Symmetricom

bc635PCI-V2, bc635PCI-V2-OCXO
bc637PCI-V2, bc637PCI-V2-OCXO

Time and Frequency Processor

User's Guide

Revision A, July 2008

CD Part Number 098-00007-000

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General

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Preface

Conventions

The conventions used in this manual are:

Note:	Tips and clarifications
Warning:	Actions to prevent equipment damage.
Bold:	Used to show messages, menu items, etc., that appear on a computer screen. For example, click on **Submit Changes**.
`Tex`t:	Used to indicate text you should enter with your keyboard, *exactly* as printed.

Errata

Errata are available on the CD ROM supplied with the equipment. The errata file name is “Errata.pdf”.

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1 Introduction

1.1 General Information

The Symmetricom model bc635PCI-V2 and bc637PCI-V2 Time and Frequency Processors (TFP) are high performance, 32-bit PCI plug-in cards used for precise time synchronization of the host computer over the PCI bus. These timing cards operate at 33 MHz and are compatible with PCI Local Bus Specification Revision 2.3. These products support both the 3.3V and 5V signaling environments defined by the PCI Local Bus Specification. They are considered Universal add-in cards that are capable of detecting the signaling environment and adapting themselves to that environment.

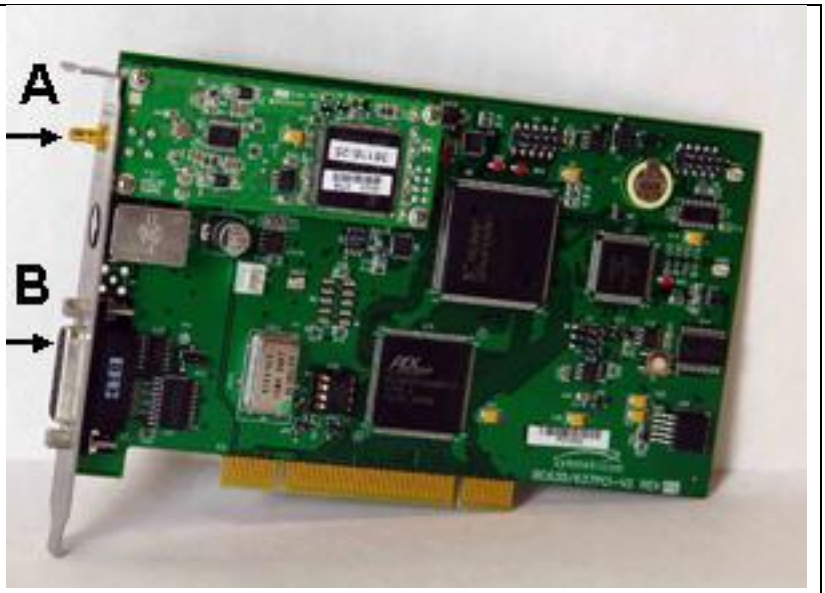
These products may be used in either Generator or Synchronized Generator mode, supplying precise time (100's nanoseconds through thousands of years) to the host computer. When the card is operating as a Synchronized Generator, the output signals are synchronized to the timing reference. The card phase locks to the timing reference and controls the on-board oscillator to remove frequency errors. If the timing reference is lost, the card continues to increment time and output timing signals based upon the card’s 10 MHz oscillator frequency (flywheeling).

There are four separate products supported by this manual:

1. bc635PCI-V2 Standard (with TCXO)
2. bc637PCI-V2 Optional GPS receiver (with TCXO)
3. bc635PCI-V2-OCXO Option: OCXO
4. bc637PCI-V2-OCXO Options: GPS, OCXO

Images of 1 and 2 follow:

Figure 1-1: Model bc635PCI-V2 Synchronized Generator



GPS Antenna	**bc637PCI V2**
P/N 142-614-50	A: SMB Antenna Connector
	B: J1 Module I/O 15 pin 'DS'

Figure 1-2: Model bc637PCI-V2 (GPS option shown with GPS antenna)

Note: These Time and Frequency Processors will be referred as "TFP" or "TFPs" for the remainder of the document.
All sections of this manual are applicable to all boards except where noted.

1.2 Key Features

- All modes of operation are supplemented by flywheel operation. If the synchronization source is lost, the TFP will continue to function at the last known reference rate. The following operational modes are supported, and are distinguished by the reference source.

Mode	Source of Synchronization
0	Time Code - IRIG A, B, G, E, IEEE 1344, NASA 36, XR3 & 2137
1	Free Running (Generator Mode) - 10 MHz Selected Reference (Internal or External)
2	1 PPS - External One Pulse Per Second Input
3	RTC-Uses battery backed on-board real time clock I.C.
4-5	Reserved
6	GPS (bc637) - GPS Antenna/Receiver

- Time may be captured in two independent sets of time capture registers. These registers latch and hold the current time on request. The default time format is provided in binary form (UNIX seconds through 100 nanoseconds). The TFP Device Register Summary and register formats are outlined in Chapter 4.
- In synchronized generator mode, the TFP uses the selected reference source to discipline either the standard on-board TCXO (Temperature Compensated Crystal Oscillator), optional on-board OCXO (Oven Controlled Crystal Oscillator) or external 10 MHz oscillator. The 10 MHz oscillator drives all timing functions and outputs on the card. t and 1 PPS signals are provided as outputs, among others. The advantage of the OCXO is a better holdover rate should the synchronization source be lost.
- The TFP generates IRIG A, B, G, E, IEEE 1344, NASA 36, XR3 & 2137 time codes, synchronized to the reference source. Modulated and DC level shift formats are produced simultaneously. For more information on time code formats, refer to: http://www.symmttm.com/pdf/Gps/an_Time_and_Time_Code_Ref.pdf. This application note discusses time scales of measurement, digital clock accuracy, synchronization and Time Code Formats.
- A Programmable Periodic (a.k.a. Heartbeat) output is provided. The output frequency is programmable and may be synchronized to the TFP 1 PPS signal. The Periodic output programming is discussed in Chapter 5. This signal may be internally connected to the Event Input to capture the time associated with the Programmable Periodic edge. The Event Input configuration is manipulated via the CONTROL Register as described in Chapter 4. The Periodic square wave output is multiplexed with the DDS square wave output so that either signal may be selected for output on J1 pin 15.

- A DDS (a.k.a. frequency synthesizer) output may be selected in place of the periodic rate generator's output. The DDS offers a much wider frequency range than the Programmable Periodic. The DDS is discussed in more detail in Chapter 4. Note that the DDS and the Programmable Periodic signals are capable of generating PCI interrupts. Caution should be taken when using either of these sources with a rate that exceeds the computer's ability to service the interrupts (which may cause the computer to crash).

- A Time Coincidence Strobe output is provided. The Strobe is programmable from days through microseconds. The strobe also has an each second mode (referred to in this manual as Minor Time Mode) programmable to microseconds. The strobe is discussed in more detail in Chapter 4.
- One set of time capture registers is used for event time capture. Time is captured on the rising or falling edge (user programmable) of the Event Input signal provided to the TFP via the J1 I/O connector or from the Programmable Periodic Output signal. The Event Input configuration is manipulated via the CONTROL Register as described in Chapter 4.
- Five maskable interrupt sources are supported. PCI bus levels one through seven are supported. All interrupt sources may be polled. Interrupts are discussed in more detail in Chapter 4.

Note: The bc635/637PCI-V2 does not provide interrupts at system start-up and therefore does not support the PCI Local Bus Specification Revision 2.3 feature of software disable of interrupts at start-up.

1.3 Definition of Terms

The following is a glossary of key terms used in the discussion of timing operations: An expanded glossary of terms is available on-line at:

http://www.symmetricom.com

BCD: Binary Coded Decimal. Also called packed decimal, this is the representation of each digit of a decimal number by four-bit binary numbers. So the number 42 would be encoded as 0100 0010 .

Coordinated Universal Time (UTC): See UTC.

COTS: Commercial Off-The-Shelf products or services that are generally available and not built to customized specifications.

DCLS: Direct Current Level Shift, or digital IRIG.

Discipline: The word discipline, as used in this manual, means to adjust the frequency of the 10 MHz oscillator to track the incoming reference signal..

DPRAM: Dual Port RAM.

Epoch: A reference time or event. Epoch often refers to a one pulse per second event.

Event: An event is defined here as a transition of a digital signal (rising or falling), which can be used to time stamp the event.

Flywheel: To maintain time or frequency accuracy when the reference source has been lost or removed.

GPS: Global Positioning System. Originally designated NAVSTAR (Navigation System with Timing And Ranging), GPS was developed by the US Department of Defense to provide all-weather round-the-clock navigation capabilities for military ground, sea, and air forces.

HW: Hardware.

IRIG: Serial time format standard maintained by the Inter Range Instrumentation Group.

ISA: Industry Standard Architecture; desktop PC adapter board specification.

Jamsync: Is the process of abruptly synchronizing with a time reference, as opposed to gradually adjusting to match up with the time reference.

Major Time: Units of time larger than or equal to seconds.

MHz: A MegaHertz is one million (1,000,000) cycles per second.

Minor Time: Sub-second time to whatever resolution is supported.

MTBF: Mean Time Between Failure, a measure of reliability. The longer the time span between failures, the more reliable the device.

MTTR: Mean Time To Repair.

NASA 36: National Aeronautics & Space Administration 1-second BCD 36-bit Time Code.

NIST: National Institute of Standards and Technology, the National

Measurement Institute in the United States.

OCXO: Oven-Controlled Crystal Oscillator

OS: Operating System.

Packet: A group of bytes conforming to a defined structure. Packets are usually used in bit serial or byte serial data transmissions to allow framing of the transmitted data. The bc637PCI-V2 uses data packets to communicate with the optional GPS receiver.

PCI: Peripheral Component Interconnect, a local bus that supports high-speed connection with peripherals. It plugs into a PCI slot on the motherboard.

PCISIG: PCI Special Interest Group.

PCM: Pulse Code Modulation.

Periodic: A programmable frequency that is obtained by dividing the TFP reference frequency. Periodics are sometimes referred to as "heartbeats."
PICMG: PCI Industrial Computer Manufacturers Group.

PLL: Phase-Locked Loop.

ppm: parts per million.

pps: pulse per second.

RAM: Random Access Memory.

Resolution: Resolution of a time code refers to the smallest increment of time, whether it is days, hours, seconds, or other.

Strobe: The strobe is a programmable "alarm." It compares the reference time with a user-programmed time, and outputs a signal when the two values are the same. The signal is indicated by a transition from low to high voltage. The duration of the signal is equal to the resolution of the strobe comparators (i.e., the reference time and the programmed time). The Strobe function is also referred to as Time Compare.

SW: Software.

TCXO: Temperature Compensated Crystal Oscillator

TFP: Time and Frequency Processor is the name given to the bc635PCI-V2 family of products.

USNO: U.S. Naval Observatory, in Washington, D.C., where the atomic clock that serves as the official source of time for the United States is maintained.

UTC: The international time standard is called Universal Coordinated Time or, more commonly, UTC, for "Universal Time, Coordinated". This ITU standard has been in effect since 1972. UTC is maintained by the Bureau International de l'Heure (BIH), which forms the basis of a coordinated dissemination of standard frequencies and time signals.

VCXO: Voltage-controlled Crystal Oscillator.

1.4 Performance Specifications Input

1.4.1 Time Code Translator

Formats	IRIG A, B, G, E, IEEE 1344[1], NASA 36, XR3 & 2137 (AM/DCLS)
Carrier Range	± 20 PPM
Time Accuracy[2]	< 5 µsec. (AM with carrier frequencies 1 kHz or greater) < 1 µsec. (DCLS)
Flywheel Accuracy	Typical Drift < 2 Milliseconds Per Hour
AM Modulation Ratio	2:1 to 4:1
AM Input Amplitude	1 to 8 Vp-p
AM Input Impedance	5 k:, AC Coupled
DCLS Input	5V HCMOS, >2V high, <0.8V low, 270Ω

[1] IEEE 1344 compliance – The translator processes the 27 control function bits of IRIG B time code as set forth in IEEE 1344.

[2] May require a calibration to attain this accuracy. See "Time Code Calibration" in Chapter 3.

1.4.2 Output Time Code Generator

Formats	IRIG A, B, G, E, IEEE 1344, NASA 36, XR3 & 2137 (Modulated/DCLS)
Modulation Ratio	3:1 ± 10%
Output Amplitude	3V p-p ±10% (fixed) into 50 Ohms
DC Level Shift	5V HCMOS, >2V high, < 0.8V low into 50Ω

1.4.3 PCI Bus Characteristics

Specifications	Designed Per PCI Local Bus Specification, Revision 2.3[1]
Size	Single-Width 6.875" x 4.2"
Interrupts	Auto Configurable IRQ Level 2 – 15
Power (bc635PCI-V2)	+5V @ 700 mA +12V @ 50 mA
Power (bc637PCI-V2)	+5V @ 800 mA +12V @ 50 mA
Power (bc635PCI-V2-OCXO)	+5V @ 800 mA (1.1A at start up) +12V @ 50 mA,
Power (bc637PCI-V2-OCXO)	+5V @ 900 mA (1.2A at start up) +12V @ 50 mA

[1] The bc635/637PCI-V2 does not provide interrupts at system start-up and therefore does not support the PCI Local Bus Specification Revision 2.3 feature of software disable of interrupts at start-up.

1.4.4 Digital Inputs

Event Capture	5V HCMOS,>2V high, < 0.8V, 270 Ω, zero latency, Rising or Falling Edge Triggered, 20 nSmin. width, 250 nSmin. period
External 1 PPS	5V HCMOS, >2V high, < 0.8V low, 270 Ω, Rising Edge On Time,20 nS minimum width

1.4.5 Digital Outputs

1 PPS	5V HCMOS, >2V high, < 0.8V low into 50 Ω , Rising Edge On Time, 60 µS Positive pulse
Periodic	5V HCMOS, >2V high, < 0.8V low into 50 Ω , Rising Edge On Time (selectable on time control), <1 Hz to 250 kHz, square wave
DDS	5V HCMOS, >2V high, < 0.8V low into 50 Ω , Rising Edge On Time (selectable on time control), 1/1e7 – 1e8 Hz, <2 nS jitter p-p, square wave
Strobe	5V HCMOS, >2V high, < 0.8V low into 50 Ω , 1 µS Positive pulse, variable delay
1, 5, 10 MHz clock	5V HCMOS, >2V high, < 0.8V low into 50 Ω (see Chapter 3 for signal characteristics)
Time Code DCLS	5V HCMOS, >2V high, < 0.8V low into 50 Ω

1.4.6 External 10 MHz Oscillator Input

Digital 40% to 60% Duty Cycle (or) Sine wave, 0.5 to 8Vp-p, >10k Ω

1.4.7 External 10 MHz Oscillator DAC

Jumper selectable 0-5VDC or 0-10VDC into 1kΩ

Board Jumpers (JP1, JP2, JP3)

The following is a list of the hardware jumpers on the bc635/637PCI-V2 board:

1. JP1 is a 2mm jumper that is the RTC battery connect switch. The RTC battery is a non-rechargeable lithium cell with 48 mAh capacity. When the card is not powered and the RTC battery has not been disabled, the RTC draws about 20 uA which will provide >100 days of RTC operation. Long-term storage of the card should be done only after issuing the Disconnect RTC Battery command or by the manual disconnection of the jumper on JP1. The factory configuration places the 2mm J1 jumper ON.

2. JP2 is the 1,5,10 MPPS or 10 MHz oscillator select switch. The factory configuration places the 2mm JP2 jumper on pins 1-2 which will allow for the software selection of 1, 5 or 10 MPPS for the output on J1 pin 13. When the jumper is in the 2-3 position, the output on J1 pin 13 is a buffered signal from the 10 MHz oscillator.

3. JP3 is the DAC voltage range switch. When the jumper is OFF, the DAC voltage is 0-5 VDC; when ON the voltage is 0-10 VDC. Both oscillators that are offered for this board have 0-5 VDC control voltage ranges, therefore the 2mm jumper is not factory installed. If an external oscillator requires a 0-10 VDC control voltage range, a 2mm jumper should be placed on JP3.

1.4.8 Environmental Specifications

Temperature	Operating	0°C to +70°C (32°F to +158°F)
	Non-Operating	-30°C to +85°C (-22°F to +185 °F)
Relative Humidity	Operating/Non-Operating	To 95% RH, non-condensing

1.4.9 Antenna Specifications (bc637PCI-V2 only)

To operate in the GPS Synchronized Generator mode, the bc637PCI-V2 unit requires an external antenna. The standard antenna kit supplied with this option is part number 142-614-50 that includes 50 feet (15.24 meters) of coaxial cable and antenna mounting hardware.

Part Number	Description
142-614-50	L1 Antenna w/50’ RG59

Figure 1-3: Antenna parts

The antenna is housed in completely waterproof packaging designed to withstand the elements. When the four UNC 4-40 screws are loosened, the antenna module detaches as shown below, exposing the TNC connector.

Figure 1-4: Antenna with TNC connector

Warning: Model bc637PCI-V2 supplies +5 VDC to the antenna. Connection to an alternate antenna may impact the board and/or antenna functionality.

General Specifications for the Antenna	
Operating Temperature	–40°C to +85°C (–40°F to +185°F)
Storage Temperature	–40°C to +100° C (–40°F to +212°F)
Humidity	100% condensing
Power	30 mA @ 5 V (supplied by card)

Cable Specifications for the Antenna Cable	
Type	RG-59 (Belden 9104)
Length	50 feet (15.24 meters)
Weight	1.2 lb. (0.545 kg)
Humidity	All weather, outdoors
Connectors	Type TNC male to BNC male

Cable lengths from 150 feet (45 meters) to 300 feet (90 meters) require an in-line GPS Signal Amplifier (P/N 150-200).

Cable lengths from 300 feet (90 meters) to 1,500 feet (457.2 meters) require the antenna Down/Up Converter option, part number 142-6150. Refer to the optional 142-6150 Down/Up Converter antenna manual for specifications.

Antenna and Down/Up Converter units are mounted on a 12-inch (30.48 cm) long PVC mast with 3/4-inch (1.9 cm) Male Pipe Thread (MPT) on both ends.

2 Installation

2.1 Installing the Card

This section contains installation instructions for the Model bc635PCI-V2 and bc637PCI-V2 cards, and information regarding operating modes and the use of registers to configure the card. The Model bc637PCI-V2 has the additional feature of GPS mode that will automatically synchronize the card to UTC time.

Installation of PCI boards is quite a bit simpler than in most bus architectures due to two factors:

- Geographical addressing, which eliminates the need for DIP switches and jumpers normally required to select a "base address" or interrupt level for plug-in modules.
- Auto configuration that allows the host computer to read the device ID, and other configuration information directly from the PCI Configuration Registers.

Installation is as easy as choosing a vacant PCI slot, plugging in the Symmetricom bc635/637PCI-V2 Time and Frequency Processor (TFP) and installing the device driver. Be sure to consult the user documentation that came with your particular workstation for any specific PCI card installation instructions.

The TFP is shipped with software suitable for use with Microsoft Windows 2000/XP Professional. The kit includes drivers for low-level access, as well as software programs for configuring and accessing the card.

2.1.2 Installation

- Unpack the card and carefully inspect it for shipping damage. Report any damage to the carrier immediately.
- Record the card's serial number. The serial number has eight numerals, for example 08190018. The serial number is shown in the lower left of the barcode label. The barcode label is located in the upper right hand corner on the backside of the unit.
- With the computer's power turned OFF, install and secure the card in an empty PCI card slot. Fabricate any required I/O cables and connect them to the appropriate connectors.

2.1.3 Antenna Location and Installation (bc637PCI-V2 only)

When selecting a site for the antenna, find an outdoor location that provides full 360-degree visibility of the horizon. In most cases, this means locating the antenna as high as possible. Any obstruction will degrade unit performance by blocking satellite signals or increasing detrimental signal reflections. Blocked signals can significantly increase the time for satellite acquisition, or prevent acquisition all together.

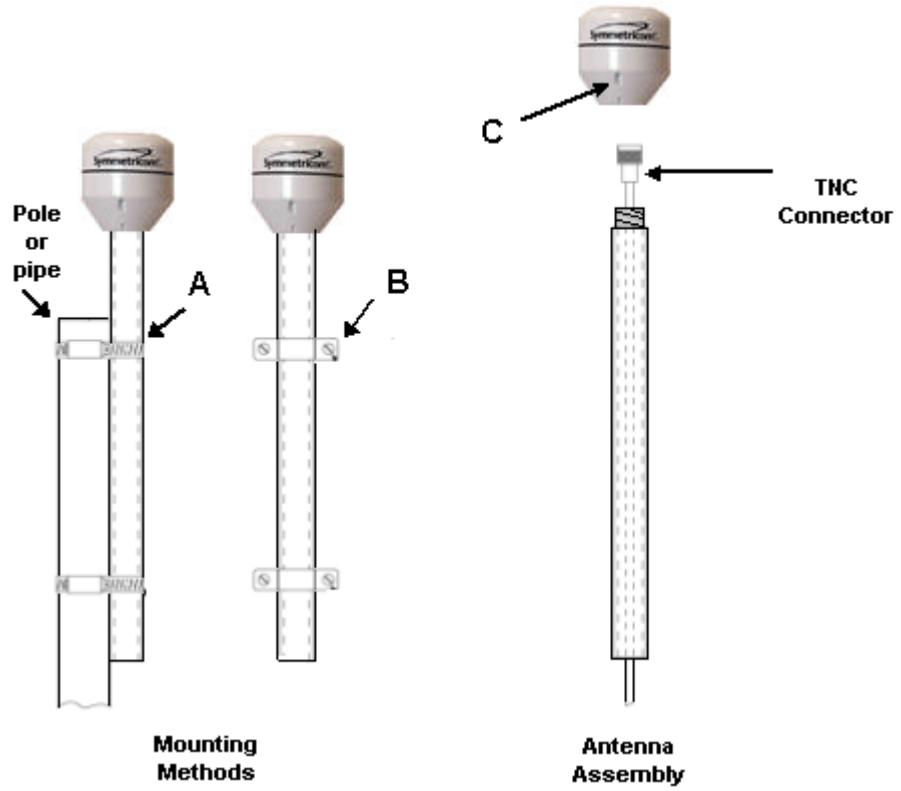
To get the GPS unit up and running as quickly as possible, to verify its

operation and to become familiar with the equipment, the installation instructions are divided into “Quick Initial Setup” and “Permanent Installation” sections. We recommend that new users follow the “Quick Initial Setup” instructions first before proceeding to a permanent installation.

2.1.4 Quick Initial Setup

Connect the antenna cable to the unit and to the antenna. Simply run the antenna outside the building or set it on a windowsill. Depending on the lead content of the glass, it may be necessary to go outside. Turn on the unit and verify its operation.

2.1.5 Permanent Antenna Installation



A: Secure mast to pole or pipe

B: Secure mast to mounting surface with pipe straps.

- **Wood mounting** – Drill hole with #43 bit and install with a #10 wood screw.
- **Drywall/Masonary** – Drill hole with 1/4 “bit, Insert #10 screw anchor. Then install the #10 wood screws.

C: To show the cable connector relative to the antenna, the antenna is shown separated from antenna mast. In reality, the cable is connected to the antenna and the mast is firmly attached to the antenna. Do not disconnect the pipe from the antenna assembly.

Figure 2-1: Permanent Antenna Installation

Mast top mounting is the preferred mounting method and special brackets are provided to mount the antenna to a pipe or the peak of a building. The

antenna mounting mast should be 2-inch (5.08-cm) water pipe or conduit. The mast must be rigid and able to withstand high winds without flexing. Guy wires may be used to stabilize a mast longer than 10 ft. (3.048 m).

2.1.6 Choosing a Location

- The antenna should be located with an unobstructed clear view of the sky from horizon to horizon for optimum tracking conditions. Get the most visibility of the sky as possible. However, if the antenna must be located on the side of a building, the satellite orbits must be considered. If your location is in the Northern Hemisphere, your antenna should face south. If you are in the Southern Hemisphere, your antenna should face north. Use the corner of the building if it is available.
- Choose a location for the antenna that allows the antenna mast to be installed as close as possible to vertical. If you plan to install the antenna in a partially enclosed environment, test the ability of your antenna to receive satellite signals before committing to a permanent installation. On vehicles (vans, ships, etc.), select a location that will be safe from damage during normal operation of the host vehicle.

Note: For installations exposed to shock and/or vibration, use a mounting scheme that isolates the antenna from excessive shock and/or vibration.

For optimal performance, avoid locating the antenna within two feet of other antennas. Choose a location that is not near radar installations, satellite communication equipment, and/or microwave dishes to prevent RF jamming. If that is not possible, move as far away from the radiating source as possible, and attempt to shadow the GPS antenna from the radiation, blocking as little of the sky as possible. Mount the antenna below and at least 10 feet away from satellite communication equipment. Shield the unit from backscatter microwave radiation. Protection can be afforded by the use of a ground plane, a metallic shield that is mounted below the desired minimum viewing angle of the antenna.

- The GPS antenna is designed to withstand the full rigors of the elements in an exposed external location. However, performance is not warranted below –40°C. The shape of the antenna has been designed to minimize the accumulation of rain, snow, and ice. If snow or ice does accumulate, the antenna will perform when partially covered with snow, provided the snow is dry. Accumulation of ice will eventually shut off performance. However if the ice sheet is not continuous, it is possible that enough signal will be received to provide normal operation.
- The antenna can receive satellite signals through glass (depending on lead content), canvas or thin fiberglass. The antenna ***cannot*** receive signals through dense wood (including trees and shrubbery)

or metal structures.

Note: To run multiple units with a single 5 VDC antenna, use a splitter.

2.2 Software Requirements and Installation

Symmetricom PCI cards include the Symmetricom Bc635pcidemo, Bc637pcidemo and TrayTime programs. These applications are software packages developed for Microsoft Windows 2000/XP Professional.

Bc635pcidemo demonstrates basic PCI card functions. TrayTime is an application used to update the Windows clock to the PCI card time at a user-configured interval. Bc637pcidemo program supports the GPS functions on the bc637pci-v2 card.

