	2	N/A
e	Eccentricity	2	10
M_0	Mean Anomaly at Reference Time	2	10
t_{oe}	Time of Ephemeris	2	10, 11
C_{rs}	Amplitude of the Sine Correction Term to the Orbit Radius	2	11
C_{uc}	Amplitude of Cosine Harmonic Correction Term to the Argument of Latitude	2	11
C_{us}	Amplitude of Sine Harmonic Correction Term to the Argument of Latitude	2	11
IODE	Issue of Data, Ephemeris	2, 3	N/A
ISF	Integrity Status Flag NOTE1, NOTE2	All	10
ω	Argument of Perigee	3	10
$\dot{\Omega}$	Rate of Right Ascension	3	N/A
$\Delta\dot{\Omega}$	Rate of Right Ascension Difference	N/A	11
Ω_0	Longitude of Ascending Node of Orbit Plane at Weekly Epoch	3	11
i_0	Inclination Angle at Reference Time	3	11
IDOT	Rate of Inclination Angle	3	11
C_{ic}	Amplitude of the Cosine Harmonic Correction Term to the Angle of Inclination	3	11
C_{is}	Amplitude of the Sine Harmonic Correction Term to the Angle of Inclination	3	11
C_{rc}	Amplitude of the Cosine Harmonic Correction Term to the Orbit Radius	3	11
ΔA	Semi-major Axis Difference at Reference Time	N/A	10

Symbol	Parameter Name	Subframe	Message
$\dot{A}$	Change Rate in Semi-major Axis	N/A	10
Δn_0	Mean Motion Difference from Computed Value at Reference Time	N/A	10
$\Delta \dot{n}_0$	Rate of Mean Motion Difference from Computed Value	N/A	10
(L1/L2/L5)	Signal Health (3 bits)	N/A	10
URA_{ED}	Elevation Dependent User Range Accuracy	N/A	10
$ISC_{L1C/A}$	Inter-signal Correction NOTE2, NOTE3	N/A	30
ISC_{L2C}	Inter-signal Correction NOTE2, NOTE3	N/A	30
ISC_{L5I5}	Inter-signal Correction NOTE2, NOTE3	N/A	30
ISC_{L5Q5}	Inter-signal Correction NOTE2, NOTE3	N/A	30
t_{op}	CEI Data Sequence Propagation Time of Week	N/A	10, 30-37
URA_{NED0}	NED Accuracy Index	N/A	30-37
URA_{NED1}	NED Accuracy Change Index	N/A	30-37
URA_{NED2}	NED Accuracy Change Rate Index	N/A	30-37
Alert	Alert Flag NOTE1	All	All

Updates to parameters in this table will prompt changes in t_{oe}/t_{oc}/IODC/IODE for LNAV and t_{oe}/t_{oc} for CNAV

NOTE1: Updates to this parameter are independent of updates to t_{oe}/t_{oc}/IODC/IODE for LNAV or t_{oe}/t_{oc} for CNAV

NOTE2: Updates to this parameter are independent of curve fit

NOTE3: This parameter is for CEI Refinement

~~NOTE1: Parameters so indicated are for CEI Refinement – not limited to curve fit. Parameters not indicated are needed for/limited to curve fit.~~

~~Updates to parameters in table shall prompt changes in t_{oe}/t_{oc} for CNAV and t_{oe}/t_{oc}/IODC/IODE for LNAV. Any parameter marked with NOTE1 may be changed with or without a change in t_{oe}/t_{oc}/IODC/IODE~~.

IS:

Symbol	Parameter Name	Subframe	Message
SV Health	SV Health (6 bits)[NOTE2]	1	N/A
IODC	Issue of Data, Clock	1	N/A
URA	URA Index	1	N/A
WN	Week Number	1	10
T_{GD}	Group Delay Differential[NOTE2, NOTE3]	1	30
WN_{OP}	CEI Data Sequence Propagation Week Number	N/A	30
a_{f0}	SV Clock Bias Correction Coefficient	1	30-37
a_{f1}	SV Clock Drift Correction Coefficient	1	30-37
a_{f2}	Drift Rate Correction Coefficient	1	30-37
t_{oc}	Time of Clock	1	30-37
$\sqrt{A}$	Square Root of the Semi-Major Axis	2	N/A
Δn	Mean Motion Difference from Computed Value	2	N/A
Fit Interval Flag	Fit Interval Flag	2	N/A
e	Eccentricity	2	10
M_0	Mean Anomaly at Reference Time	2	10
t_{oe}	Time of Ephemeris	2	10, 11
C_{rs}	Amplitude of the Sine Correction Term to the Orbit Radius	2	11
C_{uc}	Amplitude of Cosine Harmonic Correction Term to the Argument of Latitude	2	11
C_{us}	Amplitude of Sine Harmonic Correction Term to the Argument of Latitude	2	11
IODE	Issue of Data, Ephemeris	2, 3	N/A
ISF	Integrity Status Flag[NOTE1, NOTE2]	All	10
ω	Argument of Perigee	3	10
$\dot{\Omega}$	Rate of Right Ascension	3	N/A
$\Delta\dot{\Omega}$	Rate of Right Ascension Difference	N/A	11
Ω_0	Longitude of Ascending Node of Orbit Plane at Weekly Epoch	3	11
i_0	Inclination Angle at Reference Time	3	11
IDOT	Rate of Inclination Angle	3	11
C_{ic}	Amplitude of the Cosine Harmonic Correction Term to the Angle of Inclination	3	11
C_{is}	Amplitude of the Sine Harmonic Correction Term to the Angle of Inclination	3	11
C_{rc}	Amplitude of the Cosine Harmonic Correction Term to the Orbit Radius	3	11

Symbol	Parameter Name	Subframe	Message
ΔA	Semi-major Axis Difference at Reference Time	N/A	10
$\dot{A}$	Change Rate in Semi-major Axis	N/A	10
Δn_0	Mean Motion Difference from Computed Value at Reference Time	N/A	10
$\Delta \dot{n}_0$	Rate of Mean Motion Difference from Computed Value	N/A	10
(L1/L2/L5)	Signal Health (3 bits) [NOTE2]	N/A	10
URA_{ED}	Elevation Dependent User Range Accuracy	N/A	10
$ISC_{L1C/A}$	Inter-signal Correction[NOTE2, NOTE3]	N/A	30
ISC_{L2C}	Inter-signal Correction[NOTE2, NOTE3]	N/A	30
ISC_{L5I5}	Inter-signal Correction[NOTE2, NOTE3]	N/A	30
ISC_{L5Q5}	Inter-signal Correction[NOTE2, NOTE3]	N/A	30
t_{op}	CEI Data Sequence Propagation Time of Week	N/A	10, 30-37
URA_{NED0}	NED Accuracy Index	N/A	30-37
URA_{NED1}	NED Accuracy Change Index	N/A	30-37
URA_{NED2}	NED Accuracy Change Rate Index	N/A	30-37
Alert	Alert Flag[NOTE1]	All	All

Updates to parameters in this table will prompt changes in t_{oe}/t_{oc}/IODC/IODE for LNAV and t_{oe}/t_{oc} for CNAV

NOTE1: Updates to this parameter are independent of updates to t_{oe}/t_{oc}/IODC/IODE for LNAV or t_{oe}/t_{oc} for CNAV

NOTE2: Updates to this parameter are independent of curve fit

NOTE3: This parameter is for CEI Refinement

Rationale:
PRAT 2021-03 8/5/2023 Incorporate Core CEI changes from RFC-502 (T. Anthony)

IS200-1006:

Section Number:
6.3.6.1.0-4

WAS:
<DELETE>

Redlines:
~~<DELETE>~~

IS:
<DELETED OBJECT>

Rationale:
Administrative changes as a result of the two-party review. This object was proposed to be deleted in RFC-00198, but utilizing placeholder text gets snuck in to the final document.

IS200-300:

Section Number:
20.3.3.1.0-3

WAS:
Bit 23 of each TLM word is the Integrity Status Flag (ISF). A "0" in bit position 23 indicates that the conveying signal is provided with the legacy level of integrity assurance. That is, the probability that the instantaneous URE of the conveying signal exceeds 4.42 times the upper bound value of the current broadcast URA index, for more than 5.2 seconds, without an accompanying alert, is less than 1E-5 per hour. A "1" in bit-position 23 indicates that the conveying signal is provided with an enhanced level of integrity assurance. That is, the probability that the instantaneous URE of the conveying signal exceeds 5.73 times the upper bound value of the current broadcast URA index, for more than 5.2 seconds, without an accompanying alert, is less than 1E-8 per hour. The probabilities associated with the nominal and lower bound values of the current broadcast URA index are not defined.

Redlines:
Bit 23 of each TLM word is the Integrity Status Flag (ISF). A "0" in bit position 23 indicates that the conveying signal is provided with the legacy level of integrity assurance. That is, the probability that the instantaneous URE of the conveying signal exceeds 4.42 times the upper bound value of the current broadcast URA index, for more than 5.2 seconds, without an accompanying alert, is less than ~~1E~~1×10^{-5} per hour. A "1" in bit-position 23 indicates that the conveying signal is provided with an enhanced level of integrity assurance. That is, the probability that the instantaneous URE of the conveying signal exceeds 5.73 times the upper bound value of the current broadcast URA index, for more than 5.2 seconds, without an accompanying alert, is less than ~~1E~~1×10^{-8} per hour. The probabilities associated with the nominal and lower bound values of the current broadcast URA index are not defined.

IS:
Bit 23 of each TLM word is the Integrity Status Flag (ISF). A "0" in bit position 23 indicates that the conveying signal is provided with the legacy level of integrity assurance. That is, the probability that the instantaneous URE of the conveying signal exceeds 4.42 times the upper bound value of the current broadcast URA index, for more than 5.2 seconds, without an accompanying alert, is less than 1×10^{-5} per hour. A "1" in bit-position 23 indicates that the conveying signal is provided with an enhanced level of integrity assurance. That is, the probability that the instantaneous URE of the conveying signal exceeds 5.73 times the upper bound value of the current broadcast URA index, for more than 5.2 seconds, without an accompanying alert, is less than 1×10^{-8} per hour. The probabilities associated with the nominal and lower bound values of the current broadcast URA index are not defined.

Rationale:
9/10/2025: Converted the exponential notation to CSE Manual standard. (T. Anthony)

IS200-319:

Section Number:
20.3.3.3.1.3.0-4

WAS:

URA INDEX	URA (meters)		
0	0.00	< URA ≤	2.40
1	2.40	< URA ≤	3.40
2	3.40	< URA ≤	4.85
3	4.85	< URA ≤	6.85
4	6.85	< URA ≤	9.65
5	9.65	< URA ≤	13.65
6	13.65	< URA ≤	24.00
7	24.00	< URA ≤	48.00
8	48.00	< URA ≤	96.00
9	96.00	< URA ≤	192.00
10	192.00	< URA ≤	384.00
11	384.00	< URA ≤	768.00
12	768.00	< URA ≤	1536.00
13	1536.00	< URA ≤	3072.00
14	3072.00	< URA ≤	6144.00
15	6144.00	< URA ≤	(or no accuracy prediction is available - standard positioning service users are advised to use the SV at their own risk.)

Redlines:

URA INDEX	URA (meters)		
0	0.00	< URA ≤	2.40
1	2.40	< URA ≤	3.40
2	3.40	< URA ≤	4.85
3	4.85	< URA ≤	6.85
4	6.85	< URA ≤	9.65
5	9.65	< URA ≤	13.65
6	13.65	< URA ≤	24.00
7	24.00	< URA ≤	48.00
8	48.00	< URA ≤	96.00
9	96.00	< URA ≤	192.00
10	192.00	< URA ≤	384.00
11	384.00	< URA ≤	768.00
12	768.00	< URA ≤	1536.00
13	1536.00	< URA ≤	3072.00
14	3072.00	< URA ≤	6144.00
15	6144.00	< URA ≤	(or no accuracy prediction is available - standard positioning service users are advised to use the SV at their own risk.)

IS:

URA INDEX	URA (meters)		
0	0.00	< URA ≤	2.40
1	2.40	< URA ≤	3.40
2	3.40	< URA ≤	4.85
3	4.85	< URA ≤	6.85
4	6.85	< URA ≤	9.65
5	9.65	< URA ≤	13.65
6	13.65	< URA ≤	24.00
7	24.00	< URA ≤	48.00
8	48.00	< URA ≤	96.00
9	96.00	< URA ≤	192.00
10	192.00	< URA ≤	384.00
11	384.00	< URA ≤	768.00
12	768.00	< URA ≤	1536.00
13	1536.00	< URA ≤	3072.00
14	3072.00	< URA ≤	6144.00
15	6144.00	< URA	(or no accuracy prediction is available - standard positioning service users are advised to use the SV at their own risk.)

Rationale:
9/18/25: Administrative. Removed <= sign for 15 because it has no meaning if a URA prediction is not applicable. (T. Anthony)
9/3/2025 Reformatted for readability. (T. Anthony)

IS200-2025:

Section Number:
20.3.3.3.1.3.0-6

WAS:
For N = 1, 3, and 5, X should be rounded to 2.8, 5.7, and 11.3 meters, respectively.
The nominal URA value (X) is suitable for use as a conservative prediction of the RMS signal-in-space (SIS) range errors for accuracy-related purposes in the pseudorange domain (e.g., measurement de-weighting, receiver autonomous integrity monitoring (RAIM), figure of merit (FOM) computations). Integrity properties of the URA are specified with respect to the scaled (multiplied by either 4.42 or 5.73 as appropriate) upper bound values of the URA index (see 20.3.3.1).
URA accounts for SIS contributions to user range error which include, but are not limited to, the following: LNAV LSB representation/truncation error; the net effect of LNAV clock correction polynomial error and code phase error in the transmitted signal for single-frequency L1C/A, L1P(Y), L2P(Y), or dual-frequency P(Y) users who correct the code phase as described in Section 20.3.3.3.3; LNAV ephemeris error; anisotropic antenna errors; and signal deformation error. URA does not account for user range error contributions due to the inaccuracy of the broadcast ionospheric data parameters used in the single-frequency ionospheric model or for other atmospheric effects.

Redlines:
For N = 1, 3, and 5, X should be rounded to 2.8, 5.7, and 11.3 meters, respectively.
The nominal URA value (X) is suitable for use as a conservative prediction of the RMS signal-in-space (SIS) range errors for accuracy-related purposes in the pseudorange domain (e.g., measurement de-weighting, receiver autonomous integrity monitoring (RAIM), figure of merit (FOM) computations).
Integrity properties of the URA (IAURA) are specified with respect to the scaled (multiplied by either 4.42 or 5.73 as appropriate) upper bound values of the URA index (see 20.3.3.1).
URA accounts for SIS contributions to user range error which include, but are not limited to, the following: LNAV LSB representation/truncation error; the net effect of LNAV clock correction polynomial error and code phase error in the transmitted signal for single-frequency L1C/A, L1P(Y), L2P(Y), or dual-frequency P(Y) users who correct the code phase as described in Section 20.3.3.3.3; LNAV ephemeris error; anisotropic antenna errors; and signal deformation error.- URA does not account for user range error contributions due to the inaccuracy of the broadcast ionospheric data parameters used in the single-frequency ionospheric model or for other atmospheric effects.

