Symmetricom

bc637PCIe

GPS Synchronized, PCI Express Time & Frequency Processor

KEY FEATURES

- GPS Synchronized with 170 Nano Second RMS Accuracy to UTC
- IRIG A, B, G, E, IEEE 1344, NASA 36, XR3 & 2137 Time Code Inputs and Outputs
- Simultaneous AM and DCLS Time Code Inputs and Outputs
- 100-Nanosecond Clock Resolution for Time Requests
- Programmable <<1 PPS to 100 MPPS DDS Rate Synthesizer Output/Interrupt
- 1, 5, or 10 MHz Rate Generator Output
- 1 PPS and 10 MHz Inputs
- Three (3) External Event Time Capture/Interrupts
- Programmable Time Compare Output/Interrupt
- Zero Latency Time Reads
- Battery Backed Real Time Clock (RTC)
- Low Profile PCI Express Form Factor
- Linux, Solaris & Windows Software Drivers/SDKs Included
- Superior User Interface & Documentation
- Optional OCXO Upgrade

KEY BENEFITS

- Precise Sub-Microsecond Time Available to Host Computer Applications
- Easy Integration Facilitated with included Windows, Linux & Solaris SDKs & Drivers
- Extremely Fast Time Reads
- Programmable Time & Frequency Functions to Quickly Customize for Specific Applications
- Wide Variety of Time Codes Facilitate Easy Integration with Existing Systems
- Dedicated and Responsive Technical Support to Assist in PCIe Card Integration
- Very Well Documented for Easy & Fast System Integration

EASY
System Integration

Symmetricom's GPS referenced bc637PCIe timing module provides unparalleled precise time and frequency functions to the host computer and peripheral systems. Precise time is acquired from the GPS satellite system or from time code signals. GPS synchronization provides 170 nanosecond RMS accurate time to UTC (USNO) enabling the bc637PCIe to precisely synchronize multiple computers to UTC. Integration into a custom application is easy and very efficient through the use of the full-featured Windows, Linux and Solaris SDKs/drivers included standard with the module.

Extensive time code generation and translation are both supported. The translator reads and disciplines the internal oscillator to either the amplitude modulated (AM) and DC level shift (DCLS) formats of IRIG A, B, G, E, IEEE 1344, NASA 36, XR3 or 2137 time codes. The generator outputs either IRIG A, B, G, E, IEEE 1344, NASA 36, XR3 or 2137 in both AM and/or DCLS formats.

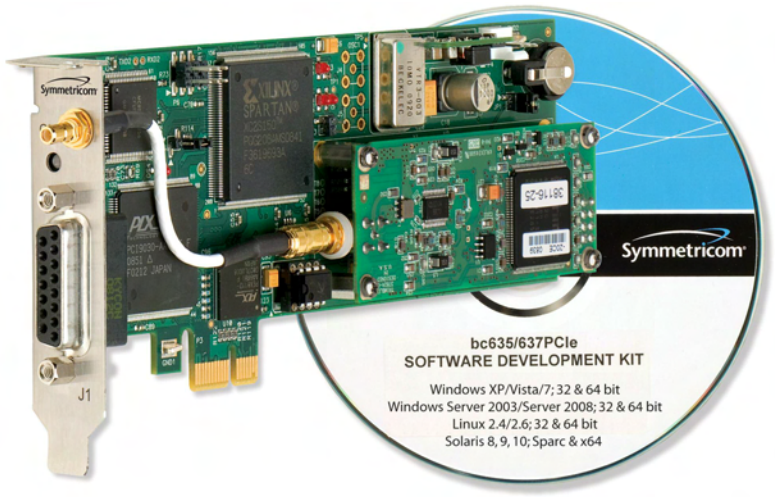
Central to the operation of the module is a disciplined 10 MHz oscillator that is either a TCXO or optional OCXO that provides the timing module's 100-nanosecond clock. Current time (days to 100 nanoseconds) can be accessed across the PCIe bus with no PCIe bus wait states, which allows for very high speed, low latency time requests. The 10 MHz oscillator drives the module's frequency and time code generator circuitry. If the input reference is lost, the module will maintain time (flywheel) based on the 10 MHz oscillator's drift rate. The optional OCXO oscillator improves flywheel drift performance over the standard TCXO. If power is lost, a battery backed real time clock (RTC) maintains the time.

