

There are additional modules and programs in GPS Toolbox version 5. For a complete list please request a demo copy.

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(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

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(2) Angle transformations

tadmarad 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)

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(3) Coordinate transformations - Point transformation

tecef2gd ECEF to geodetic coordinates (direct method)
 tecef2gd2 ECEF to geodetic coordinates (iterative method)
 tgdecef geodetic to ECEF coordinates
 xcecf2gd_complain program executing comparison between two ECEF to geodetic transformation methods
 xptransf main program executing transformations from/to ECEF/geodetic to/from geodetic/ECEF coordinates

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(4) Coordinate transformations - Matrix transformation

ml1w GPS body to LLM (Local Level Wander azimuth)
 mcefec1ECEF (Earth Centered Earth Fixed) to ECI (Earth Centered Inertial)
 mcefec2ECEF (Earth Centered Earth Fixed) to ENU (East, North, Up)
 mcefeinsECEF (Earth Centered Earth Fixed) to INS (Wander/ North, West, Up)
 mcecfllwECEF (Earth Centered Earth Fixed) to (Local Level Wander azimuth)
 mceiecefECI (Earth Centered Inertial) to ECEF (Earth Centered Earth Fixed)
 mencecfENU (East, North, Up) to ECEF (Earth Centered Earth Fixed)
 mendlw ENU (East, North, Up) to LLM (Local Level Wander azimuth)
 minceceINS (Wander / North, West, Up) to ECEF (Earth Centered Earth Fixed)
 ml1wb LLM (Local Level Wander azimuth) to GPS body
 ml1wcecfLLM (Local Level Wander azimuth) to ECEF (Earth Centered Earth Fixed)
 ml1wenu LLM (Local Level Wander azimuth) to ENU (East North Up)
 mxtransf main program generating matrix transformations specified in the above mentioned list (by selection)

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(5) Coordinate transformations - Vector transformation

vl1w GPS body to LLM (Local Level Wander Azimuth)
 vcefec1ECEF (Earth Centered Earth Fixed) to ECI (Earth Centered Inertial)
 vcefec2ECEF (Earth Centered Earth Fixed) to ENU (East, North, Up)
 vcecf2gd ECEF (Earth Centered Earth Fixed) to Geodetic (latitude, longitude, altitude) for a given position vector and a reference point
 vcefeinsECEF (Earth Centered Earth Fixed) to INS (Wander / North, West, Up)
 vcecfllwECEF (Earth Centered Earth Fixed) to LLM (Local Level Wander azimuth)
 vcecfp90ECEF (Earth Centered Earth Fixed) to PZ-90 (Parametri Zemli 1990)
 vcecfz85ECEF (Earth Centered Earth Fixed) to SGS-85 (Soviet Geodetic System 1985)
 vceiecefECI (Earth Centered Inertial) to ECEF (Earth Centered Earth Fixed)
 vnuencefENU (East, North, Up) to ECEF (Earth Centered Earth Fixed)
 venug2d ENU (East, North, Up) to Geodetic (latitude, longitude, altitude) for a given position vector and a reference point
 venullw ENU (East, North, Up) to LLM (Local Level Wander azimuth)
 vlgdecef Geodetic (latitude, longitude, altitude) to ECEF (Earth Centered Earth Fixed) by the external points in geodetic coordinates
 vlgenu Geodetic (latitude, longitude, altitude) to ENU (East, North, Up) for a given position vector specified by the external points in geodetic coordinates
 vlncecfINS (Wander / North, West, Up) to ECEF (Earth Centered Earth Fixed)
 vl1wb LLM (Local Level Wander azimuth) to GPS body
 vl1wcecfLLM (Local Level Wander azimuth) to ECEF (Earth Centered Earth Fixed)
 vl1wenu LLM (Local Level Wander azimuth) to ENU (East North Up)
 vp90cecfPZ-90 (Parametri Zemli 1990) to ECEF (Earth Centered Earth Fixed)
 vs85cecfSGS-85 (Soviet Geodetic System 1985) to ECEF (Earth Centered Earth Fixed)
 vxtransf main program executing vector transformations specified in the above mentioned list (by selection)

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(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
 xyp2d x-y graph of the difference between columns (from different files), with statistics
 xyp2rssx-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
 xyp3rs x-y graph for RSS (root sum square) of three selected columns, with statistics
 xyp3rs2w x-y graph for RSS (root sum square) of three selected columns corresponding to position and velocity errors, in two windows/subplots, with statistics
 xypvtd x-y graph for a selected column and the associated envelope (standard deviation), with statistics