IS:
For N = 1, 3, and 5, X should be rounded to 2.8, 5.7, and 11.3 meters, respectively.
The nominal URA value (X) is suitable for use as a conservative prediction of the RMS signal-in-space (SIS) range errors for accuracy-related purposes in the pseudorange domain (e.g., measurement de-weighting, receiver autonomous integrity monitoring (RAIM), figure of merit (FOM) computations).
Integrity properties of the URA (IAURA) are specified with respect to the scaled (multiplied by either 4.42 or 5.73 as appropriate) upper bound values of the URA index (see 20.3.3.1).
URA accounts for SIS contributions to user range error which include, but are not limited to, the following: LNAV LSB representation/truncation error; the net effect of LNAV clock correction polynomial error and code phase error in the transmitted signal for single-frequency L1C/A, L1P(Y), L2P(Y), or dual-frequency P(Y) users who correct the code phase as described in Section 20.3.3.3.3; LNAV ephemeris error; anisotropic antenna errors; and signal deformation error. URA does not account for user range error contributions due to the inaccuracy of the broadcast ionospheric data parameters used in the single-frequency ionospheric model or for other atmospheric effects.

Rationale:
9/3/2025: Worked IAURA into the integrity properties (T. Anthony)

IS200-1925:

Section Number:
20.3.3.3.3.1.0-4

WAS:

The orbit parameters (e, $\sqrt{A}$, E_k) used here are described in discussions of data contained in subframes 2 and 3, while F is a constant whose value is

$$F = \frac{-2\sqrt{\mu}}{c^2} = -4.442807633\ (10)^{-10}\ \frac{\text{sec}}{\sqrt{\text{meter}}},$$

where

$$\mu = 3.986005 \text{ x } 10^{14}\ \frac{\text{meters}^3}{\text{second}^2} = \quad \text{value of Earth's universal gravitational parameters}$$

$$c = 2.99792458 \text{ x } 10^{8}\ \frac{\text{meters}}{\text{second}} = \quad \text{speed of light.}$$

Redlines:
The orbit parameters (e, _, Ek) used here are described in discussions of data contained in subframes 2 and 3, while F is a constant whose value is

$$F = \frac{-2\sqrt{\mu}}{c^2} =- - 4.442807633\ (\times\ 10)^{-10}-\ \frac{\text{sec}}{\sqrt{\text{meter}}}$$

where

m μ =- 3.986005 x× 1014 meters3/second2 = value of Earth's universal gravitational parameters

c = 2.99792458299,792,458 xmeters/second 108 = speed of light.

IS:

The orbit parameters (e, $\sqrt{A}$, E_k) used here are described in discussions of data contained in subframes 2 and 3, while F is a constant whose value is

$$F = \frac{-2\sqrt{\mu}}{c^2} = -4.442807633 \times 10^{-10}\ \frac{\text{sec}}{\sqrt{\text{meter}}}$$

where

$\mu = 3.986005 \times 10^{14}$ meters^3/second^2 = value of Earth's universal gravitational parameters

c = 299,792,458 meters/second = speed of light

Rationale:
8/21/2025: Converted the exponential notation to CSE Manual standard. (T. Anthony)
PRAT 2020-03 8/5/2025 Normalize the use of scientific notation across the public GPS interface documents. (T. Anthony)

IS200-366:

Section Number:
20.3.3.4.3.1.0-4

WAS:

Parameter	No. of Bits**	Scale Factor (LSB)	Valid Range***	Units
IODE	8			(see text)
C_{rs}	16*	2^{-5}		meters
Δn	16*	2^{-43}		semi-circles/sec
M_0	32*	2^{-31}		semi-circles
C_{uc}	16*	2^{-29}		radians
e	32	2^{-33}	0.0 to 0.03	dimensionless
C_{us}	16*	2^{-29}		radians
$\sqrt{A}$	32	2^{-19}	2530 to 8192	$\sqrt{\text{meters}}$
t_{oe}	16	2^{4}	0 to 604,784	seconds
C_{ic}	16*	2^{-29}		radians
Ω_0	32*	2^{-31}		semi-circles
C_{is}	16*	2^{-29}		radians
i_0	32*	2^{-31}		semi-circles
C_{rc}	16*	2^{-5}		meters
ω	32*	2^{-31}		semi-circles
$\dot{\Omega}$	24*	2^{-43}	-6.33E-07 to 0	semi-circles/sec
IDOT	14*	2^{-43}		semi-circles/sec

* Parameters so indicated shall be two's complement, with the sign bit (+ or -) occupying the MSB;
** See Figure 20-1 for complete bit allocation in subframe;
*** Unless otherwise indicated in this column, valid range is the maximum range attainable with indicated bit allocation and scale factor.

Redlines:

Parameter	No. of Bits~~**~~NOTE2	Scale Factor (LSB)	Valid Range~~***~~NOTE3	Units
IODE	8			(see text)
C_{rs}	16~~*~~NOTE1	2^{-5}		meters
Δn	16~~*~~NOTE1	2^{-43}		semi-circles/sec
M_0	32~~*~~NOTE1	2^{-31}		semi-circles
C_{uc}	16~~*~~NOTE1	2^{-29}		radians
e	32	2^{-33}	0.0 to 0.03	dimensionless
C_{us}	16~~*~~NOTE1	2^{-29}		radians
$\sqrt{A}$	32	2^{-19}	2530 to 8192	$\sqrt{\text{meters}}$
t_{oe}	16	2^{4}	0 to 604,784	seconds
C_{ic}	16~~*~~NOTE1	2^{-29}		radians
Ω_0	32~~*~~NOTE1	2^{-31}		semi-circles
C_{is}	16~~*~~NOTE1	2^{-29}		radians
i_0	32~~*~~NOTE1	2^{-31}		semi-circles
C_{rc}	16~~*~~NOTE1	2^{-5}		meters
ω	32~~*~~NOTE1	2^{-31}		semi-circles
$\dot{\Omega}$	24~~*~~NOTE1	2^{-43}	-6.33 $\times 10^{-7}$ ~~E-07~~to 0	semi-circles/sec
IDOT	14~~*~~NOTE1	2^{-43}		semi-circles/sec

NOTE1:~~*~~Parameters so indicated shall be two's complement with the sign bit (+ or -) occupying the MSB

NOTE2:~~**~~ See Figure 20-10 for complete bit allocation in subframe

NOTE3:~~***~~ Unless otherwise indicated in this column, valid range is the maximum range attainable with indicated bit allocation and scale factor*

IS:

Parameter	No. of Bits NOTE2	Scale Factor (LSB)	Valid Range NOTE3	Units
IODE	8			(see text)
C_{rs}	16 NOTE1	2^{-5}		meters
Δn	16 NOTE1	2^{-43}		semi-circles/sec
M_0	32 NOTE1	2^{-31}		semi-circles
C_{uc}	16 NOTE1	2^{-29}		radians
e	32	2^{-33}	0.0 to 0.03	dimensionless
C_{us}	16 NOTE1	2^{-29}		radians
$\sqrt{A}$	32	2^{-19}	2530 to 8192	$\sqrt{\text{meters}}$
t_{oe}	16	2^{4}	0 to 604,784	seconds
C_{ic}	16 NOTE1	2^{-29}		radians
Ω_0	32 NOTE1	2^{-31}		semi-circles
C_{is}	16 NOTE1	2^{-29}		radians
i_0	32 NOTE1	2^{-31}		semi-circles
C_{rc}	16 NOTE1	2^{-5}		meters
ω	32 NOTE1	2^{-31}		semi-circles
$\dot{\Omega}$	24 NOTE1	2^{-43}	-6.33×10^{-7} to 0	semi-circles/sec
IDOT	14 NOTE1	2^{-43}		semi-circles/sec

NOTE1: Parameters so indicated shall be two's complement with the sign bit (+ or -) occupying the MSB

NOTE2: See Figure 20-10 for complete bit allocation in subframe

NOTE3: Unless otherwise indicated in this column, valid range is the maximum range attainable with indicated bit allocation and scale factor

Rationale:
9/10/2025: Converted the exponential notation to CSE Manual standard. (T. Anthony)
Also, replace asterisk based notes with NOTEn (T. Anthony)

IS200-367:

Section Number:
20.3.3.4.3.1.0-6

WAS:

$\mu = 3.986005 \times 10^{14}$ meters^3/sec^2	WGS 84 value of the earth's gravitational constant for GPS user
$\dot{\Omega}_e = 7.2921151467 \times 10^{-5}$ rad/sec	WGS 84 value of the earth's rotation rate
$A = \left(\sqrt{A}\right)^2$	Semi-major axis
$n_0 = \sqrt{\frac{\mu}{A^3}}$	Computed mean motion (rad/sec)
$t_k = t - t_{oe}$*	Time from ephemeris reference epoch
$n = n_0 + \Delta n$	Corrected mean motion
$M_k = M_0 + nt_k$	Mean anomaly
	Kepler's equation ($M_k = E_k - e \sin E_k$) may be solved for Eccentric anomaly (E_k) by iteration:
$E_0 = M_k$	– Initial Value (radians)
$E_j = E_{j-1} + \frac{M_k - E_{j-1} + e \sin \quad {}_{j-1}}{1 - e \text{ co} \quad {}_{j-1}}$	– Refined Value, minimum of three iterations, (j=1,2,3)
$E_k = E_j$	– Final Value (radians)
$\nu_k = 2 \tan^{-1}\left(\sqrt{\frac{1+e}{1-e}} \tan \frac{E_k}{2}\right)$	True Anomaly (unambiguous quadrant)

* t is GPS system time at time of transmission, i.e., GPS time corrected for transit time (range/speed of light). Furthermore, t_k shall be the actual total time difference between the time t and the epoch time t_{oe}, and must account for beginning or end of week crossovers. That is, if t_k is greater than 302,400 seconds, subtract 604,800 seconds from t_k. If t_k is less than -302,400 seconds, add 604,800 seconds to t_k.

Redlines:

$\mu = 3.986005$ ×x 10^{14} meters^3/sec^2	WGS 84 value of the earth's gravitational constant for GPS user
$\dot{\Omega}_e = 7.2921151467$ ×x 10^{-5} rad/sec	WGS 84 value of the earth's rotation rate
$A = \left(\sqrt{A}\right)^2$	Semi-major axis
$n_0 = \sqrt{\frac{\mu}{A^3}}$	Computed mean motion (rad/sec)
$t_k = t - t_{oe}$*	Time from ephemeris reference epoch NOTE 1
$n = n_0 + \Delta n$	Corrected mean motion
$M_k = M_0 + n\, t_k$	Mean anomaly
Kepler's equation ($M_k = E_k - e \sin E_k$) may be solved for Eccentric anomaly (E_k) by iteration:	
$E_0 = M_k$	– Initial Value (radians)
$E_j = E_{j-1} + \frac{M_k - E_{j-1} + e \sin E_{j-1}}{1 - e \cos E_{j-1}}$	– Refined Value, minimum of three iterations, (j=1,2,3)
$E_k = E_j$	– Final Value (radians)
$v_k = 2 \tan^{-1}\left(\sqrt{\frac{1+e}{1-e}} \tan\left(\frac{E_k}{2}\right)\right)$	True Anomaly (unambiguous quadrant)

NOTE 1* t is GPS system time at time of transmission, i.e., GPS time corrected for transit time (range/speed of light). Furthermore, t_k shall be the actual total time difference between the time t and the epoch time t_{oe}, and must account for beginning or end of week crossovers. That is, if t_k is greater than 302,400 seconds, subtract 604,800 seconds from t_k. If t_k is less than -302,400 seconds, add 604,800 seconds to t_k.

IS:

$\mu = 3.986005 \times 10^{14}$ meters^3/sec^2	WGS 84 value of the earth's gravitational constant for GPS user
$\dot{\Omega}_e = 7.2921151467 \times 10^{-5}$ rad/sec	WGS 84 value of the earth's rotation rate
$A = \left(\sqrt{A}\right)^2$	Semi-major axis
$n_0 = \sqrt{\frac{\mu}{A^3}}$	Computed mean motion (rad/sec)
$t_k = t - t_{oe}$	Time from ephemeris reference epoch[NOTE 1]
$n = n_0 + \Delta n$	Corrected mean motion
$M_k = M_0 + nt_k$	Mean anomaly
Kepler's equation ($M_k = E_k - e \sin E_k$) may be solved for Eccentric anomaly (E_k) by iteration:	
$E_0 = M_k$	– Initial Value (radians)
$E_j = E_{j-1} + \frac{M_k - E_{j-1} + e \sin E_{j-1}}{1 - e \cos E_{j-1}}$	– Refined Value, minimum of three iterations, (j=1,2,3)
$E_k = E_j$	– Final Value (radians)
$v_k = 2 \tan^{-1}\left(\sqrt{\frac{1+e}{1-e}} \tan\left(\frac{E_k}{2}\right)\right)$	True Anomaly (unambiguous quadrant)
NOTE 1: t is GPS system time at time of transmission, i.e., GPS time corrected for transit time (range/speed of light). Furthermore, t_k shall be the actual total time difference between the time t and the epoch time t_{oe}, and must account for beginning or end of week crossovers. That is, if t_k is greater than 302,400 seconds, subtract 604,800 seconds from t_k. If t_k is less than -302,400 seconds, add 604,800 seconds to t_k.	

Rationale:
8/21/2025: At TIM #1, SMEs asked for NOTE identifiers to replace asterisks (T. Anthony)
8/21/2025: Converted the exponential notation to CSE Manual standard. (T. Anthony)
PRAT 2020-03 8/5/2025 Normalize the use of scientific notation across the public GPS interface documents. (T. Anthony)

IS200-368:

Section Number:
20.3.3.4.3.1.0-8

WAS:

$\Phi_k = \nu_k + \omega$		Argument of Latitude
$\delta u_k = c_{us}\sin 2\Phi_k + c_{uc}\cos 2\Phi_k$	Argument of Latitude Correction	Second Harmonic
$\delta r_k = c_{rs}\sin 2\Phi_k + c_{rc}\cos 2\Phi_k$	Radius Correction	Second Harmonic
$\delta i_k = c_{is}\sin 2\Phi_k + c_{ic}\cos 2\Phi_k$	Inclination Correction	Second Harmonic
$u_k = \Phi_k + \delta u_k$		Corrected Argument of Latitude
$r_k = A(1 - e\cos E_k) + \delta r_k$		Corrected Radius
$i_k = i_0 + \delta i_k + (IDOT)\, t_k$		Corrected Inclination
$x_k' = r_k\cos u_k$		Positions in orbital
$y_k' = r_k\sin u_k$		Positions in orbital
$\Omega_k = \Omega_0 + (\dot{\Omega} - \dot{\Omega}_e)\, t_k - \dot{\Omega}_e\, t_{oe}$		Corrected longitude of ascending node.
$x_k = x_k'\cos\Omega_k - y_k'\cos i_k\sin\Omega_k$		Earth-fixed
$y_k = x_k'\sin\Omega_k + y_k'\cos i_k\cos\Omega_k$		Earth-fixed
$z_k = y_k'\sin i_k$		Earth-fixed

Redlines:

$\Phi_k = \nu_k + \omega$ — Argument of Latitude

Second Harmonic:

$\delta u_k =$ ~~c~~$C_{us} \sin 2\Phi_k +$ ~~c~~$C_{uc} \cos 2\Phi_k$ — Argument of Latitude Correction

$\delta r_k =$ ~~c~~$C_{rs} \sin 2\Phi_k +$ ~~c~~$C_{rc} \cos 2\Phi_k$ — Radius Correction

$\delta i_k =$ ~~c~~$C_{is} \sin 2\Phi_k +$ ~~c~~$C_{ic} \cos 2\Phi_k$ — Inclination Correction

$u_k = \Phi_k + \delta u_k$ — Corrected Argument of Latitude

$r_k = A(1 - e \cos E_k) + \delta r_k$ — Corrected Radius

$i_k = i_0 + \delta i_k + (IDOT)\, t_k$ — Corrected Inclination

Positions in orbital:

$x_k' = r_k \cos u_k$

$y_k' = r_k \sin u_k$

$\Omega_k = \Omega_0 + (\dot{\Omega} - \dot{\Omega}_e)\, t_k - \dot{\Omega}_e\, t_{oe}$ — Corrected longitude of ascending node.

