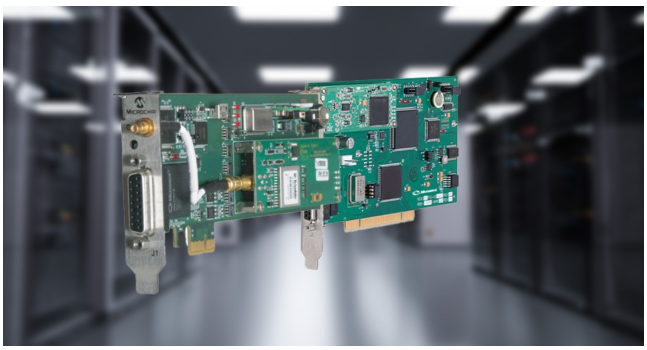


Microchip Technology bc637PCI-V2 GPS Synchronized PCI Time and Frequency Processor User Guide

Contents

Microchip Technology bc637PCI-V2 GPS Synchronized PCI Time and Frequency Processor

Product Information

The bc637PCI-V2 is a GPS synchronized, PCI time and frequency processor that provides precise time and frequency to the host computer and peripheral data acquisition systems. The module obtains precise time from the GPS satellite system or from time code signals. The GPS synchronization enables the module to be an ideal master clock for precisely synchronizing multiple computers to UTC. The module supports extensive time code generation and translation with outputs of IRIG A, B, G, E, IEEE 1344, NASA 36, XR3, or 2137 in both amplitude modulated (AM) and DC level shift (DCLS) formats. The translator reads and may be used to discipline the 10 MHz oscillator to either the AM or DCLS format of IRIG A, B, G, E, IEEE 1344, NASA 36, XR3, or 2137 time codes. The module also has a state-of-the-art direct digital synthesizer (DDS) rate synthesizer capable of 0.0000001PPS to 100MPPS.

The module has a key feature of generating interrupts on the PCI bus at programmable rates. These interrupts can be used to synchronize applications on the host computer as well as signal-specific events. The external frequency input is also a unique feature allowing the time and frequency of the module to be derived from an external oscillator that may also be disciplined (DAC voltage controlled) based on the selected input reference.

