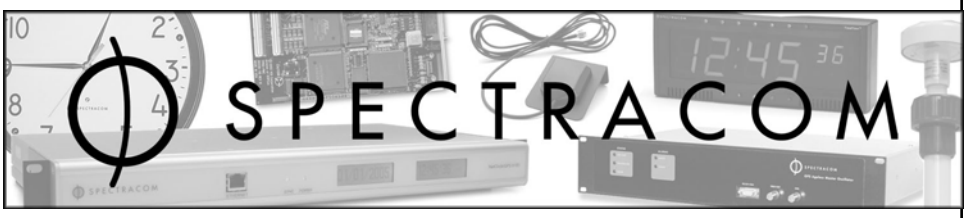
TPRO-PCI-U/TSAT-PCI-U
SYNCHRONIZABLE TIMECODE GENERATOR with UNIVERAL PCI BUS INTERFACE

LynxOS Driver
Application Programmer's Guide

95 Methodist Hill Drive
Rochester, NY 14623
Phone: US +1.585.321.5800
Fax: US +1.585.321.5219



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SPECTRACOM 95 Methodist Hill Drive Rochester, NY 14623

+1.585.321.5800 FAX: +1.585.321.5218 www.spectracomcorp.com sales@spectracomcorp.com

Table of Contents

1 Overview

The LynxOS Driver for the Spectracom TPRO/TSAT PCI boards provides the interface for multiple users to access the board using the API documented in Chapter Three.

The TPRO/TSAT-PCI performs timing and synchronization functions referenced to an input timecode signal. The board synchronizes its on-board clock to the incoming timecode. The on-board clock's time is also provided as an IRIG-B output. The board includes a time-tag TTL input, a programmable "heartbeat" pulse or squarewave output (with interrupt capability), and a programmable "match" start/stop time output (with interrupt capability)

The TPRO/TSAT-PCI continues to increment time ("freewheel") in the absence of an input timecode. Thus, the board can be used as an IRIG-B timecode generator by setting the initial time via the PCI bus.

The input timecode format (IRIG-B, IRIG-A, or NASA36) is detected automatically. Synchronization to the input timecode is also automatic and can be enabled/disabled via the PCI bus. A propagation delay offset may be specified to compensate for cable delays.

The timecode input is an amplitude-modulated sine wave. An automatic gain control (AGC) circuit permits a wide range of input amplitudes. The timecode input is differential; the board does not reference this signal to ground. A single-ended input (referenced to ground) is also acceptable.

The board can be ordered with option "-M" to synchronize to a one-pulse-per-second (1PPS) input instead of an incoming timecode. In this case, the initial time is programmed via the PCI bus, and the board begins counting on the next 1 PPS pulse.

2 Installing the Driver

2.1 The TAR File

The TAR file contains the following files:

- driver/tpropci.obj
- driver/tpro_device_info
- lib/libtpro.a
- lib/tpro.h
- examples

2.2 Installing the TPRO/TSAT-PCI LynxOS Driver

This release of the driver must be dynamically installed using the steps described below (note that a shell script can be written to execute the steps).

2.2.1 Step One

Load the driver.

Change to the driver directory and use the drinstall command:
drinstall -c tpropci.obj

2.2.2 Step Two

Install the device.

In the driver directory, use the devinstall command:
devinstall -c -d <driver-id> tpro_device_info

The <driver-id> argument is the value returned from the “drinstall” command above.

2.2.3 Step Three

Create a node using the mknod command:
mknod /dev/tpropci# c <major number> <minor number>

“#” is a zero-based board identifier. The first board has a value of 0, the second a value of 1, the third of 2, etc.

The <major number> argument is the number assigned to the device after the devinstall command and can be obtained by using the devices command. The <minor number> is user definable.

NOTE: Installation must be performed every time LynxOS boots up. Under usual conditions, Step Three needs to be performed only once, unless the device's major number changes.

