CHANGE NOTICE

Affected Document:	IRN/SCN Number	Date:
IS-GPS-705 Rev J	XXX-XXXX-XXX	DD-MMM-YYYY
Authority:	**Proposed Change Notice**	**Date:**
RFC-000544	PCN_IS-705J_RFC544	30-SEP-2025

Document Title: NAVSTAR GPS Space Segment/Navigation User Segment L5 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)	

Interface Control Contractor:
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200 N. Pacific Coast Highway, Suite 1700
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CODE IDENT 66RP1

IS705-1686:

Section Number:
3.3.1.1.0-3

WAS:
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 I5 and Q5-code chipping rate of 10.23 MHz offset by a Δf = -4.5674E-3 Hz. This is equal to 10.2299999954326 MHz.

Redlines:
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~~4647 × 10^{-10}, equivalent to a change in the I5 and Q5-code chipping rate of 10.23 MHz offset by a Δf = -4.~~5674E~~5674 × 10^{-3} Hz. This is equal to 10.2299999954326 MHz.

IS:
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 $\Delta f/f = -4.4647 \times 10^{-10}$, equivalent to a change in the I5 and Q5-code chipping rate of 10.23 MHz offset by a $\Delta f = -4.5674 \times 10^{-3}$ Hz. This is equal to 10.2299999954326 MHz.

Rationale:
8/27/2025: Converted the exponential notation to CSE Manual standard. (T. Anthony)

IS705-1496:

Section Number:
6.1.0-1

WAS:

AFMC	-	Air Force Materiel Command
AFSPC	-	Air Force Space Command
ARAIM	-	Advanced Receiver Autonomous Integrity Monitoring
ASCII	-	American Standard Code for Information Interchange
bps	-	bits per second
BPSK	-	Bi-Phase Shift Key
C/A	-	Course/Acquisition
CDC	-	Clock Differential Correction
CEI	-	Clock, Ephemeris, Integrity
CNAV	-	Civil Navigation
CRC	-	Cyclic Redundancy Check
CS	-	Control Segment
dB	-	Decibel
dBc	-	Power ratio of a signal to a (unmodulated) carrier signal, expressed in decibels
dBi	-	Decibels with respect to isotropic antenna
dBW	-	Decibels with respect to 1 Watt
DC	-	Differential Correction
DoD	-	Department of Defense
ECEF	-	Earth-Centered, Earth-Fixed
ECI	-	Earth Centered Inertial
EDC	-	Ephemeris Differential Correction
EOL	-	End of Life
FEC	-	Forward Error Correction
GGTO	-	GPS/GNSS Time Offset
GNSS	-	Global Navigation Satellite System

GPS	-	Global Positioning System
GPSW	-	Global Positioning System Wing
Hz	-	Hertz
I5	-	In-phase Code on L5 Signal
ICC	-	Interface Control Contractor
ID	-	Identification
IODC	-	Issue of Data, Clock
IS	-	Interface Specification
ISC	-	Inter-Signal Correction
ISM	-	Integrity Support Message
LNAV	-	Legacy Navigation
LSB	-	Least Significant Bit
MSB	-	Most Significant Bit
MSO	-	Military Standard Order
NAV	-	Navigation
NSI5	-	Non-Standard I-Code
NSQ5	-	Non-Standard Q-Code
OCS	-	Operational Control System
PIRN	-	Proposed Interface Revision Notice
PRN	-	Pseudo-Random Noise
P(Y)	-	Precise (Anti-Spoof) Code
Q5	-	Quadraphase code on L5 Signal
RAIM	-	Receiver Autonomous Integrity Monitoring
RF	-	Radio Frequency
RHCP	-	Right Hand Circular Polarization
RMS	-	Root Mean Square
SBAS	-	Satellite Based Augmentation System
sps	-	Symbols per Second.