Earth-fixed:

$x_k = x_k' \cos \Omega_k - y_k' \cos i_k \sin \Omega_k$

$y_k = x_k' \sin \Omega_k + y_k' \cos i_k \cos \Omega_k$

$z_k = y_k' \sin i_k$

IS:

Equation		Description
$\Phi_k = \nu_k + \omega$		Argument of Latitude
$\delta u_k = C_{us} \sin 2\Phi_k + C_{uc} \cos 2\Phi_k$	Argument of Latitude Correction	Second Harmonic
$\delta r_k = C_{rs} \sin 2\Phi_k + C_{rc} \cos 2\Phi_k$	Radius Correction	Second Harmonic
$\delta i_k = C_{is} \sin 2\Phi_k + C_{ic} \cos 2\Phi_k$	Inclination Correction	Second Harmonic
$u_k = \Phi_k + \delta u_k$		Corrected Argument of Latitude
$r_k = A(1 - e \cos E_k) + \delta r_k$		Corrected Radius
$i_k = i_0 + \delta i_k + (IDOT)\, t_k$		Corrected Inclination
$x_k' = r_k \cos u_k$		Positions in orbital
$y_k' = r_k \sin u_k$		Positions in orbital
$\Omega_k = \Omega_0 + (\dot{\Omega} - \dot{\Omega}_e)\, t_k - \dot{\Omega}_e\, t_{oe}$		Corrected longitude of ascending node.
$x_k = x_k' \cos \Omega_k - y_k' \cos i_k \sin \Omega_k$		Earth-fixed
$y_k = x_k' \sin \Omega_k + y_k' \cos i_k \cos \Omega_k$		Earth-fixed
$z_k = y_k' \sin i_k$		Earth-fixed

Rationale:
Administrative Change: 9/11/2025 Capitalize the Cxx parameters and space out the multiplied terms for easier reading. (T. Anthony)

IS200-1726:

Section Number:
20.3.3.4.3.1.0-10

WAS:

Element/Equation	Description
<u>SV Velocity</u>	
$\dot{E}_k = n / (1 - e \cos E_k)$	Eccentric Anomaly Rate
$\dot{v}_k = \dot{E}_k \sqrt{1-e^2} / (1 - e \cos E_k)$	True Anomaly Rate
$(di_k / dt) = (IDOT) + 2\, \dot{v}_k (c_{is} \cos 2\phi_k - c_{ic} \sin 2\phi_k)$	Corrected Inclination Angle Rate
$\dot{u}_k = \dot{v}_k + 2\dot{v}_k (c_{us} \cos 2\phi_k - c_{uc} \sin 2\phi_k)$	Corrected Argument of Latitude Rate
$\dot{r}_k = eA\dot{E}_k \sin Ek + 2\dot{v}_k (c_{rs} \cos 2\phi_k - c_{rc} \sin 2\phi_k)$	Corrected Radius Rate
$\dot{\Omega}_k = \dot{\Omega} - \dot{\Omega}_e$	Longitude of Ascending Node Rate
$\dot{x}'_k = \dot{r}_k \cos u_k - r_k \dot{u}_k \sin u_k$	In- plane *x* velocity
$\dot{y}'_k = \dot{r}_k \sin u_k + r_k \dot{u}_k \cos u_k$	In- plane *y* velocity
$\dot{x}_k = -x'_k \dot{\Omega}_k \sin \Omega_k + \dot{x}'_k \cos \Omega_k - \dot{y}'_k \sin \Omega_k \cos i_k$ $- y'_k(\dot{\Omega}_k \cos \Omega_k \cos i_k - (di_k / dt) \sin \Omega_k \sin i_k)$	Earth- Fixed *x* velocity (m/s)
$\dot{y}_k = x'_k \dot{\Omega}_k \cos \Omega_k + \dot{x}'_k \sin \Omega_k + \dot{y}'_k \cos \Omega_k \cos i_k$ $- y'_k(\dot{\Omega}_k \sin \Omega_k \cos i_k + (di_k / dt) \cos \Omega_k \sin i_k)$	Earth- Fixed *y* velocity (m/s)
$\dot{z}_k = \dot{y}'_k \sin i_k + y'_k (di_k / dt) \cos i_k$	Earth- Fixed *z* velocity (m/s)

Redlines:

Element/Equation	Description
<u>SV Velocity</u>	
$\dot{E}_k = n / (1 - e \cos E_k)$	Eccentric Anomaly Rate
$\dot{v}_k = \dot{E}_k \sqrt{1 - e^2} / (1 - e \cos E_k)$	True Anomaly Rate
$(di_k / dt) = (IDOT) + 2\, \dot{v}_k$ (~~e~~$C_{is} \cos 2\phi_k$ – ~~e~~$C_{ic} \sin 2\phi_k$)	Corrected Inclination Angle Rate
$\dot{u}_k = \dot{v}_k + 2\dot{v}_k$ (~~e~~$C_{us} \cos 2\phi_k$ – ~~e~~$C_{uc} \sin 2\phi_k$)	Corrected Argument of Latitude Rate
$\dot{r}_k = eA\dot{E}_k \sin E_k + 2\dot{v}_k$ (~~e~~$C_{rs} \cos 2\phi_k$ – ~~e~~$C_{rc} \sin 2\phi_k$)	Corrected Radius Rate
$\dot{\Omega}_k = \dot{\Omega} - \dot{\Omega}_e$	Longitude of Ascending Node Rate
$\dot{x}'_k = \dot{r}_k \cos u_k - r_k \dot{u}_k \sin u_k$	In- plane *x* velocity
$\dot{y}'_k = \dot{r}_k \sin u_k + r_k \dot{u}_k \cos u_k$	In- plane *y* velocity
$\dot{x}_k = -x'_k \dot{\Omega}_k \sin \Omega_k + \dot{x}'_k \cos \Omega_k - \dot{y}'_k \sin \Omega_k \cos i_k - y'_k(\dot{\Omega}_k \cos \Omega_k \cos i_k - (di_k / dt) \sin \Omega_k \sin i_k)$	Earth- Fixed *x* velocity (m/s)
$\dot{y}_k = x'_k \dot{\Omega}_k \cos \Omega_k + \dot{x}'_k \sin \Omega_k + \dot{y}'_k \cos \Omega_k \cos i_k - y'_k(\dot{\Omega}_k \sin \Omega_k \cos i_k + (di_k / dt) \cos \Omega_k \sin i_k)$	Earth- Fixed *y* velocity (m/s)
$\dot{z}_k = \dot{y}'_k \sin i_k + y'_k (di_k / dt) \cos i_k$	Earth- Fixed *z* velocity (m/s)

IS:

Element/Equation	Description
SV Velocity	
$\dot{E}_k = n / (1 - e \cos E_k)$	Eccentric Anomaly Rate
$\dot{v}_k = \dot{E}_k \sqrt{1-e^2} / (1 - e \cos E_k)$	True Anomaly Rate
$(di_k / dt) = (IDOT) + 2\ \dot{v}_k (C_{is} \cos 2\phi_k - C_{ic} \sin 2\phi_k)$	Corrected Inclination Angle Rate
$\dot{u}_k = \dot{v}_k + 2\dot{v}_k (C_{us} \cos 2\phi_k - C_{uc} \sin 2\phi_k)$	Corrected Argument of Latitude Rate
$\dot{r}_k = eA\dot{E}_k \sin Ek + 2\dot{v}_k (C_{rs} \cos 2\phi_k - C_{rc} \sin 2\phi_k)$	Corrected Radius Rate
$\dot{\Omega}_k = \dot{\Omega} - \dot{\Omega}_e$	Longitude of Ascending Node Rate
$\dot{x}'_k = \dot{r}_k \cos u_k - r_k \dot{u}_k \sin u_k$	In- plane *x* velocity
$\dot{y}'_k = \dot{r}_k \sin u_k + r_k \dot{u}_k \cos u_k$	In- plane *y* velocity
$\dot{x}_k = -x'_k\ \dot{\Omega}_k \sin \Omega_k + \dot{x}'_k \cos \Omega_k - \dot{y}'_k \sin \Omega_k \cos i_k - y'_k(\dot{\Omega}_k \cos \Omega_k \cos i_k - (di_k / dt) \sin \Omega_k \sin i_k)$	Earth- Fixed *x* velocity (m/s)
$\dot{y}_k = x'_k\ \dot{\Omega}_k \cos \Omega_k + \dot{x}'_k \sin \Omega_k + \dot{y}'_k \cos \Omega_k \cos i_k - y'_k(\dot{\Omega}_k \sin \Omega_k \cos i_k + (di_k / dt) \cos \Omega_k \sin i_k)$	Earth- Fixed *y* velocity (m/s)
$\dot{z}_k = \dot{y}'_k \sin i_k + y'_k\ (di_k / dt) \cos i_k$	Earth- Fixed *z* velocity (m/s)

Rationale:
Administrative Change: 9/11/2025 Capitalize the Cxx parameters and space out the multiplied terms for easier reading. (T. Anthony)

IS200-370:

Section Number:
20.3.3.4.3.2.0-1

WAS:
The sensitivity of the SV's antenna phase center position to small perturbations in most ephemeris parameters is extreme. The sensitivity of position to the parameters $\sqrt{A}$, C_{rc} and C_{rs} is about one meter/meter. The sensitivity of position to the angular parameters is on the order of 10^8 meters/semicircle, and to the angular rate parameters is on the order of 10^{12} meters/semicircle/second. Because of this extreme sensitivity to angular perturbations, the value of π used in the curve fit is given here. π is a mathematical constant, the ratio of a circle's circumference to its diameter.

Redlines:
The sensitivity of the SV's antenna phase center position to small perturbations in most ephemeris parameters is extreme. The sensitivity of position to the parameters , C_{rc} and C_{rs} is about one meter/meter. The sensitivity of position to the angular parameters is on the order of ~~108~~$1 \times 10^{+8}$ meters/semicircle, and to the angular rate parameters is on the order of ~~1012~~$1 \times 10^{+12}$ meters/semicircle/second. Because of this extreme sensitivity to angular perturbations, the value of ~~p~~π used in the curve fit is given here. ~~p~~π is a mathematical constant, the ratio of a circle's circumference to its diameter.

IS:
The sensitivity of the SV's antenna phase center position to small perturbations in most ephemeris parameters is extreme. The sensitivity of position to the parameters , C_{rc} and C_{rs} is about one meter/meter. The sensitivity of position to the angular parameters is on the order of $1 \times 10^{+8}$ meters/semicircle, and to the angular rate parameters is on the order of $1 \times 10^{+12}$ meters/semicircle/second. Because of this extreme sensitivity to angular perturbations, the value of π used in the curve fit is given here. π is a mathematical constant, the ratio of a circle's circumference to its diameter.

Rationale:
9/30/2025: Administrative. Replaced PI with Unicode for sustainability. (T. Anthony)
8/21/2025: Converted the exponential notation to CSE Manual standard. (T. Anthony)
PRAT 2020-03 8/5/2025 Normalize the use of scientific notation across the public GPS interface documents. (T. Anthony).

IS200-397:

Section Number:
20.3.3.5.1.2.0-7

WAS:

Parameter	No. of Bits**	Scale Factor (LSB)	Valid Range***	Units
e	16	2^{-21}	0.0 to 0.03	dimensionless
t_{oa}	8	2^{12}	0 to 602,112	seconds
δ_i****	16*	2^{-19}		semi-circles
$\dot{\Omega}$	16*	2^{-38}	-1.19E-07 to 0	semi-circles/sec
$\sqrt{A}$	24	2^{-11}	2530 to 8192	$\sqrt{\text{meters}}$
Ω_0	24*	2^{-23}		semi-circles
ω	24*	2^{-23}		semi-circles
M_0	24*	2^{-23}		semi-circles
a_{f0}	11*	2^{-20}		seconds
a_{f1}	11*	2^{-38}		sec/sec

* Parameters so indicated shall be two's complement with the sign bit (+ or -) occupying the MSB;

** See Figure 20-1 for complete bit allocation in subframe;

*** Unless otherwise indicated in this column, valid range is the maximum range attainable with indicated bit allocation and scale factor;

**** Relative to i_0 = 0.30 semi-circles.

Redlines:

Parameter	No. of Bits**NOTE2	Scale Factor (LSB)	Valid Range***NOTE3	Units
e	16	2^{-21}	0.0 to 0.03	dimensionless
t_{oa}	8	$2^{\pm 12}$	0 to 602,112	seconds
δ_i****NOTE4	16*NOTE1	2^{-19}		semi-circles
$\dot{\Omega}$	16*NOTE1	2^{-38}	-1.19×10^{-7} ~~E-7~~ to 0	semi-circles/sec
$\sqrt{A}$	24	2^{-11}	2530 to 8192	$\sqrt{\text{meters}}$
Ω_0	24*NOTE1	2^{-23}		semi-circles
ω	24*NOTE1	2^{-23}		semi-circles
M_0	24*NOTE1	2^{-23}		semi-circles
a_{f0}	11*NOTE1	2^{-20}		seconds
a_{f1}	11*NOTE1	2^{-38}		sec/sec

NOTE1:* Parameters so indicated shall be two's complement with the sign bit (+ or -) occupying the MSB~~;~~

NOTE2:** See Figure 20-10 for complete bit allocation in subframe~~;~~

NOTE3:*** Unless otherwise indicated in this column, valid range is the maximum range attainable with indicated bit allocation and scale factor~~;~~

NOTE4:**** Relative to i_0 = 0.30 semi-circles~~.~~

IS:

Parameter	No. of Bits NOTE2	Scale Factor (LSB)	Valid Range NOTE3	Units
e	16	2^{-21}	0.0 to 0.03	dimensionless
t_{oa}	8	2^{+12}	0 to 602,112	seconds
δ_i NOTE4	16 NOTE1	2^{-19}		semi-circles
$\dot{\Omega}$	16 NOTE1	2^{-38}	-1.19×10^{-7} to 0	semi-circles/sec
$\sqrt{A}$	24	2^{-11}	2530 to 8192	$\sqrt{\text{meters}}$
Ω_0	24 NOTE1	2^{-23}		semi-circles
ω	24 NOTE1	2^{-23}		semi-circles
M_0	24 NOTE1	2^{-23}		semi-circles
a_{f0}	11 NOTE1	2^{-20}		seconds
a_{f1}	11 NOTE1	2^{-38}		sec/sec

NOTE1: Parameters so indicated shall be two's complement with the sign bit (+ or -) occupying the MSB

NOTE2: See Figure 20-10 for complete bit allocation in subframe

NOTE3: Unless otherwise indicated in this column, valid range is the maximum range attainable with indicated bit allocation and scale factor

NOTE4: Relative to i_0 = 0.30 semi-circles

Rationale:
8/27/2025: Converted the exponential notation to CSE Manual standard. (T. Anthony)
8/21/2025: At TIM #1, SMEs asked for NOTE identifiers to replace asterisks (T. Anthony)

IS200-450:

Section Number:
20.3.3.5.2.6.0-4

WAS:

The ionospheric correction model is given by

$$T_{iono} = \begin{cases} F * \left[5.0 * 10^{-9} + (AMP)\left(1 - \frac{x^2}{2} + \frac{x^4}{24}\right)\right], & |x| < 1.57 \\ F * \left(5.0 * 10^{-9}\right), & |x| \geq 1.57 \end{cases} \quad \text{(sec)}$$

where

T_{iono} is referred to the L1 frequency; if the user is operating on the L2 frequency, the correction term must be multiplied by γ (reference paragraph 20.3.3.3.3.2),

$$AMP = \begin{cases} \sum_{n=0}^{3} \alpha_n \phi_m^n, & AMP \geq 0 \\ \text{if } AMP < 0, & AMP = 0 \end{cases} \quad \text{(sec)}$$

$$x = \frac{2\pi\ (t - 50400)}{PER} \quad \text{(radians)}$$

$$PER = \begin{cases} \sum_{n=0}^{3} \beta_n \phi_m^n, & PER \geq 72{,}000 \\ \text{if } PER < 72{,}000, & PER = 72{,}000 \end{cases} \quad \text{(sec)}$$

$$F = 1.0 + 16.0\ [0.53 - E]^3$$

and α_n and β_n are the satellite transmitted data words with n = 0, 1, 2, and 3.

