MADOCALIB Detailed Manual

QZSS Strategy Office, Cabinet Office

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Contents

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1. MADOCALIB detailed manual

Below is a detailed explanation of the differences between MADOCALIB and RTKLIB, the source software.

1.1. MADOCALIB folder structure

Figure 1.1-1 shows the folder structure of MADOCALIB. It consists only of the files necessary for redistributing the post-processing positioning software and building it on Windows.

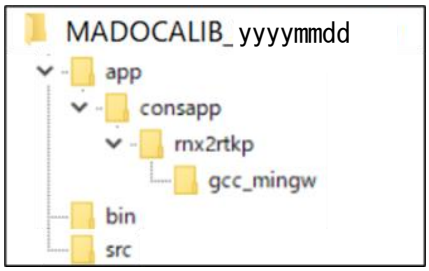

Figure 1.1-1 MADOCALIB folder structure

“gcc_mingw” folder：

“gcc_mkl” and “bcc” folders were deleted. Renamed gcc folder to gcc_mingw folder.
The makefile stored in the gcc folder is for Unix, so by reviewing the preprocessor options and linked libraries as shown below, it was modified to be able to build rnx2rtkp.exe that can be executed on Windows.

・Added -DWIN32 to OPTS.

・LDLIBS was set to -lwinmm.

“bin” folder：

A folder that stores executable formats generated using makefiles.

“src” folder：

・Diverted and stored 21 files included in RTKLIB 2.4.3b34.

・Overwritten the existing file with ppp_ar.c, the copyright of which is owned by JAXA, for PPP-AR processing.

・Added mdccssr.c, which performs L6E decoding to process Compact-SSR MADOCA-PPP in QZSS L6 archive format.

・Added mdciono.c, which performs L6D decoding of QZSS L6 archive format.

・Added ppp_iono.c, which handles ionospheric correction information.

1.2. Galileo E1-E5a signal support, addition of signal selection function

Figure 1.2-1 shows the types of dual-frequency signals in each satellite system used.

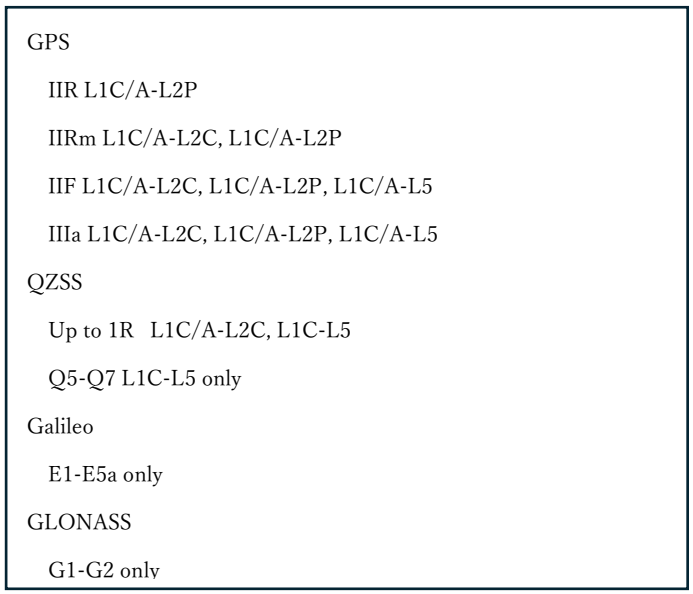

Figure 1.2-1 Dual frequency signals in each satellite system

The signal combinations to be used can be switched between two or three types specified by the requirements by definitions (GPS_IIR-M, GPS_IIF, GPSIIIA, QZSS-2) added to the Configuration File. For satellites other than those defined here, GPS used L1C/A-L2P, QZSS used L1C-L5, Galileo used E1-E5a, and GLONASS used G1-G2.

In the "**signal_sel_ppp**" function shown in Figure 1.2-2, by replacing [0] and [1] of the existing b34 **"obsd_t"** structure with the observable quantities of the specified signal using index operations, signal selection and import of Galileo E1-E5a was achieved. In addition, the "**signal_sel_ppp**" function was implemented in a way that does not require changes to the existing source code and variable contents before PPP processing by changing the variable name and passing the **"obsd_t"** through a variable called **"pppobs"** during PPP processing.