The module has a state-of-the-art DDS rate synthesizer with a range from 0.0000001 PPS to 100 MPPS. The module may also be programmed to generate an interrupt at a precise predetermined time based on a time compare (Strobe). Three Event Time Capture inputs provide a means of latching time of different external events.

A key feature of the bc637PCIe is the ability to generate interrupts on the PCIe bus at programmable rates. These interrupts are useful to synchronize applications on the host computer as well as signal specific timing events over the bus.

The unique external frequency input allows the time and frequency of the bc637PCIe 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 PCIe based clock for all bc637PCIe timing functions.

Integration of the module is easily facilitated with the included SDKs/drivers for 32/64 bit Windows and Linux, and 64 bit Solaris.

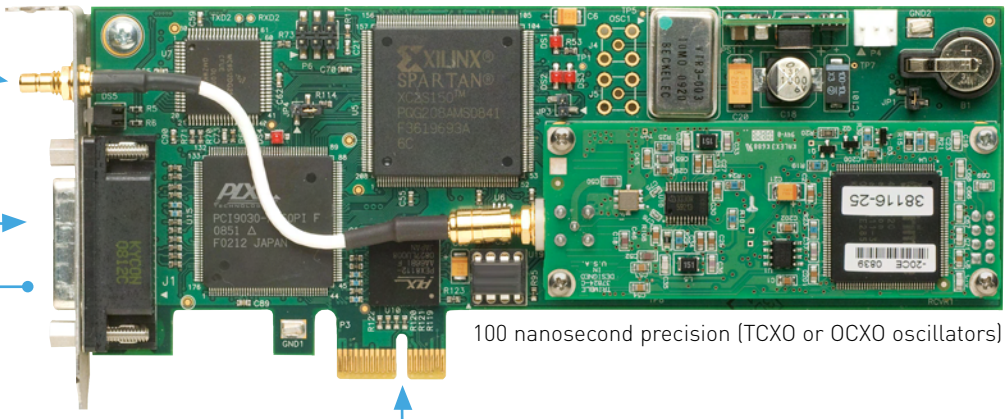


bc637PCIe GPS Synchronized Time & Frequency Processor & Included SDKs/Drivers

Precision Time & Frequency in the PCIe Form Factor

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 100 MPPS rates
- 1PPS
- 1,5,10 MHz
- Oscillator Control Voltage



100 nanosecond precision (TCXO or OCXO oscillators)

Over the PCIe Bus
- Precise time
- Event Interrupts
- Alarm interrupts (time compare/strobe)
- Programmable interrupt rates
- Configuration & Control

Reading the Precise Time
The bc637PCIe provides precise time on request and extremely fast response to host applications. This request for time is simply and quickly done using the included SDK software functions. Time can be provided in binary or decimal form.

A Multitude of Time Codes
The bc637PCIe has the widest time code input and output support available in any bus level timing card. Over 30 different time codes including IRIG A, B, G, E, IEEE 1344, NASA 36, XR3, 2137 in AM and DCLS formats.

Measure Events – External or Internal
Measure the exact time up to three independent external events occur. Bus interrupts instantly notify the CPU the measurements are made and waiting. Similarly, host application generated interrupts to the bc637PCIe card over the bus can be precisely time stamped for precise host application based processes.

Flexible Rate Generation
The Direct Digital Synthesizer on board the bc637PCIe can be programmed to generate rates up to 100 MPPS 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 of a hertz.

Frequency Outputs
Precise clocks are excellent sources of frequency outputs. The bc637PCIe offers 1, 5 or 10 MHz outputs directly from the steered internal oscillator of the clock.

External Frequency Inputs and DAC Control
The external frequency input is a unique feature allowing the time and frequency of the bc637PCIe to be derived from an external oscillator such as a 10 MHz from a Cesium or Rubidium standard. This creates an extremely stable PCIe based clock for all bc637PCIe timing functions. For closed loop control, an external oscillator may be disciplined via DAC voltage control output from the bc637PCIe.

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

Over the Bus Features
Aside from precise time stamps, the bc637PCIe can provide very precisely timed interrupts on the bus at fixed rates, predetermined times, or to signal 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 bc637PCIe 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 & DRIVERS

Windows, Linux and Solaris Software Development Kits Speed PCIe Integration
These full-featured software development kits, included standard with the PCIe card, speed the integration of Symmetricom PCIe 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 Symmetricom PCIe card straightforward and help keep your software development focused on the end application.