SIS	-	Signal In Space
SS	-	Space Segment
SSV	-	Space Service Volume
SV	-	Space Vehicle
TBD	-	To Be Determined
TBS	-	To Be Supplied
TOW	-	Time Of Week
TSO	-	Technical Standard Order
URA	-	User Range Accuracy
US	-	User Segment
USNO	-	US Naval Observatory
UTC	-	Coordinated Universal Time
WGS 84	-	World Geodetic System 1984
WN	-	Data Sequence Propagation Week Number
WN_e	-	Extended Week Number

Redlines:

AFMC	-	Air Force Materiel Command
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IS:

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URA	-	User Range Accuracy
US	-	User Segment
USNO	-	US Naval Observatory
UTC	-	Coordinated Universal Time

WGS 84	-	World Geodetic System 1984
WN	-	Week Number
WN_e	-	Extended Week Number

Rationale:
CRM #89 11/29/2022 Correct Parameter Name for WN is “Week Number” (T. Anthony)

IS705-1515:

Section Number:
6.2.8.0-1

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 t_{op} 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. The t_{op} term provides the epoch time of week of the state data utilized for the core CEI data set.

Rationale:
5/1/2023: CRM #68 With the re-engineering of CEI Parameter NOTEs, the correct NOTE here is now NOTE3. (T. Anthony)
3/7/2023: Changes to the Notes section of the CEI Parameters Table has caused NOTE1 in this paragraphs to be renumbered to NOTE2 (T. Anthony)

IS705-1524:

Section Number:
6.2.8.1.0-1

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 -- see 20.3.4.1. 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 -- see 20.3.4.1. 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 -- see 20.3.4.1. 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:
5/9/2023: CRM #45 Switching to NOTE3 after re-engineering the NOTES (T. Anthony)
5/9/2023: CRM #20 Change reference from the table being removed to 20.3.4.1 (T. Anthony)
3/7/2023: Changes to the Notes section of the CEI Parameters Table has caused NOTE1 in this paragraphs to be renumbered to NOTE2 (T. Anthony)

IS705-1521:

Section Number:
6.2.8.1-2

WAS:

Symbol	Parameter Name	Message
$\dot{A}$	Change Rate in Semi-major Axis	10
ΔA	Semi-major Axis Difference at Reference Time	10
Δn_0	Mean Motion Difference from Computed Value at Reference Time	10
$\Delta \dot{n}_0$	Rate of Mean Motion Difference from Computed Value	10
ω	Argument of Perigee	10
e	Eccentricity	10
ISF	Integrity Status Flag NOTE1	10
(L1/L2/L5)	Signal Health (3 bits)	10
M_0	Mean Anomaly at Reference Time	10
URA_{ED}	Elevation Dependent User Range Accuracy	10
WN	Week Number	10
t_{oe}	Time of Ephemeris	10, 11
t_{op}	CEI Data Sequence Propagation Time of Week	10, 30-37
$\Delta\dot{\Omega}$	Rate of Right Ascension Difference	11
Ω_0	Longitude of Ascending Node of Orbit Plane at Weekly Epoch	11
C_{ic}	Amplitude of the Cosine Harmonic Correction Term to the Angle of Inclination	11
C_{is}	Amplitude of the Sine Harmonic Correction Term to the Angle of Inclination	11
C_{rc}	Amplitude of the Cosine Harmonic Correction Term to the Orbit Radius	11
C_{rs}	Amplitude of the Sine Correction Term to the Orbit Radius	11
C_{uc}	Amplitude of Cosine Harmonic Correction Term to the Argument of Latitude	11
C_{us}	Amplitude of Sine Harmonic Correction Term to the Argument of Latitude	11
i_0	Inclination Angle at Reference Time	11
IDOT	Rate of Inclination Angle	11
$ISC_{L1C/A}$	Inter-signal Correction	30
ISC_{L2C}	Inter-signal Correction	30
ISC_{L5I5}	Inter-signal Correction	30
ISC_{L5Q5}	Inter-signal Correction	30
T_{GD}	Group Delay Differential	30

Symbol	**Parameter Name**	**Message**
WN_{OP}	CEI Data Sequence Propagation Week Number	30
a_{f0}	SV Clock Bias Correction Coefficient	30-37
a_{f1}	SV Clock Drift Correction Coefficient	30-37
a_{f2}	Drift Rate Correction Coefficient	30-37
t_{oc}	Time of Clock	30-37
URA_{NED0}	NED Accuracy Index	30-37
URA_{NED1}	NED Accuracy Change Index	30-37
URA_{NED2}	NED Accuracy Change Rate Index	30-37
Alert	Alert Flag^{NOTE1}	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}. Any parameter marked with NOTE1 may be changed with or without a change in t_{oe}/t_{oc}.		