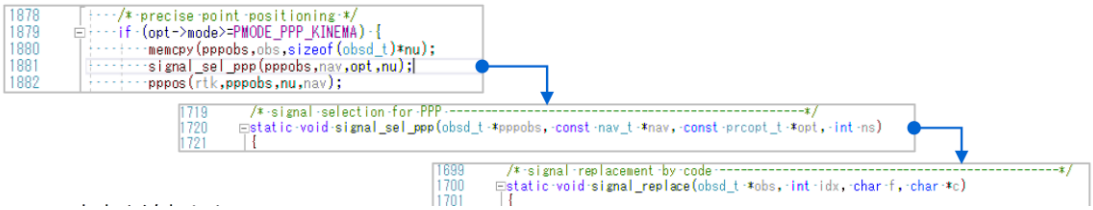

Figure 1.2-2 **"signal_sel_ppp"** function (excerpt)

Based on the above, we defined an option for signal selection in config as shown in Figure 1.2-3, so that the frequency used for calculation can be selected for each satellite group.

```
pos2-siggpsIIR-M    =0          # (0:L1C/A-L2P,1:L1C/A-L2C)
pos2-siggpsIIF      =0          # (0:L1C/A-L2P,1:L1C/A-L2C,2:L1C/A-L5)
pos2-siggpsIIIA     =0          # (0:L1C/A-L2P,1:L1C/A-L2C,2:L1C/A-L5)
pos2-sigqzs1_2      =1          # (0:L1C-L5,1:L1C/A-L2C)
```

Figure 1.2-3 Options for signal selection in config (excerpt)

In addition, in MADOCALIB, the combination of L1-L5 for GPS and L1-L2 for QZSS can be selected in the Configuration File, but if this selection is made, the satellite PCO is corrected to match the provider's definition.

1.3. Addition of augmentation data input function according to L6 archive format

A process to read L6 archive format Compact-SSR MADOCA-PPP correction information was added to MADOCALIB so that the existing RTCM3 SSR correction information application process can be reused. Although this is not a defined requirement, the implementation considers stream input, in future real-time processing. Figures 1.3-1 and 1.3-2 show the processing flow of augmented data according to the L6 archive format. Code Bias information distributed from L6 is read in **"mdccssr.c"**. Noted that regarding "update_qzssl6", "input_qzssl6", "input_qzssl6f", "update_qzssl6", and "decode_qzss_l6msg" in Figure 1.3-1 and Figure 1.3-2, in MADOCALIB 1.1b, they were renamed as follows: "input_qzssl6e", "input_qzssl6ef", "update_qzssl6e", " decode_qzss_l6emsg".