SDKs Save Time and Money
Programmers will find the SDK an invaluable resource in accelerating the integration of Symmetricom PCI cards into applications, saving both time and money. The SDK functions address each Symmetricom PCIe timing card feature, and the function names and parameters provide insight into the capability of each function.

By using the SDK, you can leverage Symmetricom's timing expertise and confidently integrate a Symmetricom PCI card into your application.

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

Windows SDK and Driver

- Windows XP/Vista/7
- Windows Server 2003/2008
- 32 & 64 bit support
- Kernel Mode Driver
- Code Examples
- Test Application Program
- Complete Documentation
- Time Keeping Utility Program

The Windows SDK for bc637PCIe cards includes a Windows XP/Vista/Server/7 kernel mode device driver for the 32 and 64 bit PCIe 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 Symmetricom's bc637PCIcfg application program, which can be used to ensure proper operation of the PCIe card, as well as the TrayTime application allowing the user to update the system clock in which the card is installed. Source code for these programs as well as smaller example programs are included.

MINIMUM SYSTEM REQUIREMENTS
Operating System:
Windows XP/Vista/7
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

- Linux 2.4 & 2.6 Kernel
- 32 & 64 bit kernel support
- Code Examples
- Test Application Program
- Complete Documentation

The Linux® SDK for bc637PCIe cards includes PCIe kernel mode device drivers for both 32-bit and 64- bit kernels, an interface library accessing all bc637PCIe features, and example programs with source code.

The target programming environment is the GNU Compiler Collection (GCC) and the C/C++ programming languages.

Also included is Symmetricom's bc63xPCIcfg application program to ensure proper operation of the PCIe 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 was 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 2.4, 2.6.

Hardware:
x86 processor.

Memory: 32 MB

Development environment:
GNU GCC recommended.

Solaris SDK and Driver

- Solaris Kernel Mode Driver
- 64-bit Solaris 8-10
- Code Examples
- Test Application Program
- Complete Documentation

Symmetricom's Solaris SDK includes bc63xPCIcfg, an application program to ensure proper operation of the PCI card in the host computer. The example program includes sample code 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 target programming environment is the Solaris application development tool chain and the C/C++ programming languages.

The Solaris SDK includes the Solaris device driver source code. Applications access the features of the hardware through the standard 'ioctl' Solaris system function. The IOCTL codes are defined for all the features of the card. The bc63xPCIcfg program shows how to use most IOCTL codes. Developers can copy any useful code from the bc63xPCIcfg source code and use it in their own applications.

MINIMUM SYSTEM REQUIREMENTS
Operating System:
Solaris versions 8, 9 and 10.

Hardware: SPARC & x86_64.

Memory: 32 MB

Development environment:
Solaris compilers.

SDK FUNCTION REFERENCE LIST

Windows and Linux
SDK Function Reference List (Partial)*

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 nanosecond 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 sends and retrieves 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.

* See manual for complete listing

Solaris

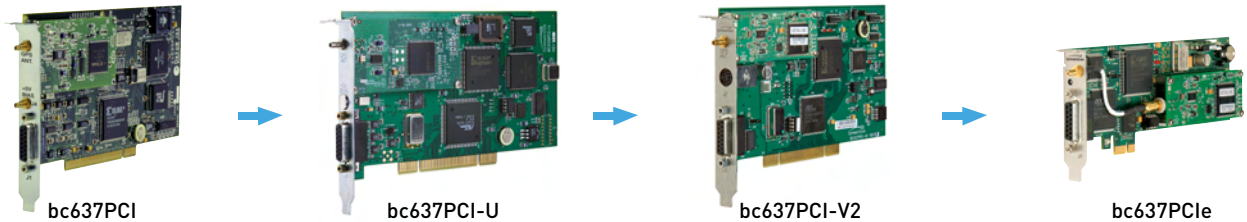
SDK Function Reference List

The Solaris SDK uses custom IOCTL commands to facilitate easy communication and control of the bc637PCIe card. The commands cover basic operational functions, event management, oscillator controls, and mode related functions.