Redlines:

Symbol	Parameter Name	Message
$\dot{A}$	Change Rate in Semi-major Axis	10
ΔA	Semi-major Axis Difference at Reference Time	10
Δn_0	Mean Motion Difference from Computed Value at Reference Time	10
$\Delta \dot{n}_0$	Rate of Mean Motion Difference from Computed Value	10
ω	Argument of Perigee	10
e	Eccentricity	10
ISF	Integrity Status Flag NOTE1	10
(L1/L2/L5)	Signal Health (3 bits)	10
M_0	Mean Anomaly at Reference Time	10
URA_{ED}	Elevation Dependent User Range Accuracy	10
WN	Week Number	10
t_{oe}	Time of Ephemeris	10, 11
t_{op}	CEI Data Sequence Propagation Time of Week	10, 30-37
$\Delta\dot{\Omega}$	Rate of Right Ascension Difference	11
Ω_0	Longitude of Ascending Node of Orbit Plane at Weekly Epoch	11
C_{ic}	Amplitude of the Cosine Harmonic Correction Term to the Angle of Inclination	11
C_{is}	Amplitude of the Sine Harmonic Correction Term to the Angle of Inclination	11
C_{rc}	Amplitude of the Cosine Harmonic Correction Term to the Orbit Radius	11
C_{rs}	Amplitude of the Sine Correction Term to the Orbit Radius	11
C_{uc}	Amplitude of Cosine Harmonic Correction Term to the Argument of Latitude	11
C_{us}	Amplitude of Sine Harmonic Correction Term to the Argument of Latitude	11
i_0	Inclination Angle at Reference Time	11
IDOT	Rate of Inclination Angle	11
$ISC_{L1C/A}$	Inter-signal Correction	30
ISC_{L2C}	Inter-signal Correction	30
ISC_{L5I5}	Inter-signal Correction	30
ISC_{L5Q5}	Inter-signal Correction	30
T_{GD}	Group Delay Differential	30
WN_{OP}	CEI Data Sequence Propagation Week Number	30
a_{f0}	SV Clock Bias Correction Coefficient	30-37
a_{f1}	SV Clock Drift Correction Coefficient	30-37

Symbol	Parameter Name	Message
a_{f2}	Drift Rate Correction Coefficient ~~Index~~	30-37
t_{oc}	Time of Clock	30-37
URA_{NED0}	NED Accuracy Index	30-37
URA_{NED1}	NED Accuracy Change Index	30-37
URA_{NED2}	NED Accuracy Change Rate Index	30-37
Alert	Alert Flag[NOTE1]	All
Updates to parameters in this table will prompt changes in t_{oe}/t_{oc}		
NOTE1: Updates to this parameter are independent of updates to t_{oe}/t_{oc}		
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}. Any parameter marked with NOTE1 may be changed with or without a change in t_{oe}/t_{oc}.~~		

IS:

Symbol	Parameter Name	Message
$\dot{A}$	Change Rate in Semi-major Axis	10
ΔA	Semi-major Axis Difference at Reference Time	10
Δn_0	Mean Motion Difference from Computed Value at Reference Time	10
$\Delta \dot{n}_0$	Rate of Mean Motion Difference from Computed Value	10
ω	Argument of Perigee	10
e	Eccentricity	10
ISF	Integrity Status Flag[NOTE1, NOTE2]	10
(L1/L2/L5)	Signal Health (3 bits)[NOTE2]	10
M_0	Mean Anomaly at Reference Time	10
URA_{ED}	Elevation Dependent User Range Accuracy	10
WN	Week Number	10
t_{oe}	Time of Ephemeris	10, 11
t_{op}	CEI Data Sequence Propagation Time of Week	10, 30-37
$\Delta\dot{\Omega}$	Rate of Right Ascension Difference	11
Ω_0	Longitude of Ascending Node of Orbit Plane at Weekly Epoch	11
C_{ic}	Amplitude of the Cosine Harmonic Correction Term to the Angle of Inclination	11
C_{is}	Amplitude of the Sine Harmonic Correction Term to the Angle of Inclination	11
C_{rc}	Amplitude of the Cosine Harmonic Correction Term to the Orbit Radius	11
C_{rs}	Amplitude of the Sine Correction Term to the Orbit Radius	11
C_{uc}	Amplitude of Cosine Harmonic Correction Term to the Argument of Latitude	11
C_{us}	Amplitude of Sine Harmonic Correction Term to the Argument of Latitude	11
i_0	Inclination Angle at Reference Time	11
IDOT	Rate of Inclination Angle	11
$ISC_{L1C/A}$	Inter-signal Correction[NOTE2, NOTE3]	30
ISC_{L2C}	Inter-signal Correction[NOTE2, NOTE3]	30
ISC_{L5I5}	Inter-signal Correction[NOTE2, NOTE3]	30
ISC_{L5Q5}	Inter-signal Correction[NOTE2, NOTE3]	30
T_{GD}	Group Delay Differential[NOTE2, NOTE3]	30
WN_{OP}	CEI Data Sequence Propagation Week Number	30
a_{f0}	SV Clock Bias Correction Coefficient	30-37
a_{f1}	SV Clock Drift Correction Coefficient	30-37

