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# Table of Contents

## 1 OVERVIEW

## 2 INSTALLING THE DRIVER

2.1 The TAR File

2.2 Installing the TPRO/TSAT-PCI LynxOS Driver

2.2.1 Step One

2.2.2 Step Two

2.2.3 Step Three

2.3 Application Example

## 3 INTERFACE TO THE LYNXOS DRIVER API

3.1 Header File

3.2 TPRO API — Routine Descriptions

3.2.1 TPRO_open

3.2.2 TPRO_close

3.2.3 TPRO_getAltitude

3.2.4 TPRO_getDate

3.2.5 TPRO_getLatitude

3.2.6 TPRO_getLongitude

3.2.7 TPRO_getSatInfo

3.2.8 TPRO_getTime

3.2.9 TPRO_resetFirmware

3.2.10 TPRO_setHeartbeat

3.2.11 TPRO_setMatchTime

3.2.12 TPRO_setPropDelayCorr

3.2.13 TPRO_setTime

3.2.14 TPRO_setYear

3.2.15 TPRO_simEvent

3.2.16 TPRO_synchControl

3.2.17 TPRO_synchStatus

3.2.18 TPRO_waitEvent

3.2.19 TPRO_waitHeartbeat

3.2.20 TPRO_waitMatch
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);
    }

    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;

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

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

    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.

```c
#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)
```

Synchronizable Timecode Generator Application Programmer’s Guide
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;
}

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

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

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

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;
}

typedef struct TPRO_SatObj  
{ /*------------------------------------------------------------------*/
    unsigned char satsTracked;  /*-- num sats tracked ----------*/
    unsigned char satsView;   /*-- num sats in view ----*/
    /*------------------------------------------------------------------*/
    TPRO_SatObj;
}
TRO HEARTBEAT OBJECT
==========================================================================*/
typedef struct TPRO_HeartObj 
{
    unsigned char signalType;  /*-- square or pulse -------------*/
    unsigned char outputType;  /*-- jamming option -----------*/
    double frequency;   /*-- heartbeat freq --------------*/
} TPRO_HeartObj;

/*==========================================================================
TRO 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;

/*==========================================================================
TRO 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;

/*==========================================================================
TRO 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 ---*/

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

```c
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**

```c
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**

```c
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**

```c
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**

```c
unsigned char TPRO_getLatitude(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

```c
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

```c
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

```c
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

```c
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

```c
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

```c
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

```c
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

<table>
<thead>
<tr>
<th>Revision Level</th>
<th>ECN Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2187</td>
<td>First draft of Spectracom documentation for this product.</td>
</tr>
<tr>
<td>B</td>
<td>2332</td>
<td>Minor corrections.</td>
</tr>
</tbody>
</table>