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Triangle MicroWorks, Inc.  
IEC 60870-5-104 Master  
Source Code Library

What's New?

*a description of the changes included in all versions of the library*

Version 3.13.00  
November 17, 2011

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This document describes features or corrections that have been added to the IEC 60870-5-104 Master Source Code Library.





The symbols to the left of each revision are used to help define the following kinds of revisions:


- 104** Additional IEC 60870-5-104 Features, giving the Library support for more IEC 60870-5-104 objects or functions.
-  Additional Implementation Features, allowing implementers to more efficiently install the Source Code Library.
-  Corrections to problems, with indications for when the problems were introduced.


### **Version 3.13.00 (November 17, 2011)**


-  Modified 56-bit time decoding so that years 70-99 assume 1970-1999 instead of 2070-2099
-  Implemented performance improvement by modifying locking calls in `tmwdb_storeEntry`. This change applies only when processing data asynchronously.
-  Provided big endian get and put functions.
-  *Description:* LinIOTarg could access channel structure members after marking a channel for deletion.  
*Introduced:* v3.07  
*Resolution:* Fixed in v3.13


### **Version 3.12.00 (July 7, 2011)**

-  Added support for Double Transmission.
-  *Description:* The timer callback may continue to loop if a very short timer is added in the timer callback.  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.12
-  *Description:* When using redundancy, if a bad sequence number was detected, the library could fail to send the STARTDT if there was only one redundant channel.  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.12
-  *Description:* `tmwdtime_addOffset` did not follow 0 -599999 rule.  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.12


 *Description:* Some compilers issued warnings when a break followed a return (e.g., in tmwphysd.c).  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.12


 *Description:* In function tmwmem\_lowlnit(), a failure to allocate memory resulted in a return with no indication to the caller that a failure occurred.  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.12

 *Description:* The Master could try to send STOPDT on a disconnected channel.  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.12

 *Description:* LinIOTarg computed date incorrectly when converting a “struct tm” to TMWDTIME.  
*Introduced:* v3.07  
*Resolution:* Fixed in v3.12


### **Version 3.11.00 (October 1, 2010)**

 *Description:* The MASTER could send a STOPDT on a disconnected channel.  
*Introduced:* v3.03  
*Resolution:* Fixed in v3.11

 *Description:* A redundancy manual switchover could sent the STARTDT too soon.  
*Introduced:* v3.03  
*Resolution:* Fixed in v3.11


### **Version 3.10.00 (August 25, 2010)**


 Improved redundancy channel Open/Close/Active statistics.


 *Description:* The T3 timer did not get restarted on transmit.  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.10


### **Version 3.09.00 (March 15, 2010)**


 Added user data pointers to TMWCHNL, TMWSCTR, and TMWSESN.

 *Description:* When multiple application contexts are used, closing one deleted the memory pool lock, which could cause problems if another application context was open.  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.09

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*Description:* WinIOTarg could fail to process all available characters, causing timeouts when running at high baud rates.  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.09
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*Description:* When configured to use system time, WinIOTarg System time not setting the dstlnEffect flag correctly.  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.09
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*Description:* LinIOTarg did not set dayOfWeek in tmwtarg\_getDateTime function..  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.09
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*Description:* LinIOTarg could cause high levels of processor utilization when multiple channels were opened.  
*Introduced:* v3.07  
*Resolution:* Fixed in v3.09


### **Version 3.08.00 (September 25, 2009)**


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*Description:* The rs232Reader thread in WinIOTarg was missing a stop event.  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.08

### **Version 3.07.00 (July 17, 2009)**

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Added LinIOTarg (low-level target for Linux) and new command line-based examples (that can be used with Linux).
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Integrated WinIOTarg (low-level target for Windows) into the standard release package.
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Added IEC 60870-5-104 redundancy examples.
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Added FormatMessage Win32 API function to WinIOTarg to provide more descriptive errors instead of just numeric values.