Symbol	Parameter Name	Message
a_{f2}	Drift Rate Correction Coefficient	30-37
t_{oc}	Time of Clock	30-37
URA_{NED0}	NED Accuracy Index	30-37
URA_{NED1}	NED Accuracy Change Index	30-37
URA_{NED2}	NED Accuracy Change Rate Index	30-37
Alert	Alert Flag[NOTE1]	All
Updates to parameters in this table will prompt changes in t_{oe}/t_{oc} NOTE1: Updates to this parameter are independent of updates to t_{oe}/t_{oc} NOTE2: Updates to this parameter are independent of curve fit NOTE3: This parameter is for CEI Refinement		

Rationale:
5/13/2023: Reworked clarifying the NOTEs based on the feedback from AWG #1. (T. Anthony)
4/26/2023: CRM #5 Reworked NOTEs across all documents with SMEs to more accurately address flags and health bits. (T. Anthony)
3/7/2023: At TIM #2, the NOTES were completely reworked resulting in a new NOTE1 and other changes. (T. Anthony)
2/27/2023: This simplified note was argued as being compatible with the rest of IS-GPS-200. The comments about "curve-fit" do not speak to the main point of the note. (T. Anthony)

IS705-218:

Section Number:
20.3.3.1.1.0-7

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.

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.

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.

Rationale:
8/27/2025: Converted the exponential notation to CSE Manual standard. (T. Anthony)

IS705-639:

Section Number:
20.3.3.1.1.0-8

WAS:
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:
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:
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:
8/27/2025: Converted the exponential notation to CSE Manual standard. (T. Anthony)

IS705-1704:

Section Number:
20.3.3.1.1.4.0-6

WAS:
For each URA index (N), users may compute a nominal URA value (X) as given by:

- If the value of N is 6 or less, $X = 2^{(1 + N/2)}$,
- If the value of N is 6 or more, but less than 15, $X = 2^{(N - 2)}$,
- 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 de-weighting, 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 20.3.3.1.1).
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(E+90 degrees))
Adjusted IAURA$_{ED}$ = IAURA$_{ED}$ (sin(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: LSB representation/truncation error, alongtrack ephemeris errors, and crosstrack 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~~URA$_{ED}$ index (N), users may compute a nominal ~~URA~~ 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 ~~de-weighting~~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 ~~20~~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 ~~³~~≥ 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, ~~alongtrack~~CNAV 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)

IS705-240:

Section Number:
20.3.3.1.3.0-4

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)

IS705-241:

Section Number:
20.3.3.1.3.0-6

WAS:

Parameter Symbol	Parameter Description	No. of Bits**	Scale Factor (LSB)	Valid Range***	Units
WN	Data Sequence Propagation Week Number	13	1		weeks
URA_{ED} INDEX	ED accuracy	5*			(see text)
Signal health (L1/L2/L5)		3	1		(see text)
t_{op}	CEI Data sequence propagation time of week	11	300	0 to 604,500	seconds
ΔA ****	Semi-major axis difference at reference time	26*	2^{-9}		meters
$\dot{A}$	Change rate in semi-major axis	25*	2^{-21}		meters/sec
Δn_0	Mean Motion difference from computed value at reference time	17*	2^{-44}		semi-circles/sec
$\Delta \dot{n}_0$	Rate of mean motion difference from computed value	23*	2^{-57}		semi-circles/sec^2
M_{0-n}	Mean anomaly at reference time	33*	2^{-32}		semi-circles
e_n	Eccentricity	33	2^{-34}	0.0 to 0.03	dimensionless
ω_n	Argument of perigee	33*	2^{-32}		semi-circles