Product Usage Instructions

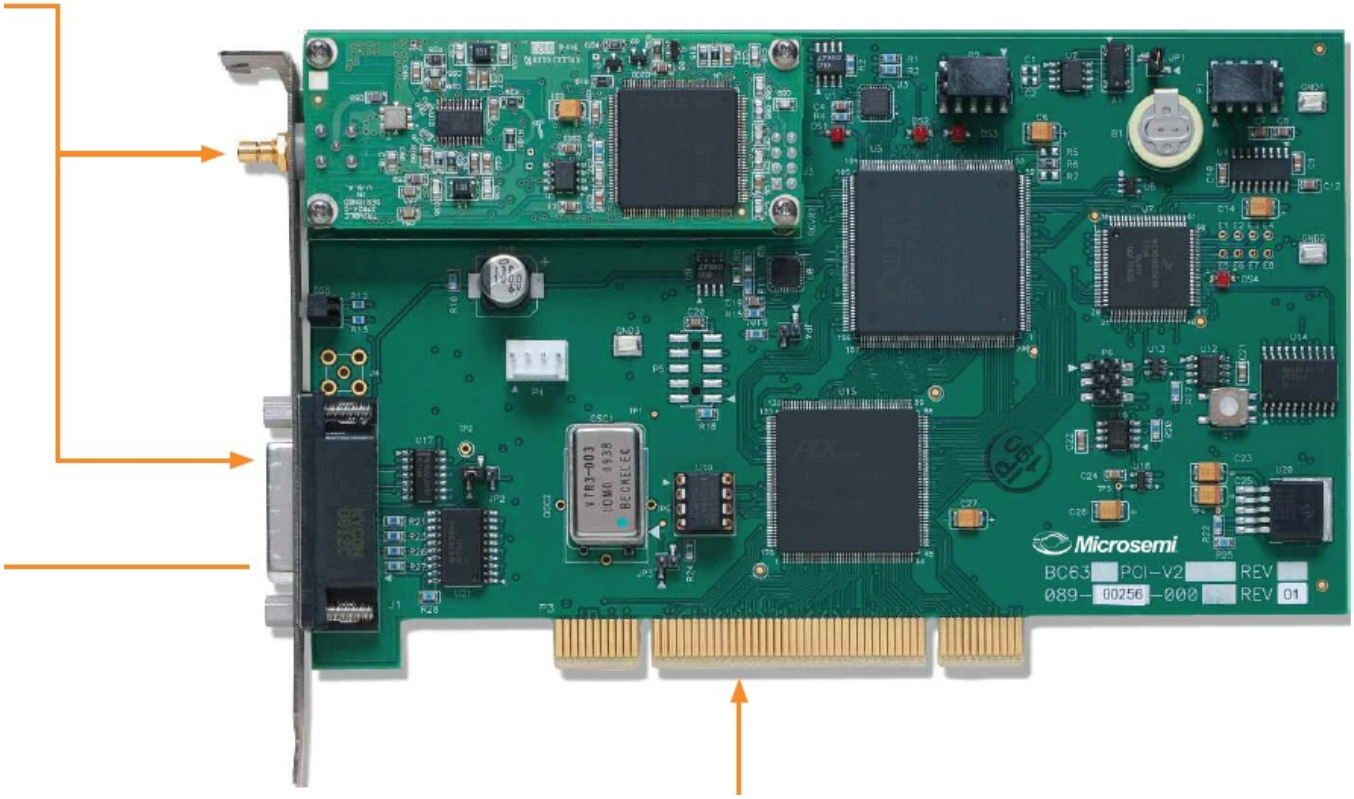
1. Connect the bc637PCI-V2 to the host computer’s PCI slot.
2. Install the optional drivers for Windows or Linux for easy integration of the module.
3. Configure the module to obtain precise time from the GPS satellite system or from time code signals.
4. Use the module as an ideal master clock for precisely synchronizing multiple computers to UTC.
5. Generate time code outputs of IRIG A, B, G, E, IEEE 1344, NASA 36, XR3, or 2137 in both amplitude modulated (AM) and DC level shift (DCLS) formats.
6. Use the translator to discipline the 10 MHz oscillator to either the AM or DCLS format of IRIG A, B, G, E, IEEE 1344, NASA 36, XR3, or 2137 time codes.
7. Use the state-of-the-art direct digital synthesizer (DDS) rate synthesizer capable of 0.0000001PPS to 100MPPS.
8. Generate interrupts on the PCI bus at programmable rates for synchronizing applications on the host computer and signal-specific events.
9. Use the external frequency input to derive the time and frequency of the module from an external oscillator that may also be disciplined (DAC voltage controlled) based on the selected input reference.

Summary
The Microchip GPS referenced bc637PCI-V2 timing module provides precise time and frequency to the host computer and peripheral data acquisition systems. Precise time is acquired from the GPS satellite system or from time code signals. GPS synchronization provides 170 ns RMS accurate time to UTC (USNO) and enables the bc637PCI-V2 to be an ideal master clock for precisely synchronizing multiple computers to UTC.
Central to the operation of the module is a disciplined TCXO 10 MHz oscillator provides the timing module's 100-nanosecond clock. Current time (days to 100 ns) can be accessed across the PCI bus with no PCI bus wait states, which allows for very high-speed time requests. The selected on-board or off-board 10 MHz oscillator drives the module's frequency and time code enerator circuitry. If the input reference is lost, the module will continue to maintain time (flywheel) based on the selected 10 MHz oscillator's drift rate. If power is lost, a battery-backed RTC is available to maintain time.
Extensive time code generation and translation are supported. The generator outputs either IRIG A, B, G, E, IEEE 1344, NASA 36, XR3, or 2137 in both amplitude modulated (AM) and DC level shift (DCLS) formats. The translator reads and may be used to discipline the 10 MHz oscillator to either the AM or DCLS format of IRIG A, B, G, E, IEEE 1344, NASA 36, XR3, or 2137 time codes.
The module also has a state-of-the-art direct digital synthesizer (DDS) rate synthesizer capable of 0.0000001PPS to 100MPPS. The module may also be programmed
to generate a single interrupt at a predetermined time based on a time compare
(strobe). An event time capture feature provides a means of latching time of an external event.
A key feature of the bc637PCI-V2 is the ability to generate interrupts on the PCI bus at programmable rates. These interrupts can be used to synchronize applications on the host computer as well as signal-specific events.
The external frequency input is a unique feature allowing the time and frequency of the bc637PCI-V2 to be derived from an external oscillator that may also be disciplined (DAC voltage controlled) based on the selected input reference. The module may be operated in generator (undisciplined) mode where an external 10 MHz from a Cesium
or Rubidium standard is used as the frequency reference. This creates an extremely stable PCI based clock for all bc637PCI-V2 timing functions.
The bc637PCI-V2 automatically supports both 3.3 V and 5.0 V signaling of the PCI bus. Integration of the module is easily facilitated with optional drivers for Windows or Linux.