### **Version 3.06.00 (April 14, 2009)**


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Added TMWCNFG\_MAX\_APPLRCVS to “break out” of loop in tmwappl\_checkForInput() after the specified number of iterations.
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Modified timer values in tmwlink\_channelCallback to speed up retries.
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*Description:* The Source Code Library did not properly close the channel after receiving a disturbed sequence number.  
*Introduced:* v3.0  
*Resolution:* Fixed in v3.06

### **Version 3.05.00 (December 4, 2008)**


-  *Description:* Closing a channel and quickly reconnecting it could result in a state of STOPPED.  
*Introduced:* v3.0  
*Resolution:* Fixed in v3.05


### **Version 3.04.01 (September 30, 2008)**


-  Improved comments on compiler options such as TMWCONFIG\_USE\_MANAGED\_SCL.


### **Version 3.04 (September 12, 2008)**

- 104 Added support for F\_SC\_NB (defined in IEC 60870-5-104 Edition 2).



-  *Description:* The Source Code Library could resend iframes in error if the W value on the receiver was larger than the K value on the sender and if the target layer could not send the iframes as fast as they were generated.  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.04


-  *Description:* The “link layer” did not properly handle receiving only the first octet of a message. (This condition is very unlikely to occur, and most likely requires a serial to TCP converter or TCP radio with slow data rates).  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.04

-  *Description:* tmwdb\_lockQueue and tmwdb\_unlockQueue were described in the header comments for tmwdb\_storeEntry in tmwdb.h, but they were not defined in tmwdb.c.  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.04

-  *Description:* Test Frames were sent even after disconnecting.  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.04

### **Version 3.03.00 (April 1, 2008)**


-  Added ability to include session indicator in channel statistics.
-  Modified behavior of Source Code Library to comply with IEC 60870-5-104 Edition 2. This change affects: C\_TS\_TA; handling of delayed commands containing time stamps; maximum APDU length; support for Type IDs <2>, <4>, <6>, <8>, <10>, <12>, <14>, <16>, <17>, <18>, <19>; and updates to the device profile document.


-  *Description:* The Source Code Library did not send STARTDT on a redundant channel until it received a test frame.  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.03

### **Version 3.02.00 (December 7, 2007)**


No updates to IEC 60870-5-104 Master Source Code Library in this release.


### **Version 3.01.01 (August 8, 2007)**

-  Added ability to keep time on a per-session basis. Added pSession to tmwdtime structure; target layer can use this parameter to return a time specific to the session.


-  *Description:* If an event was reported using a CP24 time stamp, and if the event time was larger than the current time, the Source Code Library decremented the hour.  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.01.01


### **Version 3.01.00 (May 23, 2007)**


-  Modified online notification algorithm to facilitate notification of sessions that never go online.

-  *Description:* The IEC 60870-5-104 “link layer” open may occur before ACTIVE\_STOPPED is set.  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.00.51

### **Version 3.00.49 (November 1, 2009)**

-  Renamed TMWCHNL\_STAT\_CALLBACK and TMWSESN\_STAT\_CALLBACK macros to TMWCHNL\_STAT\_CALLBACK\_FUNC and TMWSESN\_STAT\_CALLBACK\_FUNC. This change avoids having a macro and a typedef with the same name.

-  *Description:* The Source Code Library did not properly recognize the response to a C\_BO\_TA command.  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.00.49

-  *Description:* The Source Code Library did not allow the target to specify the control mode for C\_BO\_NA commands.  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.00.49



*Description:* The link layer could send, even after the target layer indicated the connection was broken.

*Introduced:* v3.00

*Resolution:* Fixed in v3.00.49



*Description:* The received frame sequence number processing code was too tolerant of missed frames.

*Introduced:* v3.00

*Resolution:* Fixed in v3.00.49



*Description:* The Source Code Library did not properly convert between QCC and counter groups when processing a freeze counter command.