Redlines:

The ionospheric correction model is given by

$$T_{\text{iono}} = \begin{Bmatrix} F\left[5.0 \times * \, 10^{-9} + (\text{AMP})\left(1 - \frac{x^2}{2} + \frac{x^4}{24}\right)\right], & |x| < 1.57 \\ F\,[5.0 \times * \, 10^{-9} \qquad], & |x| \geq 1.57 \end{Bmatrix} \quad \text{(sec)}$$

where

T_{iono} is referred to the L1 frequency; if the user is operating on the L2 frequency, the correction term must be multiplied by γ (reference paragraph 20.3.3.3.3.2),

$$\text{AMP} = \begin{Bmatrix} \sum_{n=0}^{3} \alpha_n \varphi_m^n, & \text{AMP} \geq 0 \\ \text{if AMP} < 0, & \text{AMP} = 0 \end{Bmatrix} \quad \text{(sec)}$$

$$x = \frac{2\pi\ (\text{t - }50{,}400)}{PER} \quad \text{(radians)}$$

$$\text{PER} = \begin{Bmatrix} \sum_{n=0}^{3} \beta_n \varphi_m^n & , \text{PER} \geq 72{,}000 \\ \text{if PER} < 72{,}000, & \text{PER} = 72{,}000 \end{Bmatrix} \quad \text{(sec)}$$

$$F = 1.0 + 16.0\,[0.53 - E]^3$$

and α_n and β_n are the satellite transmitted data words with n = 0, 1, 2, and 3.

IS:

The ionospheric correction model is given by

$$T_{\text{iono}} = \begin{Bmatrix} F\left[5.0 \times 10^{-9} + (\text{AMP})\left(1 - \frac{x^2}{2} + \frac{x^4}{24}\right)\right], & |x| < 1.57 \\ F\left[5.0 \times 10^{-9} \right], & |x| \geq 1.57 \end{Bmatrix} \quad \text{(sec)}$$

where

T_{iono} is referred to the L1 frequency; if the user is operating on the L2 frequency, the correction term must be multiplied by γ (reference paragraph 20.3.3.3.3.2),

$$\text{AMP} = \begin{Bmatrix} \sum_{n=0}^{3} \alpha_n \varphi_m^n, & \text{AMP} \geq 0 \\ \text{if AMP} < 0, & \text{AMP} = 0 \end{Bmatrix} \quad \text{(sec)}$$

$$x = \frac{2\pi\ (\text{t - 50,400})}{PER} \quad \text{(radians)}$$

$$\text{PER} = \begin{Bmatrix} \sum_{n=0}^{3} \beta_n \varphi_m^n, & \text{PER} \geq 72{,}000 \\ \text{if PER} < 72{,}000, & \text{PER} = 72{,}000 \end{Bmatrix} \quad \text{(sec)}$$

$$F = 1.0 + 16.0\,[0.53 - E]^3$$

and α_n and β_n are the satellite transmitted data words with n = 0, 1, 2, and 3.

Rationale:
8/21/2025: Converted the exponential notation to CSE Manual standard. (T. Anthony)
PRAT 2020-03 8/5/2025 Normalize the use of scientific notation across the public GPS interface documents. (T. Anthony)

IS200-451:

Section Number:
20.3.3.5.2.6.0-6

WAS:

Other equations that must be solved are

$$\phi_m = \phi_i + 0.064\cos(\lambda_i - 1.617) \qquad \text{(semi-circles)}$$

$$\lambda_i = \lambda_u + \frac{\psi \sin A}{\cos \phi_i} \qquad \text{(semi-circles)}$$

$$\phi_i = \begin{cases} \phi_u + \psi \cos A, & |\phi_i| \le 0.416 \\ \text{if } \phi_i > +0.416, \text{ then } \phi_i = +0.416 \\ \text{if } \phi_i < -0.416, \text{ then } \phi_i = -0.416 \end{cases} \qquad \text{(semi-circles)}$$

$$\psi = \frac{0.0137}{E + 0.11} - 0.022 \qquad \text{(semi-circles)}$$

$$t = 4.32\,(10^4)\,\lambda_i + \text{GPS time} \qquad \text{(sec)}$$

where

$0 \le t < 86400$: therefore, if $t \ge 86400$ seconds, subtract 86400 seconds;

if $t < 0$ seconds, add 86400 seconds.

Redlines:

Other equations that must be solved are

$$\phi_m = \phi_i + 0.064 \cos(\lambda_i - 1.617) \quad \text{(semi-circles)}$$

$$\lambda_i = \lambda_u + \frac{\psi \sin A}{\cos f_i} \quad \text{(semi-circles)}$$

$$\varphi_i = \begin{cases} \varphi_u + \psi \cos A, & |\varphi_i| \leq 0.416 \\ \text{if } \varphi_i > +0.416, & \text{then } \varphi_i = +0.416 \\ \text{if } \varphi_i < -0.416, & \text{then } \varphi_i = -0.416 \end{cases} \quad \text{(semi-circles)}$$

$$\psi = \frac{0.0137}{E=0.11} - 0.022 \quad \text{(semi-circles)}$$

$$t = 4.32 \underline{\times} \sout{(}10^{\underline{+}4}\sout{)} \lambda_i + \text{GPS time} \quad \text{(sec)}$$

where

0 ≤ t < 86,400: therefore, if t ≥ 86,400 seconds, subtract 86,400 seconds;
if t < 0 seconds, add 86,400 seconds.

IS:

Other equations that must be solved are

$$\phi_m = \phi_i + 0.064 \cos(\lambda_i - 1.617) \quad \text{(semi-circles)}$$

$$\lambda_i = \lambda_u + \frac{\psi \sin A}{\cos f_i} \quad \text{(semi-circles)}$$

$$\varphi_i = \begin{cases} \varphi_u + \psi \cos A, & |\varphi_i| \leq 0.416 \\ \text{if } \varphi_i > +0.416, & \text{then } \varphi_i = +0.416 \\ \text{if } \varphi_i < -0.416, & \text{then } \varphi_i = -0.416 \end{cases} \quad \text{(semi-circles)}$$

$$\psi = \frac{0.0137}{E=0.11} - 0.022 \quad \text{(semi-circles)}$$

$$t = 4.32 \times 10^{+4} \lambda_i + \text{GPS time} \quad \text{(sec)}$$

where

0 ≤ t < 86,400: therefore, if t ≥ 86,400 seconds, subtract 86,400 seconds;
if t < 0 seconds, add 86,400 seconds.

Rationale:
8/21/2025: Converted the exponential notation to CSE Manual standard. (T. Anthony)
PRAT 2020-03 8/5/2025 Normalize the use of scientific notation across the public GPS interface documents. (T. Anthony)

IS200-460:

Section Number:
20.3.4.3.0-1

WAS:
The speed of light used by the CS for generating the data described in the above paragraphs is

c = 2.99792458 x 10^8 meters per second

which is the official WGS 84 speed of light. The user shall use the same value for the speed of light in all computations.

Redlines:
The speed of light used by the CS for generating the data described in the above paragraphs is

c = ~~2.99792458 x 108~~299,792,458 meters per second

which is the official WGS 84 speed of light. The user shall use the same value for the speed of light in all computations.

IS:
The speed of light used by the CS for generating the data described in the above paragraphs is

c = 299,792,458 meters per second

which is the official WGS 84 speed of light. The user shall use the same value for the speed of light in all computations.

Rationale:
PRAT 2020-03 8/5/2025 Normalize the use of scientific notation across the public GPS interface documents. (T. Anthony)

IS200-1943:

Section Number:
30.3.3.1.1.0-8

WAS:
Bit 272 of Message Type 10 is the Integrity Status Flag (ISF). A "0" in bit position 272 indicates that the conveying signal is provided with the legacy level of integrity assurance. That is, the probability that the instantaneous URE of the conveying signal exceeds 4.42 times the current broadcast IAURA value, for more than 5.2 seconds, without an accompanying alert, is less than 1E-5 per hour. A "1" in bit-position 272 indicates that the conveying signal is provided with an enhanced level of integrity assurance. That is, the probability that the instantaneous URE of the conveying signal exceeds 5.73 times the current broadcast IAURA value, for more than 5.2 seconds, without an accompanying alert, is less than 1E-8 per hour. The probabilities associated with the nominal and lower bound values of the current broadcast URA_{ED} index, URA_{NED} indexes, and related URA values are not defined.

Redlines:
Bit 272 of Message Type 10 is the Integrity Status Flag (ISF). A "0" in bit position 272 indicates that the conveying signal is provided with the legacy level of integrity assurance. That is, the probability that the instantaneous URE of the conveying signal exceeds 4.42 times the current broadcast IAURA value, for more than 5.2 seconds, without an accompanying alert, is less than ~~1E~~1×10^{-5} per hour. A "1" in bit-position 272 indicates that the conveying signal is provided with an enhanced level of integrity assurance. That is, the probability that the instantaneous URE of the conveying signal exceeds 5.73 times the current broadcast IAURA value, for more than 5.2 seconds, without an accompanying alert, is less than ~~1E~~1×10^{-8} per hour. The probabilities associated with the nominal and lower bound values of the current broadcast URA_{ED} index, URA_{NED} indexes, and related URA values are not defined.

IS:
Bit 272 of Message Type 10 is the Integrity Status Flag (ISF). A "0" in bit position 272 indicates that the conveying signal is provided with the legacy level of integrity assurance. That is, the probability that the instantaneous URE of the conveying signal exceeds 4.42 times the current broadcast IAURA value, for more than 5.2 seconds, without an accompanying alert, is less than 1×10^{-5} per hour. A "1" in bit-position 272 indicates that the conveying signal is provided with an enhanced level of integrity assurance. That is, the probability that the instantaneous URE of the conveying signal exceeds 5.73 times the current broadcast IAURA value, for more than 5.2 seconds, without an accompanying alert, is less than 1×10^{-8} per hour. The probabilities associated with the nominal and lower bound values of the current broadcast URA_{ED} index, URA_{NED} indexes, and related URA values are not defined.

Rationale:
PRAT 2021-03 9/10/2023 Incorporate Core CEI changes from RFC-502 (T. Anthony)

IS200-1946:

Section Number:
30.3.3.1.1.4.0-6

WAS:
For each URA_{ED} index (N), users may compute a nominal URA_{ED} value (X) as given by:

• If the value of N is 6 or less, but more than -16, $X = 2^{(1 + N/2)}$,
• If the value of N is 6 or more, but less than 15, $X = 2^{(N - 2)}$,
• N = -16 or N = 15 shall indicate the absence of an accuracy prediction and shall advise the standard positioning service user to use that SV at his own risk.

For N = 1, 3, and 5, X should be rounded to 2.8, 5.7, and 11.3 meters, respectively.

The nominal URA_{ED} value (X) is suitable for use as a conservative prediction of the RMS ED range errors for accuracy-related purposes in the pseudorange domain (e.g., measurement deweighting, RAIM, FOM computations). Integrity properties of the $IAURA_{ED}$ are specified with respect to the scaled (multiplied by either 4.42 or 5.73 as appropriate) upper bound values of the broadcast URA_{ED} index (see 30.3.3.1.1).

For the nominal URA_{ED} value and the $IAURA_{ED}$ value, users may compute an adjusted URA_{ED} value as a function of SV elevation angle (E), for $E \geq 0$, as follows:

$$\text{Adjusted Nominal } URA_{ED} = \text{Nominal } URA_{ED} (\sin(E+90 \text{ degrees}))$$
$$\text{Adjusted } IAURA_{ED} = IAURA_{ED} (\sin(E+90 \text{ degrees}))$$

URA_{ED} and $IAURA_{ED}$ account for SIS contributions to user range error which include, but are not limited to, the following: CNAV LSB representation/truncation error, CNAV alongtrack ephemeris errors, and crosstrack CNAV ephemeris errors. URA_{ED} and $IAURA_{ED}$ do not account for user range error contributions due to the inaccuracy of the broadcast ionospheric data parameters used in the single-frequency ionospheric model or for other atmospheric effects.

Redlines:

For each URA_{ED} index (N), users may compute a nominal URA_{ED}- value (X) as given by:

- If the value of N is 6 or less, but more than -16, X = 2(1 + N/2),
- If the value of N is 6 or more, but less than 15, X = 2(N - 2),
- N = -16 or N = 15 shall indicate the absence of an accuracy prediction and shall advise the standard positioning service user to use that SV at his own risk.

For N = -15, 1, 3, and 5, X should be rounded to .01, 2.8, 5.7, and 11.3 meters, respectively.

The nominal URA_{ED}- value (X) is suitable for use as a conservative prediction of the RMS ED range errors for accuracy-related purposes in the pseudorange domain (e.g., measurement deweighting, RAIM, FOM computations).- Integrity properties of the $IAURA_{ED}$- are specified with respect to the scaled (multiplied by either 4.42 or 5.73 as appropriate) upper bound values of the broadcast URA_{ED}- index (see 30.3.3.1.1).