Features

- GPS synchronized with 170 ns RMS accuracy to UTC
- IRIG A, B, G, E, IEEE 1344, NASA 36, XR3, and 2137 time code inputs and outputs
- Simultaneous AM and DCLS time code inputs and outputs
- 100 ns clock resolution for time of day requests
- Programmable <<1PPS to 100MPPS DDS rate synthe-sizer output/interrupt
- 1, 5, or 10MPPS rate genera-tor output
- 1PPS and 10 MHz inputs
- External event time capture/interrupts
- Programmable time com-pare output/interrupt
- Zero latency time reads
- Battery backed real time clock (RTC)
- PCI local bus operation
- Universal Signaling (3.3 V or 5.0 V bus)
- RoHS 5/6 compliant
- Linux and Windows soft-ware drivers/SDKs included

Precision Time and Frequency in the PCI Form Factor (100-Nanosecond Precision)



Inputs

- GPS
- AM time codes
- DCLS time codes
- External events (3x)
- 10 MHz
- 1PPS

Outputs

- AM time codes
- DCLS time codes
- Programmable alarm
- (strobe/time compare)
- <<1PPS to 100MPPS rates
- 1PPS
- 1, 5, or 10MPPS
- Oscillator control voltage

Over the PCI Bus

- Precise time
- Event interrupts
- Alarm interrupts (time compare/strobe)
- Programmable interrupt rates

- Configuration and control

Reading the Precise Time
The bc637PCI-V2 provides precise time on request and extremely fast response to host applications. This request for time is made using the included SDK software functions. Time can be provided in binary or decimal form.

A Multitude of Time Codes
The bc637PCI-V2 has the widest time code input and output support available in any bus level timing card. Support is available for 30 different time codes including IRIG A, B, G, E, IEEE 1344, NASA 36, XR3, and 2137 in AM and DCLS formats.

Measure External or Internal Events
Measure the exact time up to the occurrence of three in-dependent external events. Bus interrupts instantly notify the CPU that the measurements are made and are wait-ing. Similarly, host application-generated interrupts to the bc637PCI-V2 card over the bus can be precisely time stamped for precise host application-based processes.

Flexible Rate Generation
The DDS on the bc637PCI-V2 can be programmed to generate rates up to 100MPPS or as little as once every 115 days. These rates are available as timing signal outputs or as interrupts on the bus. The rate adjustment resolution is as small as 1/32 Hz.

Frequency Outputs

Precise clocks are excellent sources of frequency outputs. The bc637PCI-V2 offers 1, 5, or 10MPPS outputs directly from the steered internal oscillator of the clock.

External Frequency Inputs and DAC Control
The external frequency input is an unique feature that allows the time and frequency of the bc637PCI-V2 to be derived from an external oscillator such as a 10 MHz Cesium or Ru-bidium standard. This creates an extremely stable PCI-based clock for all bc637PCI-V2 timing functions. For closed loop control, an external oscillator may be disciplined using DAC voltage control output from the bc637PCI-V2.

Time Compare/Strobe/Alarm
A useful feature of any precise clock is the ability to notify when a particular time is reached (like an alarm clock). When the preset time precisely matches the actual time, an external signal and an interrupt to the bus are instantly generated, signaling an application that point in time has just occurred.