*Introduced:* v3.00

*Resolution:* Fixed in v3.00.49

### **Version 3.00.46 (April 27, 2006)**



Modified release to include WinIoTarg.dll built with Visual Studio 6. This DLL is used when using Visual Studio to build the sample applications.



Provided a method to cancel the physical layer if a command is canceled at a higher layer.



Updated sample Makefiles to correctly build Source Code Library.

### **Version 3.00.45 (March 17, 2006)**



Improved documentation in protocol-specific section of the manual. Provided additional text, reorganized layers, and included all header files that comprise the API.



Added support for Gasunie PIDs (mitnc, mittc, csenz, mctna, cctna, msptb, mdptb, mbotb, mmetf, and ctsna). Also optionally modified GI RTU/LU behavior. (Note: this behavior contradicts the specification and should only be used for Gasunie).



Updated sample Makefiles to correctly build Source Code Library.

### **Version 3.00.44 (February 2, 2006)**



Added a sample application to provide an example of a multi-threaded, event-driven application.



Set receive indication in diagnostic information to indicate the direction of the message.



Enhanced statistics to include additional values such as CRC errors, number of invalid start bytes, frame length errors, etc.



Split into tmwtarg.h/c into tmwtarg.h/c and tmwtargp.c/c. This change moves all Triangle MicroWorks, Inc. specific code into a separate file. Customers only need to modify tmwtarg.c.

### **Version 3.00.43 (December 2, 2005)**

No updates to IEC 60870-5-104 Master Source Code Library in this release.

### **Version 3.00.42 (September 12, 2005)**



Improved documentation by updating *IEC 60870-5-104 Master.doc* to improve readability and include all user-modifiable files.



Added subversion to SCL filename (e.g., m104v30042.exe). This allows the version number to be determined from the file name. The version number continues to be defined in tmwvrsn.h.



*Description:* The Source Code Library could potentially reference a Null pointer in tmwdlist\_removeEntry

*Introduced:* v3.00

*Resolution:* Fixed in v3.00.42

### **Version 3.00.41 (July 20, 2005)**



Added ability (via new m104brm\_cicnaDeact function and new activate parameter to m14brm\_cicna function) to send C\_IC\_NA with COT\_DEACTIVATION.



Added comment in header of m104brm.h to describe proper handling of an error response to a general interrogation command.



*Description:* The Source Code Library incorrectly reported an I Frame timeout if the response was received after the response timer timeout, but before the link layer timeout.

*Introduced:* v3.00

*Resolution:* Fixed in v3.00.41

### **Version 3.00.40 (June 3, 2005)**




Added 104Master sample application executables and required DLLs to allow running this application without having to build it.




Improved documentation of memory type configuration.





Fixed compiler warning for TMWTYPES\_BOOL type.


 *Description:* m14mem\_init() used compiled values instead of runtime values for initialization.  
*Introduced:* v3.00.39  
*Resolution:* Fixed in v3.00.40

 *Description:* TMWMEM\_FREE\_FUNC was doubly defined.  
*Introduced:* v3.00.39  
*Resolution:* Fixed in v3.00.40


### **Version 3.00.39 (March 29, 2005)**


 Improved memory management within Source Code Library. Added new #define (TMWCNFG\_ALLOC\_ONLY\_AT\_STARTUP) to tmwcnfg.h. Also added new functions that the target to set the maximum number of each buffer in each pool at runtime. Both “only at startup” and static allocations use a linked list of free and allocated buffers instead of just an array that was accessed sequentially.

 Added call to channel statistics (TMWCHNL\_STAT\_ACTIVE) to indicate which channel in a redundancy group is active.


 Added description and example of custom ASDU support to User Manual.

### **Version 3.00.38 (January 18, 2005)**

 Modified the API for the channel, session, sector modify functions to initialize a structure with the current settings. Any of these settings may then be modified by the target code.