The programs are examples created using the optional PCI-WINSDK (PCI Windows Software Development Kit). Using the SDK, a programmer may customize Bc635pcidemo or create new software applications for the PCI card. It is presumed that the user is familiar with creating a GUI using the provided SDK software. There are also developer kits available for Linux and Solaris. Contact the factory regarding additional software requirements.

2.3 Minimum System Requirements

- Pentium III, 300 MHz or faster PC with one free PCI slot
- Microsoft Windows 2000/XP Professional
- 2 MB disk space

2.4 Installation Under Windows 2000/XP

1. With the PC turned off, insert the Symmetricom bc635/637PCI-V2 Time and Frequency Processor (TFP) in an open PCI slot.
2. Boot the PC. Once running, Windows may prompt you to install newly found hardware. Disregard/cancel this dialog box.
3. Insert the CD labeled “Bus Level Products” in your CD and follow the automated installation procedure. If Auto-Run is disabled, manually install the driver by running setup.exe, located on the CD-ROM. The driver can support up to four bc635/637PCI-V2 devices. If multiple cards are to be installed, device 0 should be installed first.
4. After the computer reboots, Windows will prompt you to install the newly found hardware. Let Windows install the utility and driver software automatically. If multiple setup files are detected, select the W2kPci.inf file.
5. Launch the bc635PCI Demonstration Software (Bc635pcidemo.exe) to begin communication with the card.

Note: To update/upgrade the Bc635pcidemo software, uninstall the existing software using the supplied installer to ensure all software components are

removed and the registry properly cleaned. Do not use the Windows add/remove wizard supplied via the Windows OS Control Panel or delete the software from 'program files'. When installing the updated software, the application will prompt the user to uninstall the existing installation.

2.5 Optional Windows Software Development Kit

To develop Windows-based applications for Symmetricom PCI cards, you may order the optional PCI-WINSDK, PCI Windows Software Developer's Kit. The PCI SDK for Windows® is a full-featured software development kit containing functions necessary to control and read the time from the board. This allows the user to create customized code for use with these Symmetricom boards with a minimum of time and effort.

The SDK is an easy-to-integrate and highly reliable alternative to writing lower-level code to address a card's memory registers directly. The function calls and device drivers in the SDK make interfacing to a Symmetricom PCI card straightforward, keeping software development focused on the end application.

The SDK provides the Windows 2000/XP kernel mode device driver for the 32-bit PCI interface. The SDK includes .h, .lib, and DLL files for linking applications to drivers. The target-programming environment is Microsoft® Visual C++. The SDK also includes source code for Symmetricom's bc635cpp application program and the TrayTime application to update the system clock in which the card is installed, as well as smaller example programs.

2.5.1 Optional Linux Software Kit

To develop Linux® based applications for Symmetricom PCI cards you may order the optional PCI-LXDRV, PCI Linux Software Kit. The SW Kit includes a 32-bit PCI interface kernel mode device driver and an interface library accessing all bc635/637PCI features and example programs with source code. Symmetricom's pcidemo application program may be used to ensure proper operation of the PCI card.

The PCI Linux® Linux Driver is a full-featured software kit available to facilitate Symmetricom PCI product integration into an application. This kit is an easy-to-integrate and highly reliable alternative to writing lower-level code to address the card's memory registers directly.

The target-programming environment is GNU, GCC, C/C++. The example program was developed using discrete functions for each operation, allowing the developer to clip any useful code and use it in their own applications.

2.5.2 Installation Under Other Operating Systems

Usage of the bc635/637PCI-V2 under other operating systems may require

the customer to develop a PCI driver for the device. Please contact Symmetricom for the availability of a driver for a particular operating system. With the wide variety of machines and operating systems that support the PCI bus, it is not possible for Symmetricom to develop drivers for use in all of these environments. While the interface to the device is well defined in this manual, the instructions for enabling and accessing the device are beyond the scope of this manual. Refer to your system documentation for further details.

3 Functional Description

3.1 General

This chapter provides a description of the bc635/637PCI-V2 Time and Frequency Processor (TFP) timing functions. Everyone using the TFP should read this chapter. Several terms used in this chapter are defined in Chapter 1, Definition of Terms.

3.2 Timing Modes

The primary function of the TFP is to provide precise time to the user across the PCI bus. The TFP can derive time from any one of the sources listed in Chapter 1.

In all but the Free Running mode of operation, the TFP synchronizes its 10 MHz oscillator to the timing source. The TFP achieves synchronization from the timing source and disciplines the 10 MHz oscillator such that the locally generated 1 PPS signal is matched in phase and frequency to the reference.

Once synchronization is achieved, the TFP is able to maintain time even if the timing source is lost (though some timing drift will occur). This is referred to as *flywheeling*. The TFP must also obtain major time (days, hours, minutes, and seconds) from the timing source if it's available. In Time Code and GPS Mode, this major time is readily available, but in the Free Running and External 1 PPS Modes, major time is not available and must be set manually by the user. The Timing Mode is selected via the dual-port RAM interface as described in Chapter 5, using command 10.

3.2.1 Mode 0 (Time Code Mode)

In Time Code Mode, the TFP derives time from the currently selected input time code. The TFP will accept time code in either amplitude modulated (AM) or DC Level Shift (DCLS) form. AM time code is a sinusoidal analog signal that is amplitude modulated with the time data. DCLS is simply the envelope of the modulated time code and is a digital signal. All supported time codes provide both major time (days, hours, minutes, and seconds) and minor time (subseconds) to the card. Some IRIG time codes (e.g. IEEE1344) and GPS (if equipped) provide year information.

3.2.2 Mode 1 (Free Running Mode)

In Free Running Mode, no external timing source is used. The TFP oscillator is allowed to free-run. The user must set major time manually. The Major Time is selected via the dual port RAM interface as described in Chapter 5, using command 11. Free Run mode allows the user to perform timing tests when an external timing source is unavailable.

3.2.3 Mode 2 (External 1 PPS Mode)

In External 1 PPS Mode, the TFP synchronizes its oscillator to a user-supplied 1 PPS signal. The user must set major time manually. The Major Time is selected via the dual-port RAM interface as described in Chapter 5, using command 11.

3.2.4 Mode 3 (RTC)

In the Real Time Clock (RTC) mode, the TFP synchronizes from the on-board RTC circuit.

3.2.5 Mode 6 (GPS) - bc637PCI-V2 only

In GPS Mode, like Time Code Mode, both major and minor times are derived from the timing source. In addition to time, other information is available from the GPS system such as position and velocity. This mode requires the use of a GPS antenna mounted with an unobstructed view to the sky. An unobstructed view to the sky is important because the GPS receiver must initially acquire and track at least four satellites to obtain accurate time. If, however, the user's position is accurately known, or has been previously determined by the GPS system, it can be sent to the GPS system and allow it to derive precise time from just one satellite.

3.3 Time Capture

The TFP supports two independent sets of time capture registers. Each set consists of two 32-bit wide registers that hold both the major and minor time. One set of registers, labeled TIME0 and TIME1, support time on demand across the PCI bus. Time is captured in these registers whenever the user accesses a special time request register (TIMEREQ). The captured time is held until a subsequent access of the TIMEREQ register. Valid time can be read from the TIMEx registers immediately following the access of the TIMEREQ register. Chapter 4 describes the available time formats used on the TFP.

The second set of time capture registers, labeled EVENT0 & EVENT1, are identical in format to the TIMEx registers. Time is captured in these registers whenever the user accesses the special time request register labeled EVENTREQ. Additionally, the EVENTx registers can be set up to capture time in response to either the Event Input (see below) or the Programmable Periodic Output (see next section). These device registers are described in more detail in Chapter 4.

3.4 Event Time Capture

The EVENTx registers can be configured to support event time capture. Four bits of the CONTROL register (see Chapter 4) are used to configure the event time capture function. An externally applied digital signal (Event Input) causes time to be captured in the same way as an access of the EVENTREQ register. The user can configure the EVENTx time capture to occur on a rising or falling edge of the Event Input or the Programmable Periodic Output (also when DDS is used in place of Periodic), or can be disabled. The EVENTx

time capture function may also be set up in a capture lockout mode, where only the first Event Input or Periodic/DDS signal will store the event time. Any subsequent Event Times will not be stored until the capture lockout is disabled.

3.5 Programmable Periodic Output (PPO)

The Programmable Periodic Output (PPO aka heartbeat) allows the user to configure a repetitive digital output synchronized with the timing source. The PPO may optionally be synchronized to the TFP's 1 PPS signal (used when the Periodic Output frequency is an integer value). If PPO is not an integer value and Synchronous Mode is used, the last Periodic Output cycle before the 1 PPS edge will not be square.

The PPO signal is generated by dividing down a 1 MHz clock, synchronous to the 10 MHz oscillator. The periodic output frequency ranges from 250 kHz ($n_1 = n_2 = 2$) to less than 1 Hz. The frequency is determined by the relationship:

Frequency = 1,000,000 / (n_1 * n_2) Hz

Where:

- n_1 : divider 1 (range = 2-65535)
- n_2 : divider 2 (range = 2-65535)

Setting the periodic output frequency to less than 1 Hz and using Synchronous Mode will cause the periodic output to be held at a logic high level. When a rate below 1PPS is desired, Asynchronous Mode must be used. Values of 0 or 1 for either $n_{1\ or}$ $n_{2\ will}$ also cause the periodic output to be held at a logic high level in either Synchronous or Asynchronous Modes.

3.6 DDS Output

This DDS circuit is a frequency synthesizer that provides a square wave output with a frequency resolution of 0.03125 (1/32) Hz. Refer to manual section on Digital Outputs for specifications.

The formula for setting the desired frequency is:

Frequency x 32 = DDS tuning word value.

The DDS circuit has two synchronization modes, Continuous and Fractional. Note that the DDS circuit is always resynchronized to the 1PPS rising edge when a new frequency is chosen.

3.6.1 Continuous mode

Continuous mode synchronizes the DDS circuit each second, maintaining rising edge timing to the card's on-time 1PPS signal. Continuous mode may be used when the DDS is set for an integer rate.

3.6.2 Fractional mode

Fractional mode allows the DDS circuit to generate a non-integer frequency after first being synchronized to the card's on-time 1PPS signal.

DDS fractional frequency example:

Desired frequency:	10,491,426.56 Hz
Desired frequency x 32	10,491,426.56 x 32 = 335,725,649.92 Hz
Rounded to integer	335,725,650
Actual DDS frequency	10,491,426.5625 Hz

This is the closest the DDS can get to the desired frequency with 1/32 Hz resolution.

3.6.3 Divider Source

The DDS circuit also includes 7 decades of divider that may be used. The DDS frequency is passed through a divider circuit before being output. The divider's input source may be selected to be one of the following:

0. DDS
1. Multiplier (DDS x multiplier)
2. 100 MHz PLL source

3.6.4 Divider Mode

The divider can be used to generate low or fractional frequencies. The divide range is 1E0 through 1E7 in decades. The divider will also allow for fractional frequency outputs where the divider’s input source is decimal shifted by up to seven places.

The divider has another selectable mode, Period Mode. This mode may be desirable when the DDS cannot be set exactly to the desired frequency but using a period value would be exact. When operating in this mode, the output is also a square wave with the period resolution equal to 2 times the period of the input (Divider Source). If the Divider Source of 100 MHz is selected, the period resolution is 20nS. When using 100 MHz as the Divider Source, a period register of 0 corresponds to a 40 nS period (25 MHz) which is Period Mode’s upper limit. Use the following formula to set the Period Value Register.

Period Register = (Desired Period / (Divider Source period * 2)) – 2

Example of period mode calculation using 100 MHz Divider Source:

Desired period 59.3 ms = (59.3E-3 / 20E-9) – 2

Result = 2964998

3.6.5 Multiplier Mode

The DDS circuit also includes a frequency multiplier that may be used. The multiplier's input is the DDS and the output is DDS times the multiplication factor. This circuit can multiply the DDS frequency by 1, 2, 3, 4, 6, 8, 10 or 16. Note that the DDS frequency must be high or low enough for use (depends on multiplication factor - see following table).

	Input (MHz)
x1	22 - 150
x2	11 - 75
x3	8 - 56
x4	6 - 38
x6	5 - 23
x8	5 - 19
x10	5 - 15
x16	5 - 10

\

When using the Multiplier Mode, the resolution of the DDS is 1/32 Hz * the multiplier value.

The output of this circuitry is capable of creating PCI bus interrupts. This circuit can generate rates that far exceed a computer's ability to service the DDS interrupts. Care should be taken when enabling interrupts from this source (Periodic/DDS) to prevent a system crash from the frequency (interrupt) being set too high.

Note: that the bc635/637pci-v2 card will load previously set DDS configuration registers at power-on.

3.7 Time Coincidence Strobe Output

The TFP provides one Time Coincidence Strobe Output signal. The Strobe output is like an alarm that is activated at some preprogrammed time. The programmed strobe time is held in the STROBE1 - STROBE4 registers. The Strobe time can be set from days through microseconds. The duration of the Strobe pulse is one microsecond. Two modes of operation are supported. In one mode (STRMODE=0), both the major and minor times are used to generate the Strobe. In the other mode (STRMODE=1), only the minor time is used to generate the Strobe output, producing an output pulse once each second. The Strobe is programmed using the CONTROL Register as described in Chapter 4.

3.8 PCI Interrupts

The TFP supports the five interrupt sources listed in Table 1. Each interrupt source can be individually masked off. Use the MASK register to mask on or off each interrupt source. Each interrupt source sets a corresponding bit in the INTSTAT register when the interrupt occurs. The TFP generates interrupts at an auto configured PCI IntReq level (LEVEL register). When servicing a TFP interrupt, the Interrupt Service Routine (ISR) in the WinRT driver reads the INTSTAT register in order to determine the interrupt source(s) requesting service.

TFP Interrupt Sources

Int	Interrupt Source
0	Signal transition on Event Input has occurred (edge selected by EVSENSE)
1	PPO edge has occurred (edge selected by EVSENSE)
2	Time Coincident Strobe output rising edge has occurred
3	One second epoch (1 PPS output) rising edge has occurred
4	GPS data packet is available (bc635pci-v2 only)

3.9 Timing Outputs

In addition to the Programmable Periodic Output and Time Coincidence Strobe, the TFP provides other useful timing outputs that are synchronized to the timing source. The DDS output, a wide range rate synthesizer, may be selected in place of PPO signal. The 1 PPS output is a 60 µsec wide pulse with the rising edge occurring at each 1 second epoch. A Time Code output signal is available in both AM and DCLS forms simultaneously. An output frequency of 1 MHz, 5 MHz, or 10 MHz TTL signal is selectable.

3.10 Time Code Calibration

This is a calibration procedure to adjust the phase of the Bc635/637PCI-V2 Time and Frequency Processor when in Time Code Mode. Modulation ratio, carrier frequency, impedance loading, and other effects may degrade time code performance accuracy. Some applications require very high

synchronization accuracy while using a time code as a reference. The following calibration procedure helps assure the best time code synchronization accuracy. Because of the inherent differences in the time codes, a different calibration factor exists for each type. The user should determine which time code to use in their system, and then perform the calibration for that code. The user can consult Symmetricom if unsure of which code type is best for their application.

3.11 Calibration Procedure

The following procedure uses the Bc635pcidemo.exe program to perform all adjustments. This procedure will synchronize the on-time mark of an incoming time code reference with the rising edge of an incoming 1 PPS signal. (The accuracy of this calibration is limited by the synchronization of the incoming 1 PPS and the on-time mark of the incoming time code).

1. Connect the Time code reference to the Time code Input on J1 of the bc635/637PCI-V2 card (pin 7 for AM or pin 10 for DCLS).
2. Select the Format and Modulation type for the reference Time code (using the Bc635pcidemo.exe pull down menu "Time code > Decode").
3. Connect the 1 PPS reference to the External Event Input on J1 of the bc635/637PCI-V2 card (pin 6).
4. Enable the External Event Input on the Rising Edge (using the Bc635pcidemo.exe pull down menu "Signals > Events", and select External Input and Rising Edge).
5. Read the minor event time (using the Bc635pcidemo.exe pull down menu "Time > Get Event Time").
6. Repeat the previous step to obtain an average value. You may have to average two neighboring values (e.g., the average of x.000012 and x.000013 is x.0000125).
7. Convert the minor event time to a calibration factor. If the minor event time is close to rolling over (i.e., x.999950), subtract 1 from the minor event time to get the calibration factor in microseconds (e.g., –50 uS or 50E-6 sec); otherwise the minor event time is the calibration factor (e.g., X.000012 = 12 uS or 12E-6 sec).
8. Convert the units of the calibration factor measured in the previous step from microseconds to hundreds of nanoseconds by multiplying it by 10 (12 uS = 120 hundreds of ns). x hundreds of nanoseconds is equivalent to xE-7sec.
9. Set the Propagation delay on the card to the calibration factor in units of hundreds of nanoseconds as calculated in the previous step (using the Bc635pcidemo.exe pull down menu "Time > Set Prop Delay").
10. Read the minor event time (using the Bc635pcidemo.exe pull down menu "Time > Get Event Time"), and verify that the minor time reading is .000000.

If the minor event time is greater than ±1 uS, adjust the calibration factor as necessary.

Note: Keep this calibration factor and the associated time code type (i.e., IRIG B AM CAL = +120E-7) in a safe place. If another time code type is to be used as a reference, a new calibration factor should be determined for that

code.

3.12 Field Upgrade of Embedded Program

The bc635/637PCI-V2 uses flash memory, which is upgraded using an embedded boot loader program. Field upgrades are performed using the card's serial port, which is accessed from the J2 DIN connector on the rear panel. The user transfers the program file that is in S Record format to the card via a serial port running a terminal program that supports a “text” file transfer format (e.g. TeraTerm or Hyperterminal). Insertion of the mating DIN connector is automatically detected which places the card in its boot load mode. The following procedure uses TeraTerm, an open source terminal emulator.

TeraTerm is configured as follows:

Setup/Serial port...

Port:	COMx
Baud rate:	19200
Data:	8 bit
Parity:	none
Stop:	1 bit
Flow control:	none

Transmit delay	
0 msec/char	0 msec/line

Setup/Terminal...

New-line	
Receive:	CR
Transmit:	CR
Local echo:	not selected

After plugging in the DIN serial port adapter that is connected to a serial port running TeraTerm as configured above, the following string should be output to the terminal screen:

<E>rase , <P>rogram or <R>un Application:

Press <E> to erase the Flash, then again after the message <Erased> has

been returned,

Press <P>. Use File/Send file... a dialog box pops up to select the file that is to be sent (e.g. bc635-v2.sx). The file should begin transferring with a string of asterisks being sent back to the terminal screen until the file transfer is complete (approximately 408KB). It takes approximately 5 minutes to download the new file.

Press <R> to run the application.

Note: The application is set up to run automatically. However, if the serial cable is connected to the card, but not to the host computer, the application will hang, awaiting response from the host. If the application does not run automatically, disconnect the serial cable from the card.

4 Device Registers

4.1 General

The bc635/637PCI-V2 Time & Frequency Processor (TFP) is controlled by a combination of hardware device registers and a dual-port RAM interface. This chapter describes the TFP device registers. Chapter 5 describes the dual-port RAM interface.

4.2 PCI Memory Map

The TFP is divided into two memory spaces, Dual-Port RAM and Register. The following table lists the card's physical memory map.

TFP Physical Memory Map

Start	Type	Size	Register Field
PCI Auto	R/W	0x800	Dual Port RAM
PCI Auto	R/W	0x40 (0x800 reserved)	Device Registers

4.3 Device Register Description

The TFP device registers are 32-bits wide (PCI word size). For many of the registers, only a few of the bits have any significance while the rest of the bits are ignored during writes and are meaningless during reads. Registers may be read only (R), write only (W), read/write (R/W), or access (A). Access type registers perform a function simply by being read or written without regard to the data contents. It's best to use a write operation with the access type registers because most optimizing compilers will remove statements that read a register but do nothing with the data returned. In some cases a read/write register is structured to support dissimilar data in the read and write directions. The following table summarizes the type of register located at each offset and provides a brief description of the register function.

TFP Device Register Summary

Offset	Type	Reset	Label	Description
0x00	A	See Note	TIMEREQ	Time Request (TIME0-1)
0x04	A	See Note	EVENTREQ	Event Request (EVENT0-1)
0x08	A	See Note	UNLOCK	Release Capture Lockout
0x0C	Reserved			
0x10	R/W	0	CONTROL	Control Register
0x14	R/W	See Note	ACK	Acknowledge Register
0x18	R/W	0	MASK	Interrupt Mask
0x1C	R/W	0	INTSTAT	Interrupt Status
0x20	R/W	See Note	MINSTRB	Minor Strobe Time
0x24	R/W	See Note	MAJSTRB	Major Strobe Time
0x28	Reserved			
0x2C	Reserved			
0x30	R	See Note	TIME0	Minor Time Holding Register
0x34	R	See Note	TIME1	Major Time Holding Register
0x38	R	See Note	EVENT0	Minor Event Holding Register
0x3C	R	See Note	EVENT1	Major Event Holding Register

Note: Register contents are undefined at reset.

4.3.1 TIMEREQ

Accessing this register (with a read or write operation) latches the current time and timing status in the TIME0 – TIME1 registers. The data value transferred is meaningless.

4.3.2 EVENTREQ

Accessing this register (with a read or write operation) latches the current time and timing status in the EVENT0 – EVENT1 registers. The data value transferred is meaningless. Accessing the EVENTREQ register does not generate an Event Input interrupt.

4.3.3 UNLOCK

Accessing this register (with a read or write operation) releases the EVENTx time capture lockout function if it has been enabled, allowing the Event Input or Periodic/DDS Output to capture a new time. The Event Time Capture Lockout is enabled using bit 1 in the CONTROL Register.

4.3.4 CONTROL

This register controls a variety of TFP hardware functions. The following table lists the function of each bit in this register.

CONTROL Register

Bit	Name	Function
0	LOCKEN	EVENTx Capture Lockout Enable 0 = Disable Lockout 1 = Enable Lockout
1	EVSOURCE	EVENTx Time Capture Register Source Select 0 = Event Input 1 = Periodic/DDS (Select Active Edge With EVSENSE)
2	EVSENSE	Event Edge Select 0=Falling 1=Rising
3	EVENTEN	Event Capture Register Enable 0 = Disable 1 = Enable (Use EVSOURCE to Select Event Source)
4	STREN	Time Coincidence Strobe Output Enable 0 = Disable (Strobe Output is Held Low) 1 = Enable
5	STRMODE	Time Coincidence Strobe Mode 0 = Use Major and Minor Time for Strobe Function 1 = Use Minor Time Only for Strobe Function IN STRMODE = 1, an Output Strobe is Produced Each Second
6	FREQSEL0	Output Frequency Select 00 = 10MHz 01 = 5MHz 1X = 1MHz
7	FREQSEL1	Output Frequency Select 00 = 10MHz 01 = 5MHz 1X = 1MHz
8 - 31	Reserved	

Note: Register contents are undefined at reset.

The EVSOURCE bit selects one of two signal sources for capturing time in the EVENTx registers; either the Event Input signal from the Signal I/O connector or the PPO/DDS Output. When PPO/DDS is selected as the Event Source, the PPO/DDS and Event Input are internally connected, eliminating the need for an external physical connection.

The EVENTEN bit is used to enable capture of time into the EVENTx registers. This bit controls the PPO/DDS and Event Input for event time capture.

The EVSENSE bit controls the active edge that is used to capture time into the EVENTx registers from the selected event source External Input or PPO/DDS Output.

Enabling the Lockout function via the LOCKEN bit allows only the first instance of the selected signal source to latch time in the EVENTx registers, locking out any subsequent events, external or PPO/DDS. Use the UNLOCK register (0x08) to re-arm the circuit.

4.3.5 ACK

The ACK register is used to prevent dual-port RAM data contention when the same address on both sides of a dual-port RAM is accessed simultaneously. See Chapter 5 for more information on the format and use of this register.

4.3.6 MASK

Bits 0-4 in the MASK register correspond to interrupt sources zero through four listed in the following table. An interrupt source is enabled (to generate a PCI interrupt) by writing a value of one to the corresponding MASK bit. Writing a zero to the interrupt MASK bit disables that interrupt source.

4.3.7 INTSTAT

The INTSTAT register has the same structure as the MASK register listed in the following table. Each interrupt source sets its corresponding bit in this register when it occurs. The INTSTAT register bits get set regardless of the state of the MASK bits. INTSTAT bits are cleared by writing to the INTSTAT register with the corresponding bit(s) set. For example, to clear INTSTAT bit zero, write 0x01 to the INTSTAT register. To clear all INTSTAT bits simultaneously, write 0x1F to the INTSTAT register. The corresponding INSTAT bit MUST be cleared in order to enable the next interrupt occurrence.

A PCI interrupt is generated anytime one or more INTSTAT bits [0 through 4] are set and the corresponding bit(s) are set in the MASK register and interrupts have been enabled (started).

INTSTAT Register

Bit	Function
0	Event Input has occurred
1	Periodic/DDS Output has occurred
2	Strobe (time coincidence) has occurred
3	1 PPS output has occurred
4	GPS Data Packet is available (bc637PCI-V2 only)
5	Reserved
6	Reserved
7	Reserved
8-31	Reserved

Note: Register contents are undefined at reset.

4.3.8 MINSTRB - MAJSTRB

These registers hold the programmed Time Coincidence Strobe time. The contents of these registers depend on the time format selected. The Strobe

time is programmable from hours through microseconds in the decimal time format. When the time format is set to binary, only the 22 least significant bits of the major time are used (in addition to microseconds), this allows the user to program the Strobe to become activated up to 48 days beyond the current time.

Note: Disable the Strobe output (see CONTROL register) while programming the Strobe time to prevent spurious Strobe output pulses.

4.3.9 TIME0 – TIME1

These registers hold time captured by an access of the TIMEREQ register. The contents of these registers depend on the time format selected.