2.3 Application Example

```
#include <stdio.h>
#include <stdlib.h>

#include <tpro.h>

int main (int argc, char *argv[])
{
  TPRO_BoardObj *pBoard;
  TPRO_TimeObj tproTime = {0};
  int tmp;
  unsigned char rv;

  if (argc != 5) {
    printf ("Usage: SetTime <days> <hours> <minutes> <seconds>\n");
    return (1);
  }

  /**
  ***  read into time object
  **/

  sscanf (argv[1], "%d", &tmp);
  tproTime.days = (unsigned short) tmp;

  sscanf (argv[2], "%d", &tmp);
  tproTime.hours = (unsigned char) tmp;

  sscanf (argv[3], "%d", &tmp);
  tproTime.minutes = (unsigned char) tmp;

  sscanf (argv[4], "%d", &tmp);
  tproTime.seconds = (unsigned char) tmp;


  /**
  ***  open board
  **/

  if (rv = TPRO_open (&pBoard, "/dev/tpropci0"), rv != TPRO_SUCCESS) {
    printf ("Could Not Open Board!! [%d]\n", rv);
    return (1);
  }


  /**
  ***  set time
  **/

  if (rv = TPRO_setTime (pBoard, &tproTime), rv != TPRO_SUCCESS) {
    printf ("Could not set time!! [%d]\n", rv);
    return (1);
  }


  /**
  ***  close board
  **/

  if (rv = TPRO_close (pBoard), rv != TPRO_SUCCESS) {
    printf ("Could Not Close Board!! [%d]\n", rv);
    return (1);
  }

  return (0);
}
```

3 Interface to the LynxOS Driver API

NOTE: The “example” directory contains source files and the makefiles to build them. The “lib” directory contains the tpro.h header file and the libtpro.a library used to build custom applications.