Over-the-Bus Features
Beside from precise time stamps, the bc637PCI-V2 can provide very precisely timed interrupts on the bus at fixed rates, predetermined times, or to signal that an event has occurred on the card. These interrupts can be integrated into user applications requiring more deterministic behavior or application synchronization with other computers. Similarly, user applications can use interrupts as markers in time and later retrieve exactly when the interrupt occurred.

Configuration and Control
The bc637PCI-V2 includes easy-to-use programs to easily configure the card and validate operations. This software is also included with the SDKs and driver software.

PCIe Card Integration Made Easy with Included SDKs and Drivers

Windows and Linux SDKs Speed PCI Integration
The PCIe card includes standard full-featured software development kits, speeding the integration of Microchip

PCI cards into any application.
Using an SDK is an easy-to-integrate and highly reliable alternative to writing lower-level code to address a card's memory registers directly with just a driver. The function calls and device drivers
in the SDKs make interfacing to a Microchip PCI card straight forward and help keep the software development focused on the end application.

SDKs Save Time and Money
Programmers find the SDK an invaluable resource in acceler-ating the integration of Microchip PCI cards into applications, saving both time and money. The SDK functions address each Microchip PCI timing card feature, and the function names and parameters provide insight into the capability of each function.
By using the SDK, one can leverage Microchip's timing expertise and confidently integrate a Microchip PCI card into your application.

License-Free
Distribution of embedded Microchip software in customer applications is royalty free.

Driver Comparison

Windows SDK and Driver

- Windows XP/Vista/7/10
- Windows Server 2003/2008/2019
- 32- and 64-bit support
- Kernel mode driver
- Code examples
- Test application program
- Complete documentation
- Timekeeping utility program

The Windows SDK for bc637PCI-V2 cards include a Windows XP/Vista/Server/7/10 kernel mode device driver for the 32- and 64-bit PCI interface. The SDK includes .h, .lib, and DLL files to support both 32- and 64-bit applications development.
The target programming environment is Microsoft Visual Studio (Microsoft Visual C++ V6.0 or higher). Both Visual C++ 6.0 and Visual Studio 2008 project files are supplied with the source code.
Also included is Microchip's bc637PCIcfg application program that can be used to ensure proper operation of the PCI card, and the TrayTime application that allows the user to update the system clock in which the card is installed. Source code for these programs and smaller example programs are included.

Minimum System Requirements

Operating System

- Windows XP/Vista/7/10
- Windows server 2003/2008

Hardware
PC-compatible system with a Pentium or faster processor

Memory 24 MB

Development Environment
Microsoft Visual Studio (Visual C++) 6 or higher

Linux SDK and Driver

- Up to Linux Kernel 5.7.1
- 64-bit kernel support
- Code examples
- Test application program
- Complete documentation

The Linux SDK for bc637PCI-V2 cards includes PCI kernel mode device drivers for 64-bit kernels, an interface library accessing all bc637PCI-V2 features, and example programs with the source code.
The target programming environment is the GNU compiler collection (GCC) and the C/C++ programming languages.
Also included is Microchip's bc63xPCIcfg application program, which ensures proper operation of the PCI card in the host computer. The example program includes sample code, exercising the interface library, and conversion examples of the ASCII format data objects passed to and from the device into a binary format suitable for operation and conversion. The example program is developed using discrete functions for each operation, allowing the developer to copy any useful code and use it in their own applications.

Minimum System Requirements

- **Operating System**
  Linux Kernels 5.7.1 or lower
- **Hardware**
  x86 processor
- **Memory**
  32 MB
- **Development Environment**
  GNU GCC recommended

Windows and Linux SDK Function Reference

Note: For complete list of functions, see the manual.

Basic Time and Frequency Processor (TFP) Functions

- bcStartPCI/bcStopPCI Opens/closes underlying device layer.
- bcStartInt/bcStopInt Starts/stops the interrupt thread to signal interrupts.
- bcSetInt/bcReqInt Enables/returns enabled interrupt.
- bcShowInt Interrupt service routine.
- bcReadReg/ bcWriteReg. Returns/sets requested register contents
- bcReadDPReg/bcWriteDPReg Returns/sets requested Dual Port RAM register contents.
- bcCommand Sends SW reset command to board.
- bcReadBinTime/bcSetBinTime Reads/sets TFP major time in binary format.
- bcReadDecTime/bcSetDecTime Reads/sets TFP major time in BCD format.