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(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)
 xcepvep main program determining the CEP or VEP of a specified data set
 xtstat main program testing the macros: rms, rss, rssxy, and statup
 xtatic main program determining the mean, standard deviation and rms of the elements of a specified column

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(8) Specialized signal processing and Kalman filter functions

demnorm 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
 kfconv Kalman filter covariance matrix by using conventional formulation
 kfconva 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
 xkfconv 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

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(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)
 day2ymd determination of civil day (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
 m10day determination of the modified Julian day from the civil day (year, month, day, hour and fraction)
 timestr determination of GPS time of transmission based on time of measurement (reception)
 ymd2day determination of day of year for a specified civil date (year, month, day)
 ymd2day2 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)
xgps1secmain program determining UTC leap seconds value for a specified year between 1980 and 2059
xgps1timeinmain program executing GPS time related transformations

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(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
m2zfc symmetric matrix storage transformation from compact form (upper triangular part, column-wise, one-dimensional array) to full form (all elements, two-dimensional array)
mz2fc symmetric matrix storage transformation from full form (all elements, two-dimensional array) to compact form (upper triangular part, column-wise, one-dimensional array)
select 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_gps main program reading GSM 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)

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(11) Trajectory and related utilities

gcnav great circle navigation position, velocity, acceleration
geodes geodesic 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
xgpcr main program determining great circle dead reckoning trajectory
xgpcrv 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
xppva 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

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(12) Satellite position and velocity computation

svpalm ECEF satellite position based on almanac data
svpeph ECEF satellite position based on ephemeris data
svpvall ECEF satellite position and velocity based on ephemeris data
xsvpalm main program determining ECEF satellite position based on almanac data
xsvpeph main program determining ECEF satellite position difference based on ephemeris and almanac data, and executing the corresponding graph
xsvpvall main program determining ECEF satellite position and velocity based on ephemeris data
xsvpvall main program computing the ECEF satellite position and velocity based on almanac data; WGS-84 constants are used
xsvpvall main program computing the ECEF satellite position/velocity based on ephemeris and almanac data; WGS-84 constants are used
xsvpeph main program computing the ECEF satellite position and velocity based on ephemeris data; WGS-84 constants are used

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(13) Elevation and azimuth determination, and satellite 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
uvert 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
xpeleasmain program executing the azimuth-elevation plot for all satellites in view, and the number of visible satellites plot
xpeleasmain program executing graphs related to elevation and azimuth angles for a specified satellite and selected used (input file can be generated by xelaz)

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(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 factor 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)
xmatall main program determining the construction of the H matrix based on line-of-sight, baro and clock measurements
xmatdop 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

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(15) Pseudorange and Delta range determination and related functions

ionoec L1 iono correction computation by using Klobuchar model
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
uerror user earth rotation correction vector
xambig main program generating ambiguity numbers
xionoec 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
xnaerr main program generating 3A errors
xtropoc1 main program generating tropospheric delay contours for a specified location
xuclock main program generating user clock bias and clock drift
xueorcor main program generating and plotting the magnitude of the earth rotation correction vector for a specified longitude/latitude grid

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(16) Determination of user's position and related functions

uopp04 position fix determination by using Bancroft's algorithm when 4 measurements are known
uopp04 position fix determination by using Bancroft's algorithm when at least 4 measurements are known
uoppit 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
xupos04 main program determining the user's position fix by using a direct method when 4 measurements are known
xupos04 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 known

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(17) RINEX 2 data processing and position determination

svclock computation of satellite clock correction. WGS-84 constants are used
xrinex main program reading 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 reading 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

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(18) Basic RAIM/FDE functions

dmax delta_h_max computation (used in RAIM constant alarm rate algorithm)
raimfd RAIM availability and fault detection by using the parity vector algorithm (one step implementation)
raimat RAIM availability and fault detection by using the standard (constant alarm rate) algorithm
slopemaxslopemax computation (used in RAIM constant alarm rate algorithm)
XOPFR 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
xraimda 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
xraimat main program determining RAIM availability and fault detection by using the standard (constant alarm rate) algorithm
xraiope main program determining slopemax and delta_h_max for RAIM baseline standard (constant alarm rate) algorithm