3.1 Header File

The following is the “TPRO.H” API Interface Header File.

```
/*****************************************************************
  KSI TPRO/TSAT - Interface Header

               KSI
               380 Foothill Road
               Bridgewater, NJ 08807

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*****************************************************************/

/*****************************************************************
  TPRO.H
*****************************************************************/

#ifndef _defined_TPRO_
#define _defined_TPRO_

/*****************************************************************
                        SUPPORT CONSTANTS
*****************************************************************/


/**
***  Heartbeat constants
**/

#define SIG_PULSE      (0xE5)          /*-- heartbeat is a pulse --------*/
#define SIG_SQUARE     (0xE7)          /*-- heartbeat is a squarewave ---*/

#define SIG_NO_JAM     (0)             /*-- start next cycle ------------*/
#define SIG_JAM                (1)     /*-- start immediately -----------*/


/**
***  Match constants
**/

#define MATCH_TIME_START       (0)     /*-- start time ------------------*/
#define MATCH_TIME_STOP        (1)     /*-- stop time -------------------*/


/**
***  Oscillator frequencies - for Compact PCI Card Only
**/

#define OSC_OUT_OFF            (0)
#define OSC_OUT_1KHZ   (1)
#define OSC_OUT_1MHZ   (2)
#define OSC_OUT_5MHZ   (3)
#define OSC_OUT_10MHZ  (4)


/*****************************************************************
                             OBJECTS
*****************************************************************/


/*===============================================================
                        TPRO BOARD OBJECT
```

```
=========================================================================*/

typedef struct TPRO_BoardObj
{ /*-----------------------------------------------------------------*/
  int file_descriptor;
  unsigned short devid;

  unsigned short options;

  unsigned char firmware[5];
  unsigned char FPGA[5];
  unsigned char driver[7];
{ /*-----------------------------------------------------------------*/
TPRO_BoardObj;


/*=========================================================================
                       TPRO ALTITUDE OBJECT
=========================================================================*/

typedef struct TPRO_AltObj
{ /*-----------------------------------------------------------------*/
  float         meters;                                 /*-- meters -------------*/
{ /*-----------------------------------------------------------------*/
TPRO_AltObj;


/*=========================================================================
                         TPRO DATE OBJECT
=========================================================================*/

typedef struct TPRO_DateObj
{ /*-----------------------------------------------------------------*/
  unsigned short year;               /*-- year --------------------*/
  unsigned char  month;                     /*-- month -------------------*/
  unsigned char  day;                /*-- day ---------------------*/
{ /*-----------------------------------------------------------------*/
TPRO_DateObj;


/*=========================================================================
                 TPRO LONGITUDE/LATTITUDE OBJECT
=========================================================================*/

typedef struct TPRO_LongLat
{ /*-----------------------------------------------------------------*/
  unsigned short degrees;                   /*-- degrees -----------------*/
  float         minutes;                    /*-- minutes -----------------*/
{ /*-----------------------------------------------------------------*/
TPRO_LongObj, TPRO_LatObj;


/*=========================================================================
                        TPRO MATCH OBJECT
=========================================================================*/

typedef struct TPRO_MatchObj
{ /*-----------------------------------------------------------------*/
  unsigned char   matchType;         /*-- start/stop time ---------*/

  double         seconds;                   /*-- seconds -----------------*/
  unsigned char   minutes;                  /*-- minutes -----------------*/
  unsigned char   hours;                    /*-- hours -------------------*/
  unsigned short  days;                     /*-- days --------------------*/
{ /*-----------------------------------------------------------------*/
TPRO_MatchObj;


/*=========================================================================
                       TPRO SATINFO OBJECT
=========================================================================*/

typedef struct TPRO_SatObj
{ /*-----------------------------------------------------------------*/
  unsigned char satsTracked;         /*-- num sats tracked ----------*/
  unsigned char satsView;                   /*-- num sats in view ----*/
{ /*-----------------------------------------------------------------*/
TPRO_SatObj;


/*=========================================================================
```

```
                      TPRO HEARTBEAT OBJECT
==========================================================================*/

typedef struct TPRO_HeartObj
{ /*-------------------------------------------------------------------------*/
  unsigned char signalType;          /*-- square or pulse -------------*/
  unsigned char outputType;          /*-- jamming option --------------*/

  double  frequency;                 /*-- heartbeat freq ---------------*/
{ /*-------------------------------------------------------------------------*/
TPRO_HeartObj;


/*==========================================================================
                        TPRO TIME OBJECT
==========================================================================*/

typedef struct TPRO_TimeObj
{ /*-------------------------------------------------------------------------*/
  double         secsDouble;         /*-- seconds floating pt ---------*/
  unsigned char  seconds;                   /*-- seconds whole num -----------*/
  unsigned char  minutes;                   /*-- minutes ---------------------*/
  unsigned char  hours;                     /*-- hours -----------------------*/
  unsigned short days;               /*-- days ------------------------*/

  unsigned short year;                      /*-- year for CPCI board ---------*/
{ /*-------------------------------------------------------------------------*/
TPRO_TimeObj;


/*==========================================================================
                        TPRO WAIT OBJECT
==========================================================================*/

typedef struct TPRO_WaitObj
{ /*-------------------------------------------------------------------------*/
  unsigned int ticks;                /*-- # ticks to wait -------------*/

  double  seconds;                          /*-- seconds ----------------------*/
  unsigned char  minutes;                   /*-- minutes ---------------------*/
  unsigned char  hours;                     /*-- hours -----------------------*/
  unsigned short days;               /*-- days ------------------------*/
{ /*-------------------------------------------------------------------------*/
TPRO_WaitObj;

/*==========================================================================
                  TPRO MEM OBJECT FOR PEEK/POKE
==========================================================================*/

typedef struct TPRO_MemObj
{ /*-------------------------------------------------------------------------*/
  unsigned short offset;
  unsigned short value;

  unsigned long l_value;
} /*-------------------------------------------------------------------------*/
TPRO_MemObj;


/****************************************************************************
                          ERROR CODES
****************************************************************************/

#define TPRO_SUCCESS                  (0)     /*-- success ---------------*/
#define TPRO_HANDLE_ERR                       (1)     /*-- error bad handle ------*/
#define TPRO_OBJECT_ERR                       (2)     /*-- error creating obj ----*/
#define TPRO_CLOSE_HANDLE_ERR         (3)     /*-- err closing device ----*/
#define TPRO_DEVICE_NOT_OPEN_ERR              (4)     /*-- device not opened -----*/
#define TPRO_INVALID_BOARD_TYPE_ERR   (5)     /*-- invalid device --------*/
#define TPRO_FREQ_ERR                 (6)     /*-- invalid frequency -----*/
#define TPRO_YEAR_PARM_ERR                    (7)     /*-- invalid year ----------*/
#define TPRO_DAY_PARM_ERR                     (8)     /*-- invalid day -----------*/
#define TPRO_HOUR_PARM_ERR                    (9)     /*-- invalid hour ----------*/
#define TPRO_MIN_PARM_ERR                     (10)    /*-- invalid minutes -------*/
#define TPRO_SEC_PARM_ERR                     (11)    /*-- invalid seconds -------*/
#define TPRO_DELAY_PARM_ERR           (12)    /*-- invalid delay ---------*/
#define TPRO_TIMEOUT_ERR                      (13)    /*-- device timed out ------*/
#define TPRO_COMM_ERR                 (14)    /*-- communication error ---*/

/****************************************************************************
```

```
                    PUBLIC ROUTINE PROTOTYPES
*************************************************************************/

unsigned char TPRO_open       (TPRO_BoardObj **hnd, char *deviceName);
unsigned char TPRO_close      (TPRO_BoardObj *hnd);

unsigned char TPRO_getAltitude       (TPRO_BoardObj *hnd, TPRO_AltObj *Altp);
unsigned char TPRO_getDate    (TPRO_BoardObj *hnd, TPRO_DateObj *Datep);
unsigned char TPRO_getLatitude       (TPRO_BoardObj *hnd, TPRO_LatObj *Latp);
unsigned char TPRO_getLongitude      (TPRO_BoardObj *hnd, TPRO_LongObj *Longp);
unsigned char TPRO_getSatInfo (TPRO_BoardObj *hnd, TPRO_SatObj *Satp);
unsigned char TPRO_getTime           (TPRO_BoardObj *hnd, TPRO_TimeObj *Timep);
unsigned char TPRO_resetFirmware     (TPRO_BoardObj *hnd);
unsigned char TPRO_setHeartbeat      (TPRO_BoardObj *hnd, TPRO_HeartObj *Heartp);
unsigned char TPRO_setMatchTime      (TPRO_BoardObj *hnd, TPRO_MatchObj *Matchp);
unsigned char TPRO_setOscillator     (TPRO_BoardObj *hnd, unsigned char *freq);
unsigned char TPRO_setPropDelayCorr  (TPRO_BoardObj *hnd, int *us);
unsigned char TPRO_setTime    (TPRO_BoardObj *hnd, TPRO_TimeObj *Timep);
unsigned char TPRO_setYear    (TPRO_BoardObj *hnd, unsigned short *yr);
unsigned char TPRO_simEvent   (TPRO_BoardObj *hnd);
unsigned char TPRO_synchControl      (TPRO_BoardObj *hnd, unsigned char *enbp);
unsigned char TPRO_synchStatus       (TPRO_BoardObj *hnd, unsigned char *status);
unsigned char TPRO_waitEvent  (TPRO_BoardObj *hnd, TPRO_WaitObj *waitp);
unsigned char TPRO_waitHeartbeat     (TPRO_BoardObj *hnd, unsigned int *ticks);
unsigned char TPRO_waitMatch  (TPRO_BoardObj *hnd, unsigned int *ticks);
unsigned char TPRO_peek       (TPRO_BoardObj *hnd, TPRO_MemObj *Mem);
unsigned char TPRO_poke       (TPRO_BoardObj *hnd, TPRO_MemObj *Mem);

#endif  // _defined_TPRO_
```