- bcReqTimeFormat Returns selected time format.
- bcSetTimeFormat Sets the major time format to binary or grouped decimal.
- bcReqYear/bcSetYear Returns/sets year value.
- bcSetYearAutoIncFlag Included for backward compatibility to the bc635/637PCI-U card.
- bcSetLocalOffsetFlag Enables or disables local time offset in conjunction with bcSetLocOff.
- bcSetLocOff Sets board to report time at an offset relative to UTC.
- bcSetLeapEvent Inserts or deletes leap second data (in non-GPS modes).
- bcSetMode Sets TFP operating mode.
- bcSetTcIn Sets time code format for time code decoding mode.
- bcSetTcInEx Sets time code and subtype for time code decoding mode.
- bcSetTcInMod Sets time code modulation for time code decoding mode.
- bcReqTimeData Returns selected time data from the board.
- bcReqTimeCodeData Returns selected time code data from the board.
- bcReqTimeCodeDataEx Returns selected time code and subtype data from the board.
- bcReqOtherData Returns selected data from the board.
- bcReqVerData Returns firmware version data from the board.
- bcReqSerialNumber Returns board serial number.
- bcReqHardwareFab Returns hardware fab part number.
- bcReqAssembly Returns assembly part number.
- bcReqModel Returns TFP model identification.
- bcReqTimeFormat Returns selected time format.
- bcReqRevisionID Returns board revision.

Event Functions

- bcReadEventTime Latches and returns TFP time caused by an external event
- bcReadEventTimeEx Latches and returns TFP time caused by an external event with 100 ns resolution.
- bcSetHbt Sets a user programmable periodic output.
- bcSetPropDelay Sets propagation delay compensation.
- bcSetStrobeTime Sets strobe function time.
- bcSetDDSFrequency Sets DDS output frequency.
- bcSetPeriodicDDSSelect Selects periodic or DDS output.
- bcSetPeriodicDDSEnable Enables or disables periodic or DDS output
- bcSetDDSDivider Sets DDS divider value.
- bcSetDDSDividerSource Sets DDS divider source.
- bcSetDDSSyncMode Sets DDS synchronization mode.
- bcSetDDSMultiplier Sets DDS multiplier value.
- bcSetDDSPeriodValue Sets DDS period value.
- bcSetDDSTuningWord Sets DDS turning word value.

Oscillator Functions

- bcSetClkSrc Enables or disables on-board oscillator.
- bcSetDac Sets oscillator DAC value.

- bcSetGain Modifies on-board oscillator frequency control algorithm.
- bcReqOscData Returns TFP oscillator data.

Generator Mode Functions

- bcSetGenCode Sets time code generator format.
- bcSetGenCodeEx Sets time code and subtype generator format.
- bcSetGenOff Sets an offset to the on-board timecode generation function.

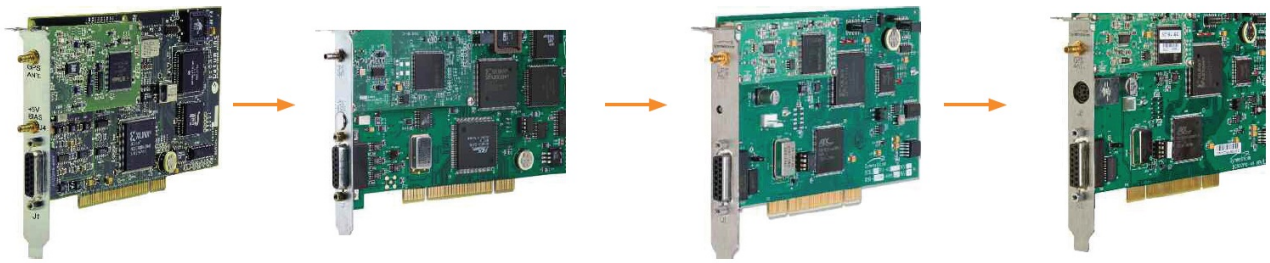
GPS Mode Functions

- bcGPSReq/ bcGPSSnd Returns/sends a GPS receiver data packet.
- bcGPSMan Manually send and retrieve GPS receiver data packets.
- bcSetGPSOperMode Sets the GPS receiver to function in static or dynamic mode.
- bcSetGPSTmFmt Sets TFP to use GPS or UTC time base.
- Real-Time Clock (RTC) Functions
- bcSyncRtc Synchronizes RTC to current TFP time.
- bcDisRtcBatt Sets RTC circuit and battery to disconnect after power is turned off.
- Backward Compatibility Provides Seamless