 Added ability to display structured IOAs. A new configuration option specified when opening an IEC 60870-5-101 or -104 session indicates that the IOA should be specified as a set of bytes instead of an unsigned long.

### **Version 3.00.37 (December 15, 2004)**

 *Description:* i870lnk4.c generated two “result comparison always returns 0” warnings if UCHAR was defined as 8 bits.  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.00.37

### **Version 3.00.36 (November 2, 2004)**

No updates to IEC 60870-5-104 Master Source Code Library in this release.

### **Version 3.00.35 (September 22, 2004)**



Added #define TMWCNFG\_MEMORY\_ALIGN\_NEEDED to tmwcnfg.h to support processors requiring long word (4 byte) alignment and compilers that create unpacked structures.



Added tmwapp\_startTimer and tmwapp\_cancelTimer to tmwtarg.c.  
NOTE: These functions must be defined in the target in order for the Source Code Library to link.

### **Version 3.00.34 (July 30, 2004)**



*Description:* The Source Code Library could call tmwtarg\_startTimer with a negative value. For some operating systems, this causes timers to stop running.  
*Introduced:* v3.00.32  
*Resolution:* Fixed in v3.00.34



*Description:* The algorithm for sorting timers did not work properly if the two times being compared were more than 17 days apart.  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.00.34



*Description:* The simulated database did not check for an error return from tmwsim\_newPoint, potentially causing the sample application to crash.  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.00.34



*Description:* i870util.h was sometimes included as l870util.h, causing compilation problems with some compilers.  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.00.34

### **Version 3.00.33 (June 17, 2004)**



Added ability to queue requests with duplicate ASDU types. Instead of failing the request, the Source Code Library now queues the new request on a pendingMsgQueue. If the request is a duplicate, the request already on the pendingMsgQueue is canceled.



*Description:* The C\_SC\_TA Single command, C\_DC\_TA double command, and C\_RC\_TA Regulating Step command did not work properly because the Master did not clear the select bit when sending an execute when automatically performing select/execute commands.  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.00.33

## **Version 3.00.32 (June 4, 2004)**



Enhanced support for multiple threads. Added support for one timer queue per channel. Also improved locking/unlocking to prevent threads from being interrupted or deadlocked. This enhancement required two changes to the API:

- Added new `#define(TMWCNFG_MULTIPLE_TIMER_QS)` to allow support of multiple timer queues (default is `TMWDEFS_FALSE`)
- Added new parameter to `tmwdb_storeEntry()` to indicate whether the queue should be locked (default is not to lock the queue).

*Any implementation using multiple threads should upgrade to this release*



Added support for using RES1 bit in 7 octet binary time to indicate Genuine or Substituted time.



Improved detection of sessions going offline. The session is no longer marked offline if an application request times out.



Added a session-level statistic to indicate that an application layer response timed out.



*Description:* Opening a redundant IEC 60870-5-104 channel did not initialize dynamic memory.

*Introduced:* v3.00

*Resolution:* Fixed in v3.00.32



*Description:* The `_timerCallback` function in `tmwtimer.c` did not always lock the proper channel.

*Introduced:* v3.00

*Resolution:* Fixed in v3.00.32



*Description:* Modifying a session to set “active” to `TMWDEFS_TRUE` did not make the session active.

*Introduced:* v3.00

*Resolution:* Fixed in v3.00.32



*Description:* `tmwappl_initApplication()` could not be called more than once.

*Introduced:* v3.00.29

*Resolution:* Fixed in v3.00.32



*Description:* A 31-day timer would expire immediately.

*Introduced:* v3.00

*Resolution:* Fixed in v3.00.32

### **Version 3.00.29 (March 31, 2004)**



*Description:* When configured for Static memory support, the Source Code Library could fail to allocate buffers if they contained non-zero data on startup.