4.3.10 EVENT0 – EVENT1

These registers hold time captured when the EVENTREQ register is accessed by an Event Input (if enabled), or a PPO/DDS signal is generated (if enabled). The contents of these registers depend on the time format selected.

4.4 TIME FORMAT

The TFP major time registers (TIME0, EVENT0, MAJSTRB) support binary time (Table 1) and decimal time (Table 2) formats. Sub-second time is always represented in binary format. The 32-bit binary format represents time as the number of seconds since midnight, January 1, 1970 UTC (Universal Time Coordinated), which is the standard time format found on most UNIX systems. Note that the year field is stored in the dual-port RAM. The decimal time format is derived from the “struct-tm” format used on UNIX systems. The bottom numbers in each cell in Table 1 and Table 2 define the bit positions for each data field. All undefined bit positions in Table 2 are N/A.

Table 1. TFP Binary Time Format

Register	Data Bits					
	31 - 28	27 - 24	23 - 20	19 - 16	15 - 8	7 - 0
TIME1 EVENT1	Major Time UNIX Seconds 31 - 0					
TIME0 EVENT0	N/A 31 - 28	Status 27 -24	100 ns 23 - 20	Binary microseconds 19 - 0		
MAJSTRB	N/A 31 - 22			Major Time UNIX Sec (22 bits LSB) 21 -0		
MINSTRB	N/A 31 - 28	Status 27 -24	N/A 23 – 20	Binary microseconds 19 - 0		

Table 2. TFP Decimal Time Format

Register	Data Bits					
	31 - 28	27 - 24	23 - 20	19 - 16	15 - 8	7 - 0
TIME1_ EVENT1	Days (0-366) Bits 7-0 31-24		Hours (0 - 23) 20 - 16		Min (0-59) 12-8	Sec (0-59) 5-0
TIME0_ EVENT0	Days Bit 8 28	Status 27 -24	100 ns 23 - 20	Binary microseconds 19 - 0		
MAJSTRB	N/A 31-24		Hours (0 - 23) 20-16		Min(0-59) 12-8	Sec(059) 5-0
MINSTRB	N/A 31 - 28	Status 27 -24	N/A 23 - 20	Binary microseconds 19 - 0		

The format of the minor time registers (TIME0, EVENT0, MINSTRB) is always binary, 20 bits of binary microseconds (0 - 999,999) in the lower part of the registers with an additional four bit field of hundreds of nanoseconds (0 - 9) located in bits 20 - 23. Most UNIX time functions use microseconds, but the TFP maintains time to hundreds of nanoseconds.

4.4.1 STATUS BITS

The TFP Status bits found in the TIME0 and EVENT0 time registers are summarized in the following table and are described below. Bits 24, 25 and 26, in the PCI Windows demonstration program, are represented as LEDs labeled Tracking (T), Phase (P) and Frequency (F), respectively (0 = Green, 1 = Red).

TIME0, EVENT0 Status Bits Summary

Bit	**Description**
24	Tracking (T) 0: Locked To Selected Reference 1: Flywheeling (Not Locked)
25	Phase (P) 0: < X Microseconds 1: > X Microseconds X = 5 (Mode 0) X = 2 (All Other Modes)
26	Frequency (F) 0: < 5 x 10-8 1: > 5 x 10-8
27	Reserved

4.4.2 STATUS: Tracking (Bit 24)

This bit indicates that the TFP is not tracking the reference time source, usually because the time source has been lost or has become unusable. When a timing Mode change occurs, this bit is set until the TFP locks to the new timing source.

4.4.3 STATUS: Phase (Bit 25)

This bit indicates the synchronization accuracy of the TFP relative to the timing source. This bit is updated approximately once per second. When the TFP's oscillator is synchronized to less than 5 microseconds with AM time code mode as a reference and less than 2 microseconds in other modes, this bit is cleared.

4.4.4 STATUS: Frequency Offset (Bit 26)

This bit is an indication of the TFP on-board oscillator frequency offset relative to the timing source. This bit reflects the short-term stability of the TFP's oscillator.

5 Dual-Port RAM Interface

5.1 General

The byte-wide dual-port RAM (DPRAM) interface provides a communications pathway between the user and the bc635/637PCI-V2 Time & Frequency Processor (TFP) micro-controller (MPU). The RAM size is 2Kx8. The ACK register is used in conjunction with the DPRAM to avoid data contention when a memory location is accessed simultaneously from both sides of the DPRAM. Four areas within the DPRAM are available to the user:

5.1.1 Input Area

This area is used for sending commands to the TFP to set the timing Mode, time code format, etc. This area is also used to send data packets to the optional bc637PCI-V2 GPS receiver.

5.1.2 Output Area

This area holds data that the user requests from the TFP.

5.1.3 GPS Area

This area holds packets of data from the bc637PCI-V2's GPS receiver such as position, velocity, GPS status, etc.

5.1.4 Year Area

This area holds the year number derived from the timing source (if available). The year value is restored after a power cycle.

DPRAM Address and Contents

Data	Size	Offset
Year Area	2 bytes	0x00
GPS Area	0x80 bytes	0x02
Output Area	0x80 bytes	0x82
Input Area	0x80 bytes	0x102

5.2 ACK Register

This register is used to prevent dual-port RAM data contention when the same address on both sides of a dual-port RAM is accessed simultaneously. Only three bits in this register are used, and each bit operates independently. The function of each bit in this register is described below.

5.2.1 ACK Bit 0

Set by the TFP to acknowledge the receipt of a user command from the DPRAM Input Area. The user can clear this bit by writing to the ACK register with bit 0 set, but cannot set this bit.

5.2.2 ACK Bit 2

Set by the TFP to indicate that a GPS packet is available in the DPRAM GPS Packet Area. The user can clear this bit by writing to the ACK register with bit two set, but cannot set this bit. The transition of this bit from zero to one activates interrupt source four.

5.2.3 ACK Bit 7

The user writes to the ACK register with bit seven set to cause the TFP to read a command from the DPRAM Input Area. This bit has no meaning when read.

5.3 TFP DPRAM Commands

This section describes the TFP commands available through the DPRAM Interface. Commands consist of a command ID byte followed by zero or more data bytes. The command ID byte is written to the first location in the DPRAM Input Area, followed by the command data byte(s). The following command data types are used. Command data is loaded into the DPRAM in the Big-Endian fashion, most significant byte first. The following table summarizes the DPRAM commands.

DPRAM Commands

UINT8	Unsigned 8 Bit Integer (1 Byte)
INT8	Signed 8 Bit Integer (1 Byte)
UINT16	Unsigned 16-Bit Integer (2 Bytes)
INT16	Signed 16-Bit Integer (2 Bytes)
UINT32	Unsigned 32-Bit Integer (4 Bytes)
INT32	Signed 32-Bit Integer (4 Bytes)
FLOAT	ANSI / IEEE Std 754 Standard Floating-Point Format (4 Bytes)
DOUBLE	ANSI / IEEE Std 754 Standard Floating-Point Format (8 Bytes)

The following steps should be followed when sending commands to the TFP.

1. Write the command ID and data bytes to the DPRAM starting at the first location in the Input Area.
2. Clear bit zero of the ACK register by writing 0x01 to the ACK register.
3. Inform the TFP that a command is waiting by writing 0x80 to the ACK register.
4. Wait for the TFP to set bit 0 of the ACK register. Do not begin writing another command to the Input Area until this bit becomes set.

Windows example: Set the Periodic rate output to 10KPPS and Synchronous Mode. Select the Advanced Menu. Use the Special Tab and the DP RAM selection from the menu list.

a. Offset 102 (input packet base address)
b. Value 14 (14 is the set periodic output command ID)
c. select the WRITE button

d. Offset 103
e. Value 1 (value of 1 here selects Synchronous Mode)
f. select the WRITE button

g. Offset 104
h. Value 0 (msb of n1 value)
i. select the WRITE button

j. Offset 105
k. Value a (lsb of n1 value set to decimal 10)
l. select the WRITE button

m. Offset 106
n. Value 0 (msb of n2 value)
o. select the WRITE button

p. Offset 107
q. Value a (lsb of n2 value set to decimal 10)
r. select the WRITE button

s. select the ACK button and the Periodic output will be set.

DPRAM Command Summary

ID	Reset	Command
0x10	NV	Set TFP Timing Mode
0x11	1	Set Time Register Format (1 = binary, 0 = bcd)
0x12	RTC	Set Major Time
0x13	RTC	Set Year
0x14	NV	Set Periodic Output
0x15	NV	Set Input Time Code Format
0x16	NV	Set Input Time Code Modulation
0x17	NV	Set Propagation Delay Compensation
0x18	NV	Request UTC Time Data (bc637 only)
0x19	N/A	Request TFP Data
0x1A	N/A	Software Reset
0x1B	NV	Set Time Code Output Format
0x1C	NV	Set Generator Time Offset
0x1D	NV	Set Local Time Offset
0x1E	0	Set Leap Second Event
0x20	NV	Set Clock Source -(0 = Internal, 1=External)
0x21	1	Control Jamsync
0x22	N/A	Force Jamsync
0x24	NV	Load DAC
0x25	N/A	Set Disciplining Gain
0x27	N/A	Synchronize RTC to TFP Time
0x30	N/A	Send Packet to GPS Receiver (bc637 only)
0x31	N/A	Request Packet from GPS Receiver (bc637 only)
0x32	N/A	Manual Request GPS Packet (bc637 only)
0x33	0	Select GPS Time Format (bc637 only)
0x34	N/A	Set GPS Mode Flag (not used)
0x40	NV	Observe Local Time Flag
0x41	NV	IEEE 1344 Daylight Saving and Local Time Flags
0x43	NV	Periodic/DDS Select (0=Periodic, 1=DDS)
0x44	NV	Periodic/DDS Enable (0 = OFF, 1=ON)
0x45	NV	DDS Divide Select
0x46	NV	DDS Divide Source
0x47	NV	DDS Sync Mode
0x48	NV	DDS Multiplier
0x49	NV	DDS Period Value
0x4A	NV	DDS Tuning Word
0x4F	N/A	Request PCI Firmware Part Number
0xF4	N/A	Request Assembly Part Number

0xF5	N/A	Request Hardware Fab Part Number
0xF6	N/A	Request TFP Model Identification
0xFE	N/A	Request TFP Serial Number (Request only)

- RTC: Real Time Clock (Restored at Power-on)
- NV: Non Volatile (Restored at Power-on)

5.3.1 Command 0x10: Set TFP Timing Mode

This command selects the timing mode of the TFP.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x10
1	UINT8	Timing Mode	See Below

TFP Timing Mode:

- 0x00 Time Code (Selected Time Code AM or DCLS)
- 0x01 Free Running (Internal or External 10 MHz Reference Selected)
- 0x02 1 PPS (External One Pulse Per Second)
- 0x03 Real Time Clock (Battery backed RTC)
- 0x06 GPS (bc637PCI-V2 only)

5.3.2 Command 0x11: Set Time Register Format

This command allows the user to select the major time format. Available time formats are Binary Coded Decimal (BCD) and UNIX (Binary). The time format affects the TIMEx, and EVENTx registers and Command 0x12. See Table 1 and Table 2 for the UNIX and BCD time register definitions, respectively.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x11
1	UINT8	Data Format	See Below

Time Data Format:

- 0x00 BCD TIME FORMAT
- 0x01 UNIX TIME FORMAT (default)

5.3.3 Command 0x12: Set Major Time

This command allows the user to load the major time to the TFP Major Time Registers in binary (UNIX) or BCD format. The format is determined by Command 0x11 as referenced above. The default major time format is UNIX binary time. This command normally applies to the TFP while in time modes 1, 2 or 3. The TFP derives its major time from the selected external timing

reference signal in time modes 0 and 6, and from the RTC in mode 3. If time mode 0 or 6 is used, any major time written by this command will be overwritten when the selected source is providing a valid time to the TFP.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x12

Case 1: UNIX Time Data Format = 0x01 (Command 0x11, format 0x01) default

Byte	Type	Item	Value or Range
1-4	UINT32	UNIX Time	0 to 0xffffffff

Case 2: BCD Time Data Format = 0x00 (Command 0x11, format 0x00)

Byte	Type	Item	Value or Range
0	UINT8	ID	0x12
1-2	UINT16	Year	1970 – 2036
3-4	UINT16	Days	0 to 0x16e (0 to 366)
5	UINT8	Hours	0 to 0x17 (0 to 23)
6	UINT8	Minutes	0 to 0x3b (0 to 59)
7	UINT8	Seconds	0 to 0x3b (0 to 59)

The time loaded by this command will not be readable until the one-second epoch following the load. There is a possibility the TFP will have incremented the time during the load. To prevent ambiguities in the time, the user must issue this command in advance of the 800-millisecond point within the one-second epoch, referencing the current epoch.

This command normally applies to the TFP modes 1 and 2. The TFP derives its major time from the timing reference signal in other modes. The format data of this command depends on the Command 0x11 time format selection.

5.3.4 Command 0x13: Set Year

This command allows the user to set the year.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x13
1	UINT16	Year	1970 – 2036

5.3.5 Command 0x14: Set Periodic Output

This command establishes the frequency of the TFP Programmable Periodic Output. Chapter 6 describes the relationship between the dividers n_1, n_2 and the Periodic Output frequency.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x14
1	UINT8	Sync Flag	0 = Don't Sync To 1PPS 1 = Sync To 1 PPS
2-3	UINT16	Divider n_1	2 - 65535
4-5	UINT16	Divider n_2	2 - 65535

5.3.6 Command 0x15: Set Input Time Code Format

This command selects the time code format for TFP Timing Mode "0" time code input. (See Command 0x10.) Use Command 0x16 to set the modulation type. Note that this selection is restored at power-up from NV memory.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x15
1	UINT8	Format1	See below
2	UINT8	Format2	See below

Format Choices:

Format1	Format2	ASCII	AM	Time Code	DCLS
0x41	0x0	'A'	A130,1,2,3	IRIG A no year	A000,1,2,3
0x41	0x59	'AY'	A134,5,6,7	IRIG A w/year	A004,5,6,7
0x42	0x0	'B'	B120,1,2,3	IRIG B no year	B000,1,2,3
0x42	0x59	'BY'	B124,5,6,7	IRIG B w/year	B004,5,6,7
0x45	0x0	'E'	E121,2	IRIG E 1K no year	E001,2
0x45	0x59	'EY'	E125,6	IRIG E 1K w/year	E005,6
0x65	0x0	'e'	E111,2	IRIG E 100 no year	E001,2
0x65	0x59	'eY'	E115,6	IRIG E 1K w/year	E005,6
0x47	0x0	'G'	E141,2	IRIG G no year	G001,2
0x47	0x59	'GY'	E145,6	IRIG G w/year	G005,6
0x42	0x54	'BT'	AM	IRIG B TrueTime	DCLS
0x49	0x0	'I'	AM	IRIG B IEEE 1344	DCLS
0x4e	0x0	'N'	AM	NASA 36	DCLS
0x58	0x0	'X'	AM	XR3 (250 Hz)	DCLS
0x32	0x0	'2'	AM	2137 (1 kHz)	DCLS

Note that AM time codes with carrier frequencies less than 1 KHz (IRIG E111, 2, 5, 6 @ 100 Hz and XR3 @ 250 Hz) will decode properly but will not necessarily maintain short term phase and frequency lock. Long term, the low frequency carrier time codes maintain phase and frequency with reduced accuracy. Phase and frequency accuracy is better when using DCLS time

codes.

Note: that when Legacy TrueTime IRIG B is used, the bc635/637PCI-V2 will decode the “Lock” bit that is encoded in the Control Function area and will not lock to the incoming code if the this bit = 1.

5.3.7 Command 0x16: Set Input Time Code Modulation Type

This command selects the time code modulation type format for TFP Timing Mode “0” time code input (See Command 0x10). Use Command 0x15 to select the time code format.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x16
1	UINT8	modulation	See below

Modulation Choices:

- 0x4D (‘M’) amplitude modulated sine wave (AM)
- 0x44 (‘D’) DC level shift (DCLS)

5.3.8 Command 0x17: Set Propagation Delay Compensation

It is sometimes desired to program an offset into the basic TFP time keeping functions relative to the reference input. For example, if the reference input is an IRIG B time code, there may be significant cable delay between the IRIG B generator and the TFP location. This command allows this time difference to be removed by inserting the known amount of offset between the IRIG B reference and TFP location. The offset is programmable in units of 100 nanoseconds, and may be positive or negative.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x17
1-4	UINT32	offset	**–4,000,000 to +4,000,000**

5.3.9 Command 0x18: Request UTC Time Data (bc637PVI-V2 only)

This command queries current GPS and UTC time information derived from the GPS receiver. This command must be used in conjunction with Command 0x19.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x18
1	UINT8	GPS Time Format	See below
2	UINT8	Leap Second	0 to 0xff
3	INT8	Leap Second Flag	See below
4-7	UINT32	Leap Event UNIX Time	0 to 0xffffffff

GPS Time Format:

- 0x00 UTC Time (GPS time plus leap seconds)
- 0x01 GPS Time

Leap Second Flag:

- 0xff Deletion Event
- 0x00 No Event
- 0x01 Addition event

5.3.10 Command 0x19: Request TFP Data

This command requests data from the TFP that is not available via the device registers. The TFP transfers the requested data to the DPRAM Output Area. The data is available to the user as soon as the TFP sets ACK bit 0.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x19
1	UINT8	Req. data type	(See DPRAM Command Summary List)

5.3.11 Command 0x1A: Software Reset

This command vectors the TFP MPU to its power-on reset point and contains no data.

5.3.12 Command 0x1B: Set Time Code Output Format

This command allows the user to select the time code format that is generated by the TFP on J1. Note that this selection is restored at power-up from NV memory.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x1B
1	UINT8	Format1	See below
2	UINT8	Format2	See below

Time Code Output Formats:

Format1	Format2	ASCII	AM	Time Code	DCLS
0x41	0x30	'A0'	A130	BCD, CF, SBS	A000
0x41	0x31	'A1'	A131	BCD, CF	A001
0x41	0x32	'A2'	A132	BCD	A002
0x41	0x33	'A3'	A133	BCD, SBS	A003
0x41	0x34	'A4'	A134	BCD, YR, CF, SBS	A004
0x41	0x35	'A5'	A135	BCD, YR, CF	A005
0x41	0x36	'A6'	A136	BCD, YR	A006
0x41	0x37	'A7'	A137	BCD, YR, SBS	A007
0x42	0x30	'B0'	B120	BCD, CF, SBS	B000
0x42	0x31	'B1'	B121	BCD, CF	B001
0x42	0x32	'B2'	B122	BCD	B002
0x42	0x33	'B3'	B123	BCD, SBS	B003
0x42	0x34	'B4'	B124	BCD, YR, CF, SBS	B004
0x42	0x35	'B5'	B125	BCD, YR, CF	B005
0x42	0x36	'B6'	B126	BCD, YR	B006
0x42	0x37	'B7'	B127	BCD, YR, SBS	B007
0x42	0x0	'B'	B122	BCD	B000
0x42	0x54	'BT'	AM	Legacy TrueTime	DCLS
0x49	0x0	'I'	AM	IEEE 1344	DCLS
0x45	0x31	'E1'	E121	BCD, CF	E001
0x45	0x32	'E2'	E122	BCD	E002
0x45	0x35	'E5'	E125	BCD, YR, CF	E005
0x45	0x36	'E6'	E126	BCD, YR	E006
0x65	0x31	'e1'	E111	BCD, CF	E001
0x65	0x32	'e2'	E112	BCD	E002
0x65	0x35	'e5'	E115	BCD, YR, CF	E005
0x65	0x36	'e6'	E116	BCD, YR	E006
0x47	0x35	'G5'	G145	BCD, YR, CF	G005
0x4e	0x0	'N'	AM	Nasa 36	DCLS
0x58	0x0	'X'	AM	XR3	DCLS
0x32	0x0	'2'	AM	2137	DCLS

IRIG Control Function (CF) Bits In the following tables, tq1 through tq4 are time quality bits. For time quality and unlock bits, "1" means active.

For IRIG output codes A, B, E or G with CF bits, the following CF bits are encoded:

Index count	Bit name	
70	(0)	
71	(0)	
72	(0)	
73	unlock	(1 = unit not locked to reference)
74	(0)	
75	tq1	(1 = timing error estimate > 1us)
76	tq2	(1 = timing error estimate > 10us)
77	tq3	(1 = timing error estimate > 100us)
78	tq4	(1 = timing error estimate > 1ms)

For Legacy TrueTime IRIG B, the following CF bits are encoded:

Index count	Bit name	
50	(0)	
51	(0)	
52	(0)	
53	unlock	(1 = unit not locked to reference)
54	(0)	
55	tq1	(1 = timing error estimate > 1us)
56	tq2	(1 = timing error estimate > 10us)
57	tq3	(1 = timing error estimate > 100us)
58	tq4	(1 = timing error estimate > 1ms)

Note that when Legacy TrueTime IRIG B is selected, CF bits are encoded. The unlock bit may be used to inform time code readers of the generators lock status.

5.3.13 Command 0x1C: Set Generator Time Offset

This command is used to add/subtract an offset to the time code generator output. This command affects the generator output only.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x1C
1-2	UINT16	Local Offset	0xfff0 to 0x0010 (–16 to +16)
3	UINT8	Half Hour	0 or 1

HALF HOUR:

- 0 = half hour not present (30 min)
- 1 = half hour present (30 min)

5.3.14 Command 0x1D: Set Local Time Offset

This command adds/subtracts local time offset to the TFP time. This command affects the TFP time only; the generator time is not affected. (See Command 0x1C.)

Byte	Type	Item	Value or Range
0	UINT8	ID	0x1D
1-2	UINT16	Local Offset	0xfff0 to 0x0010 (–16 to +16)
3	UINT8	Half Hour	0 or 1

HALF HOUR:

- 0 = half hour not present (30 min)
- 1 = half hour present (30 min)

5.3.15 Command 0x1E: Program Leap Second Event

Byte	Type	Item	Value or Range
0	UINT8	ID	0x1E
1	INT8	LS_Flag	–1 to +1

Leap Second Flag:

- 1 = Insertion
- –1 = Deletion (0xff)
  - = Disable

5.3.16 Command 0x20: Select Clock Source

This command selects the clock source for the TFP. The TFP uses a time base frequency of 10 MHz. The 10 MHz may be derived from the on-board oscillator or it may be supplied from an external oscillator via the J1 connector.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x20
1	UINT8	clock source	see below

Clock Source Choices:

- 0x49 (‘I’) Internal 10 MHz Oscillator
- 0x45 (’E’) External 10 MHz Oscillator

5.3.17 Command 0x21: Control Jamsync

This command can be used to disable TFP jam-syncs that normally occur

automatically. The default is jamsync enabled.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x21
1	UINT8	jamsync ctrl	0 = jamsync disabled 1 = jamsync enabled

5.3.18 Command 0x22: Force Jamsync

This command forces the TFP to perform a single jamsync operation and contains no data. (See Command 0x21).

5.3.19 Command 0x24: Load DAC

The TFP on-board crystal oscillator frequency is voltage controlled using the output of a 16-bit DAC as the controlling voltage. This command allows the user to directly load a 16-bit value to the DAC. This feature allows the user to fine tune the TFP time base in the Free Running Mode. This voltage is also routed out of the TFP via the **J1** connector allowing external oscillators to be disciplined. The DAC output voltage ranges nominally from 0 V (value = 0x0000) to 5 V (value = 0xFFFF).

JP3 is used to select the DAC voltage range. When the 2mm jumper is OFF, the DAC voltage is 0-5 VDC; when ON the voltage is 0-10 VDC. Both internal oscillators that are offered for this card use the 0-5 VDC control voltage range. If an external oscillator requires a 0-10 VDC control voltage range, a 2mm jumper must be placed on JP3.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x24
1-2	UINT16	DAC value	0x0000 - 0xFFFF

5.3.20 Command 0x25: Set Disciplining Gain

This command allows the gain and sense of the disciplining process to be set by the user. A positive gain indicates that the voltage-controlled clock source frequency increases with increasing control voltage. This feature is valuable to anyone using the TFP to discipline an external oscillator.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x25
1-2	INT16	gain	–100 to +100

Note: Use this command with caution, as it will affect the TFP disciplining routine.

Gain Default:

- 0x02 = TCXO

- 0x20 = OCXO

5.3.21 Command 0x27: Synchronize RTC to External Time Data

This command forces the TFP to synchronize the RTC time to the current time. Note that when the TFP is locked to a timing reference, the RTC is adjusted automatically.

5.3.22 Command 0x30: Send Packet to GPS Receiver (bc637PCI-V2 only

This command allows the user to send a GPS packet to the GPS receiver. The format and use of this command is described in Appendix A: GPS Receiver Interface.

5,3.23 Command 0x31: Request Packet from GPS Receiver

(bc637PCI-V2 only)

This command allows the user to request a GPS packet (i.e., position, velocity, status, etc.) from the GPS receiver. The format and use of this command is described in Appendix A: GPS Receiver Interface.

5.3.24 Command 0x32: Manually Request Packet from GPS Receiver

(bc637 only)

This command is similar in function to Command 0x31. Refer to Appendix A: GPS Receiver Interface.

5.3.25 Command 0x33: Set GPS Time Format (bc637PCI-V2 only)

This command allows the user to select between GPS time and UTC when using Timing Mode 6 (GPS). The relationship between UTC and GPS time is shown below. The default setting is UTC (UTC = GPS Time + Leap Seconds).