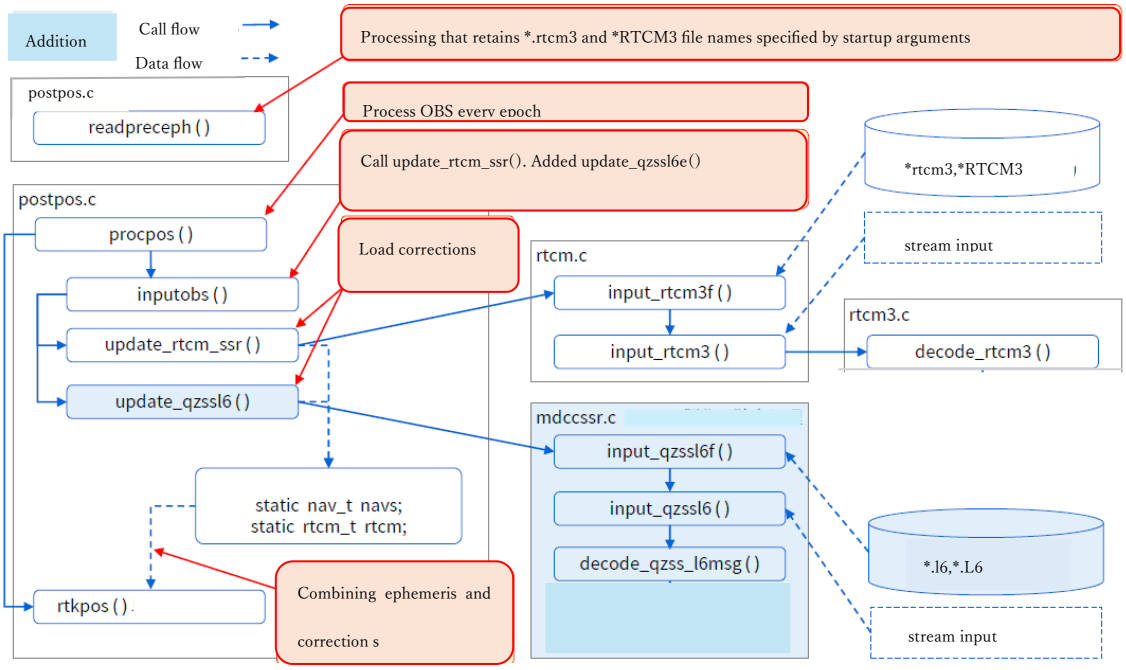

Figure 1.3-1 Augmentation data processing flow according to L6 archive format (1/2)

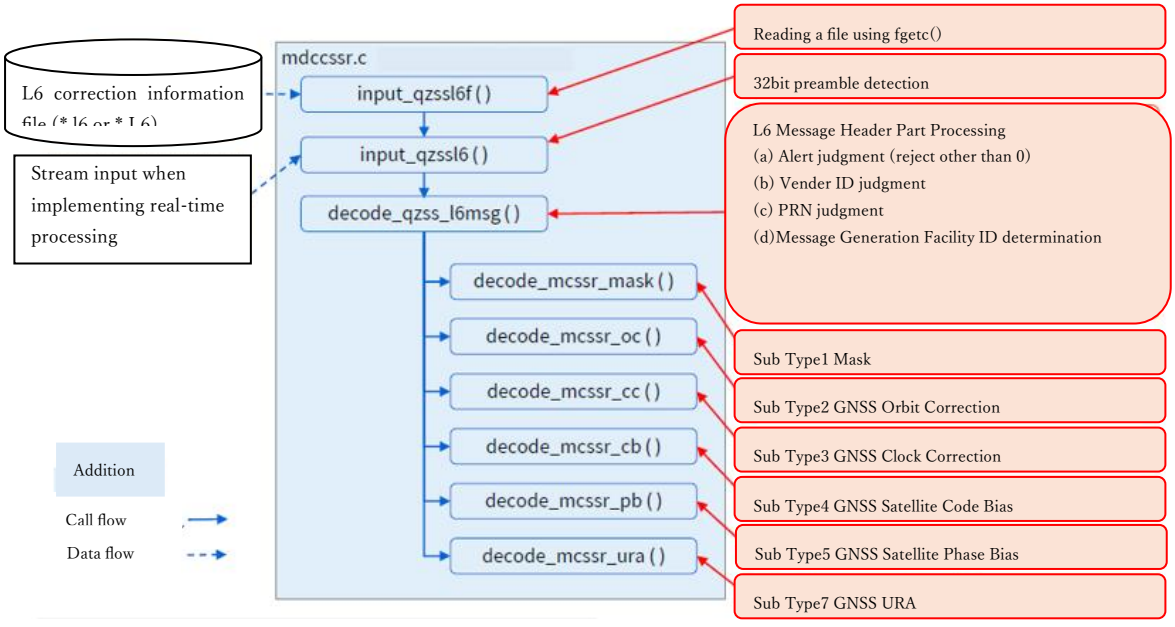

Figure 1.3-2 Augmentation data processing flow according to L6 archive format (2/2)