*Introduced:* v3.00.23

*Resolution:* Fixed in v3.00.29

### **Version 3.00.28 (March 2, 2004)**



*Description:* Application Layer messages were not removed from the queue when the Link Layer timed out.

*Introduced:* v3.00

*Resolution:* Fixed in v3.00.27

### **Version 3.00.27 (February 3, 2004)**

No updates to IEC 60870-5-104 Master Source Code Library in this release.

### **Version 3.00.26 (January 15, 2004)**

No updates to IEC 60870-5-104 Master Source Code Library in this release.

### **Version 3.00.25 (December 12, 2003)**

No updates to IEC 60870-5-104 Master Source Code Library in this release.

### **Version 3.00.24 (November 10, 2003)**

No updates to IEC 60870-5-104 Master Source Code Library in this release.

### **Version 3.00.23 (October 31, 2003)**



Added locks to tmwmem.c to add support for multiple threads to memory management routines.



Provided optimizations when diagnostics are not compiled in.



*Description:* The Source Code Library did not deallocate the txData structure when using a serial link and the confirm was not received.

*Introduced:* v3.00

*Resolution:* v3.00.23

### **Version 3.00.21 (October 8, 2003)**



Improved detection of sessions going offline. Any application layer error will now take a session offline.

### **Version 3.00.20 (September 2, 2003)**



Added callback function to let target application know when a channel is idle and can be disconnected.



An evaluation version of a working sample of a Windows application is now shipped with the Source Code Library. The evaluation expires after running for two hours.



*Description:* If TMWCNFG\_SUPPORT\_DOUBLE wasn't supported, compilation issues would occur.

*Introduced:* v2.00

*Resolution:* Fixed in v3.00.20

### **Version 3.00.19 (August 8, 2003)**



*Description:* The Source Code Library could call tmwtarg\_startTimer even if the timer was already running. This issue only affected event driven implementations (i.e., implementations that did not use the polled timer implementation).

*Introduced:* v3.00

*Resolution:* Fixed in v3.00.19

### **Version 3.00.18 (July 22, 2003)**

No updates to IEC 60870-5-104 Master Source Code Library in this release.

### **Version 3.00.17 (July 10, 2003)**



Improved implementation of internal data passed to callback functions to return a well defined structure and status codes.



Consolidated M14SESN\_RESPONSE\_INFO, M103SESN\_RESPONSE\_INFO etc. into a single structure (I870CHNL\_RESPONSE\_INFO).



Added TMWTARG\_CONFIG structure to allow specification of parameters that are common to multiple protocols.



*Description:* If a command required multiple responses, the reference returned by the m104brm\_xxx callback functions was not the original reference.









*Introduced:* v3.00

*Resolution:* Fixed in v3.00.17

### **Version 3.00.16 (June 19, 2003)**





Added limit checks for sprintf statements. This prevents buffer corruption caused by writing past the end of the current buffer.

-  Modified Source Code Library to avoid string copies for diagnostics when the diagnostics aren't enabled.
-  Restructured Source Code Library to allow Master and Slave sessions on a channel simultaneously to support Peer or Dual mode. Removed p10x files.
-  Added a sector configuration parameter for all command types (CSENA, CSENB, CSENC, CSETA, CSETB, CSETC) to specify whether the optional ACT TERM is sent back to the master upon completion of the Set command.
-  Added current version number to *tmwvrsn.c/h* in the *utils* directory to simplify determining which version of the Source Code Library is in use.
-  Improved Protocol Analyzer display to use terminology from standards documents; now display "SQ" instead of "SEQ" for Single/Sequence bit.
-  Cleaned up compiler warnings and issues identified by *lint*.
-  *Description:* Broadcast times did not work properly  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.00.16
-  *Description:* Broadcast messages for Clock Sync & General Interrogation commands did not work properly  
*Introduced:* v3.00  
*Resolution:* Fixed in v3.00.16



### **Version 3.00.15 (May 27, 2007)**

No updates to IEC 60870-5-104 Master Source Code Library in this release.