For the nominal URA_{ED}- value and the $IAURA_{ED}$- value, users may compute an adjusted URA_{ED}- value as a function of SV elevation angle (E), for E ≥ 0, as follows:

Adjusted Nominal URA_{ED}- =- Nominal URA_{ED}- (~~sin~~cos(E~~+90~~ degrees))

- Adjusted $IAURA_{ED}$- =- $IAURA_{ED}$- (~~sin~~cos(E~~+90~~ degrees))

URA_{ED}- and $IAURA_{ED}$- account for SIS contributions to user range error which include, but are not limited to, the following: CNAV LSB representation/truncation error, CNAV ~~alongtrack~~along-track ephemeris errors, and ~~crosstrack~~cross-track CNAV ephemeris errors.- URA_{ED}- and $IAURA_{ED}$- do not account for user range error contributions due to the inaccuracy of the broadcast ionospheric data parameters used in the single-frequency ionospheric model or for other atmospheric effects.

IS:

For each URA_{ED} index (N), users may compute a nominal URA_{ED} value (X) as given by:

- If the value of N is 6 or less, but more than -16, $X = 2^{(1 + N/2)}$,
- If the value of N is 6 or more, but less than 15, $X = 2^{(N - 2)}$,
- N = -16 or N = 15 shall indicate the absence of an accuracy prediction and shall advise the standard positioning service user to use that SV at his own risk.

For N = -15, 1, 3, and 5, X should be rounded to .01, 2.8, 5.7, and 11.3 meters, respectively.

The nominal URA_{ED} value (X) is suitable for use as a conservative prediction of the RMS ED range errors for accuracy-related purposes in the pseudorange domain (e.g., measurement deweighting, RAIM, FOM computations). Integrity properties of the $IAURA_{ED}$ are specified with respect to the scaled (multiplied by either 4.42 or 5.73 as appropriate) upper bound values of the broadcast URA_{ED} index (see 30.3.3.1.1).

For the nominal URA_{ED} value and the $IAURA_{ED}$ value, users may compute an adjusted URA_{ED} value as a function of SV elevation angle (E), for $E \geq 0$, as follows:

$$\text{Adjusted Nominal } URA_{ED} = \text{Nominal } URA_{ED} (\cos(E \text{ degrees}))$$
$$\text{Adjusted } IAURA_{ED} = IAURA_{ED} (\cos(E \text{ degrees}))$$

URA_{ED} and $IAURA_{ED}$ account for SIS contributions to user range error which include, but are not limited to, the following: CNAV LSB representation/truncation error, CNAV along-track ephemeris errors, and cross-track CNAV ephemeris errors. URA_{ED} and $IAURA_{ED}$ do not account for user range error contributions due to the inaccuracy of the broadcast ionospheric data parameters used in the single-frequency ionospheric model or for other atmospheric effects.

Rationale:

9/3/2025 Simplified the sinusoidal formulas from sin (E+90) to cos (E) per stakeholder request (T. Anthony)

IS200-551:

Section Number:
30.3.3.1.3.0-3

WAS:
The sensitivity of the SV's position to small perturbations in most ephemeris parameters is extreme. The sensitivity of position to the parameters A, C_{rc-n}, and C_{rs-n} is about one meter/meter. The sensitivity of position to the angular parameters is on the order of 10^8 meters/semi-circle, and to the angular rate parameters is on the order of 10^{12} meters/semi-circle/second. Because of this extreme sensitivity to angular perturbations, the value of π used in the curve fit is given here. π is a mathematical constant, the ratio of a circle's circumference to its diameter. Here π is taken as 3.1415926535898.

Redlines:
The sensitivity of the SV's position to small perturbations in most ephemeris parameters is extreme. The sensitivity of position to the parameters A, C_{rc-n}, and C_{rs-n} is about one meter/meter. The sensitivity of position to the angular parameters is on the order of ~~108~~$1 \times 10^{+8}$ meters/semi-circle, and to the angular rate parameters is on the order of ~~1012~~$1 \times 10^{+12}$ meters/semi-circle/second. Because of this extreme sensitivity to angular perturbations, the value of ~~p~~π used in the curve fit is given here. ~~p~~π is a mathematical constant, the ratio of a circle's circumference to its diameter. Here ~~p~~π is taken as 3.1415926535898.

IS:
The sensitivity of the SV's position to small perturbations in most ephemeris parameters is extreme. The sensitivity of position to the parameters A, C_{rc-n}, and C_{rs-n} is about one meter/meter. The sensitivity of position to the angular parameters is on the order of $1 \times 10^{+8}$ meters/semi-circle, and to the angular rate parameters is on the order of $1 \times 10^{+12}$ meters/semi-circle/second. Because of this extreme sensitivity to angular perturbations, the value of π used in the curve fit is given here. π is a mathematical constant, the ratio of a circle's circumference to its diameter. Here π is taken as 3.1415926535898.

Rationale:
9/30/2025: Administrative. Replaced PI with Unicode for sustainability. (T. Anthony)
8/21/2025: Converted the exponential notation to CSE Manual standard. (T. Anthony)
PRAT 2020-03 8/5/2025 Normalize the use of scientific notation across the public GPS interface documents. (T. Anthony)

IS200-553:

Section Number:
30.3.3.1.3.0-7

WAS:

Parameter		No. of Bits**	Scale Factor (LSB)	Valid Range***	Units
t_{oe}	Ephemeris data reference time of week	11	300	0 to 604,500	seconds
Ω_{0-n}	Longitude of Ascending Node of Orbit Plane at Weekly Epoch	33*	2^{-32}		semi-circles
$\Delta\dot{\Omega}$****	Rate of right ascension difference	17*	2^{-44}		semi-circles/sec
i_{0-n}	Inclination angle at reference time	33*	2^{-32}		semi-circles
IDOT	Rate of inclination angle	15*	2^{-44}		semi-circles/sec
C_{is-n}	Amplitude of the sine harmonic correction term to the angle of inclination	16*	2^{-30}		radians
C_{ic-n}	Amplitude of the cosine harmonic correction term to the angle of inclination	16*	2^{-30}		radians
C_{rs-n}	Amplitude of the sine correction term to the orbit radius	24*	2^{-8}		meters
C_{rc-n}	Amplitude of the cosine correction term to the orbit radius	24*	2^{-8}		meters
C_{us-n}	Amplitude of the sine harmonic correction term to the argument of latitude	21*	2^{-30}		radians
C_{uc-n}	Amplitude of the cosine harmonic correction term to the argument of latitude	21*	2^{-30}		radians

* Parameters so indicated are two's complement, with the sign bit (+ or -) occupying the MSB;
** See Figure 30-1 and Figure 30-2 for complete bit allocation in Message Types 10 and 11;
*** Unless otherwise indicated in this column, valid range is the maximum range attainable with indicated bit allocation and scale factor.
**** Relative to $\dot{\Omega}_{REF}$ = -2.6 x 10^{-9} semi-circles/second.

Redlines:

Parameter		No. of Bits**NOTE2	Scale Factor (LSB)	Valid Range***NOTE3	Units
t_{oe}	Ephemeris data reference time of week	11	300	0 to 604,500	seconds
Ω_{0-n}	Longitude of Ascending Node of Orbit Plane at Weekly Epoch	33*NOTE1	2^{-32}		semi-circles
$\Delta\dot{\Omega}$****	Rate of right ascension difference NOTE4	17*NOTE1	2^{-44}		semi-circles/sec
i_{0-n}	Inclination angle at reference time	33*NOTE1	2^{-32}		semi-circles
IDOT	Rate of inclination angle	15*NOTE1	2^{-44}		semi-circles/sec
C_{is-n}	Amplitude of the sine harmonic correction term to the angle of inclination	16*NOTE1	2^{-30}		radians
C_{ic-n}	Amplitude of the cosine harmonic correction term to the angle of inclination	16*NOTE1	2^{-30}		radians
C_{rs-n}	Amplitude of the sine correction term to the orbit radius	24*NOTE1	2^{-8}		meters
C_{rc-n}	Amplitude of the cosine correction term to the orbit radius	24*NOTE1	2^{-8}		meters
C_{us-n}	Amplitude of the sine harmonic correction term to the argument of latitude	21*NOTE1	2^{-30}		radians
C_{uc-n}	Amplitude of the cosine harmonic correction term to the argument of latitude	21*NOTE1	2^{-30}		radians

NOTE1:* Parameters so indicated are two's complement, with the sign bit (+ or -) occupying the MSB

NOTE2:** See Figure 30-1 and Figure 30-2 for complete bit allocation in Message Types 10 and 11

NOTE3:*** Unless otherwise indicated in this column, valid range is the maximum range attainable with indicated bit allocation and scale factor

NOTE4:**** Relative to $\dot{\Omega}_{REF} = -2.6 \times 10^{-9}$ semi-circles/second

IS:

Parameter		No. of Bits^NOTE2	Scale Factor (LSB)	Valid Range^NOTE3	Units
t_{oe}	Ephemeris data reference time of week	11	300	0 to 604,500	seconds
$\Omega_{0\text{-}n}$	Longitude of Ascending Node of Orbit Plane at Weekly Epoch	33^NOTE1	2^{-32}		semi-circles
$\Delta\dot{\Omega}$	Rate of right ascension difference^NOTE4	17^NOTE1	2^{-44}		semi-circles/sec
$i_{0\text{-}n}$	Inclination angle at reference time	33^NOTE1	2^{-32}		semi-circles
IDOT	Rate of inclination angle	15^NOTE1	2^{-44}		semi-circles/sec
$C_{is\text{-}n}$	Amplitude of the sine harmonic correction term to the angle of inclination	16^NOTE1	2^{-30}		radians
$C_{ic\text{-}n}$	Amplitude of the cosine harmonic correction term to the angle of inclination	16^NOTE1	2^{-30}		radians
$C_{rs\text{-}n}$	Amplitude of the sine correction term to the orbit radius	24^NOTE1	2^{-8}		meters
$C_{rc\text{-}n}$	Amplitude of the cosine correction term to the orbit radius	24^NOTE1	2^{-8}		meters
$C_{us\text{-}n}$	Amplitude of the sine harmonic correction term to the argument of latitude	21^NOTE1	2^{-30}		radians
$C_{uc\text{-}n}$	Amplitude of the cosine harmonic correction term to the argument of latitude	21^NOTE1	2^{-30}		radians

NOTE1: Parameters so indicated are two's complement, with the sign bit (+ or -) occupying the MSB
NOTE2: See Figure 30-1 and Figure 30-2 for complete bit allocation in Message Types 10 and 11
NOTE3: Unless otherwise indicated in this column, valid range is the maximum range attainable with indicated bit allocation and scale factor
NOTE4: Relative to $\dot{\Omega}_{REF} = -2.6 \times 10^{-9}$ semi-circles/second

Rationale:
8/21/2025: At TIM #1, SMEs asked for NOTE identifiers to replace asterisks (T. Anthony)
8/21/2025: Converted the exponential notation to CSE Manual standard. (T. Anthony)
PRAT 2020-03 8/5/2025 Normalize the use of scientific notation across the public GPS interface documents. (T. Anthony)

IS200-554:

Section Number:
30.3.3.1.3.0-9

WAS:

Element/Equation	Description
μ = 3.986005 x 10^{14} meters^3/sec^2	WGS 84 value of the earth's gravitational constant for GPS user
$\dot{\Omega}_e$ = 7.2921151467 x 10^{-5} rad/sec	WGS 84 value of the earth's rotation rate
$A_0 = A_{REF} + \Delta A$ *	Semi-Major Axis at reference time
$A_k = A_0 + (\dot{A})\, t_k$	Semi-Major Axis
$n_0 = \sqrt{\frac{\mu}{A_0^{\,3}}}$	Computed Mean Motion (rad/sec)
$t_k = t - t_{oe}$ **	Time from ephemeris reference time
$\Delta n_A = \Delta n_0 + \frac{1}{2} \Delta \dot{n}_0\, t_k$	Mean motion difference from computed value
$n_A = n_0 + \Delta n_A$	Corrected Mean Motion
$M_k = M_0 + n_A\, t_k$	Mean Anomaly
	Kepler's equation ($M_k = E_k - e \sin E_k$) may be solved for Eccentric Anomaly (E_k) by iteration:
$E_0 = M_k$	– Initial Value (radians)
$E_j = E_{j-1} + \frac{M_k - E_{j-1} + e \sin \quad {}_{j-1}}{1 - e\, \mathrm{co} \quad {}_{j-1}}$	– Refined Value, minimum of three iterations, (j=1,2,3)
$E_k = E_j$	–Final Value (radians)
$\nu_k = 2 \tan^{-1} \left(\sqrt{\frac{1+e}{1-e}} \tan \frac{E_k}{2} \right)$	True Anomaly (unambiguous quadrant)

* A_{REF} = 26,559,710 meters

** **t** is GPS system time at time of transmission, i.e., GPS time corrected for transit time (range/speed of light). Furthermore, t_k shall be the actual total difference between the time **t** and the epoch time t_{oe}, and must account for beginning or end of week crossovers. That is if t_k is greater than 302,400 seconds, subtract 604,800 seconds from t_k. If t_k is less than -302,400 seconds, add 604,800 seconds to t_k.

Redlines:

Element/Equation	**Description**
$\mu = 3.986005 \times x\ 10^{+14}$ meters³/sec²	WGS 84 value of the earth's gravitational constant for GPS user
$\dot{\Omega}_e = 7.2921151467 \times x\ 10^{-5}$ rad/sec	WGS 84 value of the earth's rotation rate
$A_0 = A_{REF} + \Delta A$ NOTE1*	Semi-Major Axis at reference time NOTE1
$n_0 = \sqrt{\frac{\mu}{A_0^3}}$	Computed Mean Motion at reference time (rad/sec)
$t_k = t - t_{oe}$	Time from ephemeris reference time NOTE2
$A_k = A_0 + (\dot{A})\ t_k$	Semi-Major Axis
$t_k = t - t_{oe}$ **	Time from ephemeris reference time
$\Delta n_A = \Delta n_0 + ½\ \Delta \dot{n}_0\ t_k$	Mean motion difference from computed value
$n_A = n_0 + \Delta n_A$	Corrected Mean Motion
$n'_0 = n_0 + \Delta n_0$	Corrected Mean Motion at reference time
$n_k = n'_0 + \Delta \dot{n}_0\ t_k$	Mean Motion
$M_k = M_0 + \int_{t_{oe}}^{t} n_k\ dt = M_0 + n'_0\ t_k + \Delta \dot{n}_0\ t_k^2/2$ $M_k = M_0 + n_A\ t_k$	Mean Anomaly
Kepler's equation ($M_k = E_k - e \sin E_k$) may be solved for Eccentric Anomaly (E_k) by iteration	
$E_0 = M_k$	– Initial Value (radians)
$E_j = E_{j-1} + \frac{M_k - E_{j-1} + e \sin E_{j-1}}{1 - e \cos E_{j-1}}$	– Refined Value, minimum of three iterations, (j=1,2,3)
$E_k = E_j$	– Final Value (radians
$\nu_k = 2 \tan^{-1}\left(\sqrt{\frac{1+e}{1-e}} \tan\left(\frac{E_k}{2}\right)\right)$	True Anomaly (unambiguous quadrant)

NOTE1: * A_{REF} = 26,559,710 meters NOTE2: ** **t** is GPS system time at time of transmission, i.e., GPS time corrected for transit time (range/speed of light). Furthermore, t_k shall be the actual total difference between the time **t** and the epoch time t_{oe}, and must account for beginning or end of week crossovers. That is if t_k is greater than 302,400 seconds, subtract 604,800 seconds from t_k. If t_k is less than -302,400 seconds, add 604,800 seconds to t_k.