An over view of the IOCTL functions include

- Interrupt Management
- Read/write Dual Port RAM. Send command to timing engine for processing
- Read and write time
- Timing mode and time format
- Read and write the card control register
- Input time code format and modulation selection
- Set local time
- Leap seconds control
- Read various version information and miscellaneous data
- Reset the board
- Clock source, jamsync management
- DAC control
- On-board oscillator frequency control
- Advance or retard the internal clock
- Read event time latched by external event
- Read event time latched by software event
- Event source/ sense control
- Set propagation delay
- Periodic output and output frequency control
- Strobe control
- DDS frequency output control
- Set output time code format
- Set offset for output time code generation
- GPS control
- Sync Real Time Clock
- Disconnect between RTC and battery after power off

BACKWARDS COMPATIBILITY PROVIDES SEAMLESS MIGRATION PATHS



bc637PCI
Mid-1990's
1st PCI timing
card Introduced

bc637PCI-U
2003
3.3V & 5.0V Universal Signaling
backward compatibility retained

bc637PCI-V2
2008
Electronics updated
backward compatibility retained

bc637PCIe
2009
PCIe supported
backward compatibility retained

The PCI based bc637 cards have long product lifecycles since the first introduction of PCI timing cards in the mid 1990's. To preserve the customer investment of time and money to integrate bc637PCI cards into their systems, Symmetricom has maintained the features and software interface to the bc637PCI cards while keeping them current with respect to changing bus signaling, form factors, and new features.

This commitment to backwards compatibility and current bus architectures assures the bc637PCI cards integrate smoothly in the latest workstations available in the market with little to no impact on customer application software.

OPTIONAL ACCESSORIES SPEED TEST AND SIMPLIFY INTEGRATION

Breakout cables with BNC connectors simplify access to the in and out timing signals of the PCIe card. These labeled cables mitigate the need to create special cables during project development and assure the correct timing signals are being accessed.

For more integrated rack mount systems needing 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 PCIe 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.

Timing Input/Output Breakout Cable and Patch Panel BNC Map	"D" to 5-BNC	"D" to 6-BNC	Patch/Breakout
Outputs			
Time Code (AM)	✓	✓	✓
Time Code (DCLS)		✓	✓
1, 5, 10 MHz			✓
Heartbeat/DDS			✓
Strobe	✓		✓
1 PPS	✓	✓	✓
Oscillator Control Voltage			✓
Inputs			
Time Code (AM)	✓	✓	✓
Time Code (DCLS); Event2			✓
External Event1	✓	✓	✓
External 1 PPS; Event3		✓	✓
External 10 MHz			✓

Input/Output signals "D" to BNC connector breakout cables

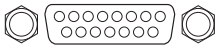
1U patch panel of Input/Output and high frequency signals
for standard rack mount size chassis

bc637PCIe SPECIFICATIONS

ELECTRICAL SPECIFICATIONS

- GPS Receiver/Antenna
  - 12 channel parallel receiver
  - GPS time traceable to UTC(USNO)
  - Accuracy: 170 ns RMS, 1 µSec peak to peak to UTC(USNO), at stable temperature and ≥4 satellites tracked.
  - Maximum Belden 9104 cable length: 150' (45 m). For longer cable runs see Options.
- Real Time Clock
  - Bus request resolution: 100 nanoseconds
  - Latency: Zero
  - Major time format: Binary or BCD
  - Minor time format: Binary
- Synchronization sources: GPS, Time code, 1 PPS
- 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 to 8V p-p
  - AM Input impedance: >5kΩ
  - DCLS Input, Event2: 5V HCMOS >2V high, <0.8V low
- 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 +/- 0.5Vpp into 50Ω
  - DCLS amplitude: 5V HCMOS, >2V high, < 0.8V low into 50Ω
- Timing functions (outputs are rising edge on time)
  - DDS rate synthesizer
  - Frequency range: 0.0000001 PPS to 100 MPPS
  - Output amplitude: 5V HCMOS, >2V high, < 0.8V low into 50Ω, square wave
  - Jitter: <2 nS p-p
  - Legacy pulse rate synthesizer (Heartbeat, aka Periodic)
  - Frequency range: <1 Hz to 250 kHz
  - Output amplitude: 5V HCMOS, >2V high, < 0.8V low into 50Ω, square wave
  - Time compare (Strobe)
  - Compare range: 1 µS through days
  - Output amplitude: 5V HCMOS, >2V high, < 0.8V low into 50Ω, 1 µS pulse
  - 1 PPS Output: 5V HCMOS, >2V high, < 0.8V low into 50Ω, 60 µS pulse
  - 1 PPS Input, Event3: 5V HCMOS, >2V high, < 0.8V low
  - External Event Input: 5V HCMOS, >2V high, < 0.8V low, zero latency
  - External 10 MHz oscillator: Digital 40% to 60% or sine wave, 0.5 to 8Vp-p, >10kΩ
  - Oscillator Control Voltage: Jumper selectable 0-5VDC or 0-10VDC
- On-board disciplined oscillator
  - Frequency: 10 MHz
  - 1, 5, or 10 MHz output: 5V HCMOS, >2V high, < 0.8V low into 50Ω
  - Stability:
  - Standard TCXO: 5.0E-8 short term 'tracking'
    5.0E-7/day long term 'flywheeling'
  - Optional OCXO: 2.0E-9 short term 'tracking'
    5.0E-8 /day long term 'flywheeling'
- Real-time clock (RTC) Battery backed time and year information
- PCIe Specification: Single lane PCI Express (PCIe) Interface, r1.0a compatible
  - Size: Standard height Low Profile PCIe
  - Power: +3.3V @ 400 mA
    +12V @ 300 mA (TCXO), 400 mA (OCXO)

