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%==========================================================================
%                GPS SOFTWARE TOOLBOX  -- Version 4 -- List of functions
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%  Last update:  02/02/06
%                           contents.m
%==========================================================================
%                 (1) GPS related constants and conversion factors
%  convcon          most used conversion constants
%  gpscon           most used GPS constants
%  pz90con          most used PZ-90 constants
%  sgs85con         most used SGS-85 constants
%  wgs72con         most used WGS-72 constants
%  wgs84con         most used WGS-84 constants
%  xcon             main program displaying constants specified in macros
%                   convcon, gpscon, pz90con, sgs85con, wgs72con, and wgs84con
%==========================================================================
%                   (2) Angle transformations
%  tadmsrad         degrees/minutes/seconds to radians
%  taraddms         radians to degrees/minutes/seconds
%  xatransf         main program executing angle transformations from/to
%                   degrees/minutes/seconds to/from radians (by selection)
%==========================================================================
%                   (3) Coordinate transformations - Point transformation
%  tecefgd          ECEF to geodetic coordinates (direct method)
%  tecefgd2         ECEF to geodetic coordinates (iterative method)
%  tgdecef          geodetic to ECEF coordinates
%  xecef2gd_comp    main program executing comparison between two ECEF to
%                   geodetic transformation methods
%  xptransf         main program executing transformations from/to ECEF/geodetic
%                   to/from geodetic/ECEF coordinates
%==========================================================================
%                   (4) Coordinate transformations - Matrix transformation
%  mbllw            GPS body to LLW (Local Level Wander azimuth)
%  mecefeci         ECEF (Earth Centered Earth Fixed) to ECI (Earth Centered
%                   Inertial)
%  mecefenu         ECEF (Earth Centered Earth Fixed) to ENU (East, North, Up)
%  mecefins         ECEF (Earth Centered Earth Fixed) to INS (Wander/ North,
%                   West, Up)
%  mecefllw         ECEF (Earth Centered Earth Fixed) to (Local Level Wander
%                   azimuth)
%  meciecef         ECI (Earth Centered Inertial) to ECEF (Earth Centered Earth
%                   Fixed)
%  menuecef         ENU (East, North, Up) to ECEF (Earth Centered Earth Fixed)
%  menullw          ENU (East, North, Up) to LLW (Local Level Wander azimuth)
%  minsecef         INS (Wander / North,  West, Up) to ECEF (Earth Centered Earth
%                   Fixed)
%  mllwb            LLW (Local Level Wander azimuth) to  GPS body
%  mllwecef         LLW (Local Level Wander azimuth) to ECEF (Earth Centered
%                   Earth Fixed)
%  mllwenu          LLW (Local Level Wander azimuth) to ENU (East North Up)
%  xmtransf         main program generating matrix transformations specified in
%                   the above mentioned list (by selection)
%==========================================================================
%                   (5) Coordinate transformations - Vector transformation
%  vbllw            GPS body to LLW (Local Level Wander Azimuth)
%  vecefeci         ECEF (Earth Centered Earth Fixed) to ECI (Earth Centered
%                   Inertial)
%  vecefenu         ECEF (Earth Centered Earth Fixed) to ENU (East, North, Up)
%  vecefgd          ECEF (Earth Centered Earth Fixed) to Geodetic (latitude,
%                   longitude, altitude) for a given position vector and a
%                   reference point
%  vecefins         ECEF (Earth Centered Earth Fixed) to INS (Wander / North,
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%                   West, Up)
%  vecefllw         ECEF (Earth Centered Earth Fixed) to LLW (Local Level Wander
%                   azimuth)
%  vecefp90         ECEF (Earth Centered Earth Fixed) to PZ-90 (Parametri Zemli
%                   1990)
%  vecefs85         ECEF (Earth Centered Earth Fixed) to SGS-85 (Soviet Geodetic
%                   System 1985)
%  veciecef         ECI (Earth Centered Inertial) to ECEF (Earth Centered Earth
%                   Fixed)
%  venuecef         ENU (East, North, Up) to ECEF (Earth Centered Earth Fixed)
%  venugd           ENU (East, North, Up)  to Geodetic (latitude, longitude,
%                   altitude) for a given position vector and a reference point
%  venullw          ENU (East, North, Up) to LLW (Local Level Wander azimuth)
%  vgdecef          Geodetic (latitude, longitude, altitude) to ECEF (Earth
%                   Centered Earth Fixed), for a given position vector specified
%                   by the external points in geodetic coordinates
%  vgdenu           Geodetic (latitude, longitude, altitude) to ENU (East, North,
%                   Up) for a given position vector specified by the external
%                   points in geodetic coordinates
%  vinsecef         INS (Wander / North, West, Up) to ECEF (Earth Centered Earth
%                   Fixed)
%  vllwb            LLW (Local Level Wander azimuth) to  GPS body
%  vllwecef         LLW (Local Level Wander azimuth) to ECEF (Earth Centered
%                   Earth Fixed)
%  vllwenu          LLW (Local Level Wander azimuth) to ENU (East North Up)
%  vp90ecef         PZ-90 (Parametri Zemli 1990) to ECEF (Earth Centered Earth
%                   Fixed)
%  vs85ecef         SGS-85 (Soviet Geodetic System 1985) to ECEF (Earth Centered