Byte	Type	Item	Value or Range
1	UINT8	ID	0x33
2-5	UINT8	GPS time format	flag

GPS time format flag:

- 0 = UTC (default)
- 1 = GPS Time

5.3.26 Command 0x40: Observe Local Time Flag

This command programs the local time observed flag. If the local time flag is enabled, the TFP adjusts its time by the local time offset. Note that the Generator Time is also affected by this setting. See Command 0x1d for programming local time offset.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x40
1	UINT8	Flag	0 or 1

Local Time Observe Flag:

- 0 = disable
- 1 = enable

5.3.27 Command 0x41: IEEE 1344 Daylight Saving and Local Time Flags

This command queries the daylight saving and local time observed flag. Additionally, this command is used to set the IEEE 1344 Time Code daylight saving observed flag. Use this command in conjunction with Command 0x19.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x41
1	UINT8	Flag	0x- 0xff

Flag:

- bit0 = reserve
- bit1 = reserve
- bit2 = reserve
- bit3 (0x8) = local time observe flag
- bit4 (0x10) – IEEE 1344 DST observe flag
- bit5 – bit7 = not used

5.3.28 Command 0x43: Select Periodic or DDS Output

This command selects the signal that is output on P1 pin 15. This output may be either the Periodic (heartbeat) signal or the DDS (frequency synthesizer) signal. Note that this selection is restored at power-up from NV memory.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x43
1	UINT8	Per/DDS	see below

- 0 = Periodic
- 1 = DDS

5.3.29 Command 0x44: Periodic or DDS Output Enable

This command controls the Periodic or DDS signal that is output on P1 pin 15. This output may be either on or off based on the selection.

Note: that this selection is restored at power-up from NV memory.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x44
1	UINT8	Dis/En	see below

- 0 = Disabled
- 1 = Enabled

5.3.30 Command 0x45: DDS Divide Select

The DDS frequency synthesizer's divider can be used to divide the selected input down to generate lower or fractional frequencies. Selectable decade divides that range from divide by 1E0 through divide by 1E7 are available. The divider will also allow for fractional frequency outputs where the divider's input source is decimal shifted by up to 7 places. The frequency synthesizer's divider is the output signal provided on P1 pin 15.

Note: that this selection is restored at power-up from NV memory.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x45
1	UINT8	Div val	see below

  - = divide by 1,
  - = divide by 10,
  - = divide by 100,
  - = divide by 1000,
  - = divide by 10000,
  - = divide by 100000,
  - = divide by 1000000,
  - = divide by 10000000
- F = divide by value in Period Register (when selected, refer to command 49)

5.3.31 Command 0x46: DDS Divide Source

The frequency synthesizer's divide chain has 3 possible input sources.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x46
1	UINT8	Div sel	see below

- 0 = DDS
- 1 = Multiplier (DDS x multiplier)
- 2 = 100 MHz (100 MHz PLL)

5.3.32 Command 0x47: DDS Synchronization Mode Select

The DDS frequency synthesizer's divider has 2 modes of operation, Fractional and Continuous. Fractional mode allows for fractional frequencies to be generated that are time synchronized only when a change is made to the DDS frequency but never again, allowing for non-integer rates. Continuous mode should be used for integer rates only where the frequency synthesizer and divider are synchronized each second. Note that integer frequency rates may use the fractional mode and it will remain on time if the unit does not adjust phase using a jamsync. Note that this selection is restored at power-up from NV memory.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x47
1	UINT8	sync sel	see below

0 = Fractional (synchronizes only once - allows fractional rates)

1 = Continuous (synchronizes every second - integer frequencies)

5.3.33 Command 0x48: DDS Multiplier Select

The DDS frequency synthesizer has the ability to multiply its output by 1, 2, 3, 4, 6, 8, 10 or 16. Note that the DDS frequency must be high or low enough for the multiplier to operate correctly (see Input Range in MHz below). Note that this selection is restored at power-up from NV memory.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x48
1	UINT8	mult sel	see below

Value Input Range in MHz

- 0x1 = DDS x1, 22 - 150
- 0x2 = DDS x2, 11 - 75
- 0x3 = DDS x3, 8 - 56
- 0x4 = DDS x4, 6 - 38

- 0x6 = DDS x6, 5 - 23
- 0x8 = DDS x8, 5 - 19
- 0xa = DDS x10, 5 - 15
- 0x10 = DDS x16 5 - 10

Note that when using Multiplier Mode, the DDS resolution is reduced to 1/32 Hz x multiplication factor.

Command 0x49: DDS Period Value

The DDS divider has another selectable mode, which is Period Mode (command 0x45 value = F). This mode may be desirable when the DDS cannot be set to the exact frequency but a period value, based on the period of the DDS rate, will be exact. Note that this value is restored at power-up from NV memory.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x49
1-4	UINT32	Period val	0x0 to 0x00FFFFFF*

* (4 byte data, 3 lower bytes used)

5.3.34 Command 0x4a: DDS Tuning Word

The DDS frequency is set with this command. The desired frequency x32 = DDS Tuning Word. Frequencies higher than 22 MHz should be attained using Multiplier Mode (0x48, 0x46 commands). Note that this value is restored at power-up from NV memory.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x49
1-4	UINT32	DDS val	0x0 to 0x3FFFFFFF

DDS frequency example (fractional mode):
Desired frequency: 10,491,426.56 Hz
Desired frequency x 32 10,491,426.56 x 32 = 335,725,649.92 Hz
Rounded to integer 335,725,650 (register value = 0x1402C452)
Actual DDS frequency 10,491,426.5625 Hz
This is the closest the DDS can get to the desired frequency with 1/32 Hz resolution.

The output of the DDS circuitry is capable of creating a PCI bus interrupt.

5.3.35 Command 0x4F: PCI Firmware Part Number (request only)

This command allows the user to request the TFP firmware revision number.

Byte	Type	Item	Value or Range
0	UINT8	ID	0x4f
1	UINT8	'P'	0x50
2	UINT8	'C'	0x43
3	UINT8	'I'	0x49
4	UINT8	'-'	0x2d
5	UINT8	'v'	0x76
6	UINT8	'2'	0x32

5.3.36 Command 0xF4: Assembly Part Number (request only)

This command queries the assembly part number of the TFP. The assembly number is an identification of the revision hardware. Use this command in conjunction with Command 0x19.

Byte	Type	Item	Value or Range
0	UINT8	ID	0xf4

5.3.37 Command 0xF5: Hardware Fab Part Number (read only)

This command queries the hardware fab part number of the TFP. The number is an identification of the fab being used for this hardware. Use this command in conjunction with Command 0x19.

Byte	Type	Item	Value or Range
0	UINT8	ID	0xf5
1-2	UINT16	ASSEMBLY	

5.3.38 Command 0xF6: TFP Model Identification (request only)

This command queries the PCI family TFP part number. Use this command in conjunction with Command 0x19.

Byte	Type	Item	Value or Range
0	UINT8	ID	0xf6
1	UINT8	Model	‘B’
2	UINT8	Model	‘C’
3	UINT8	Model	‘6’
4	UINT8	Model	‘3’
5	UINT8	Model	‘5’ or ‘7’
6	UINT8	Model	‘P’
7	UINT8	Model	‘C’
8	UINT8	Model	‘I’

Model:

- “BC635PCI” = Time Code
- “BC637PCI” = Time Code and GPS

5.3.39 Command 0xFE: TFP Serial Number (request only)

This command queries the TFP part number. Use this command in conjunction with Command 0x19.

Byte	Type	Item	Value or Range
0	UINT8	ID	0xf7
1-4	UINT32	SN	0x00 – 0xffffffff

6 Inputs and Outputs

6.1 General

Table 3 shows the pin connections for J1.

6.1.1 Signal I/O Connector

This connector is used for most of the I/O signals as defined in Table 3.

Table 3: Signal I/O Connector

Pin	Direction	Signal
1	input	External 10 MHz input
2	n/a	Ground
3	output	Strobe output
4	output	1 PPS output
5	output	Time Code output (AM)
6	input	External Event input
7	input	Time Code input (AM)
8	n/a	Ground (Recommended Time Code return)
9	output	Oscillator Control Voltage output
10	input	Time Code input (DCLS)
11	output	Time Code output (DCLS)
12	n/a	Ground
13	output	1, 5, 10 MHz output
14	input	External 1 PPS input
15	output	Periodic/DDS output

GPS Antenna

P/N 142-614-50

bc637PCI

A: Connector SMB Antenna Connector

B: Connector J1 Module I/O 15 pin ‘DS’

Figure 6-1: bc637PCI – V2 card (Shown here with GPS Interface)

6.1 General

7 Software Programs

7.1 General

Configuration and Demo Programs Bc635pcidemo, Bc637pcidemo and a System Clock Utility TrayTime are included with the bc635/637PCI-V2 module.

When installing the bc635PCI-V2 SW from the supplied CD as described in Chapter 2, the installer will create a folder in 'program files' titled 'bc635PCI Demonstration Software' containing Bc635pcidemo, TrayTime, and bc635pciReadEvent. The Bc635pcidemo clock icon is also copied to the system desktop.

When installing the bc637PCI-V2 SW, the installer will create a folder in 'program files' titled 'bc637PCI Demonstration Software' containing Bc635pcidemo, TrayTime, and bc635pciReadEvent. Icons are copied to the system desktop.

The System Clock Utility, TrayTime.exe, (described later in this chapter) is a system tray utility that queries the bc635/637PCI-V2 and periodically sets the PCI bus computer's system clock at a user-defined interval. The utility may run either as a standard application or as a Windows Service.

The Bc635pcidemo.exe program allows the user to access the bc635/637PCI-V2 card and demonstrates the card's functionality. This program is designed to operate under Microsoft Windows 2000/XP. This utility may be used to query current settings, modify settings, and retrieve or monitor data generated by the card. This program requires the runtime driver to be available in order to operate. The background window of the program provides time, as well as information regarding the clock status, interrupt bit status, and clock reference source type. A full menu system (described in the following paragraphs) has been designed to provide access to the card. Each associated pull-down menu provides a logical grouping of commands. Most of the pull-down menus also include a Current Settings selection that provides a review of the logical group.

7.2 Quickstart Guide to Operating Bc635pcidemo

Click on the desktop icon to execute the program Bc635pcidemo.exe that is an interface program for both the bc635PCI-V2 and bc637PCI-V2 cards. The bc637PCI-V2 may be set to GPS mode, and will initially display time based on the Real Time Clock until GPS lock is achieved. The bc637PCI-V2 unit is locked to GPS, and decoding time when the tracking LED in the GUI left-hand corner is green. The bc635PCI-V2 may be set to decode a time code. For testing, you may set the board time manually using the **Time** menu and selecting **Set Time**.

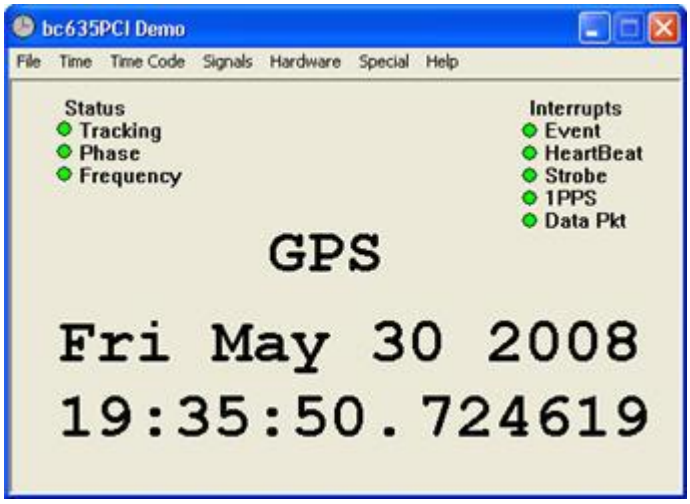


Figure 7-1: bc637PCI-V2 set to GPS mode

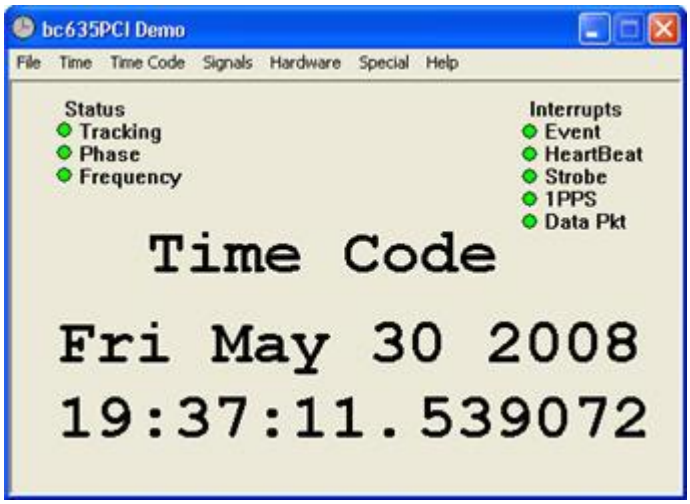


Figure 7-2: bc635PCI-V2 set to Time Code mode

7.3 Bc635pcidemo Control Panel Program Menu Interface

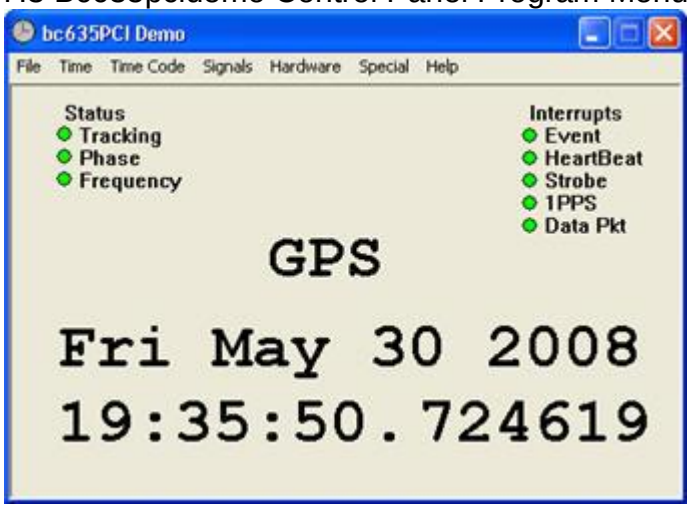


Figure 7-3: Bc635pcidemo Control Panel Program

7.3.1 File Menu

The **File** menu group provides a few common functions associated with Windows applications.

File > Open Device

Bc635pcidemo.exe is designed to communicate with only one device at a time. Open Device allows the user to open and operate any of up to four installed bc635/637PCI-V2 devices. By default, the program opens and operates using the first device in the system (Device 0). By selecting a new device to open, the program will close the currently selected device before opening the newly requested device. This command will also clear the interrupt mask.

Figure 7-4: Select Device

File > Interrupt Start

This command allows the user to start an interrupt service routine capable of handling the selected hardware interrupts created by the bc635/637PCI-V2 module. After starting the interrupt service routine, the user may initiate any interrupt source located under "**Signals** > **Interrupts**". For more information on interrupts, see the **MASK** and **INSTAT** registers described in Chapter 4.

File > Exit

This command allows the user to close the device and exit the program. This command will also clear the interrupt mask.

7.3.2 Time Menu

The **Time** menu group, see Figure 10, provides access to functions that control how the bc635/637PCI-V2 card maintains time data. These functions allow the user to select where to obtain time data, whether or not to manipulate the time data and how to present the time data.

Figure 7-5: Time Menu

Time > Set Mode

The **Set Mode** menu selection allows the user to change the operating mode of the installed card. Selecting this option reveals a secondary menu listing the available operating modes of the bc635/637PCI-V2 device. The available mode selections are:

- Time Code
- Free Running
- External 1PPS
- RTC
- GPS

Note: The card automatically increments the Year value, in every operating mode. For more information on setting the card synchronization mode, refer to Chapter 5, command 0x10.

Note: The bc635PCI-V2 cards do not support GPS mode.

Time > Get Binary Time

The **Get Binary Time** menu selection exercises the device time capture registers. Get Binary Time requests the binary time 25 times, retrieving 25 consecutive timestamps as fast as the system will allow, and displays them. See Figure 7-6. This function is designed to display binary data only. This command is provided as a demonstration of the binary time request. For more information on the Time Registers, refer to Chapter 4.

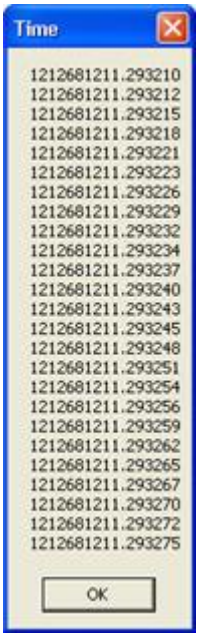


Figure 7-6: Get Binary Time

Time > Get Event Time

The **Get Event Time** menu selection exercises the event capture registers of the device. The function is similar to Get Binary Time where 25 consecutive requests are made to the event register. See Figure 11. This function is designed to display binary data. The bc635/637PCI-V2 card should be set to the binary time format when executing this function. If the decimal Time Register Format is selected, the major time (in front of the decimal point) will be garbled. Minor time will display correctly. For more information on the Event Registers, refer to Chapter 4.

Time > Set Time

The **Set Time** menu selection will set the time on the bc635/637PCI-V2 device. Set Time displays the current time, years through seconds in a decimal format. See Figure 7-7. The user may change any or all of these values and select the OK button. This command will load the time properly regardless of the currently selected time format. This function is typically used when operating in either the Free Running or External 1PPS modes. While the function may be used when operating in Time code or GPS modes, subsequent time data received from the selected reference source will overwrite the manually entered time. For information on Set Major Time, see Chapter 5, command 0x12.

Figure 7-7: Set Time

Time > Set Year

The **Set Year** menu selection will set the year data without affecting the other time data. Many time code formats (including standard IRIG B) do not include year information in the data. The supported range is 1990 – 2036, as shown in Figure 7-8. See Chapter 5, command 0x13.

Figure 7-8: Set Year

Time > Set Local Offset

The **Set Local Offset** menu selection allows the user to program a local time offset into the bc635/637PCI-V2. If the local offset value is nonzero, the device will adjust any reference timing information in order to maintain a local time in bc635/637PCI-V2 clock. Use of this function only affects the time data in the TIME registers described in Chapter 4. Allowed values are –16 through +16, and can include half hour offsets. See Chapter 5, command 1D.

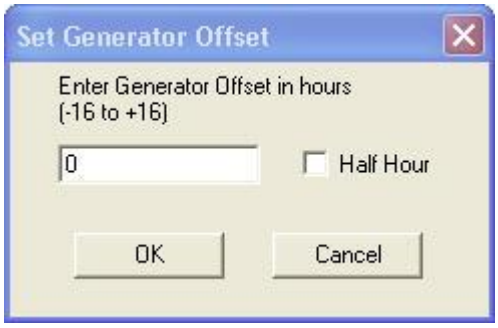


Figure 7-9: Set Local Offset

Time > Set Prop Delay

The **Set Prop Delay** menu selection allows the user to compensate for propagation delays introduced by the currently selected reference source. For example, when the unit is operating in Time code decoding mode, a long cable run may result in the input time code having a propagation delay. The delay value is programmable in units of 100 ns and has an allowed range from –4000000 (advance by 400 ms) through +4000000 (retard by 400 ms). See Chapter 5, command 0x17.

Figure 7-10: Set Propagation Delay

Time > Set Leap Event

The Set Leap Event menu selection allows the user to program a future leap second event. The user is not required to enter UNIX seconds of Leap Event when manually entering Leap Seconds settings. The card uses Year and Time of Year information to determine when a Leap Event will occur. In operating modes that do not have a time source that provides leap second information, the card will calculate the leap event for UTC midnight of the current month. GPS time and IRIG B 1344 operating modes provide automatic leap second adjustments, which normally occur on June 30th or December 31st at UTC midnight.

When the leap second insertion transition takes place (add 1 second) the Time Code output produces a second 60 followed by second 0. The application program will show 2 second 59s followed by second 0.

When the leap second deletion transition takes place (subtract 1 second) the Time Code output produces a second 58 followed by second 0. The application program will show second 58 followed by second 0.

The Bc635/637PCI-V2 card uses only the Flag values of Disable, Insertion or Deletion; the Leap Event Time value is not supported.

See Chapter 5, command 0x1E.

Figure 7-11: Set Leap Event Time

Time > Time Settings

The **Time Settings** function allows the user to modify other timing operations. The UTC Corrections may be enabled or disabled. Enabling UTC Corrections commands the device to include any leap second corrections provided by the reference source and act on any leap event data that is present. The default operation is to use UTC corrections. This function is also used to enable or disable the following options: IEEE Daylight Saving (strips DST bit from IEEE 1344 Time Code input and output) and Local Time Offset (controls the use of Local Offset value). The board time format (Binary or Decimal) is also selected using this function.

Note: the Year Auto Increment cannot be disabled; the year is always incremented when operating with sources that do not include year information.

See Chapter 5, commands 0x11, 0x1D, 0x33 and 0x41.

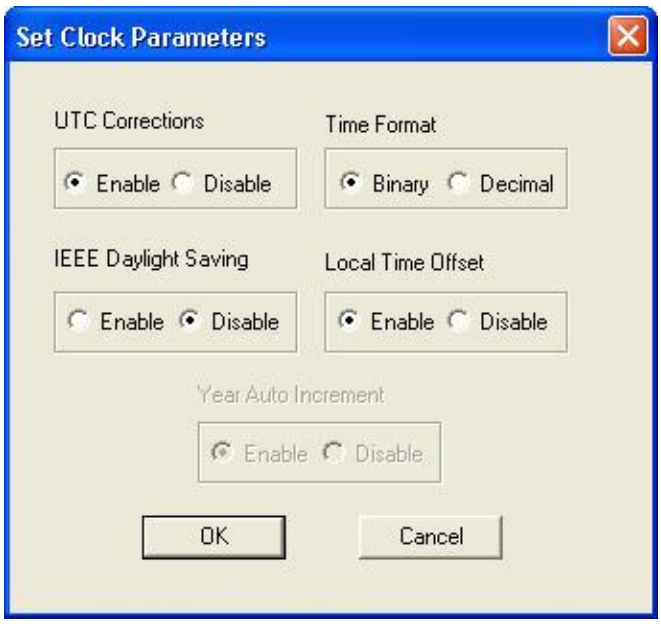


Figure 7-12: Set Clock Parameters

Time > Current Settings

The **Current Settings** function provides a summary of all the time data relevant to the devices current settings. In addition to the programmable values, the values of some of the card's timing data are also presented as information points via the **UTC Data** button. These values include UTC Control, leap second count, leap second event data and leap second event time.

Figure 7-13: Current Settings (Request Time Data)

Time Code Menu

The **Time Code** menu group, see Figure 7-14, provides access to functions that control how the bc635/637PCI-V2 card operates while decoding time code. These functions allow the user to control both the time code decoding, and the time code generating circuits.

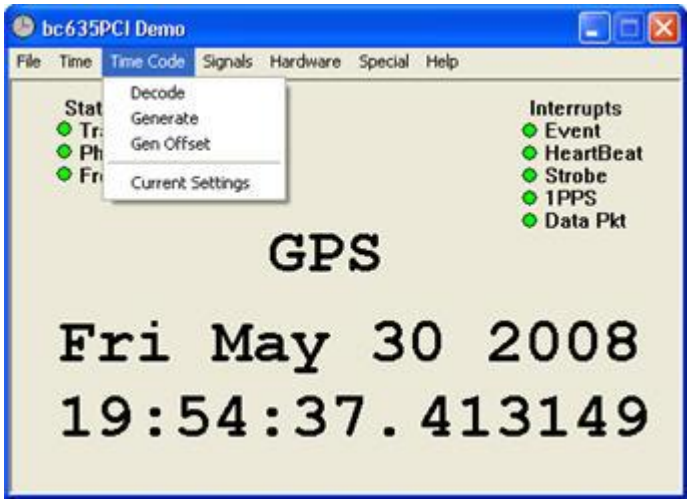


Figure 7-14: Time Code

Time Code > Decode

The **Decode** menu selection allows the user to select the format and modulation types associated with an input timing signal. See Figure 7-15. These values control how the device attempts to decode the input time code. These values may be set regardless of the mode but will only be used in time code decoding mode. The format defines the type of the time code data. The modulation defines the envelope for the signal and which input pin the signal will be extracted from. See Chapter 5, Command 0x15: Set Input Time Code Format for supported time codes and command 0x16, which is used to select the modulation type.

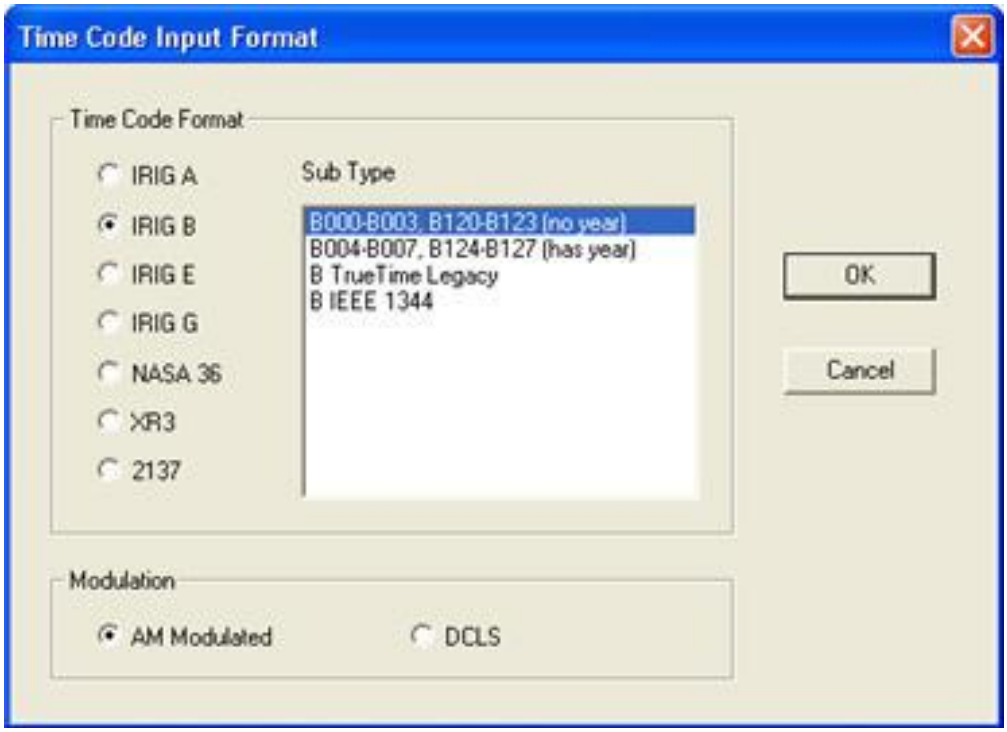


Figure 7-15: Select Time Code Format

Time Code > Generate

The **Generate** menu selection allows the user to select the time code format that will be generated by the bc635/637PCI-V2, see Figure 7-16. See Chapter 5, command 0x1B for supported time codes. Detailed performance specifications are outlined in Chapter 1.