### **Version 3.00.14 (May 9, 2003)**

-  Improved detection of sessions going offline. Any application layer error will now take a session offline. Receiving any valid fragment from that session will take it back online.
-  Improved memory management. Implemented a new memory management scheme that supports static memory as well as providing limits on the number of each type of structure that can be allocated. It also provides details on how many structures of each type have been allocated and keeps track of the maximum number that was allocated. This provides feedback that can be used in sizing applications and monitoring allocated memory. Cleaned several areas in which memory was not being freed properly.


### **Version 3.00.12 (April 28, 2003):**

-  Added Incremental Application Layer Response Timeout configuration parameter.
-  The Incremental Timeout timer is now disabled if the timeout value is set to zero


### **Version 3.00.11 (April 24, 2003):**

-  If a connection is broken or the remote device restarts, the Source Code Library will attempt to reopen the connection.
-  Added support for custom response ASDU types.

### **Version 3.00 (April 28, 2003):**

-  The Triangle MicroWorks, Inc. Source Code architecture was redesigned and reimplemented to follow modern software engineering practices and leverage new techniques in software design. We have also incorporated suggestions from our existing customer base. The main advantages to this redesign include:
  - 1) Common source code architecture across all TMW libraries - The use of a common architecture across all libraries significantly reduces time required to port additional protocols to a target device. In addition, using common software across all products results in better code, since common functions are utilized much more frequently than protocol specific functions.
  - 2) Source Code Library calling routines are now compatible with a wider variety of event driven techniques, allowing the target application to be achieve higher performance.
  - 3) Most configuration parameters are now passed as arguments in Source Code Library function calls instead of macros. The allows for data hiding and protects configuration parameters from accidentally being changed while the Source Code Library is running. In addition, macro calls to target hardware and the database interface routines were replaced with function calls.
  - 4) Significant reduction in the time to implement new features - In addition to being more flexible, the use of modern software design practices significantly reduces the time required for Triangle MicroWorks to support new features. As the existing protocols are constantly being improved by the associated Technical Committees and Working Groups, it is essential that the Source Code Libraries are able to remain up to date with the latest standards.

### **Version 2.14 (July 10, 2002):**

-  Fixed bugs in file transfer which caused the segment size to be hardcoded to 230 bytes, the information object address to be hardcoded to zero and the checksum in the last segment request to be incorrect.





### **Version 2.13 (March 21, 2002):**

- 104 Added support for protection equipment events including ASDU types 17(MEPTA), 18(MEPTB), 19(MEPTC), 38(MEPTD), 39(MEPT E), and 40(MEPTF).


### **Version 2.12 (January 24, 2002):**

- 104 Added support for File Transfer, this includes support for file transfer in both the monitor and control directions..

### **Version 2.08 (September 4, 2001):**

- 104 Added support for bitstring commands with and without time tags (Type ID C\_BO\_NA\_1 and C\_BO\_TA\_1).
- 104 Added support for custom ASDU types: 240 – Integrated Totals BCD, 241 – Integrated Totals BDC with Time Tag and 242 – Integrated Totals BDC Command.
- 104 Added limited file ID support (Type ID's 122 and 123).
-  Corrected a problem with `tmwclprm_parseSector()` that could have resulted in illegal references of memory when multiple Source Code Libraries are installed. Introduced in initial release.
-  Fixed sequence number problem when cyclic data is received during initialization by initializing `LastMatchedSequence` to 0. Introduced in initial release.
-  Fixed compile time errors when `M104TARG_DIAG_FEATURE_MASK()` is set to zero. Introduced in initial release.
-  Corrected bugs with running multiple sessions and sectors on the same communication channel. Introduced in initial release.

### **Version 2.07 (May 21, 2001):**

-  Initial release of the IEC 60870-5-104 Master Source Code Library.