In addition, the function to apply Code Bias of all GNSS read by the function in **"mdccssr.c"** to observation data is implemented by adding it to the **"corr_meas"** function that corrects b34 existing observation data shown in Figure 1.3-3.

```
413         /* SSR cbias, pbias correction */↓
414         ssrcode = mcssr_sel_biascode(sys, obs->code[i]);↓
415         if((cb==0.0) && (ssrcode != CODE_NONE)) {↓
416             if(nav->ssr[obs->sat-1].cbias[ssrcode-1]!=0.0) cb=nav->ssr[obs->sat-1].cbias[ssrcode-1];
417             if(nav->ssr[obs->sat-1].pbias[ssrcode-1]!=0.0) pb=nav->ssr[obs->sat-1].pbias[ssrcode-1];
418         }↓
419         if(cb!=0.0) {↓
420             P[i]+=cb;↓
421             trace(3,"corr_meas cbias %s %s obscode=%2d ssrcode=%2d cbias=%7.3f¥n",↓
422                 tstr,satid,obs->code[i],ssrcode,cb);↓
423         }↓
424         if(pb!=0.0) {↓
425             /* Note, In ref [12] section 5.5.3.3,↓
426                it is also additive in code bias,↓
427               but for compatibility with conventional processing,↓
428               negative values are retained and subtracted. */↓
429             L[i]-=pb;↓
430             trace(3,"corr_meas pbias %s %s obscode=%2d ssrcode=%2d pbias=%7.3f¥n",↓
431                 tstr,satid,obs->code[i],ssrcode,pb);↓
432         }↓
```

Figure 1.3-3 Applying Code Bias to observation data (excerpt of **"corr_meas"** function in **"ppp.c"**)

Figure 1.3-4 shows the input processing flow for wide area ionospheric information L6 archive data. The extension of wide-area ionospheric information L6 archive data is ".l6", which is the same format as L6E's GNSS orbit time correction information L6 archive data. In order to distinguish between the two, we decided to process the file for which **"-mdciono file name"** was specified in the startup argument of **rnx2rtkp** as wide-area ionospheric information L6 archive data. It is now possible to specify a replacement keyword according to the processing time in the file name, similar to other read files.

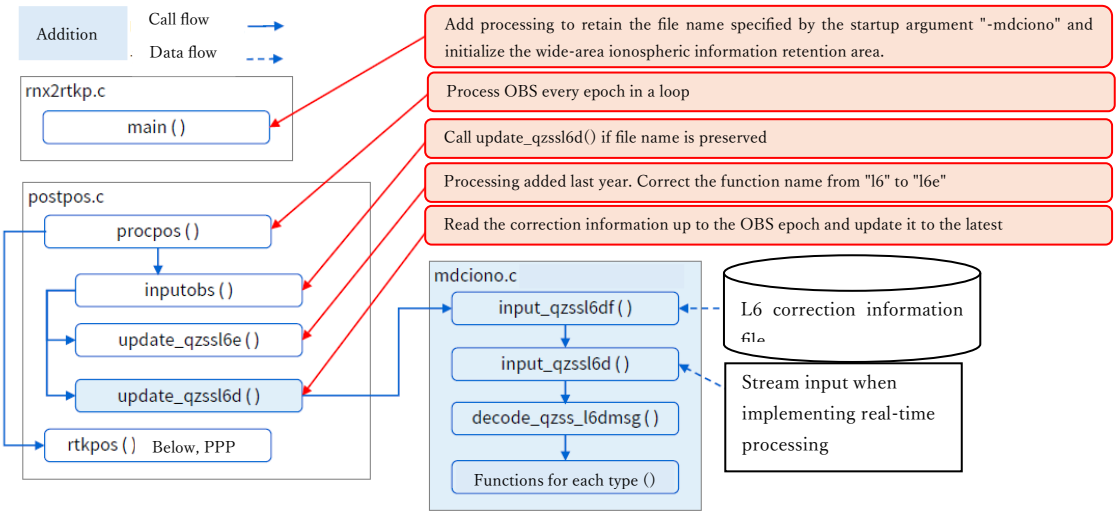

Figure 1.3-4 Wide area ionosphere information L6 archive data input process (1/2)

Figure 1.3-5 shows the structure of the main functions in **"mdciono.c"**.