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(19) Advanced RAIM/FDE functions

chi2_dof probability density function of Chi-square distribution with specified degrees of freedom
famt fault detection normalized thresholds
fbias_g parity bias for Chi-square distribution with degree of freedom greater than 1
fbias_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
ncchi2_dof probability density function for the non-central Chi-square distribution, where k is 2 to 10 for the degree of freedom 2 to 10
grupa Q-R updating algorithm of the measurement matrix when a new clock measurement is added
sdop sub-dilution of precision (sub-DOP) quantities
sdopv sub-weighted dilution of precision (sub-WDOP) quantities
xfamt main program computing the fault detection normalized thresholds
xhelvel1 main program determining the horizontal/vertical exclusion level (HEL/VEL) by using three different methods
xhplvpl1 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
xgrupa main program testing the Q-R updating algorithm of the measurement matrix when a new clock measurement is added
xdop sub-dilution of precision (sub-DOP) quantities
xwdopv sub-weighted dilution of precision (sub-WDOP) quantities

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(20) GPS receiver evaluation functions

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_clspseudorange 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
xcm_dg main program executing graphs related to carrier-to-noise power density ratio and pseudorange accuracy
xnbudget main program determining GPS error budget
xfom main program plotting the figure of merit versus estimated position error for a specified position error range
xpsrfs main program performing covariance analysis for the 5-state GPS receiver model (near stationary user)
xpsrfs main program performing covariance analysis for the 6-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

Kalman Filtering Toolbox List of Modules and Programs

To go to one of the below section click the desired link

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- [Specialized Matrix Operations](#)
- [Specialized Statistics Functions and Utilities](#)
- [Specialized Plotting Programs](#)
- [General Purpose and Conventional Kalman Filter Functions](#)
- [Specialized U-D Kalman Filter Functions](#)
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Matrix Storage and Allocation

matc2r rectangular matrix storage transformation from one-dimensional column-wise to one-dimensional row-wise

matr2c rectangular matrix storage transformation from one-dimensional row-wise to row-wise to one-dimensional column-wise

mrlto2 rectangular matrix storage transformation from one-dimensional column-wise array to two-dimensional array

mr2to1 rectangular matrix storage transformation from two-dimensional array to one-dimensional column-wise array

msc2f symmetric matrix storage transformation from one-dimensional array column-wise - only the upper triangular part stored, to two-dimensional array

msf2c symmetric matrix storage transformation from two-dimensional array to one-dimensional array - column-wise, only the upper triangular part is stored

msre reconstruct a full symmetric matrix from its stored upper triangular part; both input and output matrices are stored column-wise into one dimensional arrays

mstr extract the upper triangular part from a symmetric matrix; both input and output matrices are stored column-wise into one-dimensional arrays

mudc2f restore full U and D matrices stored as two-dimensional arrays from its compact upper triangular part stored column-wise as one-dimensional array

mudf2c store the full U and D matrices stored as two-dimensional arrays to its compact upper triangular part stored column-wise as one-dimensional array

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Specialized Matrix Operations

maat post-multiplication of a rectangular matrix by its transposed matrix; the input matrix is stored column-wise, one-dimensional, and the resultant symmetric matrix is stored column-wise - only the upper triangular part

mmab multiplication of two rectangular matrices when the resultant matrix is known to be a symmetric matrix; the input matrices are stored one-dimensional, column-wise, and the resultant matrix is stored column-wise - only the upper triangular part

mmrt multiplication of a rectangular matrix and an upper triangular matrix; the rectangular matrix is stored into two-dimensional array, the upper triangular matrix is stored into one-dimensional array column-wise - only the upper triangular part, and the

resultant matrix is stored into two-dimensional array
mphiu multiplication of a square matrix stored into two-dimensional array and a unit upper triangular matrix stored into one-dimensional array column-wise - only the upper triangular part; the resultant matrix is stored into two-dimensional array

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Specialized Statistics Functions and Utilities

cep circular error probable (CEP) computation
convcon setting of most used conversion constants
gauss_1 probability density function of the normal Gaussian distribution
genrn generation of random numbers with normal (Gaussian) distribution
gmp1 generation of first order Gauss-Markov sequence
gmp2 generation of second order Gauss-Markov sequence
rms root mean square (RMS) of a sample
rms2 modified root mean square (modified RMS) of a sample
rss root sum square (RSS) of a three component vector sample
rssxy root sum square (RSS) of a two component vector sample
rwalk generation of a random walk process
statup computation of the running mean, standard deviation and root mean square for a sample
vep vertical error probable (VEP) computation
xcepvep main program used to compute CEP or VEP
xgenrn main program generating random numbers with normal (Gaussian) distribution
xgmp1 main program generating first order Gauss-Markov sequence
xgmp2 main program generating second order Gauss-Markov sequence
xrwalk main program generating random walk process sequence
xstat main program testing the following modules: rms, rss, rssxy, and statup
xstatc main program determining mean, standard deviation, and root mean square (rms) of the elements of a specified column of the input array