%                   Earth Fixed)
%  xvtransf         main program executing vector transformations specified in
%                   the above mentioned list (by selection)
%=========================================================================
%                   (6) Specialized plotting programs
%  xpbar            bar graph for a selected column
%  xyp1             x-y graph for a selected column
%  xyp1s            x-y graph for a selected column, with statistics
%  xyp2w            x-y graph for two selected columns in two different
%                   windows/subplots, with statistics
%  xyp3w            x-y graph for three selected columns in three different
%                   windows/ subplots, with statistics
%  xypc2            x-y graph of the difference between columns (from different
%                   files), with statistics
%  xypc2rss         x-y graph for RSS (root sum square) of the difference of
%                   three columns from two files, with statistics
%  xypm             x-y graph for the selected multiple columns
%  xyprss           x-y graph for RSS (root sum square) of three selected
%                   columns, with statistics
%  xyprss2w         x-y graph for RSS (root sum square) of three selected columns
%                   corresponding to position and velocity errors, in two
%                   windows/subplots, with statistics
%  xypvstd          x-y graph for a selected column and the associated envelope
%                   (standard deviation), with statistics
%=========================================================================
%                   (7) Specialized statistics related functions
%  cep              circular error probable (CEP)
%  rms              root mean square (RMS) of a sample
%  rms2             modified root mean square (RMS) of a sample (mean of the
                    sample is assumed to be zero)
%  rss              root sum square (RSS) of a three component vector sample
%  rssxy            root sum square (RSS) of a two component vector sample
%  vep              vertical error probable (VEP)
%  statup           running mean, standard deviation and root mean square (rms)
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%  xcepvep          main program determining the CEP or VEP of a specified data
%                   set
%  xstat            main program testing the macros: rms, rss, rssxy, and statup
%  xstatc           main program determining the mean, standard deviation and rms
%                   of the elements of a specified column
%=========================================================================
%                   (8) Specialized signal processing and Kalman filter functions
%  dcmnorm          normalization of the direction cosines matrix
%  genrn            random numbers with normal (Gaussian) distribution, with mean
%                   and standard deviation specified
%  gmp1             first order Gauss-Markov sequence
%  gmp2             second order Gauss-Markov sequence
%  kfcov            Kalman filter covariance matrix by using conventional
%                   formulation
%  kfcova           Kalman filter covariance matrix by using alternate
%                   conventional formulation
%  rwalk            random walk process
%  xgenrn           main program generating the random numbers with normal
%                   (Gaussian) distribution and plotting the generated sequence,
%                   histogram, and the normalized auto-correlation sequence
%  xgmp1            main program generating first order Gauss-Markov sequence and
%                   plotting the generated sequence and the normalized auto-
%                   correlation sequence
%  xgmp2            main program generating second order Gauss-Markov sequence
%                   and plotting the generated sequence and the normalized auto-
%                   correlation sequence
%  xkfcov           main program performing the covariance analysis by using the
%                   conventional or alternate conventional Kalman filter
%                   formulation
%  xrwalk           main program generating the random walk process and plotting
%                   the generated sequence and the normalized auto-correlation
%                   sequence
%=========================================================================
%                   (9) GPS Time Utilities and related functions
%  cday             determination of the civil day (year, month, day, hour and
%                   fraction) from a specified modified Julian day (with
%                   fraction)
%  doy2ymd          determination of civil date (year, month, day) from day of
%                   year and specified year
%  gpslsec          UTC leap seconds value for a specified year between 1980 and
%                   2059
%  leapyear         determination of the leap year value
%  mjday            determination of the modified Julian day from the civil day
%                   (year, month, day, hour and fraction)
%  timetr           determination of GPS time of transmission based on time of
%                   measurement (reception)
%  ymd2doy          determination of day of year for a specified civil date
%                   (year, month, day)
%  ymd2doy2         determination of day of year for a specified civil date
%                   (year, month, day) - different algorithm
%  ymd2gps          determination of (GPS week, GPS roll number, day of week)
%                   from (year, month, day)
%  xgpslsec         main program determining UTC leap seconds value for a
%                   specified year between 1980 and 2059
%  xgpstime         main program executing GPS time related transformations