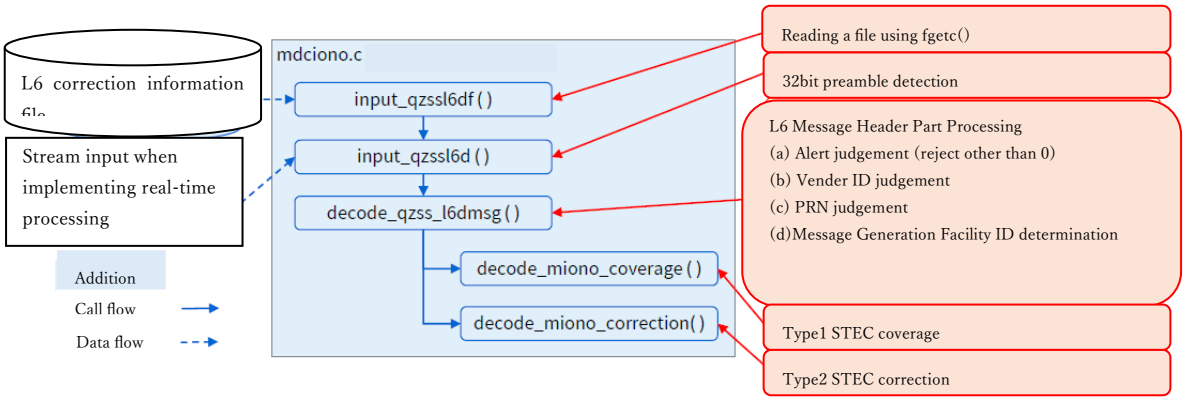

Figure 1.3-5 Wide area ionospheric information L6 archive data input process (2/2)

Additionally, files with the extension ".stat" or ".STAT" specified in the startup argument of **rnx2rtkp** will be treated as ionospheric information product output data files (*outputs slant ionospheric delay). The **"update_statcorr"** function loads the correction information up to the epoch of observation data (OBS) into **"postpos.c"** and updates it to the latest version. Inside it, the **"input_statcorr"** function processes the "$ION" line of the ionospheric information product output data file.

1.4. Addition of optional ON/OFF function for GNSS used

In order to be able to process each GNSS defined in the Compact SSR MASK of MADOCA-PPP Sub Type 1, ENAGLO, ENAGAL, ENAQZS, and ENACMP defined by the #ifdef preprocessor directive shown in Figure 1.4-1 are compiled with -D. Enabled in options.

```
145 #ifdef ENAGLO
146 #define MINPRNGLO   1                   /* min satellite slot number of GLONASS */
147 #define MAXPRNGLO   27                  /* max satellite slot number of GLONASS */
148 #define NSATGLO     (MAXPRNGLO-MINPRNGLO+1) /* number of GLONASS satellites */
149 #define NSYSGLO     1
150 #else
151 #define MINPRNGLO   0
152 #define MAXPRNGLO   0
153 #define NSATGLO     0
154 #define NSYSGLO     0
155 #endif
156 #ifdef ENAGAL
```

rtklib.h

Figure 1.4-1 Excerpt of rtklib.h

As shown in Figure 1.4-2, in the configuration file, in the **"pos1-navsys"** line, specify the GNSS to be used with the additional values of GPS: 1, GLO: 4, GAL: 8, QZS: 16, and BDS: 32. For example, when using all of these GNSS, set "pos1-navsys = 61".

```
pos1-exclsats      =          # (prn ...)
pos1-navsys        =1         # (1:gps+2:sbas+4:glo+8:gal+16:qzs+32:comp)
pos2-armode        =fix-and-hold # (0:off,1:continuous,2:instantaneous,3:fix-and-hold)
```

Ex:app¥consapp¥rnx2rtkp¥opts1.conf

Figure 1.4-2 Excerpt of configuration file

1.5. Addition of PPP-AR function

The PPP-AR feature replaced **"ppp_ar.c"** with the PPP-AR feature source file (ppp_ar.c) included in b34. Figure 1.5-1 shows how to apply the PPP-AR function source file.