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Specialized Plotting Programs

xpbar bar graph for a selected column
xyp1 x-y graph for a selected column
xypls 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

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General Purpose and Conventional Kalman Filter Functions

gobsd generation of observed data (measurements) for a linear time-invariant model; general form including control vector term is included
gobsd generation of observed data (measurements) for a

linear time-invariant model; the control term and process noise multiplier matrix are not included

kfcov covariance matrix analysis for a time-invariant model by using the conventional formulation

kfcov1 covariance matrix analysis for a time-invariant model by using the conventional formulation (variant of kfcov, time propagation and measurement incorporation steps are inverted)

kfcov1a covariance matrix analysis for a time-invariant model by using the alternate conventional formulation

mdric1 steady state solution of the discrete matrix Riccati equation; covariance matrix before measurement incorporation is determined

meas1cov covariance matrix measurement updating for one measurement by using conventional Kalman formulation (with symmetrization)

meas1jcov covariance matrix measurement updating for one measurement by using Joseph classical Kalman formulation (with symmetrization)

measjcov covariance matrix measurement updating for all measurements by using Joseph stabilized Kalman formulation

mndec decorrelation of the measurement noise

sdkf suboptimal (constant gain) discrete Kalman filter by using conventional formulation

smcov determination of smoothed covariance matrix based on Rautch-Tung-Striebel algorithm when the model parameters are constant

smcovps determination of smoothed covariance matrix and state based on Rautch-Tung-Striebel algorithm when the model parameters are constant

xgobsd main program generating the observed data (measurements) for a linear time-invariant model

xgobsdr main program generating the observed data (measurements) for a simplified linear time-invariant model

xkfcov main program executing the covariance analysis by using the conventional or alternate conventional Kalman filter formulation

xkfcovps main program executing the discrete Kalman filter (covariance and state analysis) by using the conventional Kalman filter formulation

xmdric main program computing the steady-state solution of the discrete matrix Riccati equation by using two different iterative methods

xmndec main program executing the decorrelation of the measurement noise

xsdkf main program computing the suboptimal (constant gain) discrete Kalman filter by using conventional formulation

xsmcov main program executing the Rautch-Tung-Striebel smoothing for covariance matrix, when model parameters are constant

xsmcovps main program executing the Rautch-Tung-Striebel smoothing for covariance matrix and state, when model parameters are constant

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Specialized U-D Kalman Filter Functions

mcud covariance matrix determination from its U-D factors

mrlup updating the U-D factors when a rank one matrix modification is applied

mreast measurement reasonableness test for a given scalar measurement

mudd U-D factorization of a real symmetric, positive (semi)definite matrix by using modified Cholesky decomposition

mudm U-D measurement updating by using Bierman algorithm for one measurement, when the measurement is the input

mudm1 U-D measurement updating by using Bierman algorithm

for one measurement, when the measurement residual is the input
 mudst standard deviations (sigmas) determination from the U-D factors
 mwgs1 U-D factors determination from the un-normalized W-DW factors (used in the modified weighted Gram-Schmidt algorithm)
 tpudd time propagation of U-D factors by using the direct method
 tpudds time propagation of U-D factors by using the modified weighted Gram-Schmidt method
 tpuuds time propagation of U-D factors by using the rank one matrix updating method
 xkfud main program implementing the discrete U-D form Kalman filter for a specified application. Several options related to the input/output data and selection of variant to be used are available
 xmuddu main program executing the decomposition and reconstruction of a real symmetric positive (semi) definite matrix into and from its U-D factors
 xmudm main program executing the discrete Kalman filter Biermna's U-D measurement updating algorithm
 xmudst main program determining sigmas (standard deviations) of a covariance matrix from its U-D factors
 xtpud main program executing time propagation of the U-D factors by using three different methods (direct method, rank one matrix updating method, and modified weighted Gram-Schmidt method)