%=========================================================================
%                   (10) GPS Almanac and other data processing functions
%  elimcol          elimination of a specified column of a two dimensional array
%  elimrow          elimination of a specified row of a two dimensional array
%  msc2f            symmetric matrix storage transformation from compact form
%                   (upper triangular part, column-wise, one-dimensional array)
%                   to full form (all elements, two-dimensional array)
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%  msf2c           symmetric matrix storage transformation from full form (all
%                  elements, two-dimensional array) to compact form (upper
%                  triangular part, column-wise, one-dimensional array)
%  selectd         selection of the different elements from a specified array
%  xelimrc         main program testing the elimination of a specified
%                  row/column (see macros elimrow and elimcol)
%  xmisdat         main program determining the missing data into a specified
%                  column of an input data table
%  xread_sem       main program reading SEM almanac data and creating two data
%                  files
%  xread_yuma      main program reading Yuma almanac data and creating two data
%                  files
%  xsortrec        main program sorting the records based on the elements of a
%                  specified column (in ascending order)
%=============================================================================
%                  (11) Trajectory and related utilities
%  gcnav           great circle navigation position, velocity, acceleration
%  geodes          geodetic data for a specified departure-destination pair
%  geoidh          WGS-84 geoid height correction
%  gridwaas        generation of longitude-latitude WAAS grid
%  hpe             horizontal position error (range) when latitude and longitude
%                  of two points are specified
%  trajs           vehicle trajectory in straight segment with constant speed
%  xgcdr           main program determining great circle dead reckoning
%                  trajectory
%  xgcnav          main program determining great circle navigation position,
%                  velocity and acceleration
%  xgeodes         main program determining geodesic when the departure and
%                  destination points are specified
%  xgeoidh         main program determining WGS-84 geoid height correction, and
%                  executing a contour map
%  xgridw          main program plotting the longitude-latitude WAAS grid
%  xhpe            main program determining the horizontal position error
%                  (range)
%  xppva           main program determining acceleration from position/velocity
%                  data, and plotting all relevant trajectory information
%  xppvaj          main program determining acceleration and jerk from  position
%                  and velocity data, and plotting all relevant trajectory
%                  information
%  xtrajs          main program determining the vehicle trajectory with straight
%                  segment and constant speed
%=============================================================================
%                  (12) Satellite position and velocity computation
%  svpalm          ECEF satellite position based on almanac data
%  svpeph          ECEF satellite position based on ephemeris data
%  svpvalm         ECEF satellite position and velocity based on ephemeris data
%  xsvpalm         main program determining ECEF satellite position based on
%                  almanac data
%  xsvpcomp        main program determining RSS satellite position difference
%                  based on ephemeris and almanac data, and executing the
%                  corresponding graph
%  xsvpeph         main program determining ECEF satellite position based on
%                  ephemeris data
%  xsvpvalm        computation of ECEF satellite position and velocity based on
%                  almanac data; WGS-84 constants are used
%  xsvpvcomp       computation of RSS between ECEF satellite position/velocity
%                  based on ephemeris and almanac data; WGS-84 constants are
%                  used
%  xsvpveph        computation of ECEF satellite position and velocity based on
%                  ephemeris data; WGS-84 constants are used
%=============================================================================
%                  (13) Elevation and azimuth determination, and satellite
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%                 visibility
%  eleva          elevation angle and the ECEF unit line-of-sight vector
%  elevar         elevation angle, the ECEF unit line-of-sight vector, and the
%                 range
%  elevaz         elevation angle, azimuth angle, the ECEF unit line-of-sight
%                 vector, and range
%  range          range between two position points
%  uverv          unit vertical vector for a given ECEF position vector
%  xelaz          main program determining elevation and azimuth angles for
%                 specified users, time interval, and all satellites in view
%  xpelaza        main program executing the azimuth-elevation plot for all
%                 satellites in view, and the number of visible satellites plot
%  xpelazs        main program executing graphs related to elevation and
%                 azimuth angles for a specified satellite and selected user
%                 (input file can be generated by xelaz)
%=========================================================================
%                 (14) DOPs computation, satellite selection and related