3.2 TPRO API — Routine Descriptions

The TPRO-PCI driver permits overlapping use of the TPRO-waitXXX routines and other device access routines. However, it should be noted that simultaneous access to the device requires multiple open device handles. That is, if an application requires access to the device driver from two different threads, then each thread must have its own device handle.

3.2.1 TPRO_open

unsigned char TPRO_open (TPRO_BoardObj **hnd, char *deviceName);

This routine allocates a TPRO_BoardObj object, sets a handle to the TPRO/TSAT, and sets the driver firmware, FPGA revision (if applicable), and the driver revision strings.

```
Arguments:   Pointer to TPRO_BoardObj handle
Device name - "/dev/tpropci"

Returns:     TPRO_OBJECT_ERR – error allocating board object
                    TPRO_HANDLE_ERR – error retrieving handle to device
                    TPRO_COMM_ERR - error communicating with driver
                    TPRO_SUCCESS - success
```

3.2.2 TPRO_close

unsigned char TPRO_close (TPRO_BoardObj *hnd);

This routine frees the allocated board object and closes the handle to the TPRO/TSAT device.

```
Arguments:   Pointer to TPRO_BoardObj

Returns:     TPRO_CLOSE_HANDLE_ERR – error closing handle to device
             TPRO_DEVICE_NOT_OPEN - device is not open
                    TPRO_SUCCESS - success
```

3.2.3 TPRO_getAltitude

unsigned char TPRO_getAltitude (TPRO_BoardObj *hnd, TPRO_AltObj *Altp);

This routine retrieves the altitude information from the TSAT board. Altitude distance is in meters.

```
Arguments:   Pointer to TPRO_BoardObj
Pointer to TPRO_AltObj

Returns:     TPRO_INVALID_BOARD_TYPE_ERR – invalid board type for function
             TPRO_COMM_ERR - error communicating with driver
                    TPRO_SUCCESS - success
```

3.2.4 TPRO_getDate

unsigned char TPRO_getDate (TPRO_BoardObj *hnd, TPRO_DateObj *Datep);