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

** See Figure 20-1 and Figure 20-2 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 A_{REF} = 26,559,710 meters.

Redlines:

Parameter Symbol	Parameter Description	No. of Bits**NOTE2	Scale Factor (LSB)	Valid Range***NOTE3	Units
WN	~~Data Sequence Propagation~~ Week Number	13	1		weeks
URA_{ED} INDEX	ED accuracy	5*NOTE1			(see text)
Signal health (L1/L2/L5)		3	1		(see text)
t_{op}	CEI Data sequence propagation time of week	11	300	0 to 604,500	seconds
ΔA ****	Semi-major axis difference at reference time NOTE4	26*NOTE1	2^{-9}		meters
$\dot{A}$	Change rate in semi-major axis	25*NOTE1	2^{-21}		meters/sec
Δn_0	Mean Motion difference from computed value at reference time	17*NOTE1	2^{-44}		semi-circles/sec
$\Delta \dot{n}_0$	Rate of mean motion difference from computed value	23*NOTE1	2^{-57}		semi-circles/sec^2
M_{0-n}	Mean anomaly at reference time	33*NOTE1	2^{-32}		semi-circles
e_n	Eccentricity	33	2^{-34}	0.0 to 0.03	dimensionless
ω_n	Argument of perigee	33*NOTE1	2^{-32}		semi-circles

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

NOTE2:** See Figure 20-1 and Figure 20-2 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 A_{REF} = 26,559,710 meters.

IS:

Parameter Symbol	Parameter Description	No. of Bits[NOTE2]	Scale Factor (LSB)	Valid Range[NOTE3]	Units
WN	Week Number	13	1		weeks
URA_{ED} INDEX	ED accuracy	5[NOTE1]			(see text)
Signal health (L1/L2/L5)		3	1		(see text)
t_{op}	CEI Data sequence propagation time of week	11	300	0 to 604,500	seconds
ΔA	Semi-major axis difference at reference time [NOTE4]	26[NOTE1]	2^{-9}		meters
$\dot{A}$	Change rate in semi-major axis	25[NOTE1]	2^{-21}		meters/sec
Δn_0	Mean Motion difference from computed value at reference time	17[NOTE1]	2^{-44}		semi-circles/sec
$\Delta \dot{n}_0$	Rate of mean motion difference from computed value	23[NOTE1]	2^{-57}		semi-circles/sec^2
M_{0-n}	Mean anomaly at reference time	33[NOTE1]	2^{-32}		semi-circles
e_n	Eccentricity	33	2^{-34}	0.0 to 0.03	dimensionless
ω_n	Argument of perigee	33[NOTE1]	2^{-32}		semi-circles

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

NOTE2: See Figure 20-1 and Figure 20-2 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 A_{REF} = 26,559,710 meters.

Rationale:
8/21/2025: At TIM #1, SMEs asked for NOTE identifiers to replace asterisks (T. Anthony)
CRM #89 11/29/2022 Correct Parameter Name for WN is “Week Number” (T. Anthony)

IS705-242:

Section Number:
20.3.3.1.3.0-8

WAS:

Parameter Symbol	Parameter Description	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 sine 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 20-1 and Figure 20-2 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 $\dot{\Omega}_{REF} = -2.6 \times 10^{-9}$ 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 × x 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 20-1 and Figure 20-2 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)

IS705-243:

Section Number:
20.3.3.1.3.0-10

WAS:

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
$A_k = A_0 + (\dot{A})\, t_k$	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
$\Delta n_A = \Delta n_0 + ½\, \Delta \dot{n}_0\, t_k$	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)
$E_k = Ej$	– 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
μ = 3.986005 × ~~x~~ 10^{+14} meters³/sec²	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
$A_0 = A_{REF} + \Delta A$ 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)
$E_j = E_{j-1} + \frac{M_k - E_{j-1} + e\ sinE_{j-1}}{1 - e \cos E_{j-1}}$	– Refined Value, minimum of three iterations, (j=1,2,3)
$E_k = E_j$	– Final Value (radians
$\nu_k = 2\ tan^{-1}\left(\sqrt{\frac{1+e}{1-e}}\tan\left(\frac{E_k}{2}\right)\right)$	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.