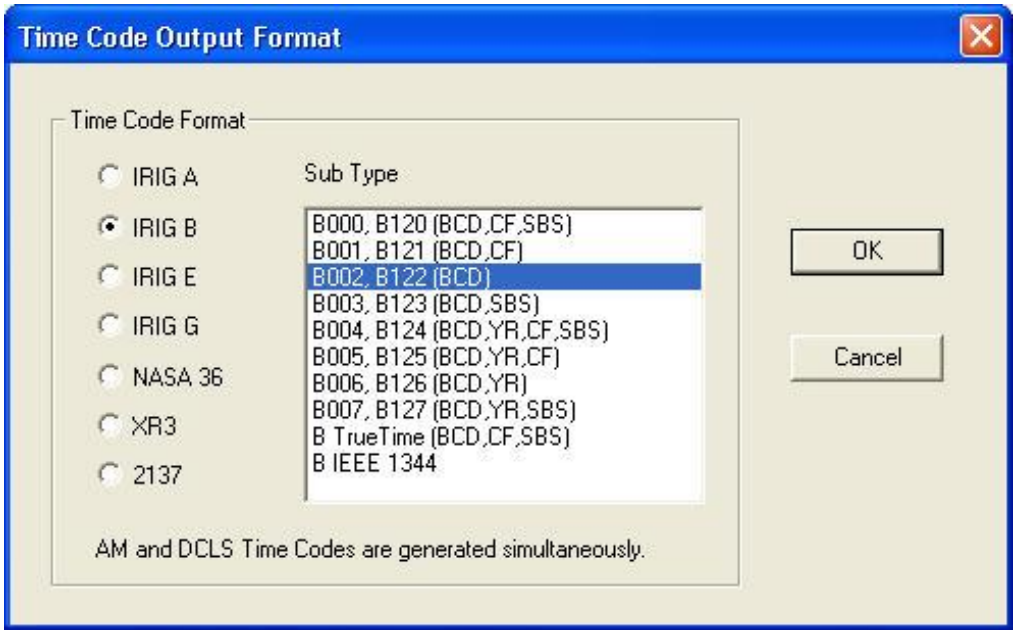


Figure 7-16: Select Generation Code Format

Time code > Gen Offset

The **Gen Offset** menu selection allows the user to add an offset to the time code signal produced by the bc635/ 637PCI-V2, see Figure 7-17. The generator offset only affects the time code generation. This functionality is useful for driving time code display units to display local time. Allowed values are –16 through +16, and may include half hour offsets. See Chapter 5, command 0x1C.

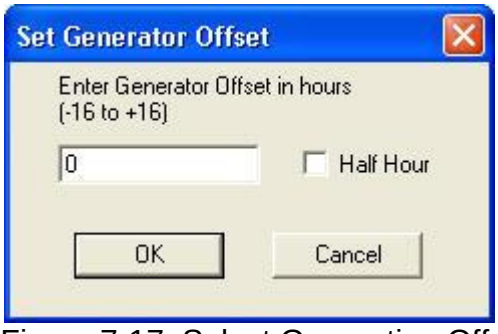


Figure 7-17: Select Generation Offset

Time code > Current Settings

The **Current Settings** menu selection provides time code output data summary.

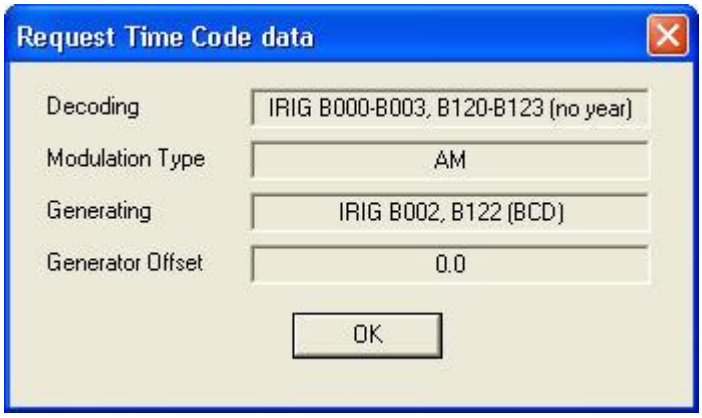


Figure 7-18: Current Settings (Request Time Code data)

7.3.3 Signals Menu

The **Signals** menu group, see Figures 7-19 thru 7-26. This menu group provides access to functions that control various hardware-timing signals.

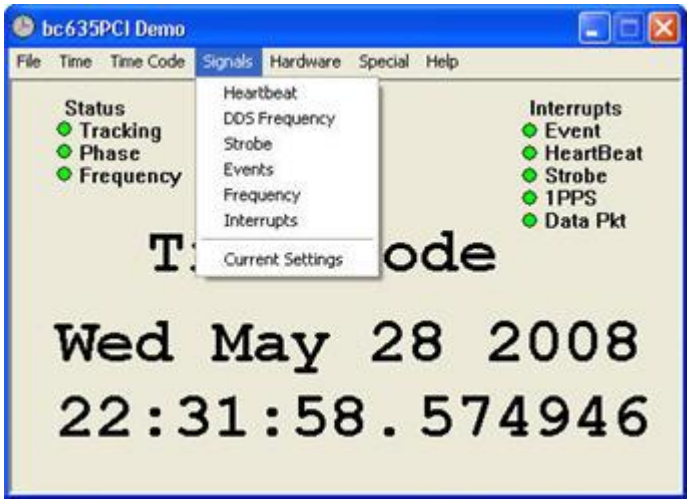


Figure 7-19: Signals Menu

Signals > Heartbeat

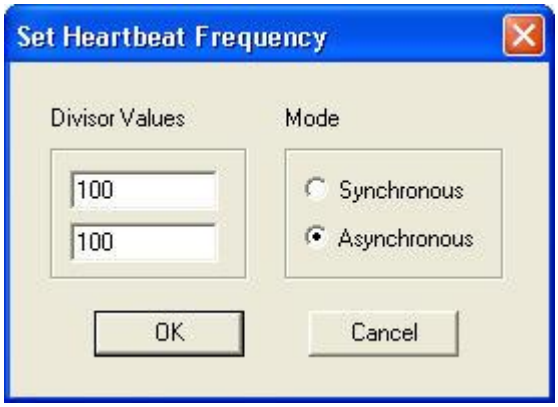


Figure 7-20: Heartbeat

The **Heartbeat** function allows the user to command the bc635/637PCI-V2 to produce a clock signal at a specified frequency. The heartbeat signal, also referred to as a periodic pulse output (PPO), periodic or programmable periodic, may be either synchronous or asynchronous to the internal 1 PPS epoch in the bc635/637PCI-V2 device. See Figure 7-20.

The formula for determining the heartbeat frequency is f = 1,000,000/n1*n2, where n1 and n2 are greater than or equal to 2 and less than 65536. Synchronous mode aligns the periodic output's rising edge to rising edge of 1PPS.

Periodic output fractional frequencies (non-integer) should use Asynchronous mode.

Signals > DDS (a.k.a. frequency synthesizer)

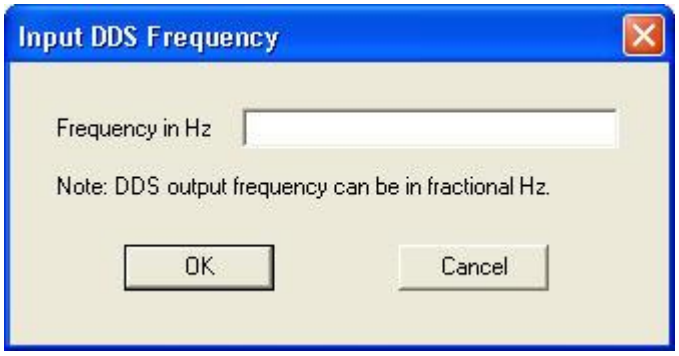


Figure 7-21: DDS Frequency

The **DDS** output may be selected in place of the periodic rate generator's output. This circuit provides a square wave output with a frequency resolution of 0.03125 (1/32) Hz. Direct frequency entry of 7 significant digits with decimal adjustment up to 7 places or entry of 8 digits with 1 Hz resolution is supported with the entry in this dialog box. Value range is 1/1e7 (.0000001) to 1e8 (100000000).

Signals > Strobe

The **Strobe** function allows the user to command the bc635/637PCI-V2 to produce a hardware signal at a particular time, or at a particular point during a 1 second interval. When major/minor mode is selected, a hardware signal (1 uS pulse) will be produced when the internal time of the bc635/637PCI-V2 device matches the values entered for the major and minor strobe registers. Up to 22 bits of binary major time may be supplied in addition to the microseconds loaded in the minor strobe register. This allows strobe signals to be programmed up to 48 days in advance. This function is designed to operate with the timing format in binary mode. When minor mode is selected, a strobe signal is produced every second when the internal microsecond count in the bc635/637PCI-V2 device matches the value entered in the minor strobe register. See Figure 7-22. The strobe register values may be in either Binary of Decimal Time format. The output of this circuitry is capable of creating a PCI bus interrupt. For details on Strobe programming, see Chapter 4.

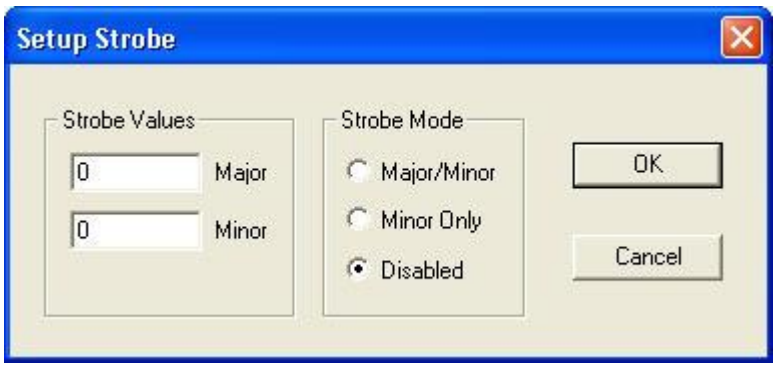


Figure 7-22: Signals Menu Setup Strobe

Signals > Events

The **Events** function allows the user to command the bc635/637PCI-V2 device to monitor a hardware-timing signal. The source for the signal can be either the External Event input or the Periodic/DDS output. The capture may be set to occur on either the rising or falling edge. See Figure 7-23. When the selected signal occurs, the time at which the signal occurred is loaded into the event time registers. The capture lockout checkbox can be used to control whether or not subsequent signals will overwrite the data in the event time registers. The output of this circuitry is capable of creating a PCI bus interrupt. See Chapter 4 for event programming details.

Figure 7-23: Set Event Controls

Note: The capture rate is dependent on the rate that the Software extracts the event times which is dependent on the operating system and speed of the host computer.

Signals > Frequency

The **Frequency** function allows the user to control the frequency signal output by the bc635/637PCI-V2 device. The available frequencies are 1, 5 and 10 MHz. See Figure 7-24. See the CONTROL Register described in Chapter 4 for more detail.

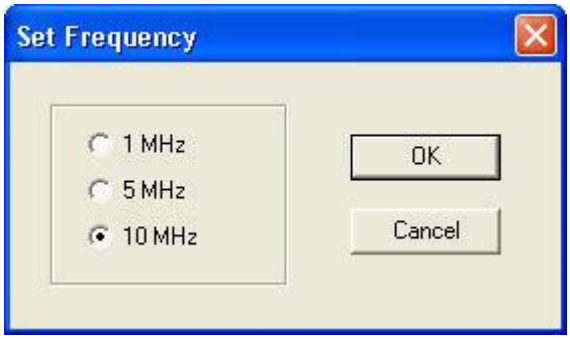


Figure 7-24: Set Frequency

Signals > Interrupts

The **Interrupts** function allows the user to control the generation of PCI bus interrupts by the bc635/637PCI-V2. See Figure 7-25. The detection of an interrupt will be displayed in the background of the main window by five "LEDs" which are displayed in the upper-right corner. When an interrupt occurs, the program queries the interrupt source and the associated LED is displayed in red. In order to display consecutive interrupts, the LEDs are changed back to green once per second. This may result in LEDs only remaining red for a short period of time.

The default state of the interrupts is OFF. Interrupt programming is described

in detail in Chapter 4.

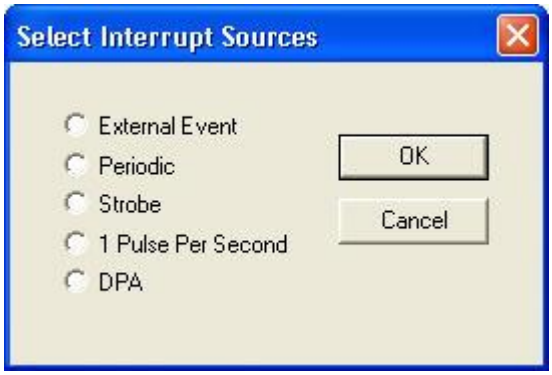


Figure 7-25: Select Interrupt Sources

Signals > Current Settings

The **Current Settings** function provides a summary of all the signal data. In addition to the programmable values, other values may be presented as information points.

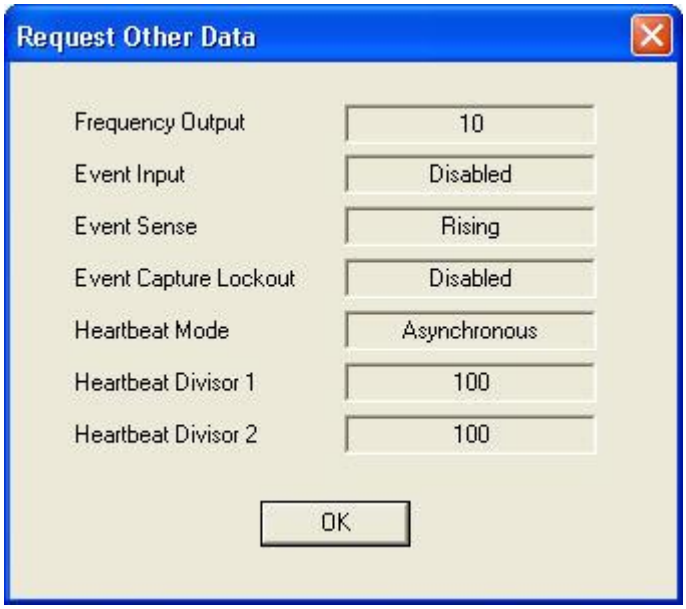


Figure 7-26: Current Settings (Request Other Data)

7.3.4 Hardware Menu

See Figure 7-27. This group provides additional access to functions that control the oscillator and its associated disciplining circuits. These functions modify the actual oscillator control function used to slave the oscillator to the selected reference signal. This function is not modified during standard operation.

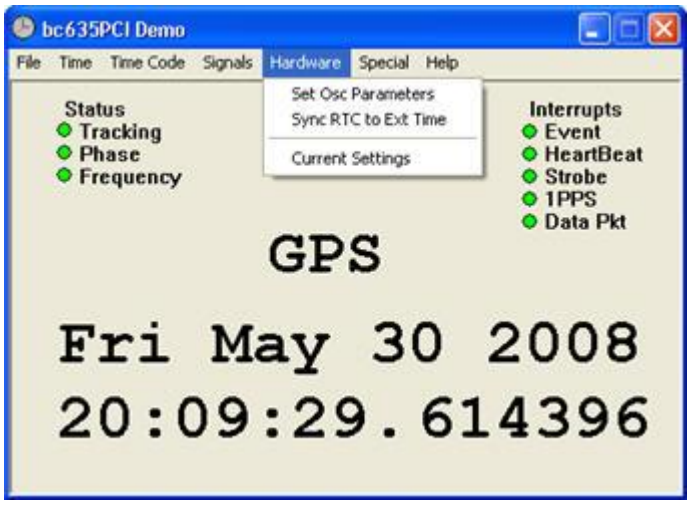


Figure 7-27: Hardware Menu

Hardware > Set Osc Parameters

The **Set Osc** Parameters function allows the user to select an external oscillator or the on-board oscillator, in addition to enabling/disabling disciplining and jamsyncing. See Figure 7-28. Oscillator selection and control is described in more detail in Chapter 5; commands 20, 21, and 24.

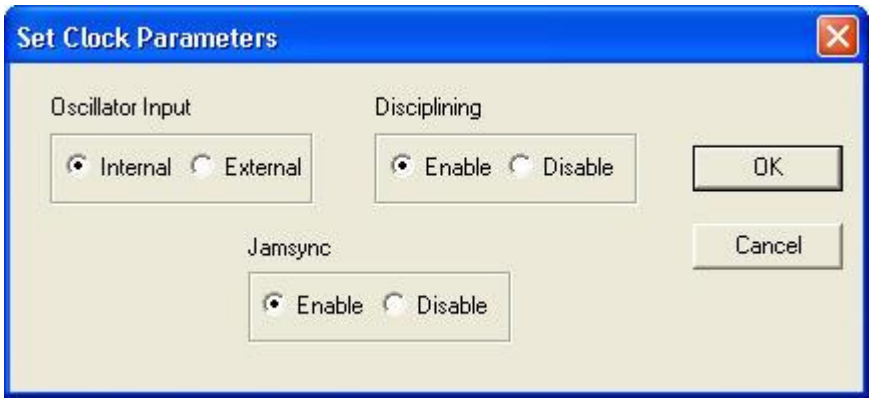


Figure 7-28: Select Clock Parameters

Hardware > Sync RTC to Ext Time

The **Sync RTC to Ext Time** function updates the RTC circuit time to the current time on the board. See Figure 7-29. The board contains a separate battery-backed Real Time Clock Circuit (RTC) that may be used to keep time while the device is powered down.

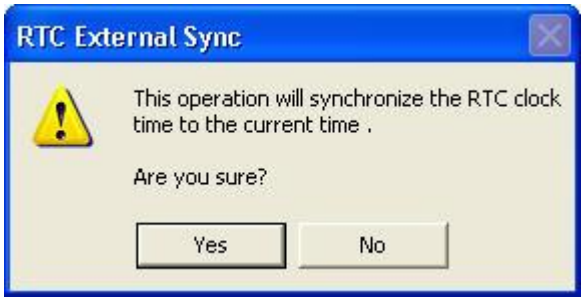


Figure 7-29: RTC External Sync

Hardware > Current Settings

The **Current Settings** function provides a summary of all the oscillator data. See Figure 7-30. In addition to the programmable values, other values may be presented as information points.

Figure 7-30: Request Oscillator Control Data

7.3.5 Special Menu

The **Special Menu** group provides access to those functions that do not fit in any particular category. See Figure 7-31. Most of these functions are not used during normal operation.

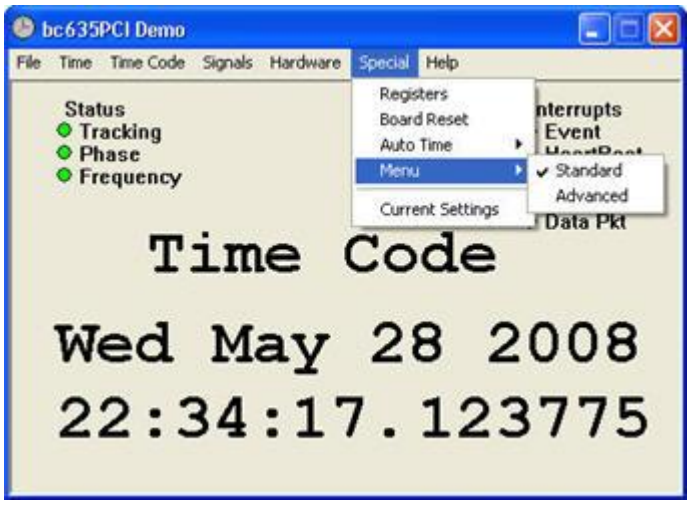


Figure 7-31: Special Menu

Special > Registers

The **Registers** function is provided to perform direct reads and writes to the bc635/ 637PCI-V2 device registers. See Figure 7-32. While most of the functionality available through the registers can be controlled via other aspects of the demo/config program, this function may be useful for debugging purposes.

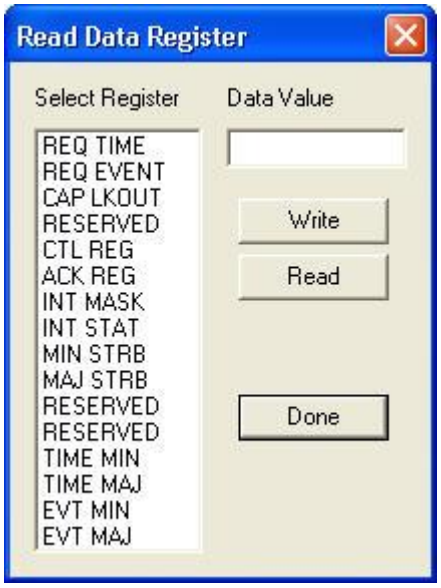


Figure 7-32: Read Data Register

Special > Board Reset

The **Board Reset** function allows the user to reset the bc635/637PCI-V2 device. See Figure 7-33. This command is useful when starting a test or in the case that unexpected behavior is observed from the card. This function is not used during normal operation. See Chapter 5, command 0x1A.

Figure 7-33: Software Reset

Special > Autotime

The **Autotime** function allows the user to control the data display in the background of the main program window. If this function is turned off, the display will stop updating but will continue to show the reference source type.

Special > Menu

The **Menu** command allows the user to switch to an advanced version of the menu. See Figure 7-34. The advanced menu selection adds Special menu options, as well as the PCI menu selection, to the menu bar. See Figure 7-.

Warning: The advanced menu contains operations that may disable the function of the bc635/637PCI-V2 device.

Special > Menu > Advanced

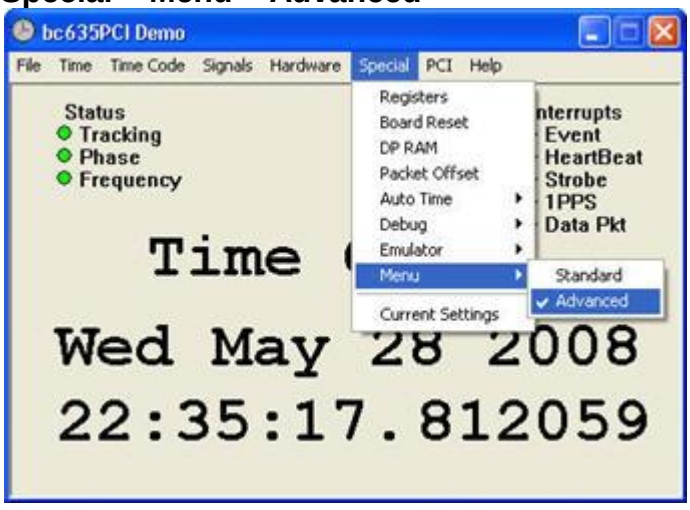


Figure 7-34: Special Menu

Selecting the advanced Special Menu, opens several new selections:

DP RAM

DP RAM allows reading, writing hex offsets, and values to the dual port RAM.

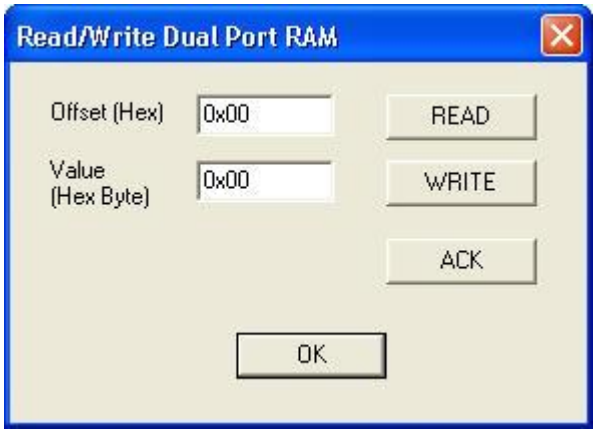


Figure 7-35: Dual Port RAM

Packet Offset

Displays the following packet information

Figure 7-36: Packet Offset

Debug

Debug can be turned off or on. Turning debug on, causes the three status lights, (tracking, Phase, and Frequency), to provide debugging information.

Emulator

The emulator can be turned off or on.

7.3.6 PCI Menu

In addition, to the additional **Special Menu** selections, a new menu choice **PCI** is available when the **Advanced Menu** is selected. The PCI menu has the following selections:

- Test DP RAM
- Packet Timing
- Board Setting
- PCI Config Reg

Special > Current Settings

The Special > **Current Settings** function provides information related to the PCI interface to the board. See Figure 39. This command is useful for determining whether or not the driver has obtained access to the device. It may also be used to review the PCI mapping of the device onto the bus. The interrupt level selected during PCI configuration may also be reviewed.

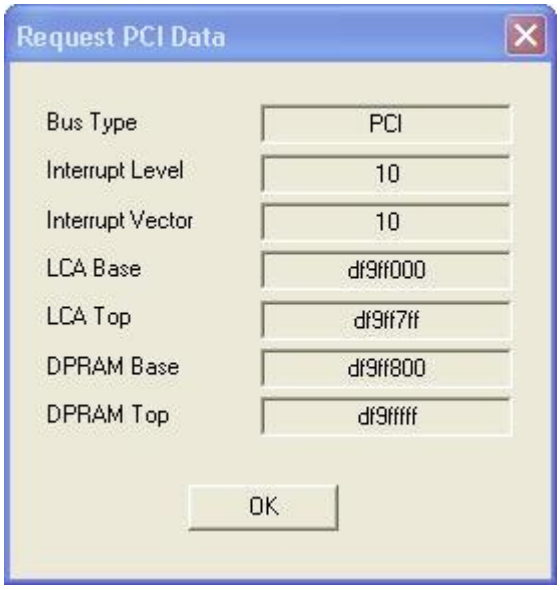


Figure 7-37: Current Settings (Request PCI Data)

7.4 System Clock Utility (Traytimecpp.exe)

This utility is designed to operate under Microsoft Windows 2000/XP. This system tray utility will query the bc635PCI-V2 or the 637PCI-V2 card, and set the system clock on a periodic basis. Double click on the “TrayTimeCPP.exe” to install. TrayTimeCPP.exe is copied to the same folder as the other demonstration software. A small world icon will show up on the lower right portion of the desktop (where the desktop clock appears in the taskbar tray). See Figure 40. Click on that icon to display the TrayTimeCPP interface window. Click Setup under Selected Source on the Status tab, and click on Hardware if it has not been selected as the source for time.