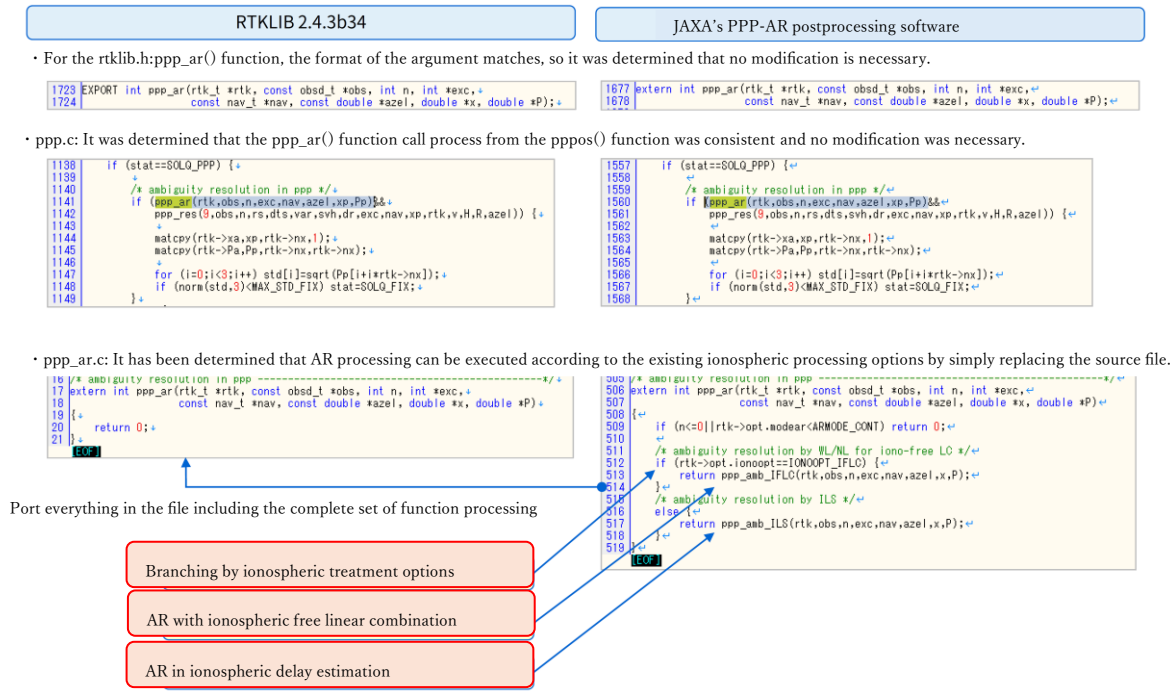

Figure 1.5-1 How to apply the PPP-AR function source file

In addition, in the ported **ppp_ar.c**, GPS, GAL, and QZS, excluding GLONASS, which are FDMA signals, are input to AR processing. As shown in Figure 1.5-2, **pos2-arsys** in the configuration file allows GNSS can be selected.

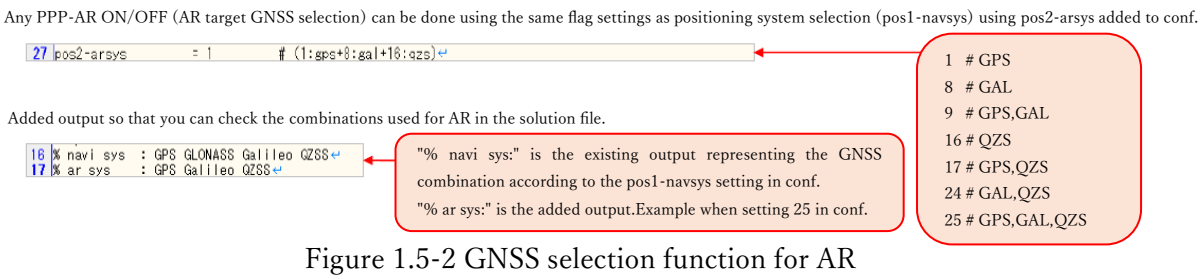

Figure 1.5-2 GNSS selection function for AR