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Application Dependent Modules

hmat measurement matrix computation
 phimat transition matrix computation
 qmat process noise matrix computation
 rmat measurement noise matrix computation

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GPS Application Modules

eleva elevation angle and the ECEF unit line-of-sight vector computation
 svpalm ECEF satellite position determination based on almanac data
 tgdecef geodetic to ECEF coordinates transformation
 uverv unit vertical vector for a given ECEF position vector
 vecefenu ECEF (Earth Centered Earth Fixed) to ENU (East, North, Up) transformation
 wgs84con setting of most used WGS-84 constants
 xgpsr5s main program performs covariance analysis for the 5-state GPS receiver model (for near-stationary user)
 xgpsr8s main program performing covariance analysis for the 8-state GPS receiver model (for near-constant velocity user)

RAS Toolbox List of modules and programs

To go to one of the below section click the desired link.

(1) General Data Processing for (Yuma, SEM, SP3, RINEX) Data Files

```
xread_sem      main program reading SEM almanac data and creating two data files
xread_sp3      main program reading the SP3 data file and creating three data files
xread_yuma     main program reading Yuma almanac data and creating two data files
xwrite_yuma    main program writing the Yuma format almanac file
xrinexn        main program reads a RINEX 2 navigation message data file and writes the data into four text files
xrinexn_select main program reads a RINEX 2 navigation message data file and writes the data into four text files;
               the reduced almanac and ephemeris data files are storing the data within the selected time interval
xrinexo        main program reads a RINEX 2 observation message file and writes the data into two text files
               (header and observation data only)
xrinexo_select main program reads a RINEX 2 observation message file and writes the data into two text files
               (header and observation data only); the reduced observation data file is storing only the data
               within the selected time interval
xrinex_obs     main program executing graphs related to the satellites data provided into the reduced observation
               data file generated by the program xrinexo
xsv_pv_plot_almanac main program executing graphs related to the position and velocity when the reduced almanac data is
               provided
xsv_pv_plot_ephemeris main program executing graphs related to the position and velocity when the reduced ephemeris data
               is provided
xsv_pv_plot_sp3  main program executing graphs related to the position and velocity provided into a sp3 file
```

(2) GPS Orbit Data Analysis

```
xsv_comparison_almanac      main program executing the satellites position/velocity comparison when two almanacs
                             data are provided
xsv_comparison_almanac_ephemeris main program executing the satellites position/velocity comparison when almanac and
                             ephemeris data are provided
xsv_comparison_almanac_sv_orbit main program executing the satellites position/velocity comparison when almanac and
                             sp3 orbit data are provided
xsv_comparison_ephemeris    main program executing the satellites position/velocity comparison when two ephemeris
                             data are provided
xsv_comparison_ephemeris_sv_orbit main program executing the satellites position/velocity comparison when ephemeris and
                             sp3 orbit data are provided
xsv_comparison_sv_orbit    main program executing the satellites position/velocity comparison when two sp3 orbit
                             data are provided
```

(3) User Position Determination

```
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
```

(4) Utility Modules

```
convcon     setting of most used conversion constants
elevaz      computation of elevation and azimuth angles, ECEF unit line of sight vector and range
geoidh      computation of WGS-84 geoid height correction
gpscon      setting of most used GPS constants
ionoc       computation of L1 iono correction for a specified user by using the Klobuchar model
pionoc      computation of pseudorange corrected for ionospheric effects
prn2svn     determination of the GPS satellite number for a specified GPS pseudorandom number
rms         computation of root mean square (RMS) of a sample
selectd     selection of the different elements from a specified array
svclockc    computation of satellite clock correction
svn2prn     determination of the GPS pseudorange number for a specified GPS satellite number
svpalm      determination of ECEF satellite position based on almanac data
svpeph      determination of ECEF satellite position based on ephemeris data
svpvalm     determination of ECEF satellite position and velocity based on almanac data
svpvpeph    determination of ECEF satellite position and velocity based on ephemeris data
tecefgd     ECEF to geodetic coordinates (direct method)
tropocl     computation of the tropospheric correction for a specified user by using a simplified model
uposit      computation of user's position from at least four ECEF satellite positions and the corresponding pseudoranges, by
             using a direct method
vecefenu    transformation from ECEF to ENU frames for a given position vector and referenced latitude/longitude angles
wgs84con    setting of most used WGS-84 constants
ymd2gps     determination of (GPS week, GPS roll number, day of week) from (year, month, day)
```

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