Figure 7-38: Tray Time Icon

If the Current Status is: "*Waiting for the board to acquire time,*" then the time on the host computer has not synchronized to the bc635PCI-V2 time yet. If the status is: "*Set Clock OK*" or "*Captured Board Time*," then the synchronizing process is taking effect. Change the **Update Interval** to the desired value and press **OK**.
To allow the program to continue running in the background, and synchronize the System Time, minimize the window or click **OK**.

Pressing "**Quit**" will terminate the program.
Drag the program into your startup group to have it run automatically at boot time.

Caution: Using both TrayTime and either the bc635PCI, or the bc637PCI Demo applications with the Local Time Offset value set to anything other than 00 (UTC) will corrupt TrayTime's time value.

7.4.1 Installation

To install TrayTime, run the TrayTime.exe installer. The installer will configure the registry, as well as add a shortcut to the TrayTime program under "Symmetricom > TrayTime" in the Programs menu.

Note: The TrayTime installer will write to the Windows Registry during the installation, so Administrator privileges may be required for a successful installation.

7.4.2 Functionality

Once the TrayTime installation is complete, a small, world icon will appear in the lower right portion of the desktop (where the clock appears), referred to as the "tray". Click on the world icon to activate the main program window. The "Reference Status" control in the GUI indicates if the selected hardware source is "Locked" or "Unlocked" to the selected input source. If "Reference Status" shows "Unlocked", the card is not tracking its reference source (GPS, Timecode, 1PPS etc). It is important to note that the TrayTime utility will not update the system's time until the selected hardware locks to its reference source. Once the hardware locks, TrayTime will update the system time at a periodic rate, selectable by the user.

Note: TrayTime assumes that the time read from the hardware is Universal Time Coordinate (UTC) based, and will adjust the hardware time with the machine's local time-zone offset.

7.4.3 TrayTime Dialog Windows

Main Window

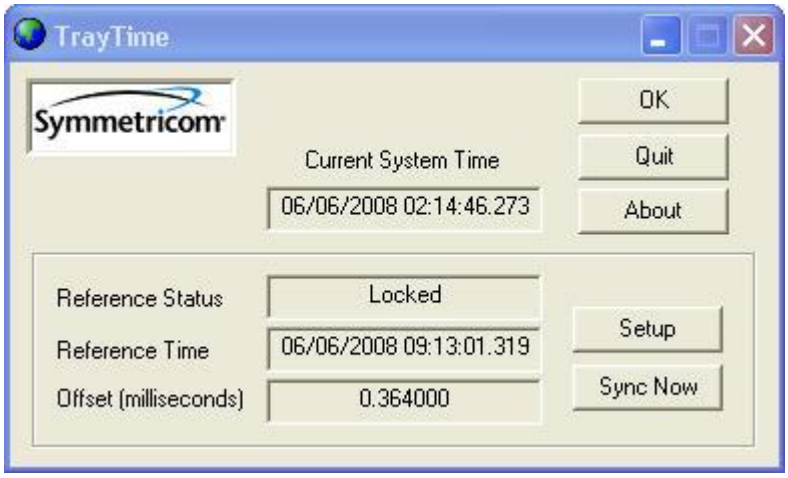


Figure 7-39: TrayTime main window

OK: Minimizes the utility into the Windows System Tray.

Quit: Exits the utility.

About: Shows utility version number.

Setup: Launches the Setup Windows.

Sync Now: Commands the utility to capture time from the board and set the system's time.

Reference Status: Shows "Locked" or "Unlocked" depending on whether the reference hardware is "tracking" or "not tracking" an external time reference, respectively.

Reference Time: Shows the reference time, UTC-Based time zone.

Offset (milliseconds): Shows the time offset between the reference hardware and the system clock in milliseconds.

Status Window

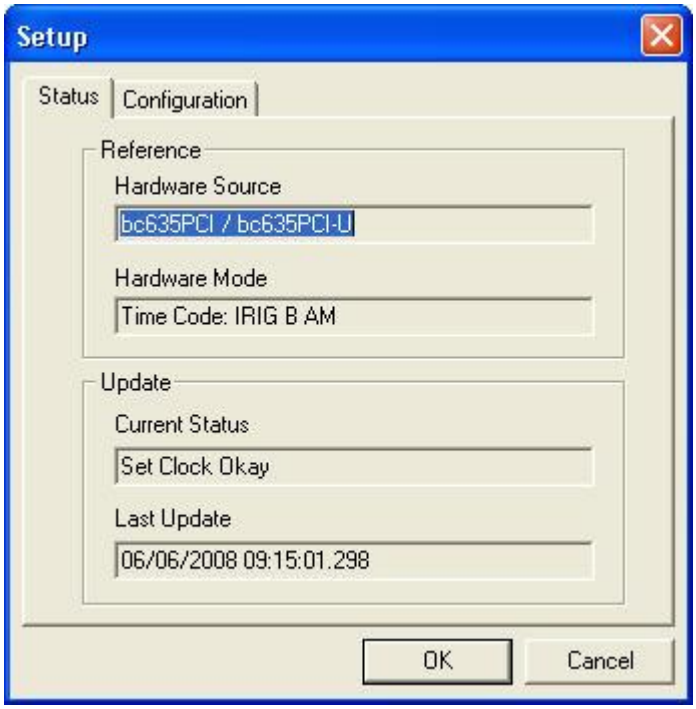


Figure 7-40: Status Window

Hardware Source: Shows the selected Hardware type used for time synchronization.

Hardware Mode: Shows the selected Hardware mode.

Current Status: Shows the current update status. If status is: "Waiting for the board to acquire time" then machine's time is not synchronized to the reference hardware since the reference hardware is not tracking an external time source. If status is: "Set Clock Okay", then the machine's time was updated to reference hardware time.

Last Update: Time of the last update, UTC based.

Configuration Window

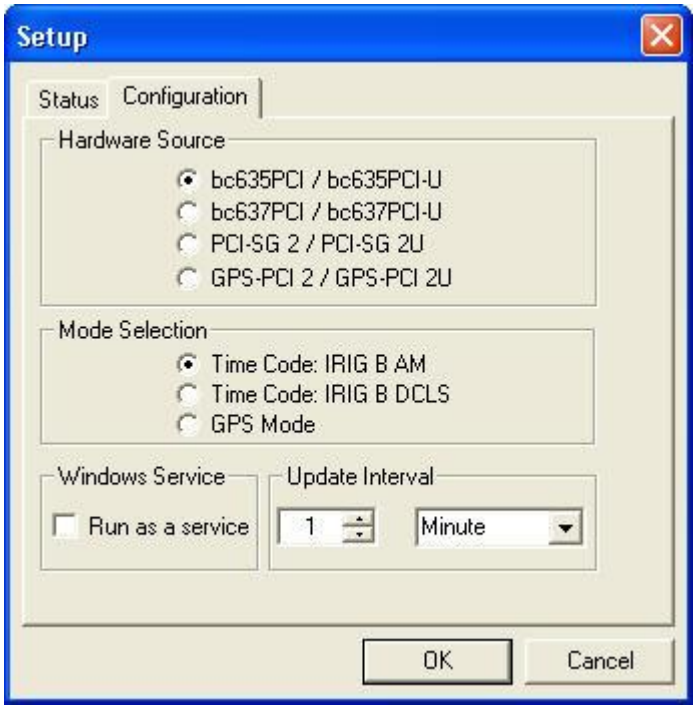


Figure 7-41: Configuration Window

Hardware Source: The TrayTime utility supports the listed 8- types of hardware sources.

Mode Selection: The TrayTime utility supports setting the mode on the selected hardware.

Note: “GPS Mode” is only available on GPS capable devices.

Windows Service: Check this option to run the TrayTime utility as a Windows service. If this option is checked, the TrayTime utility will automatically run and update the system time without a user login to the system.

Update Interval: This option sets the interval of how often the system clock time should be updated. The default interval is 1 minute.

Appendix A: GPS Receiver Interface

General

The most common difficulty encountered using GPS equipment is antenna position. The GPS antenna must be located in an area that has a clear view of the sky. The GPS signals cannot penetrate foliage or structures. A good antenna position will provide optimal timing performance. See Chapter 2 for detailed installation instructions.

GPS Timing Mode (Mode 6) Characteristics

- The 1 PPS signal generated by the GPS Receiver provides the timing reference for all timing functions.
- The 10 MHz oscillator is disciplined to the GPS 1 PPS signal whenever the receiver is tracking a sufficient number of satellites. If too few satellites are tracked then the bc637PCI-V2 will flywheel.
- The bc637PCI-V2 extracts major time and satellite tracking status information from data packets sent from the GPS receiver. By default, the bc637PCI-V2 provides UTC time to the user. The user can select GPS time instead by issuing the DPRAM Command 0x33 (Select GPS Time Format) described in Chapter 4.
- The bc637PCI-V2 provides a communications pathway between the user and the GPS receiver. This pathway is most often used to receive GPS data packets for position, velocity, and GPS system status.

Communicating With the GPS Receiver

The dual-port RAM (DPRAM) interface, described in Chapter 4, provides the communications pathway between the user and the GPS receiver. Using DPRAM commands and the DPRAM GPS Packet Area, the user can send and receive GPS data packets. A GPS data packet consists of a packet length byte, a packet ID byte, and zero or more data bytes. A packet length of zero indicates that no valid packet ID and data bytes are present. The GPS data packet structure is summarized below:

Byte	Item
0	packet length = N = number of packet data bytes + 1 (for the packet ID byte)
1	packet ID
2 - N	packet data bytes

The GPS packet IDs and packet data formats are described later in this appendix and are taken from Trimble Navigation's manuals. The user can determine the packet length from the documentation. The documentation describes a packet structure that includes, in addition to the packet ID and packet data bytes, header and trailer bytes and byte-stuffing/unstuffing. The bc637PCI-V2 automatically adds (when sending packets) and removes (when receiving packets) the header and trailer bytes and handles all byte-

stuffing/unstuffing operations. The bc637PCI-V2 user should be concerned with the packet length, packet ID, and packet data bytes only.

Sending GPS Data Packets to the GPS Receiver

To send a GPS data packet to the receiver, use the DPRAM command “Send Packet to GPS Receiver” (command ID 0x30). The format of this command is shown below:

Byte	Type	Item	Value or Range
0	UINT8	command ID	0x30
1	UINT8	packet length	1 - 255
2	UINT8	packet ID	0x00 - 0xFF
3 - N	UINT8	packet data bytes	0 - 255

GPS packet data consists of various integer and floating-point data types. The user must convert these data types to an array of bytes.

Receiving GPS Data Packets from the GPS Receiver

The DPRAM GPS Packet Area holds packets received from the GPS receiver. The bc637PCI-V2 writes GPS packets to this area upon user request. The format of the packets in the GPS Packet Area is shown below:

Byte	Type	Item	Value or Range
0	UINT8	packet length	1 - 255, 0 = no valid packet
1	UINT8	packet ID	0x00 - 0xFF
2 - N	UINT8	packet data bytes	0 - 255

There are two DPRAM commands that retrieve GPS Packets. These commands are described below. The bc637PCI-V2 sets ACK register bit two whenever it writes a GPS packet to the GPS Packet Area. The transition of ACK register bit two from 0 to 1 is interrupt source four (GPS Packet Available). The user must clear ACK register bit two.

Retrieve Packet from GPS Receiver (Command 0x31)

This command allows the user to retrieve a GPS packet (i.e., position, velocity, status, etc.) from the GPS receiver by specifying the packet ID of the GPS packet of interest. Packets that can be retrieved with this command are listed below. Packets not found on this list must be retrieved with Command 0x32. The format of Command 0x31 is shown below:

Byte	Type	Item	Value or Range
0	UINT8	command ID	0x31
1	UINT8	packet ID	0x00 - 0xFF

Some of the more commonly requested GPS packets are sent from the GPS receiver to the bc637PCI-V2 either periodically (e.g., position fix) or whenever they change (e.g., satellite selection.) The bc637PCI-V2 monitors these packets and stores them in on-board RAM so that they can be transferred to

the user immediately upon request. The rest of the GPS packets must be retrieved from the GPS receiver by the bc637PCI-V2 whenever the user requests them. Note that it can take 10's or 100's of milliseconds for the bc637PCI-V2 to retrieve a packet from the GPS receiver. GPS packets that are monitored by the bc637PCI-V2 are identified below.

Packet ID	Monitored	Packet Description
0x41	No	GPS Time
0x42	Yes	Single-Precision Position Fix, XYZ ECEF
0x43	Yes	Velocity Fix, XYZ ECEF
0x44	Yes	Satellite Selection
0x45	No	Firmware Version
0x46	Yes	Health of GPS receiver
0x47	No	Signal Level For All Satellites*
0x48	No	GPS System Message
0x49	No	Almanac Health Page For All Satellites
0x4A	Yes	Single-Precision Position Fix, Lat/Long/Alt
0x4B	Yes	Machine/Code ID And Additional Status
0x4D	No	Oscillator Offset
0x4F	No	UTC Parameters
0x55	No	I/O Options
0x56	Yes	Velocity fix, East-North-Up (ENU)
0x57	No	Information About Last Computed Fix
0x5E	No	Additional Fix Status
0x83	No	Double-Precision Position Fix, XYZ ECEF
0x84	No	Double-Precision Position Fix, Lat/Long/Alt

* **Note**: The first byte returned will be the length of the packet.

The retrieve packet command works as follows:

- If the requested packet is being monitored and a local copy exists, then the bc637PCI-V2 transfers its local copy of the packet to the DPRAM GPS Packet Area, sets ACK bit 2, then sets ACK bit 0 to acknowledge the retrieve packet command.
- If the requested packet is not being monitored or if the bc637PCI-V2 has not yet received a monitored packet, then the bc637PCI-V2 must request the packet from the receiver by sending the appropriate request packet. Once the request has been sent, the bc635PCI-V2 sets ACK bit 0 to acknowledge the retrieve packet command. Later, when the receiver responds with the retrieved packet, the bc637PCI-V2 transfers the packet to the DPRAM GPS Packet Area and sets ACK bit 2. If the receiver does not respond to the request within a timeout period (typically 3 seconds), then the bc637PCI-V2 sets the packet

length byte in the DPRAM GPS Packet Area to zero and sets ACK bit 2.

- If the retrieved packet ID is not on the list above, the bc637PCI-V2 sets the packet length byte in the DPRAM GPS Packet Area to zero, sets ACK bit 2, then sets ACK bit 0.

Manually Request Packet from GPS Receiver (Command 0x32)

This command is a hybrid of commands 0x30 and 0x31. With this command the user specifies the packet length and ID of a packet sent by the receiver (response packet) and specifies the packet length, ID, and data for the packet to be sent to the receiver (request packet.) The bc635PCI-V2 sends the request packet to the receiver and transfers the response packet to the DPRAM GPS Packet Area when it arrives. If the response packet ID is 0x00 then the bc637PCI-V2 will ignore the response, in which case, this command would be functionally identical to Command 0x30. The bc637PCI-V2 sets ACK bit 0 once the request packet is sent to the receiver. Later, when the response packet has been transferred to the DPRAM GPS Packet Area, the bc637PCI-V2 sets ACK bit 2. As with Command 0x31, if the receiver fails to respond within a timeout period, the bc637PCI-V2 sets the packet length in the DPRAM GPS Packet Area to zero and then sets ACK bit 2.

Note: A response packet length of 0 (ZERO) (Byte 1) will return any packet with the corresponding response packet ID (Byte 2). This is useful for packets, like 0x47, that return variable length responses.

Byte	Type	Item	Value or Range
0	UINT8	command ID	0x32
1	UINT8	response packet length	1 - 255
2	UINT8	response packet ID	0x00 - 0xFF
3	UINT8	request packet length	1 - 255
4	UINT8	request packet ID	0x00 - 0xFF
5 - N	UINT8	request packet data bytes	0 - 255

As an example of this command, let's suppose the user wants to retrieve packet 0x5B (satellite ephemeris status) for satellite number six. The receiver sends packet 0x5B in response to packet 0x3B (request satellite ephemeris status.) Packet 0x3B specifies the PRN number for the satellite of interest, in this case, satellite number six. The appropriate command structure for this example is shown below:

Byte	Item	Value
0	command ID	0x32
1	response packet length	17
2	response packet ID	0x5B
3	request packet length	2
4	request packet ID	0x3B
5	satellite PRN number	6

Byte	Item	Value
0	command ID	0x32
1	response packet length	0
2	response packet ID	0x47
3	request packet length	1
4	request packet ID	0x27

Position Fix Modes

One of the most confusing aspects of GPS operation is the selection of the position fix mode (GPS packet 0x22.) The GPS receiver supports the following four GPS position fix modes.

Position Fix Mode 0

This mode uses as many satellites as are available to perform both position fixes and timing functions. Confusion arises because this mode selection interacts with the dynamics code selection (GPS packet 0x2C.) If a non-static dynamics code is selected then only three or four satellites will be used because the GPS sensor assumes that it is moving. If only three satellites are usable then altitude will be held constant. If a static dynamics code is entered then mode zero will use three or four satellites for a navigation solution as previously, however, if only one or two satellites are available the sensor will use the satellite with the highest elevation to continue calculating bias and bias rate (the timing functions will continue unimpaired). It is very advantageous, therefore, to enter a static dynamics code if the sensor is static.

Position Fix Mode 1

In this mode, a user-specified satellite is used for timing functions. If mode 1 is selected, only a single satellite will be used for timing, and the current position will be assumed accurate and static.

GPS packet 0x34 allows the satellite associated with mode one to be selected. This packet has one data byte that specifies the PRN of the desired satellite. If a data byte value of 0 is entered, then the sensor will always track the single satellite that has the highest elevation within the constellation in view.

It is very advantageous to operate in a single-satellite highest elevation mode for timing applications. The greatest contribution to timing error is the electron content variation in the path between the satellite and the receiver. Selecting the highest elevation satellite minimizes this variation.

Position Fix Mode 3 and 4

These modes are rarely used for timing applications unless the user operational platform is dynamic. Mode 3 is particularly useful in a marine environment where the sensor altitude is relatively constant.

bc637PCI-V2 GPS Default Parameters

The bc637PCI-V2 sends the following GPS packets to the GPS receiver on reset or whenever the Timing Mode is changed to GPS Timing Mode 6.

Set Operating Parameters (GPS packet 0x2C)

Packet Data Item	Value
Packet ID	0x2c
Dynamics Code	4 (Static)
Elevation Angle Mask	0.1745 Radians (10 Degrees)
Signal Level Mask	6.0
PDOP Mask	12.0
PDOP Switch	8.0

Set High-8 / High-6 Mode (GPS packet 0x75)

Packet Data Item	Value
Packet ID	0x75
Mode	0 (high-8)

Set I/O Options (GPS packet 0x35)

Packet Data Item	Value
Packet ID	0x35
Position	0x03
Velocity	0x03
Timing	0x00
Auxiliary	0x00

To change any of the packet 0x35 options, keep the following in mind: The bc637PCI-V2 monitors position and velocity packets so the "position" and "velocity" options should be sent with bits 0 and 1 set; the bc637PCI-V2 extracts major time from time packets broadcast by the GPS receiver so the "timing" option should be sent with bits zero, one, and two cleared.

Appendix B: GPS Software Program

General

In addition to the Configuration and Demo Program (Bc635pcidemo.exe), and the System Clock Utility (TrayTime.exe), the bc637PCI-V2 includes a GPS demonstration program (bc637PCI GPS Demo). When installing the bc637PCI-V2 SW from the supplied CD, as described in Chapter 2, the installer will create a folder in ‘program files’ titled ‘bc637PCI Demonstration Software’ containing bc637PCI GPS Demo, Bc635pcidemo, TrayTime, and bc635pciReadEvent. The Bc635pcidemo and bc637pci clock icons are copied to the system desktop.

The System Clock Utility, TrayTime.exe is described in Chapter 6.

The bc637PCI GPS Demo program allows the user to access the bc637PCI-V2 card and demonstrates the boards GPS functionality. This program is designed to operate under Microsoft Windows 2000/XP. This utility may be used to query current settings, modify settings, and retrieve or monitor data generated by the card and/or the GPS receiver. This program requires that the runtime driver be available in order to operate. The background window of the program provides current time, as well as information regarding the clock status and clock reference source type. A full menu system (described in the following paragraphs) has been designed to provide access to the card and the GPS receiver. Each associated pull-down menu provides a logical grouping of commands.

Quickstart Guide to Operating bc637PCI GPS Demo

1. Verify that the antenna is connected to the SMB connector on the rear of the card. See Chapter 2 for hardware installation details.
2. Click on the bc637PCI GPS Demo desktop icon to execute the program. The card will start counting using the RTC value, until lock is achieved. The bc637PCI-V2 unit is locked to GPS, and decoding UTC time when the tracking LED, indicated by the letter "T" in the GUI shown in Figure B-3, is green.

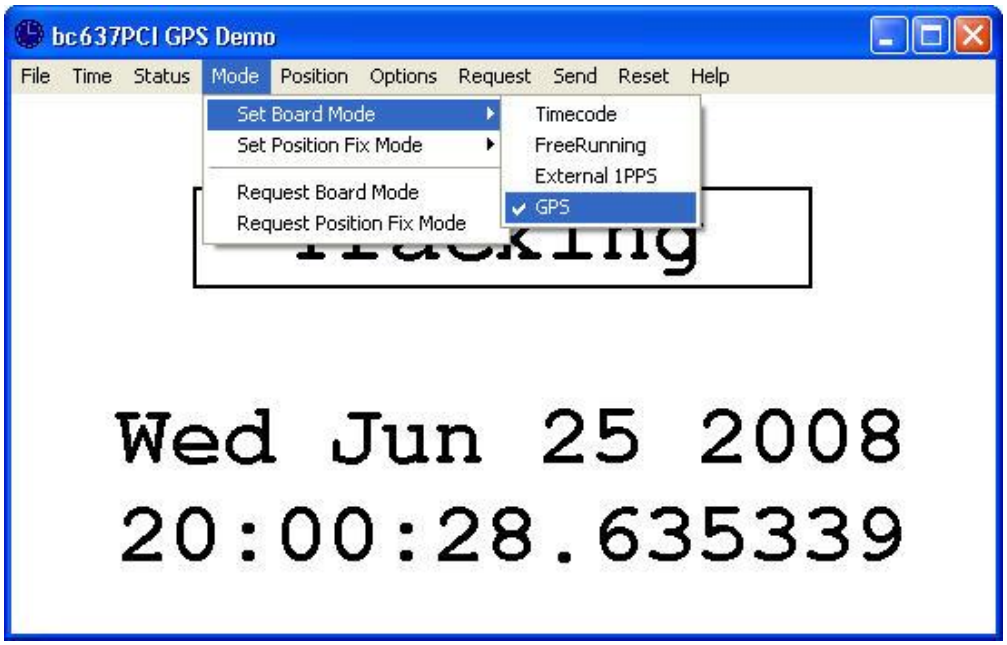


Figure B-1: bc637PCI-V2 Menus

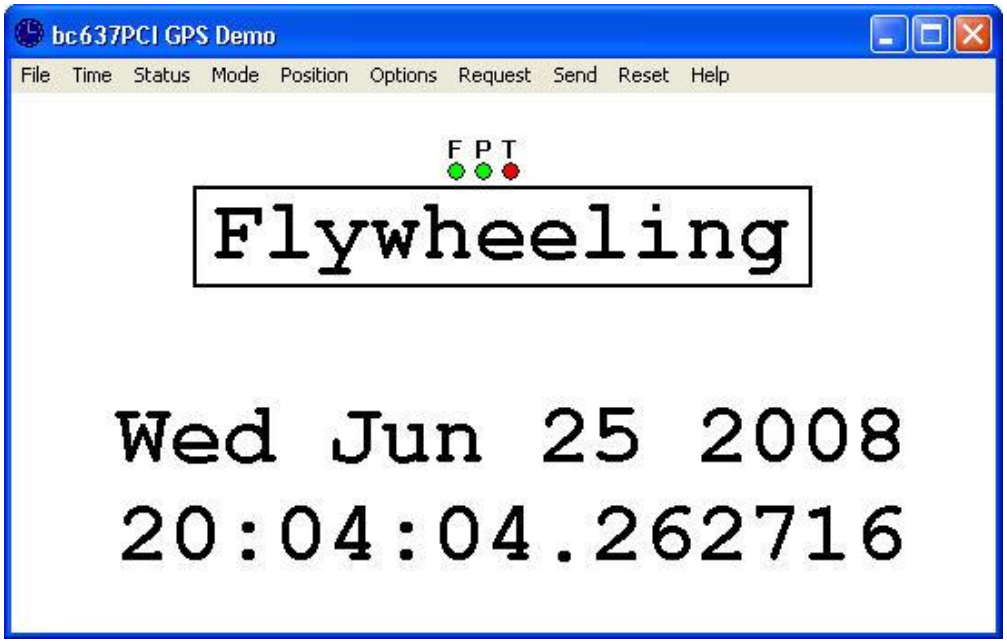


Figure B-2: bc637PCI-V2 Counting Time in Flywheel State

bc637PCI GPS Demo Control Panel Program Menu Interface

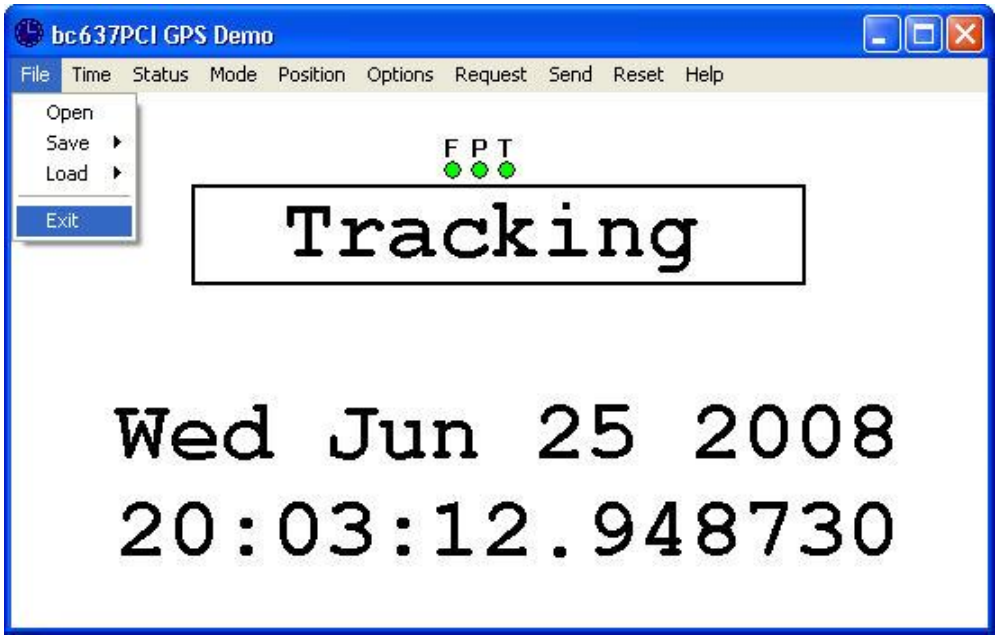


Figure B-3: File Menu

File Menu

The **File** menu group provides a few common functions associated with Windows applications.