- Connector
  - GPS Antenna: SMB socket
  - Timing I/O: 15-pin 'DS'



Pin	Direction	Signal
1	input	External 10 MHz
2		Ground
3	output	Strobe
4	output	1 PPS
5	output	Time Code (AM)
6	input	External Event1
7	input	Time Code (AM)
8		Ground
9	output	Oscillator Control Voltage
10	input	Time Code (DCLS); Event2
11	output	Time Code (DCLS)
12		Ground
13	output	1, 5, 10 MHz
14	input	External 1 PPS; Event3
15	output	Heartbeat/DDS

bc637PCIe Low profile and standard cover panels

- Complete specifications can be found in the manual located at http://www.symmetricom.com

ENVIRONMENTAL SPECIFICATIONS

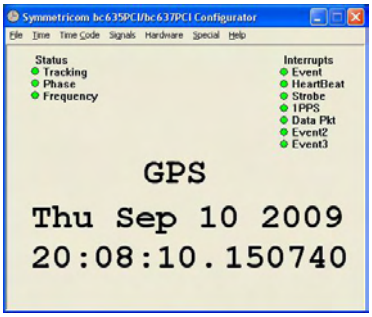
- Environment

	Module	GPS Antenna
Temperature:		
Operating:	0ºC to 70ºC	-40ºC to 70ºC
Storage:	-30ºC to 85ºC	-55ºC to 85ºC
Humidity:		
Operating:	5% to 95% non-condensing	100% condensing
Operating altitude:	Up to 18,000 meters MSL	

- Certifications: FCC, CE(RoHS)

SOFTWARE

- The bc637PCIe includes on CD the SDKs and drivers for the 32/64 bit versions of Windows and Linux, and 64 bit Solaris. Included are test application programs with source code so that you can review the bc637PCIe card status and adjust board configuration and output parameters. Each SDK includes an extensive list of function calls to quickly and easily speed integration of the bc637PCIe card into your target environment. For Windows, an additional clock utility program, TrayTime, is provided that can be used to automatically update the host computer's clock.
- The bc637PCIe firmware is easily field-upgradeable over the PCIe bus.



PRODUCT INCLUDES

- bc637PCIe GPS synchronized Time & Frequency Processor board; L1 GPS antenna; 50' (15 m) Belden 9104 coaxial cable; 1 ft. antenna mounting mast (30 cm) with two Clamps; standard height and low-profile cover plates; one year warranty; PCIe User's Guide CD; Windows, Linux and Solaris SDK/Driver software CD.

OPTIONS

- OXCO (oven controlled crystal oscillator) for extended holdover
- 15-Pin 'D' connector (J1) to BNC adapter cables
- GPS antenna in-line amplifier for cable runs to 300' (90 m)
- GPS antenna down/up converter for cable runs to 1500' (457 m)
- Lightning arrestor

Symmetricom

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