Migration Paths

The PCI-based bc637 cards have long product lifecycles since the first introduction of PCI timing cards in the mid 1990s. To pre-serve the customer's time and money investments in integrating bc637PCI cards into their systems, Microchip has maintained the bc637PCI cards' existing features and software interface while adding new features and keeping their bus signaling and form factors up to date. This commitment to backward compatibility and current bus architectures assures the bc637PCI cards inte-grate smoothly into any workstation currently available in the market with little to no impact on customer application software.

PCI Card Developments



bc637PCI

- Mid-1990s
- First PCI timing card introduced

bc637PCI-U

- 2003

- 3.3 V and 5.0 V universal signaling backward compatibility retained

bc637PCI-V2

- 2008
- Electronics updated backward compatibility retained

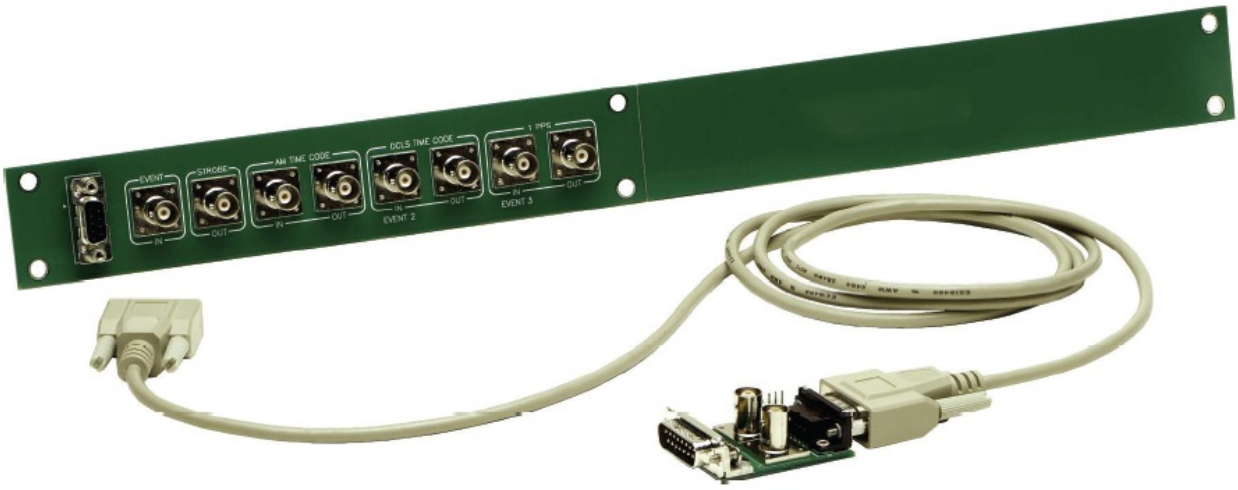
bc637PCI-V2

- 2010
- Electronics updated backward compatibility retained

Optional Accessories Speed, Test, and Simplify Integration
Breakout cables with BNC connectors simplify access to the in and out timing signals of the PCI card. These labeled cables mitigate the need to create special cables during project development and ensure that the correct timing signals are being accessed.
For more integrated rack mount systems that require easy access to timing signals, the 1U patch panel and high-frequency signal breakout exposes all available signals. The panel provides an organized and professional appearance to the external timing I/O of the PCI card functions. The 1U panel fits with standard or half rack size chassis. The high-frequency breakout adapter exposes the high-frequency signal as well as the external DC DAC control signal and ground.