File > Open

bc637PCI GPS Demo is designed to communicate with only one device at a time. Open allows the user to open and operate any of up to four installed bc637PCI-V2 devices. By default, the program opens and operates using the first device in the system (Device 0). By selecting a new device to open, the program will close the currently selected device before opening the newly requested device. This command will also clear the interrupt mask.

Figure B-4: Select Hardware Device

File > Save

This command allows the user to save the values to the GPS receiver located under "Save > Save variable". For more information on the GPS variables, see Appendix A: GPS Receiver Interface.

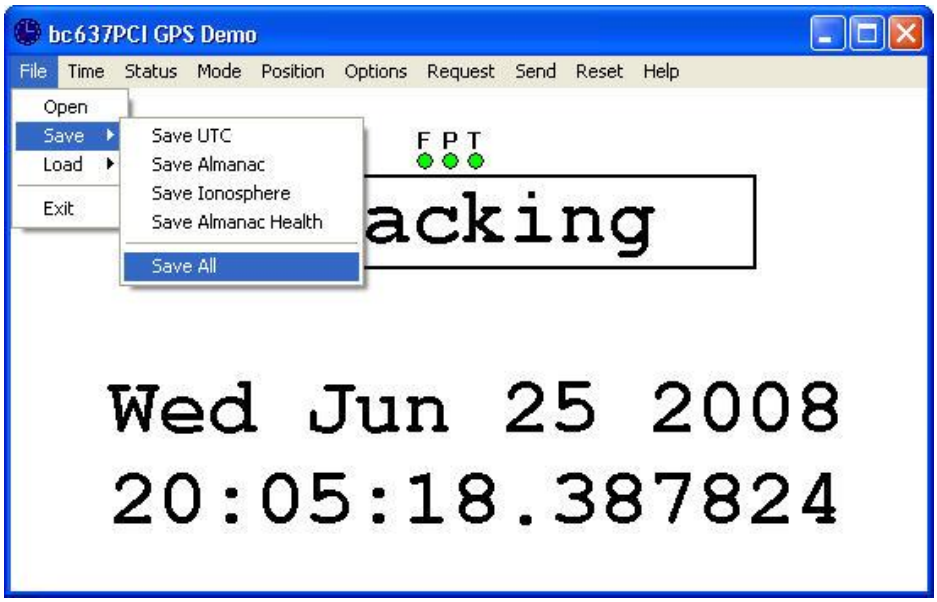


Figure B-5: File Save

File > Load

This command allows the user to save the values to the GPS receiver located under "Save > Load variable". For more information on the GPS variables, see Appendix A: GPS Receiver Interface.

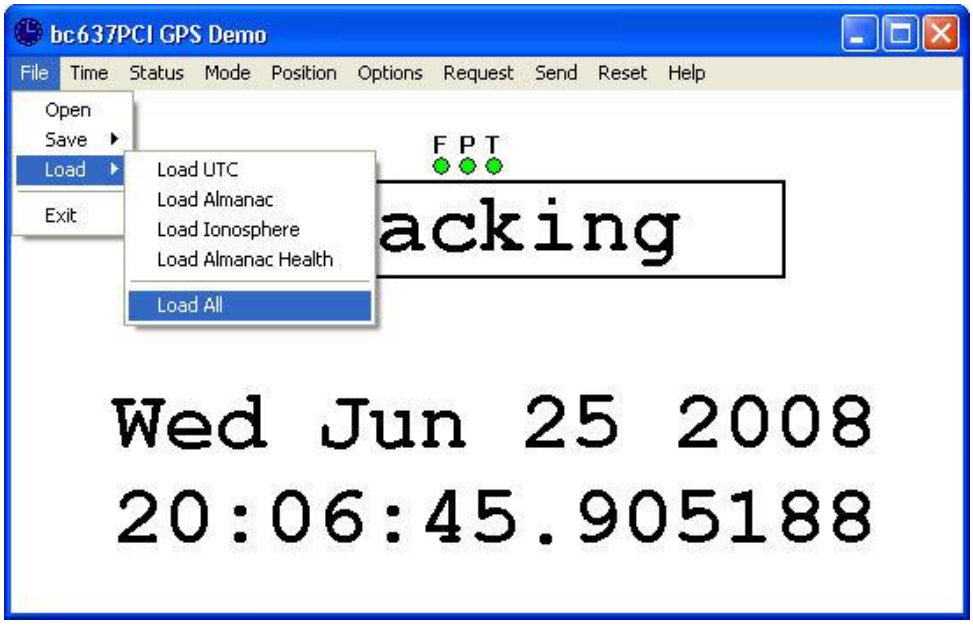


Figure B-6: File Load

File > Exit

This command allows the user to close the device and exit the program.

Time Menu

The **Time** menu group, see Figure B-7, provides access to functions that control how the bc637PCI-V2 card maintains time data. These functions allow the user to select where to obtain time data, whether or not to manipulate the time data, and how to present the time data.

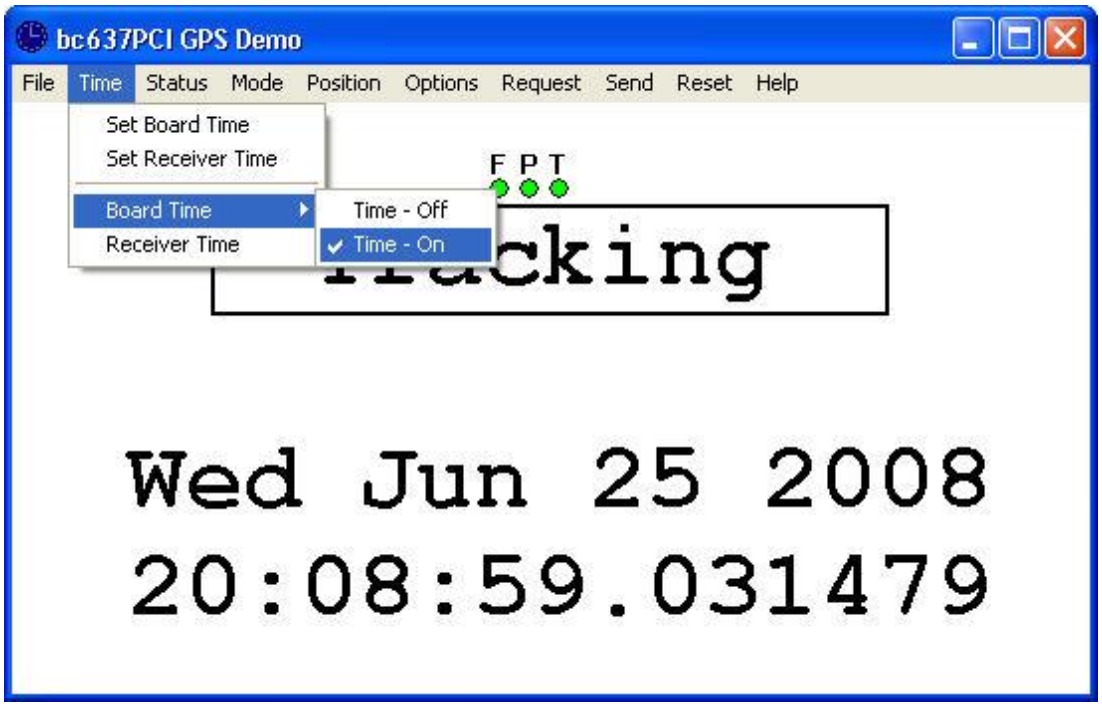


Figure B-7: Time Menu

Time > Set Board Time

The **Set Board Time** menu selection will set the time on the bc637PCI-V2 device. The Set Board Time interface GUI displays the current time, years through seconds in a decimal format, see Figure B-8. The user may change any or all of these values and select the OK button. This function is typically used when operating in either the Free Running or External 1PPS modes. While the function may be used when operating in Time code or GPS modes, subsequent time data received from the selected reference source will overwrite the loaded time when lock is achieved. This function accesses the DPRAM command 0x12, Set Major Time. For information on Set Major Time, see Chapter 5, command 12.

Figure B-8: Set Time

Time > Set Receiver Time

The **Set Receiver Time** menu selection will acquire time from the bc637PCI-V2 device and set the time on the GPS receiver, see Figure B-9. This will improve the initial time required to track satellites. This command accesses the set GPS time packet 0x2E as described in Appendix A: GPS Receiver Interface.

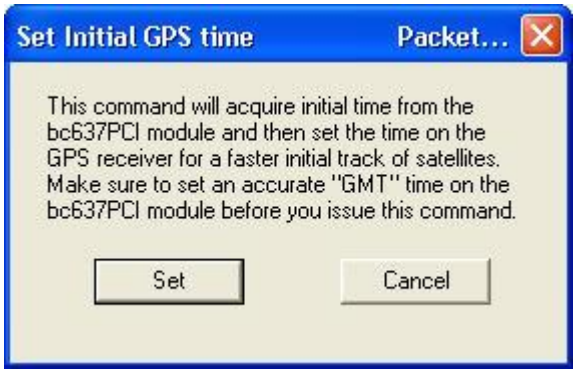


Figure B-9: Set Initial GPS time

Warning: Be sure to set an accurate "GMT" time on the bc637PCI-V2 module before issuing this command.

Time > Receiver Time

The **Receiver Time** menu selection will return time from the GPS receiver (see Figure B-10). This command requests current time via packet 0x21, and returns packet 0x41, as described in Appendix A: GPS Receiver Interface.

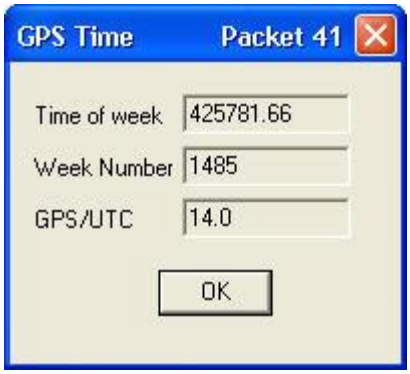


Figure B-10: Set receiver - GPS Time

Status Menu

The **Status** menu group, see Figure B-11 through B-14, provides access to the GPS data packets that provide the GPS receiver status data. These commands access the data packets that return packets 46, 47 and 4F (as described in Appendix A: GPS Receiver Interface).

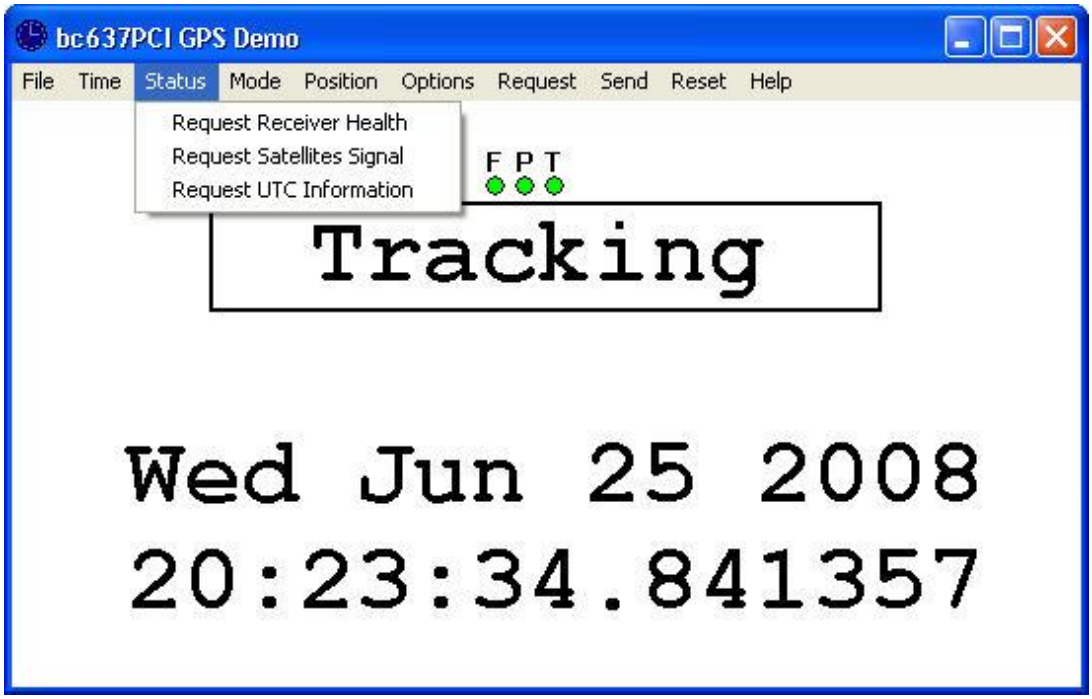


Figure B-11: Status Menu

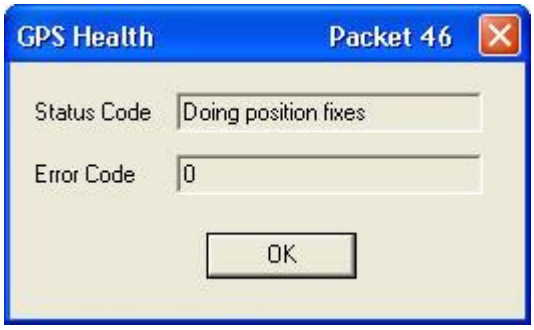


Figure B-12: Request GPS Receiver Health

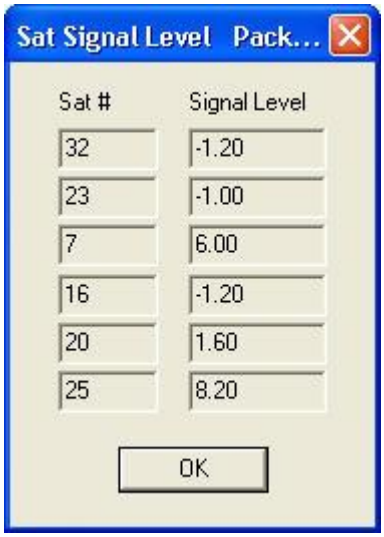


Figure B-13: Request Satellites Signal

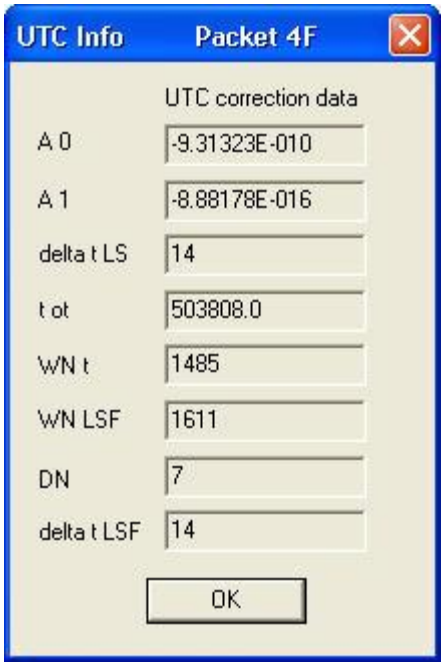


Figure B-14: Request UTC Information

Mode Menu

The **Mode** menu group, see Figure B-15 through B-18 provide access to the various functional modes of the bc637PCI-V2 and the GPS receiver.

The **Mode > Set Board Mode** menu selection allows the user to change the operating mode of the installed bc637PCI-V2 card. Selecting this option reveals a secondary menu, listing the available operating modes of the bc637PCI-V2 device. The available mode selections are:

- **Time code**
- **Free Running**
- **External 1PPS**
- **GPS**

For more information on setting the card synchronization mode, refer to Chapter 5, command 0x10. To verify the mode, select **Mode > Request Board Mode**.

The **Mode > Set Position Fix Mode** menu selection allows the user to change the GPS receiver mode. The GPS receiver modes are explained in more detail in Appendix A: GPS Receiver Interface. To verify the mode, select **Mode > Request Position Fix Mode**.

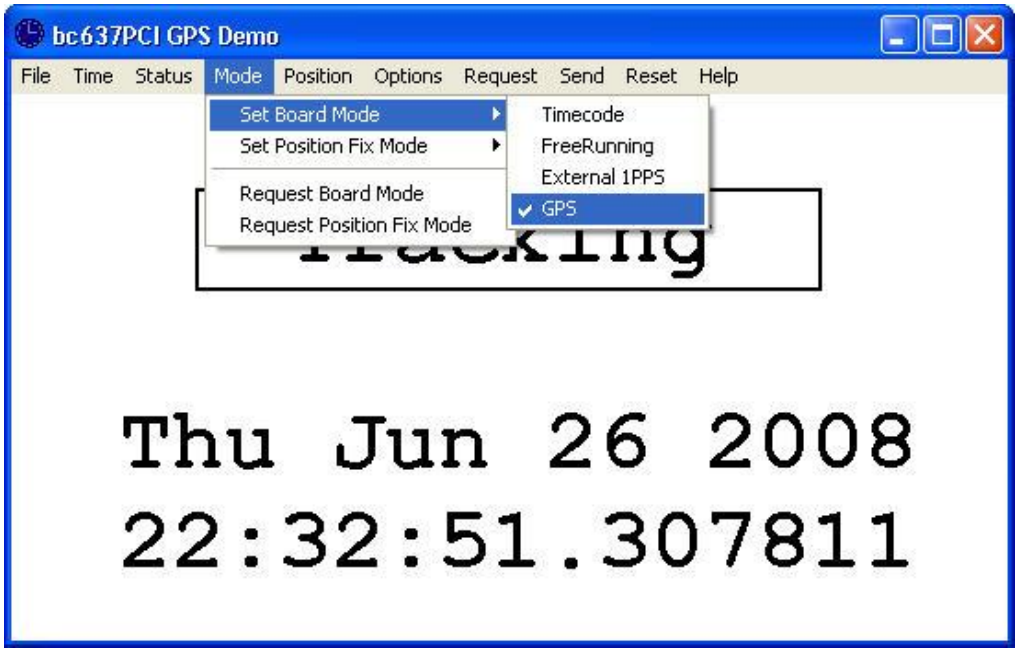


Figure B-15: Mode Menu: Set Board Mode

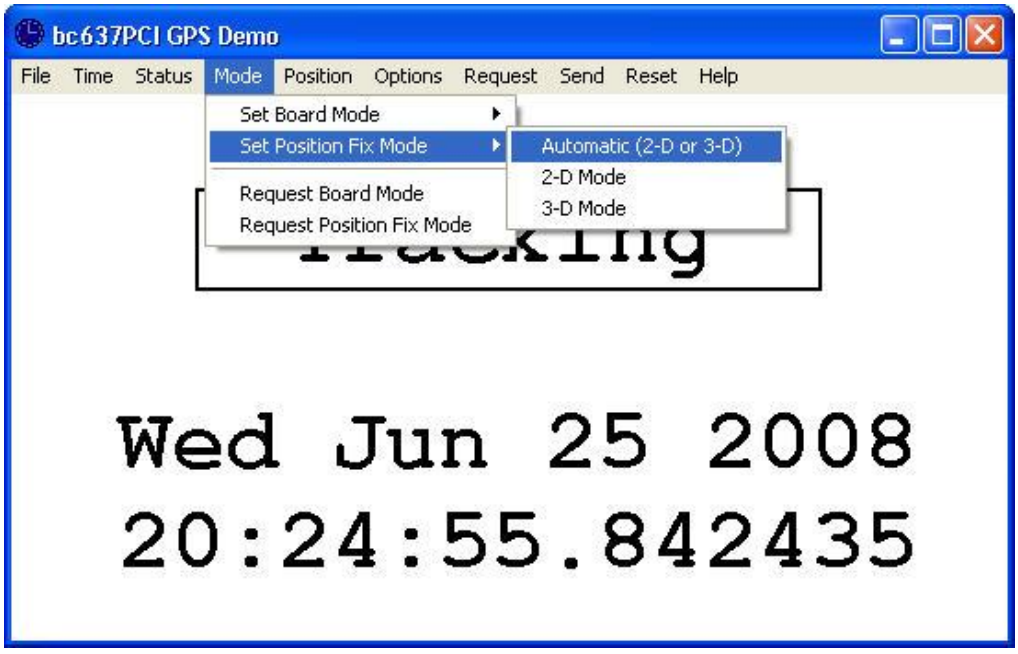


Figure B-16: Mode Menu: Set Automatic Fix Mode

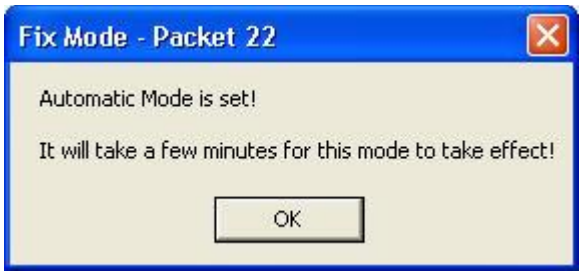


Figure B-17: Set/Request GPS Receiver Position Fix Mode

Figure B-18: Request Board Mode

Position Menu

The **Position** menu group, see Figure B-19 through B-23 provide access to position data from the GPS receiver. Both LLA and XYZ position formats are supported. These packets are addressed in more detail in Appendix A: GPS Receiver Interface, packets 0x2B, 0x31, 0x42, and 0x4A.

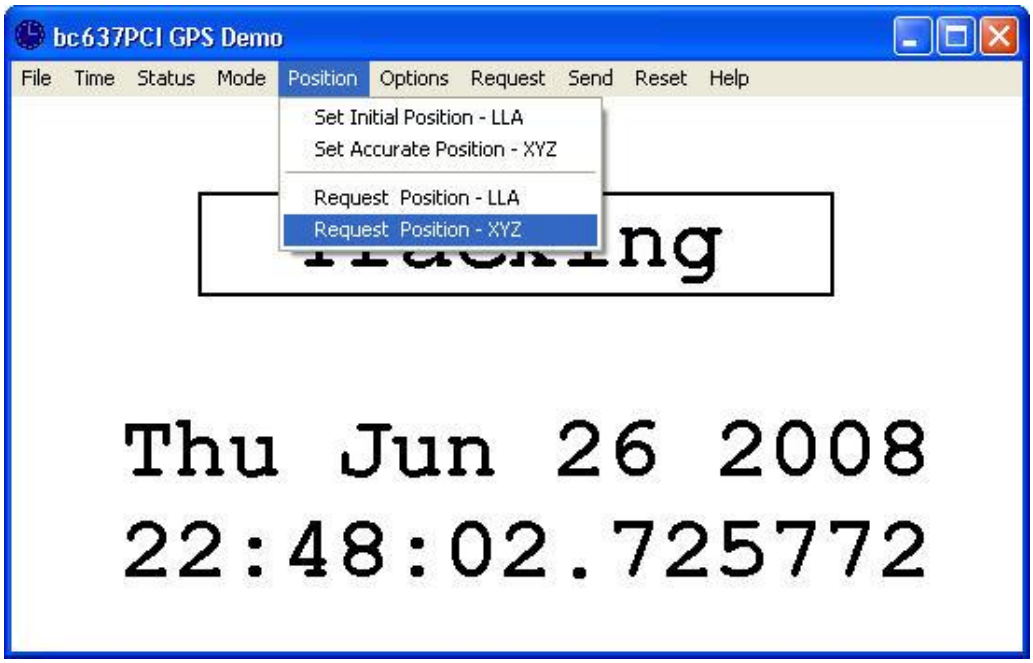


Figure B-19: Position Menu

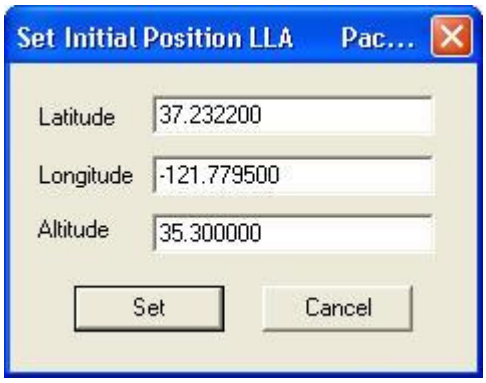


Figure B-20: Set Initial Position - LLA

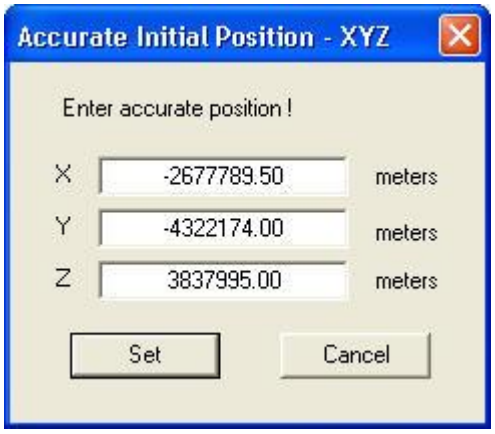


Figure B-21: Set Accurate Position – XYZ

Figure B-22: Request Position - LLA

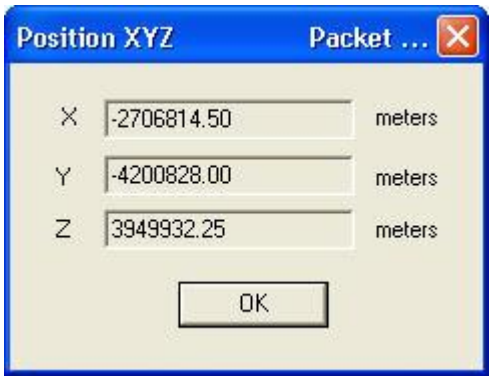


Figure B-23: Request Position - XYZ

Options Menu

The **Options** menu group, see Figures B-24 through B-28 provide access to set or request the input and output options for the GPS receiver. These commands are described in more detail in Appendix A: GPS Receiver Interface, packets 0x35, 0x43, and 0x56.

