Application Programmer's Guide

TPRO/TSAT-PCI

for Windows '00/98/ME/XP

Edition 1.3

KSI

a division of DSP*Con*, Inc.

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REVISION HISTORY

Revision Date	Revision No.	Revised Section(s)	Comments/Notes
April 2001	——	——	First Edition
June 27, 2001	1.1		Added error codes and updated installation section
September 2004	1.3	Chapter 2	Added introductory paragraph to “Support Routine Descriptions”.

Table of Contents

Chapter One

Overview

This guide provides comprehensive information on the
Windows '00/'98/ME/XP Driver for the KSI TPRO/TSAT-PCI board.

Introduction

The Driver for the KSI TPRO/TSAT-PCI Board provides functionality to the board's interfaces and devices.

Product Description

The TPRO-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-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.

Caveats

Caution

*If your system is equipped with the TPRO-PCI 450-10 software driver, it **must be uninstalled** before installing the new, updated driver.*

To uninstall the driver:

1. *Go to "Control Panel", "Add/Remove Programs".*
2. *Remove the TPRO-TSAT PCI DEVELOPERS KIT.*
3. *Perform a "find file" for **450-10** and remove all.*
4. *Perform a second "find file" for **TPRO** and remove all.*
5. *Install the new drivers as indicated in this manual.*

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Chapter Two

Installation and Application

Installing the TPRO/TSAT-PCI Win '00/'98/ME/XP Driver

Step One

Install TPRO/TSAT-PCI card in a vacant slot of desired Personal Computer.

Step Two

Power on PC. When the Plug and Play Manager finds new hardware, choose "Have Disk" to install the driver from the CD. Select the "TPRO.INF" file from the CD and follow prompts to finish installation.

Step Three

Go to the CD-ROM drive in Windows Explorer.

Step Four

Double-click on **setup.exe.** The setup utility launches.

Step Five

Follow the on-screen prompts, making sure to accept defaults. The utility commences copying application files. When this process is finished, the control utility installation is complete.

Step Six

Click the "Finish" button on the screen.

Executing the TPRO/TSAT Control Utility

Step One
From the start Menu select the “Programs” folder.

Step Two
Select the “KSI” folder.

Step Three
Select the “TPRO-TSAT Control Utility” program.

Application Example

```
/*****************************************************************************
  MAIN.C
*****************************************************************************/

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

#include <tpro.h>


/*****************************************************************************
  MAIN
*****************************************************************************/

int main (void)
{
  TPRO_BoardObj *hnd;

  if (TPRO_open (&hnd, "TPROpci0") != TPRO_SUCCESS)
    return (1);


  /**
  *** get date
  **/
  {
    TPRO_DateObj Date;

    if (TPRO_getDate (hnd, &Date) != TPRO_SUCCESS)
      return (1);

    // print results
    printf ("%d\\%d\\%d  --  ", Date.month, Date.day, Date.year);
  }


  /**
  *** get time
  **/
  {
    TPRO_TimeObj TproTime;

    if (TPRO_getTime (hnd, &TproTime) != TPRO_SUCCESS)
      return (1);

    // print results
    printf ("%d:%d:%f\n\n", TproTime.hours, TproTime.minutes,
                        TproTime.secsDouble);
  }


  /**
```

```
***  get latitude
  **/
  {
    TPRO_LatObj Latitude;

    if (TPRO_getLatitude (hnd, &Latitude) != TPRO_SUCCESS)
      return (1);

    // print results
    printf ("Latitude:  %d Degrees\t%f minutes\n",
          Latitude.degrees, Latitude.minutes);
  }


  /**
  ***  get longitude
  **/
  {
    TPRO_LatObj Longitude;

    if (TPRO_getLongitude (hnd, &Longitude) != TPRO_SUCCESS)
      return (1);

    // print results
    printf ("Longitude: %d Degrees\t%f minutes\n\n",
          Longitude.degrees, Longitude.minutes);
  }


  /**
  ***  get satellite information
  **/
  {
    TPRO_SatObj SatInfo;

    if (TPRO_getSatInfo (hnd, &SatInfo) != TPRO_SUCCESS)
      return (1);

    // print results
    printf ("Satellites tracked: %d\n", SatInfo.satsTracked);
  }


  TPRO_close (hnd);

  getchar ();
}
```