%                 functions
%  dop1           dilution of precision (DOP) quantities when at least 3 line-
%                 of-sight unit vectors are specified
%  dop2           dilution of precision (DOP) quantities when 4 line-of-sight
%                 unit vectors are specified
%  gdopv          approximate geometric dilution of precision (GDOP) when four
%                 line-of-sight unit vectors are specified
%  hmat           H matrix based on line-of-sight measurements
%  hmatb          H matrix based on line-of-sight and baro measurements
%  hmatbc         H matrix based on line-of-sight, baro and clock measurements
%  hmatc          H matrix based on line-of-sight and clock measurements
%  svsel4         selection of a set of 4 satellites based on minimum GDOP
%  svsel5         selection of a set of 5 satellites based on minimum GDOP
%  svsel6         selection of a set of 6 satellites based on minimum GDOP
%  wdop1          weighted dilution of precision (WDOP) quantities when at
%                 least 3 line-of-sight unit vectors and the corresponding
%                 weighting factors are specified
%  wdop2          weighted dilution of precision (WDOP) quantities when 4 line-
%                 of-sight unit vectors and the corresponding weighting factors
%                 are specified
%  wdopv          weighted dilution of precision (WDOP) quantities when 4 line-
%                 of-sight unit vectors and the corresponding weighting factors
%                 are specified
%  xdop           main program determining dilution of precision (DOP)
%                 quantities by using 2 methods
%  xgdopv         main program determining an approximate value of the
%                 geometric dilution of precision (GDOP)
%  xhmatall       main program testing the construction of the H matrix based
%                 on line-of-sight, baro and clock measurements
%  xmapdop        main program determining repartition of number of visible
%                 satellites and the corresponding DOPs for a specified
%                 geographical area
%  xsvsel         main program executing the selection of 4, 5 or 6 satellites
%                 based on minimum GDOP, and the computation of the
%                 corresponding DOP quantities
%  xwdop          main program computing the weighted dilution of precision
%                 (WDOP) quantities when at least 3 line-of-sight unit vectors
%                 and the corresponding weighting factors are specified
%  xwdopv         main program computing the weighted dilution of precision
%                 (WDOP) quantities when 4 line-of-sight unit vectors and the
%                 corresponding weighting factors are specified
%=========================================================================
%                 (15) Pseudorange and Delta range determination and related
%                 functions
%  ionoc          L1 iono correction computation by using Klobuchar model
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%  ionocon          setting of Klobuchar model iono constants
%  pionoc           pseudorange measurement corrected for ionospheric effects
%                   based on L1/L2 measured pseudoranges
%  pradr            pseudorange and accumulated delta range
%  tropoc1          tropospheric correction by using a simplified model
%  uclock           user clock bias and drift
%  uercor           user earth rotation correction vector
%  xambig           main program generating ambiguity numbers
%  xionoc           main program determining iono corrections by using Klobuchar
%                   model
%  xmpath           main program generating and saving the multipath pseudorange
%                   errors
%  xpradr           main program generating pseudorange and accumulated delta
%                   range
%  xsaerr           main program generating SA errors
%  xtropoc1         main program generating tropospheric delay contours for a
%                   specified location
%  xuclock          main program generating user clock bias and clock drift
%  xuercor          main program generating and plotting the magnitude of the
%                   earth rotation correction vector for a specified longitude/
%                   latitude grid
%=========================================================================
%                   (16) Determination of user's position and related functions
%  uspos4           position fix determination by using Bancroft's algorithm when
%                   4 measurements are known
%  uposdg           position fix determination by using Bancroft's algorithm when
%                   at least 4 measurements are known
%  uposit           position fix determination by using an iterative method when
%                   at least measurements are known
%  xpfwls           main program determining position fixes using weighted least
%                   squares algorithm when the user is stationary
%  xuposd4          main program determining the user's position fix by using a
%                   direct method when 4 measurements are known
%  xuposdg          main program determining the user's position fix by using a
%                   direct method when at least 4 measurements are known
%  xuposit          main program determining the user's position fix by using an
%                   iterative method when at least 4 measurements are know
%=========================================================================
%                   (17) RINEX 2 data processing and position determination
%  svclockc         computation of satellite clock correction. WGS-84 constants
%                   are used.