Input/Output Signals D to BNC Connector Breakout Cables

1U Patch Panel of Input/Output and High Frequency Signals for Standard Rack Mount Size Chassis



Timing Input/Output Breakout Cable and Patch Panel BNC Map	D to 5-BNC (BC11576- 1000)	D to 5-BNC BC11576-9860115	D to 6 BNC	Patch/ Break out
Outputs				
Time code (AM)	√	√	√	√
Time code (DCLS)			√	√
1, 5, or 10MPPS				√
Periodic/DDS				√
Strobe				√
1PPS	√	√	√	√
Oscillator control voltage				√
Inputs				
Time code (AM)	√	√	√	√
Time code (DCLS); event2				√
External event1	√	√	√	√
External 1PPS; event3		√	√	√
External 10 MHz				√

Specifications

Electrical

- GPS receiver/antenna
  - 12-channel parallel receiver
  - GPS time traceable to UTC (USNO)
  - Accuracy 170 ns RMS, 1 µs peak-to-peak to UTC (USNO), at stable temperature and four satellites tracked.
- Maximum Belden 9104 cable length 150’ (45 m). For longer cable runs see Options.

- Real time clock
  - Bus request resolution 100 ns BCD
  - Latency Zero
  - Major time format Binary or BCD
  - Minor time format Binary 1 µS to 999.999 mS
- Synchronization sources GPS, time code, 1PPS
- Time code translator (inputs)
  - Time code formats IRIG A, B, G, E, IEEE 1344, NASA 36, XR3, 2137
  - Time accuracy <5 µS (AM carrier frequencies 1 kHz or greater) <1 µS (DCLS)
  - AM ratio range 2:1 to 4:1
  - AM input amplitude 1 Vpp to 8 Vpp
  - AM input impedance > 5 kΩ
  - DCLS input 5 V HCMOS >2 V high, <0.8 V low, 270 Ω
- Timing functions (outputs are rising edge on time)
  - Time code generator (outputs)
  - Time code format IRIG A, B, G, E, IEEE 1344, NASA 36, XR3, 2137
  - AM ratio 3:1 ±10%
  - AM amplitude 3.5 Vpp ±0.5 Vpp into 50 Ω
  - DCLS amplitude 5 V HCMOS, >2 V high, <0.8 V low into 50 Ω
  - DDS rate synthesizer
  - Frequency range 0.0000001PPS to 100MPPS
  - Output amplitude 5 V HCMOS, >2 V high, <0.8 V low into 50 Ω, square wave
  - Jitter <2 nS p-p
  - Legacy pulse rate synthesizer (heartbeat, aka periodic)
  - Frequency range <1 Hz to 250 kHz
  - Output amplitude 5 V HCMOS, >2 V high, <0.8 V low into 50 Ω, square wave
  - Time compare (strobe)
  - Compare range
  - Output amplitude
  - 1PPS output 5 V HCMOS, >2 V high, <0.8 V low into 50 Ω, 60 µs pulse
  - Accuracy the same as GPS Receiver specification above, or relative to the input time code.
  - 1PPS input 5 V HCMOS, >2 V high, <0.8 V low, 270 Ω
  - External event input 5 V HCMOS, >2 V high, <0.8 V low, 270 Ω zero latency
  - External 10 MHz oscillator Digital 40% to 60% or sine wave, V0.5 pp to 8 Vpp, > 10k Ω
  - Oscillator control voltage Jumper selectable 0 VDC–5 VDC or 0 VDC–10 VDC into 1 kΩ
- On-board disciplined oscillator
- Frequency 10 MHz
- 1, 5, or 10MPPS output 5 V HCMOS, >2 V high, <0.8 V low into 50 Ω
- Stability
- Standard TCXO 5.0×10–8 short term tracking 5.0×10–7/day long term flywheeling
- Real-time clock (RTC) Battery-backed time and year information
- PCIe specification 2.2-compliant 2.3-compatible PCI-X-compatible
- Size Single-width (4.2” x 6.875”)

- Device type PCI target, 32-bit, universal signaling
- Data transfer 8-bit, 32-bit
- Interrupt levels Automatically assigned (PnP)
- Power 12 V at 50 mA, TCXO: 5 V at 700 mA
- Connector
- GPS antenna SMB socket
- Firmware update port 6-pin, PS2 mini-DIN J2
- Timing I/O 15-pin ‘DS’ J1