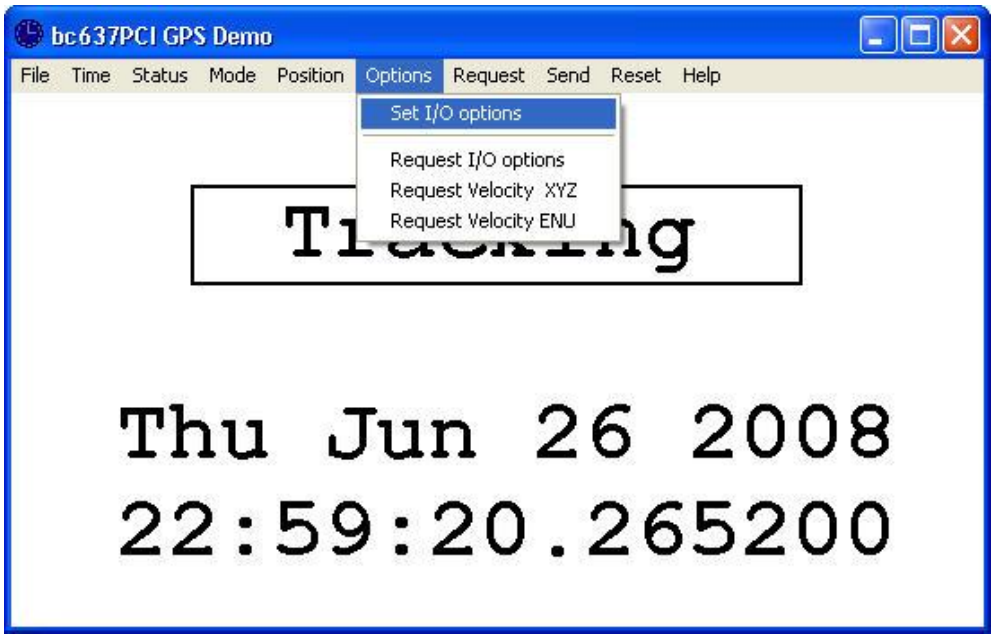


Figure B-24: Options Menu

Figure B-25: Set I/O Options

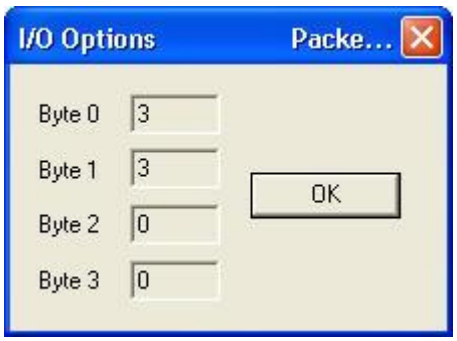


Figure B-26: Request I/O Options

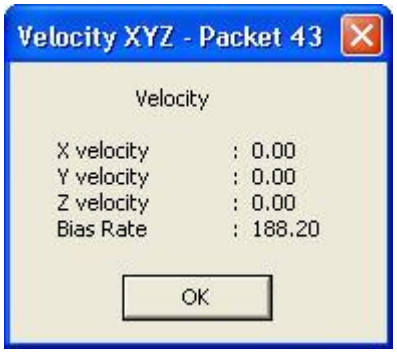


Figure B-27: Request Velocity XYZ

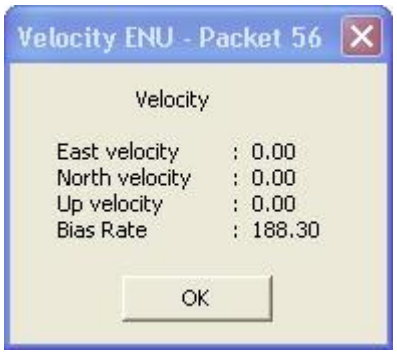


Figure B-28: Request Velocity ENU

Request Menu

The **Request** menu group, see Figures B-29 through B-32 provide access to data from the GPS receiver. These commands are described in more detail in Appendix A: GPS Receiver Interface, packets 0x40, 0x4C, and 0x4D.

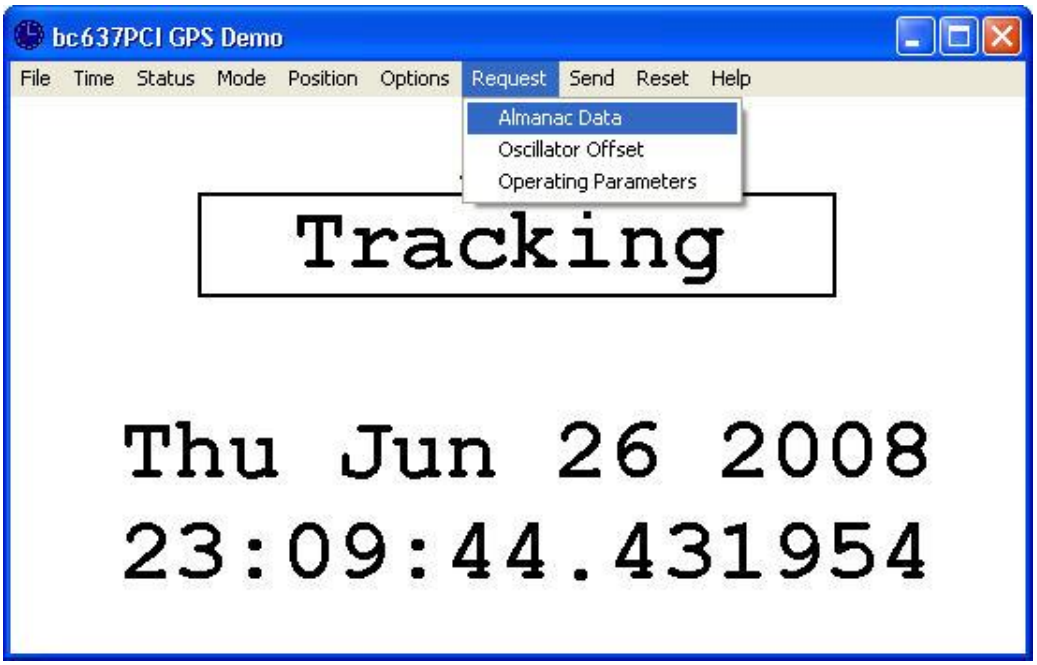


Figure B-29: Request Menu

Request > Almanac Data

This command provides almanac data for a single satellite.

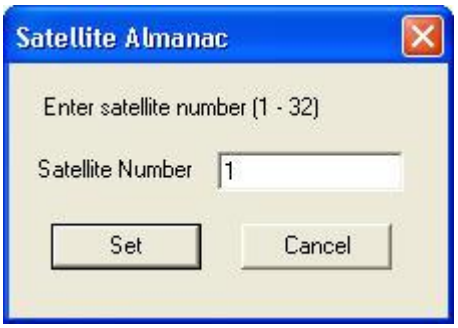


Figure B-30: Satellite Almanac

Request > Oscillator Offset

This packet provides the receiver oscillator offset in Hertz at the carrier. The packet format is described in Appendix A: GPS Receiver Interface, packet 0x4D.

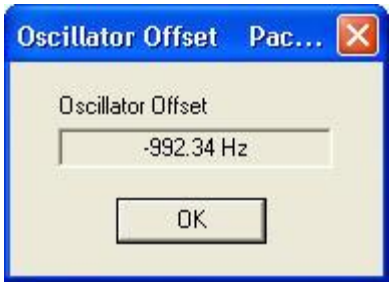


Figure B-31: Request Oscillator Offset

Request > Operating Parameter

This packet provides several operating parameters for the GPS receiver, and includes the dynamics code, elevation angle mask, signal level mask, and PDOP mask. These parameter formats are described in Appendix A: GPS Receiver Interface, packet 0x4C.

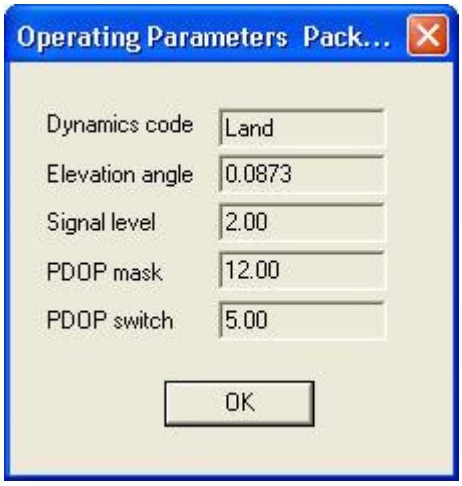


Figure B-32: Request Operating Parameters

Send Menu

The **Send** menu group, see Figures B-33 through B-35, allows the user to set the 2-D altitude and receiver operating parameters on the GPS receiver. These commands are described in more detail in Appendix A: GPS Receiver Interface, packets 0x2A and 0x2C.

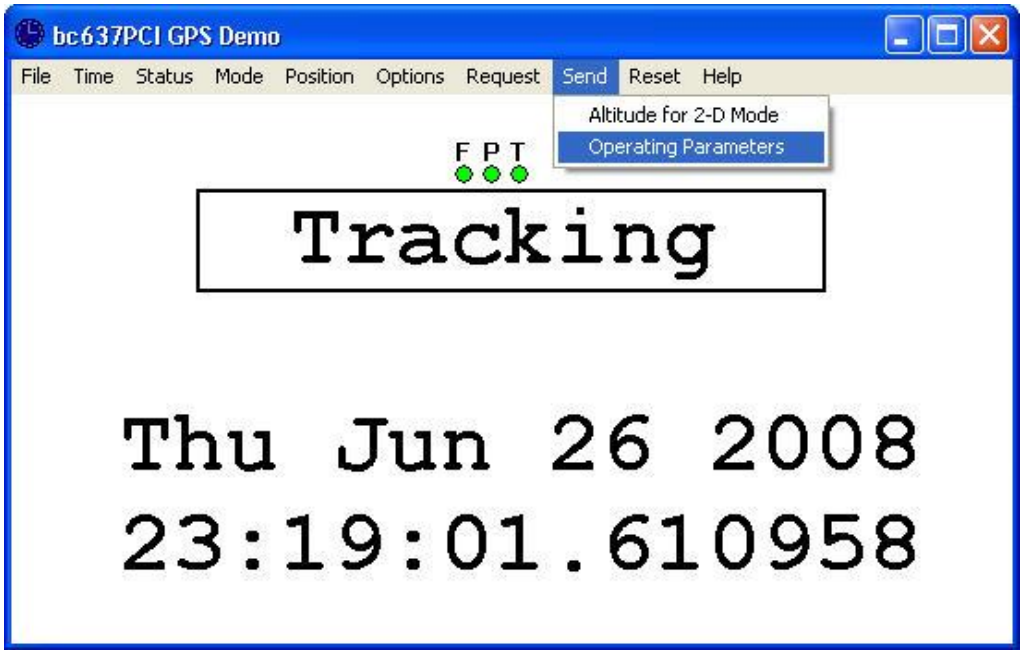


Figure B-33: Send Menu

Send > Altitude for 2-D Mode

This packet provides the altitude used for 2-D (3-satellite) mode, and is used until a 3-D fix is completed. See Appendix A: GPS Receiver Interface, packet 0x2A for more detail.

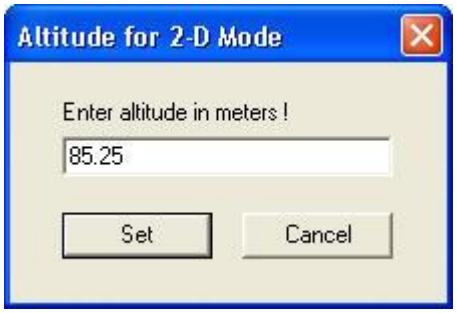


Figure B-34: Send Altitude for 2-D Mode

Send > Operating Parameters

This packet is used to optionally set the GPS receiver operating parameters, requesting the current values after they are set. See Appendix A: GPS Receiver Interface, packet 0x2C for more detail.

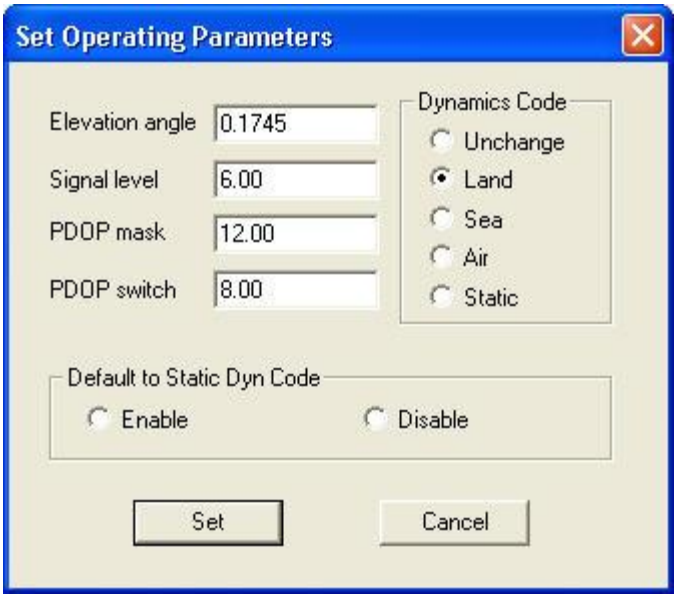


Figure B-35: Send Set Operating Parameters

Reset Menu

The **Send** menu group commands, see Figure B-36 through B-40, are used to reset various components on the PCI card and the GPS receiver.

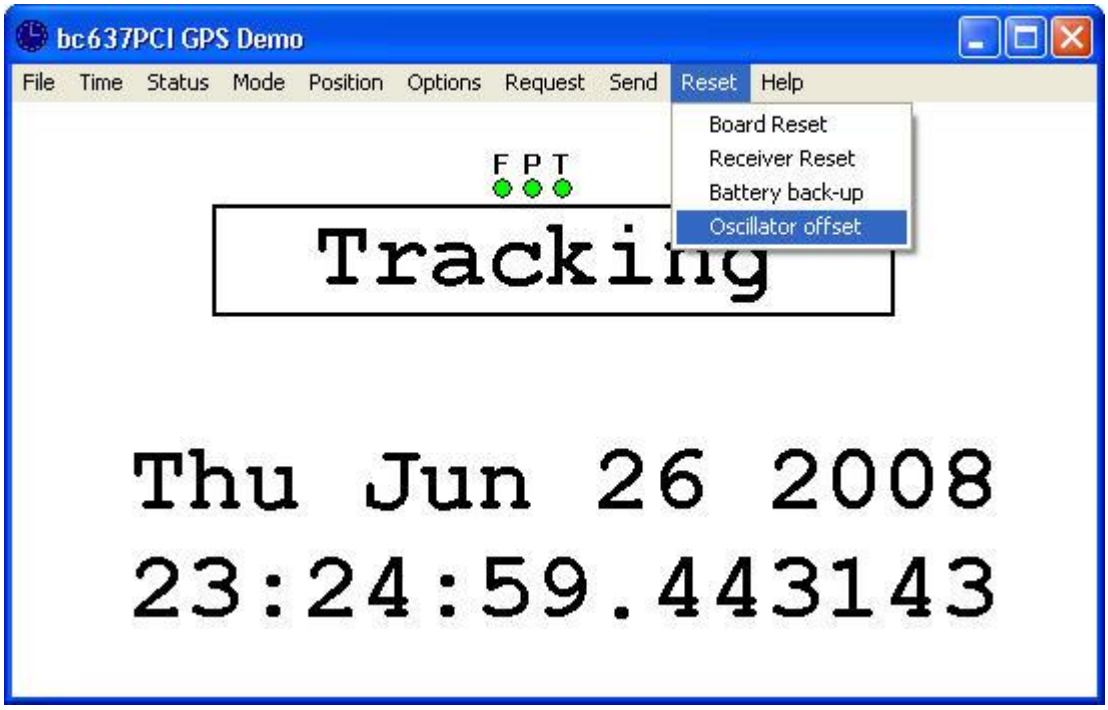


Figure B-36: Reset menu

Reset > Board Reset

This command will reset the bc637PCI-V2 card per the DPRAM command 0x1A, and is described in Chapter 5.

Figure B-37: Board Reset

Reset > Receiver Reset

This command performs a GPS receiver software reset, which is equivalent to cycling power. The self-test function is performed as part of the reset operation. This command is described in more detail in Appendix A: GPS Receiver Interface, packet 0x25.

Figure B-38: Receiver Offset

Reset > Battery back-up

This packet commands the GPS receiver to clear data and perform a software reset. This command is described in more detail in Appendix A: GPS Receiver Interface, packet 0x1E.

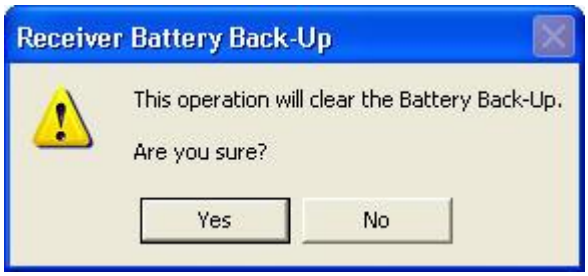


Figure B-39: Battery back-up

Reset > Oscillator offset

This packet commands the GPS receiver to clear the stored oscillator offset. This command is described in more detail in Appendix A: GPS Receiver Interface, packet 0x1D.

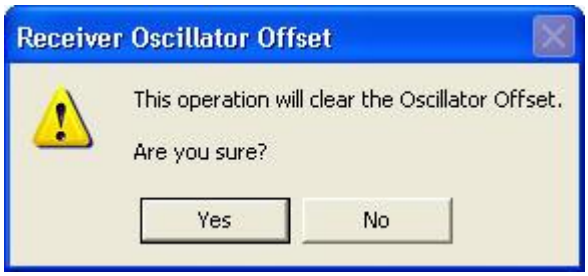


Figure B-40: Oscillator Offset

Help Menu

The **Help** menu group provide access to data from the bc637PCI-V2 hardware and GPS receiver.

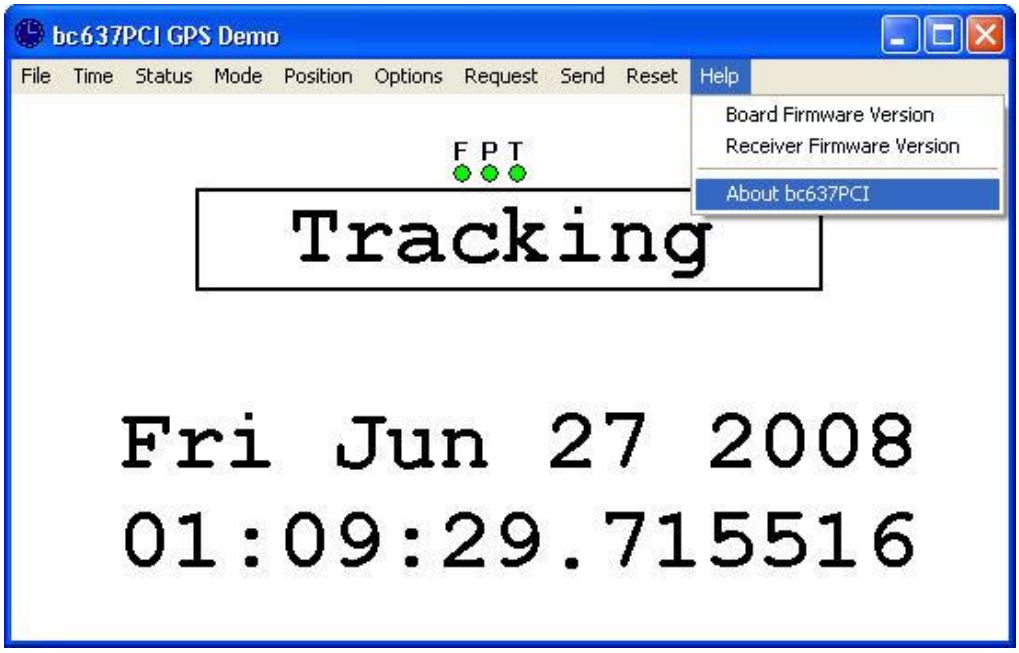


Figure B-41: Help Menu

Help > Board Firmware Version

The Board Firmware Version command returns information from the bc637PCI-V2 firmware. For the firmware data format, see Chapter 5, command 0x4F.

Figure B-42: Board Firmware Version

Help > Receiver Firmware Version

The Receiver Firmware Version returns firmware version information for the GPS receiver. The data format is covered in Appendix A: GPS Receiver Interface, packet 0x45.

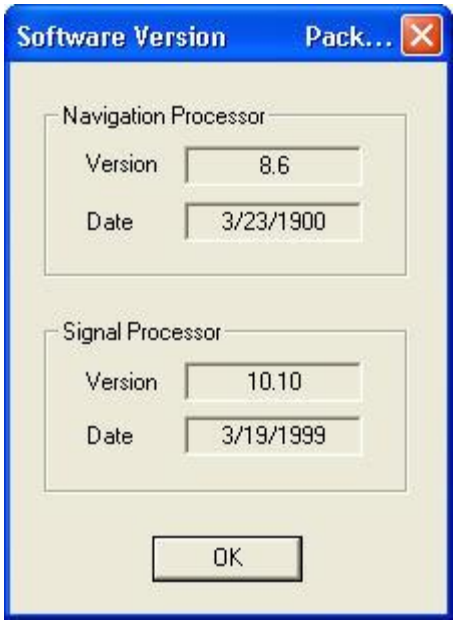


Figure B-43: Receiver Firmware Version

Help > About bc637PCI

The About bc637PCI selection, returns information on the bc637PCI GPS Demo program.

Figure B-43: About bc637PCI

List of Hardware

The GPS antenna equipment described in this manual consists of the following:

- One wide-range 5-12 VDC L1 antenna
- One 50 ft. length of Belden 9104 coaxial cable with BNC(m) and TNC(m) connectors
- SMB to BNC adaptor is included

The Antenna Kit can be ordered with optional cable lengths and accessories. Please note the following when setting up longer cable runs:

- Using Belden 9104, the maximum cable length without amplification is 150 feet . Using Belden 9104, the maximum cable length using the optional in-line amplifier is 300 feet. For cable runs longer than 300 feet, an optional GPS Down/Up Converter kit is available

Other GPS Antenna Options:

- A Lightning Arrestor kit
- A ntenna Signal Splitters(distributes the signal from a single antenna to multiple GPS receivers)

Appendix C: What is different in the bc635/637PCI-V2?

There is a difference in the PCI base address register mapping between the bc635PCI-U and the bc635/637PCI-V2 cards. Both the bc635PCI-U and the bc635/637PCI-V2 cards map both register and dpram into memory spaces.

PCI bar mapping:

bc635PCI-U	**bc635/637PCI-V2**
bar0 = 32-bit register space	bar0 = reserved
bar1 = 8-bit dpram space	bar1 = reserved
	bar2 = 32-bit register space
	bar3 = 8-bit dpram space

Differences between versions U and V2:

	bc635PCI-U	**bc635/637PCI-V2**
Standard oscillator	VCXO	TCXO (better holdover)
1pps duty cycle	63 uS	60 uS
Heartbeat (periodic) duty cycle	adjustable	square wave
Power	+5, +12, -12	+5, +12
Field program update	Replace flash	Serial port download
OCXO option	+12V	+5V
OCXO option	sine wave	square wave
Time at power-on	elapsed	RTC
Time code input level (AM)	5V to 5V P-P	1V to 8V P-P
Time code output level (AM)	4V P-P 50 ohm	3V P-P 50 ohm
NV (Restored at Power-on)	not supported	many parameters restored
Strobe output timing	1 uS late	on time
bc637 GPS receiver	Ace III	SKII (Lassen)

- The V2 card now transitions through end of year properly, version u did not
- SET CLOCK Command (10 uSec Advance Retard) is not implemented on V2 design
- The user is no longer is required to enter UNIX seconds of Leap Event when manually entering Leap Seconds settings. The V2 Card uses Year and Time of Year information to determine when Leap Event will occur. The Leap Event is calculated for the last day of the current

month at UTC midnight.

- BC635 application advanced/PCI Special Boot mode is not supported on the -v2 design.
- Although the user timing resolution of both cards is 100 nS, the -v2 card has an internal resolution of 5 nS (200 MHz clock locked to the 10 MHz oscillator).

Note1: The YEAR AUTO INCREMENT FLAG - Packet 0x42, Auto Increment Enable cannot be disabled on either the U or V2 design.

Note2: The bc635 application check box labeled LATCH EVENT TIME function (found in Signals/Interrupts window) has been removed on both the U or V2 designs.

Additions to the bc63xPCI-v2:

- Battery disconnect jumper
- DDS circuit
- IRIG G, E, XR3 & 2137 Time Code Inputs
- IRIG A, G, E, NASA 36, XR3 & 2137 Time Code Outputs

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