IS705-244:

Section Number:
20.3.3.1.3.0-12

WAS:

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
$\Omega_k = \Omega_{0\text{-}n} + (\dot{\Omega} - \dot{\Omega}_e)\, t_k - \dot{\Omega}_e\, t_{oe}$	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
$\delta u_k = C_{us-n} \sin 2\Phi_k + C_{uc-n} \cos 2\Phi_k$ $\delta r_k = C_{rs-n} \sin 2\Phi_k + C_{rc-n} \cos 2\Phi_k$ $\delta i_k = C_{is-n} \sin 2\Phi_k + C_{ic-n} \cos 2\Phi_k$	Argument of Latitude Correction Radial Correction 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[NOTE3]
$\Omega_k = \Omega_{0-n} + (\Omega - \Omega_e)\, t_k - \Omega_e\, t_{oe}$	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)

IS705-1594:

Section Number:
20.3.3.1.3.0-14

WAS:

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
$\dot{r}_k = \dot{A}(1-e\cos(E_k)) + A\,e\sin(E_k)\,\dot{E}_k + 2(c_{rs}\cos(2\phi_k) - c_{rc}\sin(2\phi_k))\,\dot{v}_k$	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
$(di_k / dt) = (\mathrm{IDOT}) + 2\,\dot{v}_k\,(eC_{is}\cos 2\phi_k - eC_{ic}\sin 2\phi_k)$	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
$\dot{r}_k = \dot{A}(1-e\cos(E_k)) + A_k\,e\sin(E_k)\,\dot{E}_k + 2\,(eC_{rs}\cos(2\phi_k) - eC_{rc}\sin(2\phi_k))\,\dot{v}_k$	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	
$\dot{E}_k = \dfrac{n_k}{1 - e\cos E_k}$	Eccentric Anomaly Rate
$\dot{v}_k = \dot{E}_k\sqrt{1-e^2}/(1 - e\cos E_k)$	True Anomaly Rate
$(di_k / dt) = (\text{IDOT}) + 2\ \dot{v}_k (C_{is} \cos 2\phi_k - C_{ic} \sin 2\phi_k)$	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
$\dot{r}_k = \dot{A}(1\text{-}e \cos(E_k)) + A_k\ e \sin(E_k)\ \dot{E}_k + 2\ (C_{rs} \cos(2\phi_k) - C_{rc} \sin(2\phi_k))\ \dot{v}_k$	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 Capiitalize 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

IS705-261:

Section Number:
20.3.3.2.4.0-4

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

IS705-302:

Section Number:
20.3.3.4.5.0-4

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 20-10 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 $\times 10^{-7}$ ~~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 20-10 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 20-10 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)
8/21/2025: At TIM #1, SMEs asked for NOTE identifiers to replace asterisks (T. Anthony)

IS705-1544:

Section Number:
20.3.3.4.6.2.1.0-4

WAS:
Table 20-VI. Reduced Almanac Parameters*****

Redlines:
Table 20-VI. Reduced Almanac ~~Parameters*****~~ParametersNOTE5

IS:
Table 20-VI. Reduced Almanac ParametersNOTE5

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

IS705-313:

Section Number:
20.3.3.4.6.2.1.0-5

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 BitsNOTE1	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:
8/28/2025 Caught up in the transition of asterisk notes to NOTEn (T. Anthony)
8/27/2025: Converted the exponential notation to CSE Manual standard. (T. Anthony)

IS705-324:

Section Number:
20.3.3.5.1.1.0-8

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 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
$UT1 = t + 604{,}800\ WN + \Delta UTGPS + \Delta U\dot{T}GPS\ t_{diff}/86{,}400$	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)

IS705-352:

Section Number:
20.3.3.7.4.0-2

WAS:
The user will construct a set of initial (uncorrected) elements by:

$A_i = A_0$
$e_i = e_n$
$i_i = i_{0-n}$
$\Omega_i = \Omega_{0-n}$
$\alpha_i = e_n \bullet \cos(\omega_n)$
$\beta_i = e_n \bullet \sin(\omega_n)$
$\gamma_i = M_{0-n} + \omega_n$