This routine retrieves the current date from the TPRO/TSAT board. The date is in Gregorian format.

```
Arguments:   Pointer to TPRO_BoardObj
             Pointer to TPRO_DateObj

Returns:     TPRO_INVALID_BOARD_TYPE_ERR – invalid board type for function
             TPRO_COMM_ERR - error communicating with driver
                    TPRO_SUCCESS - success
```

3.2.5 TPRO_getLatitude

unsigned char TPRO_getLattitude(TPRO_BoardObj *hnd, TPRO_LatObj *Latp);

This routine retrieves the latitude information from the TSAT device.

```
Arguments:   Pointer to TPRO_BoardObj
             Pointer to TPRO_LatObj

Returns:     TPRO_INVALID_BOARD_TYPE_ERR – invalid board type for function
             TPRO_COMM_ERR - error communicating with driver
                    TPRO_SUCCESS - success
```

3.2.6 TPRO_getLongitude

```
unsigned char TPRO_getLongitude(TPRO_BoardObj *hnd, TPRO_LongObj *Longp);
```

This routine retrieves the longitude information from the /TSAT device.

```
Arguments:    Pointer to the TPRO_BoardObj
              Pointer to the TPRO_LongObj

Returns:      TPRO_INVALID_BOARD_TYPE_ERR – invalid board type for function
              TPRO_COMM_ERR - error communicating with driver
                     TPRO_SUCCESS - success
```

3.2.7 TPRO_getSatInfo

```
unsigned char TPRO_getSatInfo(TPRO_BoardObj *hnd, TPRO_SatObj *Satp);
```

This routine retrieves the number of satellites tracked from the TSAT device.

```
Arguments:    Pointer to the TPRO_BoardObj
              Pointer to the TPRO_SatObj

Returns:      TPRO_INVALID_BOARD_TYPE_ERR – invalid board type for function
              TPRO_COMM_ERR - error communicating with driver
                     TPRO_SUCCESS - success
```

3.2.8 TPRO_getTime

```
unsigned char TPRO_getTime(TPRO_BoardObj *hnd, TPRO_TimeObj *Timep);
```

This routine retrieves the current time from the TPRO/TSAT device. The seconds value is received as type double.

```
Arguments:    Pointer to the TPRO_BoardObj
              Pointer to the TPRO_TimeObj

Returns:      TPRO_COMM_ERR - error communicating with driver
                     TPRO_SUCCESS – success
```

3.2.9 TPRO_resetFirmware

```
unsigned char TPRO_resetFirmware(TPRO_BoardObj *hnd);
```

This routine resets the firmware programmed on the TPRO/TSAT device. This function is used for troubleshooting purposes only, and should not be used in the main application.

```
Arguments:    Pointer to the TPRO_BoardObj

Returns:      TPRO_COMM_ERR - error communicating with driver
                     TPRO_SUCCESS - success
```

3.2.10 TPRO_setHeartbeat

```
unsigned char TPRO_setHeartbeat(TPRO_BoardObj *hnd, TPRO_HeartObj *Heartp);
```

This routine controls the heartbeat output. The heartbeat output may be a square wave or pulse at various frequencies.

```
Arguments:    Pointer to the TPRO_BoardObj
              Pointer to the TPRO_HeartObj

Returns:      TPRO_FREQ_ERR – invalid frequency value
              TPRO_COMM_ERR - error communicating with driver
                     TPRO_SUCCESS - success
```

3.2.11 TPRO_setMatchTime

```
unsigned char TPRO_setMatchTime(TPRO_BoardObj *hnd, TPRO_MatchObj *Matchp);
```

This routine drives the match output line high (start time) or low (stop time) when the desired time is met.

```
Arguments:    Pointer to the TPRO_BoardObj
              Pointer to the TPRO_MatchObj

Returns:      TPRO_DAY_PARM_ERR - invalid days parameter (must be 0-366)
              TPRO_HOUR_PARM_ERR – invalid hours parameter (must be 0 – 23)
              TPRO_MIN_PARM_ERR - invalid minutes parameter (must be 0 – 59)
              TPRO_SEC_PARM_ERR - invalid seconds parameter (must be 0 – 69)
              TPRO_COMM_ERR - error communicating with driver
                     TPRO_SUCCESS - success
```