%  xrinexn          main program reads a RINEX 2 navigation message file and
%                   writes the data into four files containing the header section
%                   main information, the complete navigation section
%                   information, the reduced ephemeris and reduced almanac data
%  xrinexo          main program reads a RINEX 2 observation message file and
%                   writes the data into two files containing the header
%                   information and the main observation data only
%  xuposr           main program computing user position based on RINEX 2
%                   navigation and observation data; no atmospheric corrections
%                   are applied
%  xuposra          main program computing user position based on RINEX 2
%                   navigation and observation data; iono and tropo corrections
%                   are applied
%  xuposrp          main program computing user position based on RINEX 2
%                   navigation and observation data; dual frequency P-code iono
%                   and tropo corrections are applied
%=========================================================================
%                   (18) Basic RAIM/FDE functions
%  dhmax            delta_h_max computation (used in RAIM constant alarm rate
%                   algorithm)
%  raimfd           RAIM availability and fault detection by using the parity
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%                 vector algorithm (one step implementation)
%  raimst         RAIM availability and fault detection by using the standard
%                 (constant alarm rate) algorithm
%  slopemax       slopemax computation (used in RAIM constant alarm rate
%                 algorithm)
%  xopcr          main program comparing four different implementations of RAIM
%                 decision variable computation
%  xraimda        main program determining the RAIM fault detection
%                 availability for a user selected or defined set of input data
%  xraimea        main program determining the RAIM fault exclusion
%                 availability for a user selected or defined set of input data
%  xraimfd        main program determining RAIM availability and fault
%                 detection by using the parity vector algorithm
%  xraimst        main program determining RAIM availability and fault
%                 detection by using the standard (constant alarm rate)
%                 algorithm
%  xslope         main program determining slopemax and delta_h_max for RAIM
%                 baseline standard (constant alarm rate) algorithm
%=========================================================================
%                 (19) Advanced RAIM/FDE functions
%  chi2_dof       probability density function of Chi-square distribution with
%                 specified degrees of freedom
%  fdnt           fault detection normalized thresholds
%  fpbias_c       parity bias for Chi-square distribution with degree of
%                 freedom greater than 1
%  fpbias_g       parity bias for Gauss distribution with one degree of freedom
%  gauss_1        probability density function for the normal Gaussian
%                 distribution
%  heLveL1        horizontal/vertical exclusion level (HEL/VEL) by using a
%                 direct conventional method
%  heLveL2        horizontal/vertical exclusion level (HEL/VEL) by using the
%                 parity method
%  heLveL3        horizontal/vertical exclusion level (HEL/VEL) by using a new
%                 efficient method
%  hpLvpL1        horizontal/vertical protection level (HPL/VPL) by using a
%                 direct conventional method
%  hpLvpL2        horizontal/vertical protection level (HPL/VPL) by using the
%                 parity method
%  ncchis2_k      probability density function for the non-central Chi-square
%                 distribution, where k is 2 to 10 for the degree of freedom 2
%                 to 10
%  qrupa          Q-R updating algorithm of the measurement matrix when a new
%                 clock measurement is added
%  sdop           sub-dilution of precision (sub-DOP) quantities
%  swdop          sub-weighted dilution of precision (sub-WDOP) quantities
%  xfdnt          main program computing the fault detection normalized
%                 thresholds
%  xheLveL        main program determining the horizontal/vertical exclusion
%                 level (HEL/VEL) by using three different methods
%  xhpLvpL        main program determining the horizontal/vertical protection
%                 level (HPL/VPL)by using two different methods
%  xpbias         main program computing the value of the parity bias for 10
%                 degrees of freedom (dof) by using Gaussian distribution for
%                 dof = 1 and Chi-square distribution for dof > 1
%  xqrupa         main program testing the Q-R updating algorithm of the
%                 measurement matrix when a new clock measurement is added
%  xsdop          main program determining sub-dilution of precision (sub-DOP)
%                 quantities
%  xswdop         main program determining sub-weighted dilution of precision
%                 (sub-WDOP) quantities
%=========================================================================
%                 (20) GPS receiver evaluation functions
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%  cn0_j           equivalent carrier to noise power density ratio for a
%                  specified jamming level
%  cn0_unj         unjammed carrier to noise power density ratio
%  fom             figure of merit determination based on ICD-059 table
%  pracc_cl        pseudorange accuracy of Costas loop implementation when the
%                  equivalent carrier to noise power density ratio is known
%  prscp           carrier phase smoothed pseudorange by using a first order
%                  filter
%  xcn0_pr         main program executing graphs related to carrier-to-noise
%                  power density ratio and pseudorange accuracy
%  xebudget        main program determining GPS error budget
%  xfom            main program plotting the figure of merit versus estimated
%                  position error for a specified position error range
%  xgpsr5s         main program performing covariance analysis for the 5-state
%                  GPS receiver model (near stationary user)
%  xgpsr8s         main program performing covariance analysis for the 8-state
%                  GPS receiver model (near constant velocity user)
%  xprcp           main program performing pseudorange and carrier phase data
%                  analysis
%  xprscp          main program executing the pseudorange smoothing by carrier
%                  phase data using a first order filter
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