IS:

Element/Equation	Description
$\mu = 3.986005 \times 10^{+14}$ meters^3/sec^2	WGS 84 value of the earth's gravitational constant for GPS user
$\dot{\Omega}_e = 7.2921151467 \times 10^{-5}$ rad/sec	WGS 84 value of the earth's rotation rate
$A_0 = A_{REF} + \Delta A$	Semi-Major Axis at reference time^{NOTE1}
$n_0 = \sqrt{\frac{m}{{A_0}^3}}$	Computed Mean Motion at reference time(rad/sec)
$t_k = t - t_{oe}$	Time from ephemeris reference time^{NOTE2}
$A_k = A_0 + (\dot{A})\, t_k$	Semi-Major Axis
$n'_0 = n_0 + \Delta n_0$	Corrected Mean Motion at reference time
$n_k = n'_0 + \Delta\dot{n}_0\, t_k$	Mean Motion
$M_k = M_0 + \int_{t_{oe}}^{t} n_k\, dt$ $= M_0 + n'_0\, t_k + \Delta\dot{n}_0\, t_k^2/2$	Mean Anomaly
Kepler's equation ($M_k = E_k - e \sin E_k$) may be solved for Eccentric Anomaly (E_k) by iteration	
$E_0 = M_k$	– Initial Value (radians)
$E_j = E_{j-1} + \frac{M_k - E_{j-1} + e\, sinE_{j-1}}{1 - e \cos E_{j-1}}$	– Refined Value, minimum of three iterations, (j=1,2,3)
$E_k = E_j$	– Final Value (radians
$v_k = 2\, tan^{-1}\left(\sqrt{\frac{1+e}{1-e}}\tan\left(\frac{E_k}{2}\right)\right)$	True Anomaly (unambiguous quadrant)
NOTE1: A_{REF} = 26,559,710 meters NOTE2: **t** is GPS system time at time of transmission, i.e., GPS time corrected for transit time (range/speed of light). Furthermore, t_k shall be the actual total difference between the time **t** and the epoch time t_{oe}, and must account for beginning or end of week crossovers. That is if t_k is greater than 302,400 seconds, subtract 604,800 seconds from t_k. If t_k is less than -302,400 seconds, add 604,800 seconds to t_k.	

Rationale:
8/21/2025: At TIM #1, SMEs asked for NOTE identifiers to replace asterisks (T. Anthony)
8/21/2025: Converted the exponential notation to CSE Manual standard. (T. Anthony)
8/19/2025: Mean Motion equation correction from delta-n-dot sub k to delta-n-dot sub 0 (T. Anthony)
PRAT 2025-02, Pre-RFC-1445 8/5/2025 Responds to Eccentric Anomaly Rate Fix. (T. Anthony)
Replaced Mean Motion difference from computed value and Corrected Mean Motion with Corrected Mean Motion at reference time and Mean Motion.
Also replace the Mean Anomaly equation.

IS200-555:

Section Number:
30.3.3.1.3.0-11

WAS:

Element/Equation *	Description
$\Phi_k = \nu_k + \omega_n$	Argument of Latitude
$\delta u_k = C_{us-n}\sin 2\Phi_k + C_{uc-n}\cos 2\Phi_k$	Argument of Latitude Correction (Second Harmonic Perturbations)
$\delta r_k = C_{rs-n}\sin 2\Phi_k + C_{rc-n}\cos 2\Phi_k$	Radial Correction (Second Harmonic Perturbations)
$\delta i_k = C_{is-n}\sin 2\Phi_k + C_{ic-n}\cos 2\Phi_k$	Inclination Correction (Second Harmonic Perturbations)
$u_k = \Phi_k + \delta u_k$	Corrected Argument of Latitude
$r_k = A_k(1 - e_n \cos E_k) + \delta r_k$	Corrected Radius
$i_k = i_{o-n} + (IDOT)t_k + \delta i_k$	Corrected Inclination
$x_k' = r_k \cos u_k$ $y_k' = r_k \sin u_k$	Positions in orbital plane
$\dot{\Omega} = \dot{\Omega}_{REF} + \Delta\dot{\Omega}$ ***	Rate of Right Ascension
$\Omega_k = \Omega_{0-n} + (\dot{\Omega} - \dot{\Omega}_e)\, t_k - \dot{\Omega}_e\, t_{oe}$	Corrected Longitude of Ascending Node
$x_k = x_k' \cos\Omega_k - y_k' \cos i_k \sin\Omega_k$ $y_k = x_k' \sin\Omega_k + y_k' \cos i_k \cos\Omega_k$ $z_k = y_k' \sin i_k$	Earth-fixed coordinates of SV antenna phase center
*** $\dot{\Omega}_{REF} = -2.6 \times 10^{-9}$ semi-circles/second.	

Redlines:

Element/Equation *	Description
$\Phi_k = \nu_k + \omega_n$	Argument of Latitude
$\delta u_k = C_{us\text{-}n} \sin 2\Phi_k + C_{uc\text{-}n} \cos 2\Phi_k$	Argument of Latitude Correction (Second Harmonic Perturbations)
$\delta r_k = C_{rs\text{-}n} \sin 2\Phi_k + C_{rc\text{-}n} \cos 2\Phi_k$	Radial Correction (Second Harmonic Perturbations)
$\delta i_k = C_{is\text{-}n} \sin 2\Phi_k + C_{ic\text{-}n} \cos 2\Phi_k$	Inclination Correction (Second Harmonic Perturbations)
$u_k = \Phi_k + \delta u_k$	Corrected Argument of Latitude
$r_k = A_k(1 - e_n \cos E_k) + \delta r_k$	Corrected Radius
$i_k = i_{o\text{-}n} + (IDOT)\, t_k + \delta i_k$	Corrected Inclination
$x_k' = r_k \cos u_k$ $y_k' = r_k \sin u_k$	Positions in orbital plane
$\dot{\Omega} = \dot{\Omega}_{REF} + \Delta\dot{\Omega}$ ***	Rate of Right Ascension NOTE3
$\Omega_k = \Omega_{0\text{-}n} + (\Omega - \Omega_e)\, t_k - \Omega_e t_{oe}$	Corrected Longitude of Ascending Node
$x_k = x_k' \cos \Omega_k - y_k' \cos i_k \sin \Omega_k$ $y_k = x_k' \sin \Omega_k + y_k' \cos i_k \cos \Omega_k$ $z_k = y_k' \sin i_k$	Earth-fixed coordinates of SV antenna phase center
NOTE3:*** $\dot{\Omega}_{REF} = -2.6 \times 10^{-9}$ semi-circles/second	

IS:

Element/Equation	Description
$\Phi_k = \nu_k + \omega_n$	Argument of Latitude
$\delta u_k = C_{us\text{-}n} \sin 2\Phi_k + C_{uc\text{-}n} \cos 2\Phi_k$	Argument of Latitude Correction (Second Harmonic Perturbations)
$\delta r_k = C_{rs\text{-}n} \sin 2\Phi_k + C_{rc\text{-}n} \cos 2\Phi_k$	Radial Correction (Second Harmonic Perturbations)
$\delta i_k = C_{is\text{-}n} \sin 2\Phi_k + C_{ic\text{-}n} \cos 2\Phi_k$	Inclination Correction (Second Harmonic Perturbations)
$u_k = \Phi_k + \delta u_k$	Corrected Argument of Latitude
$r_k = A_k(1 - e_n \cos E_k) + \delta r_k$	Corrected Radius
$i_k = i_{o\text{-}n} + (IDOT)\, t_k + \delta i_k$	Corrected Inclination
$x_k' = r_k \cos u_k$ $y_k' = r_k \sin u_k$	Positions in orbital plane
$\dot{\Omega} = \dot{\Omega}_{REF} + \Delta\dot{\Omega}$	Rate of Right Ascension[NOTE3]
$\Omega_k = \Omega_{0\text{-}n} + (\Omega - \Omega_e)\, t_k - \Omega_e t_{oe}$	Corrected Longitude of Ascending Node
$x_k = x_k' \cos \Omega_k - y_k' \cos i_k \sin \Omega_k$ $y_k = x_k' \sin \Omega_k + y_k' \cos i_k \cos \Omega_k$ $z_k = y_k' \sin i_k$	Earth-fixed coordinates of SV antenna phase center
NOTE3: $\dot{\Omega}_{REF} = -2.6 \times 10^{-9}$ semi-circles/second	

Rationale:
8/21/2025: At TIM #1, SMEs asked for NOTE identifiers to replace asterisks (T. Anthony)
8/21/2025: Converted the exponential notation to CSE Manual standard. (T. Anthony)
PRAT 2020-03 8/5/2025 Normalize the use of scientific notation across the public GPS interface documents. (T. Anthony)

IS200-1729:

Section Number:
30.3.3.1.3.0-12

WAS:
Table 30-II.	Broadcast Navigation User Equations (sheet 3 of 4)

Redlines:
Table 30-II. Broadcast Navigation User Equations (sheet 3 of 4)

IS:
Table 30-II. Broadcast Navigation User Equations (sheet 3 of 4)

Rationale:
8/2/2025 Replace the tab with a space inside "30 – II" which is the convention across the Interface Specifications and ICDs. (T. Anthony)

IS200-1730:

Section Number:
30.3.3.1.3.0-13

WAS:

Element/Equation	Description
<u>SV Velocity</u>	
$\dot{E}_k = n / (1 - e \cos E_k)$	Eccentric Anomaly Rate
$\dot{v}_k = \dot{E}_k \sqrt{1-e^2} / (1 - e \cos E_k)$	True Anomaly Rate
$(di_k / dt) = (\text{IDOT}) + 2\, \dot{v}_k (c_{is} \cos 2\phi_k - c_{ic} \sin 2\phi_k)$	Corrected Inclination Angle Rate
$\dot{u}_k = \dot{v}_k + 2\dot{v}_k (c_{us} \cos 2\phi_k - c_{uc} \sin 2\phi_k)$	Corrected Argument of Latitude Rat
$\dot{r}_k = \dot{A}(1 - e \cos(E_k)) + A\, e \sin(E_k)\, \dot{E}_k + 2(c_{rs} \cos(2\phi_k) - c_{rc} \sin(2\phi_k))\, \dot{v}_k$	Corrected Radius Rate for CNAV
$\dot{\Omega}_k = \dot{\Omega} - \dot{\Omega}_e$	Longitude of Ascending Node Rate
$\dot{x}'_k = \dot{r}_k \cos u_k - r_k \dot{u}_k \sin u_k$	In- plane x velocity
$\dot{y}'_k = \dot{r}_k \sin u_k + r_k \dot{u}_k \cos u_k$	In- plane y velocity
$\dot{x}_k = -x'_k\, \dot{\Omega}_k \sin \Omega_k + \dot{x}'_k \cos \Omega_k - \dot{y}'_k \sin \Omega_k \cos i_k - y'_k(\dot{\Omega}_k \cos \Omega_k \cos i_k - (di_k / dt) \sin \Omega_k \sin i_k)$	Earth- Fixed x velocity (m/s)
$\dot{y}_k = x'_k\, \dot{\Omega}_k \cos \Omega_k + \dot{x}'_k \sin \Omega_k + \dot{y}'_k \cos \Omega_k \cos i_k - y'_k(\dot{\Omega}_k \sin \Omega_k \cos i_k + (di_k / dt) \cos \Omega_k \sin i_k)$	Earth- Fixed y velocity (m/s)
$\dot{z}_k = \dot{y}'_k \sin i_k + y'_k\, (di_k / dt) \cos i_k$	Earth- Fixed z velocity (m/s)

Redlines:

Element/Equation	Description
SV Velocity	
$\dot{E}_k = \dfrac{n_k}{1 - e\cos E_k}$	Eccentric Anomaly Rate
$\dot{v}_k = \dot{E}_k \sqrt{1-e^2}/(1 - e\cos E_k)$	True Anomaly Rate
$(di_k / dt) = (IDOT) + 2\,\dot{v}_k\,(eC_{is}\cos 2\phi_k - eC_{ic}\sin 2\phi_k)$	Corrected Inclination Angle Rate
$\dot{u}_k = \dot{v}_k + 2\dot{v}_k\,(eC_{us}\cos 2\phi_k - eC_{uc}\sin 2\phi_k)$	Corrected Argument of Latitude Rat
$\dot{r}_k = \dot{A}(1\text{-}e\cos(E_k)) + A_k\, e\sin(E_k)\,\dot{E}_k + 2\,(eC_{rs}\cos(2\phi_k) - eC_{rc}\sin(2\phi_k))\,\dot{v}_k$	Corrected Radius Rate for CNAV
$\dot{\Omega}_k = \dot{\Omega} - \dot{\Omega}_e$	Longitude of Ascending Node Rate
$\dot{x}'_k = \dot{r}_k\cos u_k - r_k\,\dot{u}_k\sin u_k$	In- plane *x* velocity
$\dot{y}'_k = \dot{r}_k\sin u_k + r_k\,\dot{u}_k\cos u_k$	In- plane *y* velocity
$\dot{x}_k = -x'_k\,\dot{\Omega}_k\sin\Omega_k + \dot{x}'_k\cos\Omega_k - \dot{y}'_k\sin\Omega_k\cos i_k - y'_k(\dot{\Omega}_k\cos\Omega_k\cos i_k - (di_k/dt)\sin\Omega_k\sin i_k)$	Earth- Fixed *x* velocity (m/s)
$\dot{y}_k = x'_k\,\dot{\Omega}_k\cos\Omega_k + \dot{x}'_k\sin\Omega_k + \dot{y}'_k\cos\Omega_k\cos i_k - y'_k(\dot{\Omega}_k\sin\Omega_k\cos i_k + (di_k/dt)\cos\Omega_k\sin i_k)$	Earth- Fixed *y* velocity (m/s)
$\dot{z}_k = \dot{y}'_k\sin i_k + y'_k\,(di_k/dt)\cos i_k$	Earth- Fixed *z* velocity (m/s)

IS:

Element/Equation	Description
SV Velocity	
$\dot{E}_k = \frac{n_k}{1 - e \cos E_k}$	Eccentric Anomaly Rate
$\dot{v}_k = \dot{E}_k \sqrt{1 - e^2} / (1 - e \cos E_k)$	True Anomaly Rate
$(di_k / dt) = (\text{IDOT}) + 2\ \dot{v}_k (C_{is} \cos 2\phi_k - C_{ic} \sin 2\phi_k)$	Corrected Inclination Angle Rate
$\dot{u}_k = \dot{v}_k + 2\dot{v}_k (C_{us} \cos 2\phi_k - C_{uc} \sin 2\phi_k)$	Corrected Argument of Latitude Rat
$\dot{r}_k = \dot{A}(1 - e \cos(E_k)) + A_k\ e \sin(E_k)\ \dot{E}_k + 2\ (C_{rs} \cos(2\phi_k) - C_{rc} \sin(2\phi_k))\ \dot{v}_k$	Corrected Radius Rate for CNAV
$\dot{\Omega}_k = \dot{\Omega} - \dot{\Omega}_e$	Longitude of Ascending Node Rate
$\dot{x}'_k = \dot{r}_k \cos u_k - r_k \dot{u}_k \sin u_k$	In- plane *x* velocity
$\dot{y}'_k = \dot{r}_k \sin u_k + r_k \dot{u}_k \cos u_k$	In- plane *y* velocity
$\dot{x}_k = -x'_k\ \dot{\Omega}_k \sin \Omega_k + \dot{x}'_k \cos \Omega_k - \dot{y}'_k \sin \Omega_k \cos i_k - y'_k(\dot{\Omega}_k \cos \Omega_k \cos i_k - (di_k / dt) \sin \Omega_k \sin i_k)$	Earth- Fixed *x* velocity (m/s)
$\dot{y}_k = x'_k\ \dot{\Omega}_k \cos \Omega_k + \dot{x}'_k \sin \Omega_k + \dot{y}'_k \cos \Omega_k \cos i_k - y'_k(\dot{\Omega}_k \sin \Omega_k \cos i_k + (di_k / dt) \cos \Omega_k \sin i_k)$	Earth- Fixed *y* velocity (m/s)
$\dot{z}_k = \dot{y}'_k \sin i_k + y'_k\ (di_k / dt) \cos i_k$	Earth- Fixed *z* velocity (m/s)

Rationale:
Administrative Change: 9/11/2025 Capitalize the Cxx parameters and space out the multiplied terms for easier reading. (T. Anthony)
8/19/2025: Corrected Radius Rate for CNAV equation changed "A" to A-sub-k (T. Anthony)
PRAT 2025-02, Pre-RFC-1445 8/5/2025 Responds to Eccentric Anomaly Rate Fix. (T. Anthony)
Adjusted the Eccentric Anomaly Rate equation
PRAT 2020-03 8/5/2025 Normalize the use of scientific notation across the public GPS interface documents. (T. Anthony)

IS200-572:

Section Number:
30.3.3.2.4.0-3

WAS:
The user shall calculate the NED-related URA with the equation (in meters);
$IAURA_{NED} = URA_{NED0} + URA_{NED1} (t - t_{op} + 604,800*(WN - WN_{op}))$

for $t - t_{op} + 604,800*(WN - WN_{op}) \leq 93,600$ seconds

$IAURA_{NED} = URA_{NED0} + URA_{NED1}*(t - t_{op} + 604,800*(WN - WN_{op})) + URA_{NED2}*(t - t_{op} + 604,800*(WN - WN_{op}) - 93,600)^2$

for $t - t_{op} + 604,800*(WN - WN_{op}) > 93,600$ seconds

where

t is the GPS system time

Redlines:
The user shall calculate the NED-related URA with the equation (in meters);

nominal URA_{NED} = nominal URA_{NED0}

$IAURA_{NED}$ = Upper Bound $URA_{NED0} + URA_{NED1} (t - t_{op} + 604,800* (WN - WN_{op}))$

for $t - t_{op} + 604,800* (WN - WN_{op}) \leq 93,600$ seconds

$IAURA_{NED}$ = Upper Bound $URA_{NED0} + URA_{NED1}* (t - t_{op} + 604,800* (WN - WN_{op})) + URA_{NED2}* (t - t_{op} + 604,800* (WN - WN_{op}) - 93,600)2$

for $t - t_{op} + 604,800* (WN - WN_{op}) > 93,600$ seconds

where

t is the GPS system time

IS:
The user shall calculate the NED-related URA with the equation (in meters);

nominal URA_{NED} = nominal URA_{NED0}

$IAURA_{NED}$ = Upper Bound URA_{NED0} + URA_{NED1} $(t - t_{op} + 604{,}800\ (WN - WN_{op}))$

for $t - t_{op} + 604{,}800\ (WN - WN_{op}) \leq 93{,}600$ seconds

$IAURA_{NED}$ = Upper Bound URA_{NED0} + URA_{NED1} $(t - t_{op} + 604{,}800\ (WN - WN_{op}))$ + URA_{NED2} $(t - t_{op} + 604{,}800\ (WN - WN_{op}) - 93{,}600)^2$

for $t - t_{op} + 604{,}800\ (WN - WN_{op}) > 93{,}600$ seconds

where

t is the GPS system time

Rationale:
8/5/2025 Normalize the notation for scalar value multiply, use only implied multiply. (T. Anthony)
This update assumes RFC-519 is eventually approved

IS200-610:

Section Number:
30.3.3.4.6.2.1.0-3

WAS:

Parameter	No. of Bits**	Scale Factor (LSB)	Valid Range***	Units
t_{oa}	8	2^{12}	0 to 602,112	seconds
e	11	2^{-16}	0.0 to 0.03	dimensionless
δ_i****	11*	2^{-14}		semi-circles
$\dot{\Omega}$	11*	2^{-33}	-1.19E-07 to 0	semi-circles/sec
$\sqrt{A}$	17	2^{-4}	2530 to 8192	$\sqrt{\text{meters}}$
Ω_0	16*	2^{-15}		semi-circles
ω	16*	2^{-15}		semi-circles
M_0	16*	2^{-15}		semi-circles
a_{f0}	11*	2^{-20}		seconds
a_{f1}	10*	2^{-37}		sec/sec

* Parameters so indicated shall be two's complement with the sign bit (+ or -) occupying the MSB;

** See Figure 30-10 for complete bit allocation in Message Type 37;

*** Unless otherwise indicated in this column, valid range is the maximum range attainable with indicated bit allocation and scale factor;

**** Relative to i_0 = 0.30 semi-circles.

Redlines:

Parameter	No. of Bits**NOTE2	Scale Factor (LSB)	Valid Range***NOTE3	Units
t_{oa}	8	2^{12}	0 to 602,112	seconds
e	11	2^{-16}	0.0 to 0.03	dimensionless
δ_i****NOTE4	11*NOTE1	2^{-14}		semi-circles
$\dot{\Omega}$	11*NOTE1	2^{-33}	-1.19 × 10^{-7}E-7 to 0	semi-circles/sec
$\sqrt{A}$	17	2^{-4}	2530 to 8192	$\sqrt{\text{meters}}$
Ω_0	16*NOTE1	2^{-15}		semi-circles
ω	16*NOTE1	2^{-15}		semi-circles
M_0	16*NOTE1	2^{-15}		semi-circles
a_{f0}	11*NOTE1	2^{-20}		seconds
a_{f1}	10*NOTE1	2^{-37}		sec/sec

NOTE1:* Parameters so indicated shall be two's complement with the sign bit (+ or -) occupying the MSB;

NOTE2:** See Figure 30-10 for complete bit allocation in message type 37;

NOTE3:*** Unless otherwise indicated in this column, valid range is the maximum range attainable with indicated bit allocation and scale factor;

NOTE4:**** Relative to i_0 = 0.30 semi-circles.

IS:

Parameter	No. of Bits[NOTE2]	Scale Factor (LSB)	Valid Range[NOTE3]	Units
t_{oa}	8	2^{12}	0 to 602,112	seconds
e	11	2^{-16}	0.0 to 0.03	dimensionless
δ_i[NOTE4]	11[NOTE1]	2^{-14}		semi-circles
$\dot{\Omega}$	11[NOTE1]	2^{-33}	-1.19×10^{-7} to 0	semi-circles/sec
$\sqrt{A}$	17	2^{-4}	2530 to 8192	$\sqrt{\text{meters}}$
Ω_0	16[NOTE1]	2^{-15}		semi-circles
ω	16[NOTE1]	2^{-15}		semi-circles
M_0	16[NOTE1]	2^{-15}		semi-circles
a_{f0}	11[NOTE1]	2^{-20}		seconds
a_{f1}	10[NOTE1]	2^{-37}		sec/sec

NOTE1: Parameters so indicated shall be two's complement with the sign bit (+ or -) occupying the MSB

NOTE2: See Figure 30-10 for complete bit allocation in message type 37

NOTE3: Unless otherwise indicated in this column, valid range is the maximum range attainable with indicated bit allocation and scale factor

NOTE4: Relative to i_0 = 0.30 semi-circles

Rationale:
8/27/2025: Converted the exponential notation to CSE Manual standard. (T. Anthony)
8/27/2025: At TIM #1, SMEs asked for NOTE identifiers to replace asterisks (T. Anthony)

IS200-1617:

Section Number:
30.3.3.4.6.2.1.0-6

WAS:
Table 30-VI. Reduced Almanac Parameters *****

Redlines:
Table 30-VI. Reduced Almanac Parameters ~~*****~~NOTE5

IS:
Table 30-VI. Reduced Almanac Parameters NOTE5

Rationale:
8/28/2025 Caught up in the transition of asterisk notes to NOTEn (T. Anthony)

IS200-612:

Section Number:
30.3.3.4.6.2.1.0-7

WAS:

Parameter	No. of Bits	Scale Factor (LSB)	Valid Range **	Units
δ_A ***	8 *	2^{+9}	**	meters
Ω_0	7 *	2^{-6}	**	semi-circles
Φ_0 ****	7 *	2^{-6}	**	semi-circles

* Parameters so indicated shall be two's complement with the sign bit (+ or -) occupying the MSB;

** Valid range is the maximum range attainable with indicated bit allocation and scale factor;

*** Relative to A_{ref} = 26,559,710 meters;

**** Φ_0 = Argument of Latitude at Reference Time = $M_0 + \omega$;

***** Relative to following reference values:
e = 0
δ_i = +0.0056 semi-circles (i = 55 degrees)
$\dot{\Omega}$ = -2.6 x 10^{-9} semi-circles/second.

Redlines:

Parameter	No. of Bits NOTE1	Scale Factor (LSB)	Valid Range NOTE2	Units
δ_A NOTE3***	8 *	2^{+9}	— **	meters
Ω_0	7 *	2^{-6}	— **	semi-circles
Φ_0 NOTE4****	7 *	2^{-6}	— **	semi-circles

NOTE1:* Parameters so indicated shall be two's complement with the sign bit (+ or -) occupying the MSB;

NOTE2:** Valid range is the maximum range attainable with indicated bit allocation and scale factor;

NOTE3:*** Relative to A_{ref} = 26,559,710 meters;

NOTE4:**** Φ_0 = Argument of Latitude at Reference Time = $M_0 + \omega$;

NOTE5:***** Relative to following reference values:
e = 0
δ_i = +0.0056 semi-circles (i = 55 degrees)
$\dot{\Omega}$ = -2.6- ×x 10^{-9} semi-circles/second.

IS:

Parameter	No. of Bits[NOTE1]	Scale Factor (LSB)	Valid Range[NOTE2]	Units
δ_A NOTE3	8	2^{+9}	—	meters
Ω_0	7	2^{-6}	—	semi-circles
Φ_0 NOTE4	7	2^{-6}	—	semi-circles

NOTE1: Parameters so indicated shall be two's complement with the sign bit (+ or -) occupying the MSB;

NOTE2: Valid range is the maximum range attainable with indicated bit allocation and scale factor;

NOTE3: Relative to A_{ref} = 26,559,710 meters;

NOTE4: Φ_0 = Argument of Latitude at Reference Time = $M_0 + \omega$;

NOTE5: Relative to following reference values:
$e = 0$
δ_i = +0.0056 semi-circles (i = 55 degrees)
$\dot{\Omega} = -2.6 \times 10^{-9}$ semi-circles/second.

Rationale:
8/21/2025: At TIM #1, SMEs asked for NOTE identifiers to replace asterisks (T. Anthony)
8/21/2025: Converted the exponential notation to CSE Manual standard. (T. Anthony)
PRAT 2020-03 8/5/2025 Normalize the use of scientific notation across the public GPS interface documents. (T. Anthony)

IS200-623:

Section Number:
30.3.3.5.1.1.0-8

WAS:

Element/Equation		Description
$t_{diff} = (t - t_{EOP} + 604800(WN - WN_{ot}))$	[seconds]	Compute difference between GPS time and EOP reference time
$UT1 = t + 604800*WN + \Delta UTGPS + \Delta \dot{U}TGPS*t_{diff}/86400$	[seconds]	Compute UT1 at GPS time
$x_p = PM\_X + P\dot{M}\_X*t_{diff}/86400$	[arc-seconds]	Polar Motion in the x-axis
$y_p = PM\_Y + P\dot{M}\_Y*t_{diff}/86400$	[arc-seconds]	Polar Motion in the y-axis
GPS system time (t) is expressed in seconds since start of current GPS week, and WN is the current week number expressed in number of weeks since GPS epoch. The divisor 86400 converts rates per day to rates per second.		

Redlines:

Element/Equation	Units	Description
$t_{diff} = (t - t_{EOP} + 604,800(WN - WN_{ot}))$	seconds	Compute difference between GPS time and EOP reference time
$UT1 = t + 604,800*WN + \Delta UTGPS + \Delta UT\dot{G}PS*t_{diff}/86,400$	seconds	Compute UT1 at GPS time
$x_p = PM\_X + P\dot{M}\_X*t_{diff}/86,400$	arc-seconds	Polar Motion in the x-axis
$y_p = PM\_Y + P\dot{M}\_Y*t_{diff}/86,400$	arc-seconds	Polar Motion in the y-axis
GPS system time (t) is expressed in seconds since start of current GPS week, and WN is the current week number expressed in number of weeks since GPS epoch. The divisor 86,400 converts rates per day to rates per second.		

IS:

Element/Equation	Units	Description
$t_{diff} = (t - t_{EOP} + 604{,}800(WN - WN_{ot}))$	seconds	Compute difference between GPS time and EOP reference time
$UT1 = t + 604{,}800\ WN + \Delta UTGPS + \Delta UT\dot{G}PS\ t_{diff}/86{,}400$	seconds	Compute UT1 at GPS time
$x_p = PM\_X + P\dot{M}\_X\ t_{diff}/86{,}400$	arc-seconds	Polar Motion in the x-axis
$y_p = PM\_Y + P\dot{M}\_Y\ t_{diff}/86{,}400$	arc-seconds	Polar Motion in the y-axis
GPS system time (t) is expressed in seconds since start of current GPS week, and WN is the current week number expressed in number of weeks since GPS epoch. The divisor 86,400 converts rates per day to rates per second.		