3.2.12 TPRO_setPropDelayCorr

```
unsigned char TPRO_setPropDelayCorr (TPRO_BoardObj *hnd, int *us);
```

This routine sets the propagation delay correction factor.

```
Arguments:    Pointer to the TPRO_BoardObj
              Pointer to correction factor in microseconds

Returns:      TPRO_DELAY_PARM_ERR – invalid propagation delay factor
              TPRO_COMM_ERR - error communicating with driver
                     TPRO_SUCCESS - success
```

3.2.13 TPRO_setTime

```
unsigned char TPRO_setTime(TPRO_BoardObj *hnd, TPRO_TimeObj *Timep);
```

This routine sets the time on the on-board clock of the TPRO/TSAT device. If the board is synchronized to a GPS antenna this value will not be accepted.

```
Arguments:    Pointer to the TPRO_BoardObj
              Pointer to the TPRO_TimeObj

Returns:      TPRO_DAY_PARM_ERR - invalid days parameter (must be 0-366)
              TPRO_HOUR_PARM_ERR – invalid hours parameter (must be 0-23)
              TPRO_MIN_PARM_ERR - invalid minutes parameter (must be 0-59)
              TPRO_SEC_PARM_ERR - invalid seconds parameter (must be 0-69)
              TPRO_COMM_ERR - error communicating with driver
                     TPRO_SUCCESS - success
```

3.2.14 TPRO_setYear

```
unsigned char TPRO_setYear(TPRO_BoardObj *hnd, unsigned short *yr);
```

This routine programs the TPRO/TSAT device with the desired year. If the board is synchronized to a GPS antenna this value will not be accepted.

```
Arguments:    Pointer to the TPRO_BoardObj
              Pointer to the desired year

Returns:      TPRO_INVALID_BOARD_TYPE_ERR – invalid board type for function
              TPRO_COMM_ERR - error communicating with driver
                     TPRO_SUCCESS - success
```

3.2.15 TPRO_simEvent

```
unsigned char TPRO_simEvent(TPRO_BoardObj *hnd);
```

This routine simulates an external time tag event.

```
Arguments:    Pointer to the TPRO_BoardObj

Returns:      TPRO_COMM_ERR - error communicating with driver
                     TPRO_SUCCESS - success
```

3.2.16 TPRO_synchControl

```
unsigned char TPRO_synchControl(TPRO_BoardObj *hnd, unsigned char *enbp);
```

This routine commands the TPRO/TSAT device to synchronize to input or freewheel. This distinction is made using the enable argument. If the enable argument is (0) the clock will freewheel, otherwise it will synchronize to input. When disabling synchronization (freewheeling), the device will continue to synchronize until the time is set.

```
Arguments:    Pointer to the TPRO_BoardObj
              Pointer to the synch enable

Returns:      TPRO_COMM_ERR - error communicating with driver
                     TPRO_SUCCESS - success
```

3.2.17 TPRO_synchStatus

```
unsigned char TPRO_synchStatus(TPRO_BoardObj *hnd, unsigned char *status);
```

This routine reports the synchronization status of the TPRO/TSAT device. When status is equal to zero, the device is freewheeling. Otherwise the device is synchronized to its input.

```
Arguments:    Pointer to the TPRO_BoardObj
              Pointer to the synch status variable

Returns:      TPRO_COMM_ERR - error communicating with driver
              TPRO_SUCCESS - success
```

3.2.18 TPRO_waitEvent

```
Arguments:    Pointer to the TPRO_BoardObj
              Pointer to a TPRO_WaitObj

Returns:      TPRO_TIMEOUT_ERR – routine has timed out
                     TPRO_COMM_ERR - error communicating with driver
              TPRO_SUCCESS - success
```

3.2.19 TPRO_waitHeartbeat

```
Arguments:    Pointer to the TPRO_BoardObj
              Pointer to integer containing timeout in milliseconds

Returns:      TPRO_TIMEOUT_ERR – routine has timed out
                     TPRO_COMM_ERR - error communicating with driver
              TPRO_SUCCESS - success
```

3.2.20 TPRO_waitMatch

```
Arguments:    Pointer to the TPRO_BoardObj
              Pointer to integer containing timeout in milliseconds

Returns:      TPRO_TIMEOUT_ERR – routine has timed out
                     TPRO_COMM_ERR - error communicating with driver
              TPRO_SUCCESS - success
```

REVISION HISTORY

Revision Level	*ECN Number*	*Description*
A	**2187**	First draft of Spectracom documentation for this product.

Spectracom Corporation
95 Methodist Hill Drive
Rochester, NY 14623
www.spectracomcorp.com
Phone: US +1.585.321.5800
Fax: US +1.585.321.5219