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Chapter Three

The TPRO/TSAT-PCI Win ‘00/’98/ME/XP Driver

Header File

The following is the "TPRO.H" Driver Interface Header File.

```
/*****************************************************************************
  DSPCon TPRO/tSAT - Interface Header

               DSPCon, Inc.
               380 FootHill Road
               Bridgewater, NJ 08807

               e-mail: info@dspcon.com

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  Use of copyright notice is precautionary and does not imply publication
*****************************************************************************/

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

#ifndef _defined_TPRO_
#define _defined_TPRO_

#ifdef __cplusplus
extern "C" {
#endif


#define DLL_EXPORT  __declspec(dllexport)


/*****************************************************************************
                        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
{ /*---------------------------------------------------------------------*/
  void *hDevice;

  unsigned short options;
  unsigned char slotPosition;

  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 creating handle to device
#define TPRO_OBJECT_ERR               (2)     // error creating device object
#define TPRO_CLOSE_HANDLE_ERR         (3)     // error closing device handle
#define TPRO_DEVICE_NOT_OPEN_ERR      (4)     // tpro device was not opened
#define TPRO_INVALID_BOARD_TYPE_ERR   (5)     // function is not available for board type
#define TPRO_FREQ_ERR                 (6)     // invalid frequency
#define TPRO_YEAR_PARM_ERR            (7)     // invalid year parameter
#define TPRO_DAY_PARM_ERR             (8)     // invalid day parameter
#define TPRO_HOUR_PARM_ERR            (9)     // invalid hour parameter
#define TPRO_MIN_PARM_ERR            (10)     // invalid minutes parameter
#define TPRO_SEC_PARM_ERR            (11)     // invalid seconds parameter
#define TPRO_DELAY_PARM_ERR          (12)     // invalid delay factor
#define TPRO_TIMEOUT_ERR             (13)     // device timed out
#define TPRO_COMM_ERR                (14)     // error communicating with driver


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

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

DLL_EXPORT
unsigned char TPRO_close            (TPRO_BoardObj *hnd);

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

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

DLL_EXPORT
unsigned char TPRO_getLatitude      (TPRO_BoardObj *hnd, TPRO_LatObj *Latp);

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

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

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

DLL_EXPORT
unsigned char TPRO_resetFirmware    (TPRO_BoardObj *hnd);

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

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

DLL_EXPORT
unsigned char TPRO_setOscillator    (TPRO_BoardObj *hnd, unsigned char *freq);

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

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

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

DLL_EXPORT
unsigned char TPRO_simEvent         (TPRO_BoardObj *hnd);

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

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

DLL_EXPORT
unsigned char TPRO_waitEvent        (TPRO_BoardObj *hnd, TPRO_WaitObj *waitp);

DLL_EXPORT
unsigned char TPRO_waitHeartbeat    (TPRO_BoardObj *hnd, unsigned int *ticks);

DLL_EXPORT
unsigned char TPRO_waitMatch        (TPRO_BoardObj *hnd, unsigned int *ticks);

DLL_EXPORT
unsigned char TPRO_peek             (TPRO_BoardObj *hnd, TPRO_MemObj *Mem);

DLL_EXPORT
unsigned char TPRO_poke             (TPRO_BoardObj *hnd, TPRO_MemObj *Mem);


#ifdef __cplusplus
}
#endif

#endif  // _defined_TPRO_
```

Support 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.

TPRO_open

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

This routine allocates a TPRO_BoardObj obect, 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 - "TPROpci0"

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
```

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
```

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
```

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
```

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
```

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
```

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
```

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
```

TPRO_resetFirmware

unsigned char TPRO_resetFirmware(TPRO_BoardObj *hnd);

This routine resets the firmware programmed on the TPRO/tSAT device. This function is 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
```

TPRO_setHeartbeat

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

This routine controls the hearbeat 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
```

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 paramter (must be 0 - 69)
            TPRO_COMM_ERR      - error communicating with driver
            TPRO_SUCCESS       - success
```

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
```

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 paramter (must be 0 - 69)
            TPRO_COMM_ERR      - error communicating with driver
            TPRO_SUCCESS       - success
```

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
```

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
```

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
```

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
```

TPRO_waitEvent

unsigned char TPRO_waitEvent(TPRO_BoardObj *hnd, TPRO_WaitObj*waitp);

This routine will report the time an external event was detected on the Time Tag Input pin. The routine will block for a given number of ticks (in milliseconds) until an event occurs or the timeout period has been reached.

```
Arguments:  Pointer to the TPRO_BoardObj
            Pointer to wait time

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

TPRO_waitHeartbeat

unsigned char TPRO_waitHeartbeat(TPRO_BoardObj *hnd, unsigned int *ticks);

This routine will reports the condition of the heartbeat output. The routine will block for a given number of ticks (in milliseconds) until a heartbeat occurs or the timeout period has been reached.

```
Arguments:  Pointer to the TPRO_BoardObj
            Pointer to timeout variable in milliseconds

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

TPRO_waitMatch

unsigned char TPRO_waitMatch(TPRO_BoardObj *hnd, unsigned int *ticks);

This routine will reports the condition of the match start time. The routine will block for a given number of ticks (in milliseconds) until a match start time occurs or the timeout period has been reached.

```
Arguments:  Pointer to the TPRO_BoardObj
            Pointer to wait time

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

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