Environmental

- Operating temperature Module: 0ºC to 65ºC
- GPS antenna: –40 ºC to 70 ºC
- Storage temperature Module: –30 ºC to 85 ºC GPS antenna: –55 ºC to 85 ºC
- Operating humidity Module: 5% to 95% (non- condensing) GPS antenna: 100% (condensing)
- Certifications
- FCC Part 15, Subpart B. Emissions EN 55022
- Immunity EN 55024
- RoHS compliance
    - EU RoHS 6/6
    - China RoHS

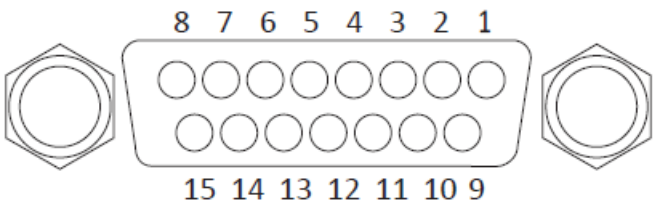
Complete specifications can be found in the manual located at **www.microchip.com**.

Pin Description

Pin	Direction	Signal
1	Input	External 10 MHz
2		Ground
3	Output	Strobe
4	Output	1PPS
5	Output	Time code (AM)
6	Input	External event
7	Input	Time code (AM)
8		Ground
9	Output	Oscillator control voltage
10	Input	Time code (DCLS)
11	Output	Time code (DCLS)
12		Ground
13	Output	1, 5, or 10MPPS
14	Input	External 1PPS
15	Output	Heartbeat/DDS

Standard Cover Panel

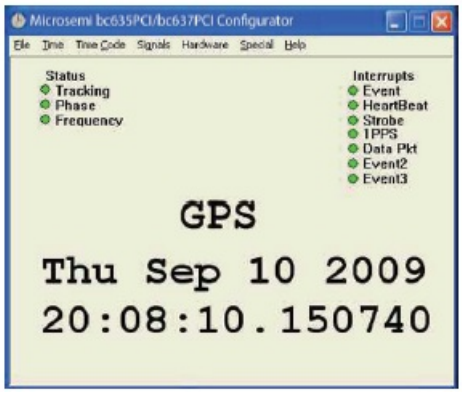
Pin Diagram



Software

The bc637PCI-V2 includes the Microchip bc635PCI demo and bc637PCI GPS demo application programs for Windows 2000/XP. Using this program, you can review the bc637PCI-V2 card status and adjust board configuration and output parameters. bc637PCI demo provides direct access to the GPS receiver used on the bc637PCI-V2 board. An additional clock utility program, TrayTime, is provided that can be used to update the host computer's clock.

Control Panel Interface



Product Includes

This product also includes a bc637PCI-V2 time and frequency processor board, standard height and cover panel, one-year warranty and an insert sheet that explains how to download the user guide and SDK/driver software.

Ordering Information

Part number: bc637PCI-V2 PCI time and frequency processor, GPS synchronized
Connector accessories that can be ordered.

- D connector to x5-BNCs adapter (provides TC in, TC out, 1PPS out, event in, periodic out) p/n: BC11576-1000
- D connector to x5-BNCs adapter with 1PPS in (pro- vides TC in, TC out, 1PPS in, 1PPS out, event in) p/n: BC11576-9860115
- D connector to x6-BNCs adapter (provides TC in, TC out, 1PPS in, 1PPS out, event in, DCLS out) p/n: PCI-BNC-CCS
- GPS Inline Lightning Arrestor with 25 ft (7.5 m) p/n: 150-709
- GPS Inline Lightning Arrestor with 50 ft (15 m) p/n: 150-710
- GPS L1 Inline Antenna Amplifier p/n: 150-200

  Contact Microchip for pricing and availability.

DS00004172A

Documents / Resources

	**Microchip Technology bc637PCI-V2 GPS Synchronized PCI Time and Frequency Processor** [pdf] User Guide bc637PCI-V2 GPS Synchronized PCI Time and Frequency Processor, bc637PCI-V2, GPS Synchronized PCI Time and Frequency Processor, Frequency Processor

References

- Empowering Innovation | Microchip Technology
- Empowering Innovation | Microchip Technology