Rationale:
8/5/2025 Normalize the notation for scalar value multiply, use only implied multiply. (T. Anthony)

IS200-654:

Section Number:
30.3.3.7.5.0-1

WAS:

The $UDRA_{op-D}$ and $\dot{UDRA}$ shall give the differential user range accuracy for the SV. It must be noted that the two parameters provide estimated accuracy after both clock and ephemeris DC are applied. The $UDRA_{op-D}$ and $\dot{UDRA}$ indices are signed, two's complement integers in the range of +15 to -16 and has the following relationship:

Index Value	$UDRA_{op-D}$ (meters)					$\dot{UDRA}$ (10^{-6} m/sec)	
15	6144.00	<	$UDRA_{op-D}$		6144.00		
14	3072.00	<	$UDRA_{op-D}$	≤	6144.00	3072.00	
13	1536.00	<	$UDRA_{op-D}$	≤	3072.00	1536.00	
12	768.00	<	$UDRA_{op-D}$	≤	1536.00	768.00	
11	384.00	<	$UDRA_{op-D}$	≤	768.00	384.00	
10	192.00	<	$UDRA_{op-D}$	≤	384.00	192.00	
9	96.00	<	$UDRA_{op-D}$	≤	192.00	96.00	
8	48.00	<	$UDRA_{op-D}$	≤	96.00	48.00	
7	24.00	<	$UDRA_{op-D}$	≤	48.00	24.00	
6	13.65	<	$UDRA_{op-D}$	≤	24.00	13.65	
5	9.65	<			$UDRA_{op-D}$ ≤	13.65	9.65
4	6.85	<			$UDRA_{op-D}$ ≤	9.65	6.85
3	4.85	<			$UDRA_{op-D}$ ≤	6.85	4.85
2	3.40	<			$UDRA_{op-D}$ ≤	4.85	3.40
1	2.40	<			$UDRA_{op-D}$ ≤	3.40	2.40
0	1.70	<			$UDRA_{op-D}$ ≤	2.40	1.70
-1	1.20	<			$UDRA_{op-D}$ ≤	1.70	1.20
-2	0.85	<			$UDRA_{op-D}$ ≤	1.20	0.85
-3	0.60	<			$UDRA_{op-D}$ ≤	0.85	0.60
-4	0.43	<			$UDRA_{op-D}$ ≤	0.60	0.43
-5	0.30	<			$UDRA_{op-D}$ ≤	0.43	0.30
-6	0.21	<			$UDRA_{op-D}$ ≤	0.30	0.21
-7	0.15	<			$UDRA_{op-D}$ ≤	0.21	0.15
-8	0.11	<			$UDRA_{op-D}$ ≤	0.15	0.11
-9	0.08	<			$UDRA_{op-D}$ ≤	0.11	0.08
-10	0.06	<			$UDRA_{op-D}$ ≤	0.08	0.06
-11	0.04	<			$UDRA_{op-D}$ ≤	0.06	0.04
-12	0.03	<			$UDRA_{op-D}$ ≤	0.04	0.03
-13	0.02	<			$UDRA_{op-D}$ ≤	0.03	0.02
-14	0.01	<			$UDRA_{op-D}$ ≤	0.02	0.01
-15					$UDRA_{op-D}$ ≤	0.01	0.005
-16					No accuracy prediction available—use at own risk		

For any time, t_k, other than t_{op-D}, UDRA is found by,

$$UDRA = UDRA_{op-D} + \dot{UDRA}(t_k - t_{op-D})$$

Redlines:

The $UDRA_{op-D}$ and $U\dot{D}RA$ shall give the differential user range accuracy for the SV. It must be noted that the two parameters provide estimated accuracy after both clock and ephemeris DC are applied. The $UDRA_{op-D}$ and $U\dot{D}RA$ indices are signed, two's complement integers in the range of +15 to -16 and has the following relationship:

Index Value	$UDRA_{op-D}$ (meters)					$U\dot{D}RA$ (1 × ~~x~~ 10^{-6} meters/sec)
15	6144.00	<	$UDRA_{op-D}$			6144.00
14	3072.00	<	$UDRA_{op-D}$	≤	6144.00	3072.00
13	1536.00	<	$UDRA_{op-D}$	≤	3072.00	1536.00
12	768.00	<	$UDRA_{op-D}$	≤	1536.00	768.00
11	384.00	<	$UDRA_{op-D}$	≤	768.00	384.00
10	192.00	<	$UDRA_{op-D}$	≤	384.00	192.00
9	96.00	<	$UDRA_{op-D}$	≤	192.00	96.00
8	48.00	<	$UDRA_{op-D}$	≤	96.00	48.00
7	24.00	<	$UDRA_{op-D}$	≤	48.00	24.00
6	13.65	<	$UDRA_{op-D}$	≤	24.00	13.65
5	9.65	<	$UDRA_{op-D}$	≤	13.65	9.65
4	6.85	<	$UDRA_{op-D}$	≤	9.65	6.85
3	4.85	<	$UDRA_{op-D}$	≤	6.85	4.85
2	3.40	<	$UDRA_{op-D}$	≤	4.85	3.40
1	2.40	<	$UDRA_{op-D}$	≤	3.40	2.40
0	1.70	<	$UDRA_{op-D}$	≤	2.40	1.70
-1	1.20	<	$UDRA_{op-D}$	≤	1.70	1.20
-2	0.85	<	$UDRA_{op-D}$	≤	1.20	0.85
-3	0.60	<	$UDRA_{op-D}$	≤	0.85	0.60
-4	0.43	<	$UDRA_{op-D}$	≤	0.60	0.43
-5	0.30	<	$UDRA_{op-D}$	≤	0.43	0.30
-6	0.21	<	$UDRA_{op-D}$	≤	0.30	0.21
-7	0.15	<	$UDRA_{op-D}$	≤	0.21	0.15
-8	0.11	<	$UDRA_{op-D}$	≤	0.15	0.11
-9	0.08	<	$UDRA_{op-D}$	≤	0.11	0.08
-10	0.06	<	$UDRA_{op-D}$	≤	0.08	0.06
-11	0.04	<	$UDRA_{op-D}$	≤	0.06	0.04
-12	0.03	<	$UDRA_{op-D}$	≤	0.04	0.03
-13	0.02	<	$UDRA_{op-D}$	≤	0.03	0.02
-14	0.01	<	$UDRA_{op-D}$	≤	0.02	0.01
-15			$UDRA_{op-D}$	≤	0.01	0.005
-16	No accuracy prediction available—use at own risk					

For any time, t_k, other than t_{op-D}, UDRA is found by,

$$UDRA = UDRA_{op-D} + U\dot{D}RA\,(t_k - t_{op-D})$$

IS:

The $UDRA_{op-D}$ and $U\dot{D}RA$ shall give the differential user range accuracy for the SV. It must be noted that the two parameters provide estimated accuracy after both clock and ephemeris DC are applied. The $UDRA_{op-D}$ and $U\dot{D}RA$ indices are signed, two's complement integers in the range of +15 to -16 and has the following relationship:

Index Value	$UDRA_{op-D}$ (meters)					$U\dot{D}RA$ (1×10^{-6} meters/sec)
15	6144.00	<	$UDRA_{op-D}$			6144.00
14	3072.00	<	$UDRA_{op-D}$	≤	6144.00	3072.00
13	1536.00	<	$UDRA_{op-D}$	≤	3072.00	1536.00
12	768.00	<	$UDRA_{op-D}$	≤	1536.00	768.00
11	384.00	<	$UDRA_{op-D}$	≤	768.00	384.00
10	192.00	<	$UDRA_{op-D}$	≤	384.00	192.00
9	96.00	<	$UDRA_{op-D}$	≤	192.00	96.00
8	48.00	<	$UDRA_{op-D}$	≤	96.00	48.00
7	24.00	<	$UDRA_{op-D}$	≤	48.00	24.00
6	13.65	<	$UDRA_{op-D}$	≤	24.00	13.65
5	9.65	<	$UDRA_{op-D}$	≤	13.65	9.65
4	6.85	<	$UDRA_{op-D}$	≤	9.65	6.85
3	4.85	<	$UDRA_{op-D}$	≤	6.85	4.85
2	3.40	<	$UDRA_{op-D}$	≤	4.85	3.40
1	2.40	<	$UDRA_{op-D}$	≤	3.40	2.40
0	1.70	<	$UDRA_{op-D}$	≤	2.40	1.70
-1	1.20	<	$UDRA_{op-D}$	≤	1.70	1.20
-2	0.85	<	$UDRA_{op-D}$	≤	1.20	0.85
-3	0.60	<	$UDRA_{op-D}$	≤	0.85	0.60
-4	0.43	<	$UDRA_{op-D}$	≤	0.60	0.43
-5	0.30	<	$UDRA_{op-D}$	≤	0.43	0.30
-6	0.21	<	$UDRA_{op-D}$	≤	0.30	0.21
-7	0.15	<	$UDRA_{op-D}$	≤	0.21	0.15
-8	0.11	<	$UDRA_{op-D}$	≤	0.15	0.11
-9	0.08	<	$UDRA_{op-D}$	≤	0.11	0.08
-10	0.06	<	$UDRA_{op-D}$	≤	0.08	0.06
-11	0.04	<	$UDRA_{op-D}$	≤	0.06	0.04
-12	0.03	<	$UDRA_{op-D}$	≤	0.04	0.03
-13	0.02	<	$UDRA_{op-D}$	≤	0.03	0.02
-14	0.01	<	$UDRA_{op-D}$	≤	0.02	0.01
-15			$UDRA_{op-D}$	≤	0.01	0.005
-16	No accuracy prediction available—use at own risk					

For any time, t_k, other than t_{op-D}, UDRA is found by,

$$UDRA = UDRA_{op-D} + U\dot{D}RA\,(t_k - t_{op-D})$$

Rationale:
8/21/2025: Converted the exponential notation to CSE Manual standard. (T. Anthony)
PRAT 2020-03 8/5/2025 Normalize the use of scientific notation across the public GPS interface documents. (T. Anthony)

IS200-674:

Section Number:
30.3.4.3.0-1

WAS:
The speed of light used by the CS for generating the data described in the above paragraphs is

$c = 2.99792458 \times 10^8$ meters per second

which is the official WGS 84 speed of light. The user shall use the same value for the speed of light in all computations.

Redlines:
The speed of light used by the CS for generating the data described in the above paragraphs is

c = ~~2.99792458 x~~299,792,458 ~~108~~ meters per second

which is the official WGS 84 speed of light. The user shall use the same value for the speed of light in all computations.

IS:
The speed of light used by the CS for generating the data described in the above paragraphs is

c = 299,792,458 meters per second

which is the official WGS 84 speed of light. The user shall use the same value for the speed of light in all computations.

Rationale:
PRAT 2020-03 8/5/2025 Normalize the use of scientific notation across the public GPS interface documents. (T. Anthony)

IS200-678:

Section Number:
30.3.5.1.0-1

WAS:
Twenty-four bits of CRC parity will provide protection against burst as well as random errors with a probability of undetected error ≤ $2^{-24} = 5.96 \times 10^{-8}$ for all channel bit error probabilities ≤ 0.5. The CRC word is calculated in the forward direction on a given message using a seed of 0. The sequence of 24 bits ($p_1,p_2,...,p_{24}$) is generated from the sequence of information bits ($m_1,m_2,...,m_{276}$) in a given message. This is done by means of a code that is generated by the polynomial

$$g(X) = \sum_{i=0}^{24} g_i X^i$$

where

$$g_i = 1 \quad \text{for} \quad i = 0,1,3,4,5,6,7,10,11,14,17,18,23,24$$
$$= 0 \quad \text{otherwise}$$

Redlines:
Twenty-four bits of CRC parity will provide protection against burst as well as random errors with a probability of undetected error £≤ 2-24 = 5.96´ × 10^{-8} for all channel bit error probabilities £≤ 0.5. The CRC word is calculated in the forward direction on a given message using a seed of 0. The sequence of 24 bits (p_1, p_2, ..., p_{24}) is generated from the sequence of information bits (m_1, m_2, ..., m_{276}) in a given message. This is done by means of a code that is generated by the polynomial

$$g(X) = \sum_{i=0}^{24} g_i X^i$$

gi = 1 for i = 0, 1, 3, 4, 5, 6, 7, 10, 11, 14, 17, 18, 23, 24
= 0 otherwise

IS:

Twenty-four bits of CRC parity will provide protection against burst as well as random errors with a probability of undetected error $\leq 2^{-24} = 5.96 \times 10^{-8}$ for all channel bit error probabilities ≤ 0.5. The CRC word is calculated in the forward direction on a given message using a seed of 0. The sequence of 24 bits ($p_1, p_2, ..., p_{24}$) is generated from the sequence of information bits ($m_1, m_2, ..., m_{276}$) in a given message. This is done by means of a code that is generated by the polynomial

$$g(X) = \sum_{i=0}^{24} g_i X^i$$

where

g_i = 1 for i = 0, 1, 3, 4, 5, 6, 7, 10, 11, 14, 17, 18, 23, 24
= 0 otherwise

Rationale:

8/21/2025: Converted the exponential notation to CSE Manual standard. (T. Anthony)
PRAT 2020-03 8/5/2025 Normalize the use of scientific notation across the public GPS interface documents. (T. Anthony)
Administrative fix 8/5/2025 Replaced less than or equal signs with Unicode characters (T. Anthony)

IS200-1981:

Section Number:
30.3.5.1.0-5

WAS:
This code has the following characteristics:

1) It detects all single bit errors per code word.

2) It detects all double bit error combinations in a codeword because the generator polynomial g(X) has a factor of at least three terms.

3) It detects any odd number of errors because g(X) contains a factor 1+X.

4) It detects any burst error for which the length of the burst is ≤ 24 bits.

5) It detects most large error bursts with length greater than the parity length r = 24 bits. The fraction of error bursts of length b > 24 that are undetected is:

a) $2^{-24} = 5.96 \times 10^{-8}$, if b > 25 bits.

b) $2^{-23} = 1.19 \times 10^{-7}$, if b = 25 bits.

Redlines:
This code has the following characteristics:

1) It detects all single bit errors per code word.

2) It detects all double bit error combinations in a codeword because the generator polynomial g(X) has a factor of at least three terms.

3) It detects any odd number of errors because g(X) contains a factor 1+X.

4) It detects any burst error for which the length of the burst is ~~£~~≤ 24 bits.

5) It detects most large error bursts with length greater than the parity length r = 24 bits. The fraction of error bursts of length b > 24 that are undetected is:

a) 2^{-24} = 5.96~~′~~ × 10^{-8}, if b > 25 bits~~.~~

b) 2^{-23} = 1.19~~′~~ × 10^{-7}, if b = 25 bits~~.~~

IS:
This code has the following characteristics:

1) It detects all single bit errors per code word.

2) It detects all double bit error combinations in a codeword because the generator polynomial g(X) has a factor of at least three terms.

3) It detects any odd number of errors because g(X) contains a factor 1+X.

4) It detects any burst error for which the length of the burst is ≤ 24 bits.

5) It detects most large error bursts with length greater than the parity length r = 24 bits. The fraction of error bursts of length b > 24 that are undetected is:

a) $2^{-24} = 5.96 \times 10^{-8}$, if b > 25 bits

b) $2^{-23} = 1.19 \times 10^{-7}$, if b = 25 bits

Rationale:
8/21/2025: Converted the exponential notation to CSE Manual standard. (T. Anthony)
PRAT 2020-03 8/5/2025 Normalize the use of scientific notation across the public GPS interface documents. (T. Anthony)

 # CP Status = 'In Review': 42

# of inserted requirements: 0
# of modified requirements: 9
# of deleted requirements: 0
# of TBDs: 0
# of TBRs: 0
of (added/modified) effectivities: 0
of VCRM additions: 0
# of VCRM modifications: 0
# of VCRM deletions: 0
# of descriptive texts: 18
of (added/modified) tables: 13
of (added/modified) figures: 2