Redlines:
The user will construct a set of initial (uncorrected) elements by:

$A_i = A_0$
$e_i = e_n$
$i_i = i_{0-n}$
$\Omega_i = \Omega_{0-n}$
$\alpha_i = e_n$ ~~•~~ $\cos(\omega_n)$
$\beta_i = e_n$ ~~•~~ $\sin(\omega_n)$
$\gamma_i = M_{0-n} + \omega_n$

IS:
The user will construct a set of initial (uncorrected) elements by:

$A_i = A_0$
$e_i = e_n$
$i_i = i_{0-n}$
$\Omega_i = \Omega_{0-n}$
$\alpha_i = e_n \cos(\omega_n)$
$\beta_i = e_n \sin(\omega_n)$
$\gamma_i = M_{0-n} + \omega_n$

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

IS705-1721:

Section Number:
20.3.3.7.4.0-4

WAS:
The quasi-Keplerian elements are then corrected by

$$A_c = A_i + \Delta A$$
$$e_c = (\alpha_c^2 + \beta_c^2)^{1/2}$$
$$i_c = i_i + \Delta i$$
$$\Omega_c = \Omega_i + \Delta\Omega$$
$$\omega_c = \tan^{-1}(\beta_c/\alpha_c)$$
$$M_{0\_c} = \gamma_c - \omega_c + \Delta M_0$$

where ΔA, Δi and ΔΩ are provided in the EDC data packet of the message type 34 or 14 and ΔM_0 is obtained from

$$\Delta M_0 = \frac{-3}{2}\left(\frac{\mu}{A_0^{\ 3}}\right)^{\frac{1}{2}}\left(\frac{\Delta A_0}{A_0}\right)\left[\left(t_{oe} + WN_{oe} * 604{,}800\right) - \left(t_{OD} + WN * 604{,}800\right)\right]$$

Redlines:
The quasi-Keplerian elements are then corrected by

A_c = Ai_ + ~~DA~~ ΔA
e_c = (~~ae2~~α_c^2 + ~~be2~~β_c^2)$^{1/2}$
i_c = i_i + Δi
~~We~~Ω_c = Ω_i ~~-~~+ ΔΩ
~~we~~ω_c = $\tan^{-1}$ (~~be~~β_c/~~ae~~α_c)~~-~~
~~M0_e~~M_{0_c} = ~~ge~~γ_c - ~~we~~ ω_c + ~~DM0~~ ΔM0

where ~~DA~~ A, ~~Di~~ i and ~~DW~~ Ω are provided in the EDC data packet of the message type 34 or 14 and DM0 is obtained from

<Formula redlines not available>

IS:

The quasi-Keplerian elements are then corrected by

A_c	=	$A_i + \Delta A$
e_c	=	$(\alpha_c^2 + \beta_c^2)^{1/2}$
i_c	=	$i_i + \Delta i$
Ω_c	=	$\Omega_i + \Delta\Omega$
ω_c	=	$\tan^{-1}(\beta_c/\alpha_c)$
$M_{0\ c}$	=	$\gamma_c - \omega_c + \Delta M_0$

where ΔA, Δi and ΔΩ are provided in the EDC data packet of the message type 34 or 14 and DM_0 is obtained from

$$\Delta M_0 = -\frac{3}{2}\sqrt{\frac{\mu}{{A_0}^3}}\left(\frac{\Delta A_0}{A_0}\right)[(t_{oe} + 604{,}800\ WN_{oe}) - (t_{OD} - 604{,}800\ WN)]$$

Rationale:

8/5/2025 Normalize the notation for scalar value multiply, use only implied multiply. (T. Anthony)
Administrative fix 8/5/2025 Many parameters needed to have their Greek letters redone in Unicode. Also some of the terms for the formula were redone because the square root was used many places, but was 1/2 power here. (T. Anthony)

IS705-354:

Section Number:
20.3.3.7.5.0-1

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 have the following relationship:

Redlines:
The $UDRA_{op-D}$ and -UḊRA 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- UḊRA indices are signed, two's complement integers in the range of +15 to -16 and have the following relationship:

IS:
The $UDRA_{op-D}$ and *UḊRA* 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 *UḊRA* indices are signed, two's complement integers in the range of +15 to -16 and have the following relationship:

Rationale:
Administrative fix 8/5/2025 Replaced bit image of UDRA-dot with ASCII and Unicode characters to improve overall look and maintainability. Matches change in IS200-654 (T. Anthony)

IS705-355:

Section Number:
20.3.3.7.5.0-2

WAS:

Index Value	$UDRA_{op\text{-}D}$ (meters)					$\dot{UDRA}$ (10^{-6} m/sec)
15	6144	<	$UDRA_{op\text{-}D}$			6144
14	3072	<	$UDRA_{op\text{-}D}$	≤	6144	3072
13	1536	<	$UDRA_{op\text{-}D}$	≤	3072	1536
12	768	<	$UDRA_{op\text{-}D}$	≤	1536	768
11	384	<	$UDRA_{op\text{-}D}$	≤	768	384
10	192	<	$UDRA_{op\text{-}D}$	≤	384	192
9	96	<	$UDRA_{op\text{-}D}$	≤	192	96
8	48	<	$UDRA_{op\text{-}D}$	≤	96	48
7	24	<	$UDRA_{op\text{-}D}$	≤	48	24
6	13.65	<	$UDRA_{op\text{-}D}$	≤	24	13.65
5	9.65	<	$UDRA_{op\text{-}D}$	≤	13.65	9.65
4	6.85	<	$UDRA_{op\text{-}D}$	≤	9.65	6.85
3	4.85	<	$UDRA_{op\text{-}D}$	≤	6.85	4.85
2	3.4	<	$UDRA_{op\text{-}D}$	≤	4.85	3.4
1	2.4	<	$UDRA_{op\text{-}D}$	≤	3.4	2.4
0	1.7	<	$UDRA_{op\text{-}D}$	≤	2.4	1.7
-1	1.2	<	$UDRA_{op\text{-}D}$	≤	1.7	1.2
-2	0.85	<	$UDRA_{op\text{-}D}$	≤	1.2	0.85
-3	0.6	<	$UDRA_{op\text{-}D}$	≤	0.85	0.6
-4	0.43	<	$UDRA_{op\text{-}D}$	≤	0.6	0.43
-5	0.3	<	$UDRA_{op\text{-}D}$	≤	0.43	0.3
-6	0.21	<	$UDRA_{op\text{-}D}$	≤	0.3	0.21
-7	0.15	<	$UDRA_{op\text{-}D}$	≤	0.21	0.15
-8	0.11	<	$UDRA_{op\text{-}D}$	≤	0.15	0.11
-9	0.08	<	$UDRA_{op\text{-}D}$	≤	0.11	0.08
-10	0.06	<	$UDRA_{op\text{-}D}$	≤	0.08	0.06
-11	0.04	<	$UDRA_{op\text{-}D}$	≤	0.06	0.04
-12	0.03	<	$UDRA_{op\text{-}D}$	≤	0.04	0.03
-13	0.02	<	$UDRA_{op\text{-}D}$	≤	0.03	0.02
-14	0.01	<	$UDRA_{op\text{-}D}$	≤	0.02	0.01
-15		<	$UDRA_{op\text{-}D}$	≤	0.01	0.005

-16	No accuracy prediction available-use at own risk

Redlines:

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

IS:

Index Value	$UDRA_{op-D}$ (meters)				$\dot{UDRA}$ (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				

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)

IS705-356:

Section Number:
20.3.3.7.5.0-3

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

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

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

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

Rationale:
Administrative fix 8/5/2025 Replaced bit image of UDRA-dot with ASCII and Unicode characters to improve overall look and maintainability. Matches change in IS200-654 (T. Anthony)

IS705-375:

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

$c = 2.99792458 \times 10^8$ 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)

IS705-379:

Section Number:
20.3.5.1.0-1

WAS:
Twenty-four bits of CRC parity will provide protection against burst as well as random errors with a probability of undetected error $\leq 2^{-24} = 5.96 \text{ x } 10^{-8}$ 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 (p1,p2,...,p24) is generated from the sequence of information bits (m1,m2,...,m276) 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

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

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 x × 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

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 equivalents (T. Anthony)

IS705-1680:

Section Number:
20.3.5.1.0-4

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': 27

# of inserted requirements: 0
# of modified requirements: 7
# 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: 10
of (added/modified) tables: 10
of (added/modified) figures: 0