

# bc635PCIe

## PCI Express Time & Frequency Processor

### KEY FEATURES

- 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  $\ll 1$  PPS to 100 MPPS DDS Rate Synthesizer Output/Interrupt
- 1, 5, or 10 MPPS 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

The Symmetricom® bc635PCIe timing module provides unparalleled precise time and frequency functions to the host computer and peripheral data acquisition systems. 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.

Time is typically acquired from time code signals such as IRIG B. 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.

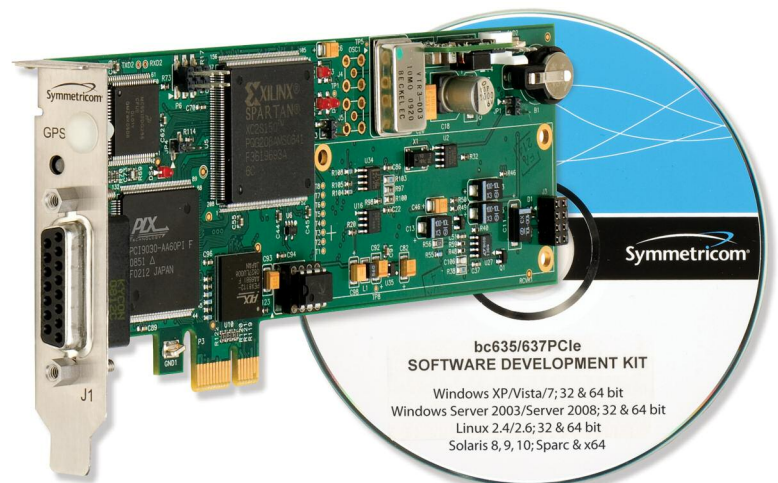
Central to the operation of the module is a disciplined 10 MHz oscillator that is either a TCXO or optional OCXO that provides the timing module's 100-nanosecond clock. Current time (days to 100 nanoseconds) can be accessed across the PCIe bus with no PCIe bus wait states, which allows for very high 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 continue to 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 bc635PCIe 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 external frequency input is a unique feature allowing the time and frequency of the bc635PCIe 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 bc635PCIe 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.



**bc635/637PCIe  
SOFTWARE DEVELOPMENT KIT**  
Windows XP/Vista/7; 32 & 64 bit  
Windows Server 2003/Server 2008; 32 & 64 bit  
Linux 2.4/2.6; 32 & 64 bit  
Solaris 8, 9, 10; Sparc & x64

bc635PCIe Time & Frequency Processor & Included SDKs/Drivers



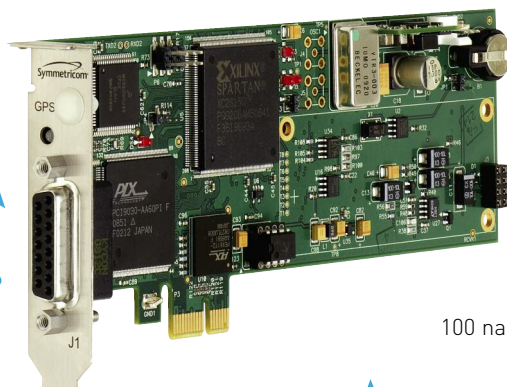
## Precision Time & Frequency in the PCIe Form Factor

### Inputs

- AM Time Codes
- DCLS Time Codes
- External Events (3x)
- 10 MHz
- 1PPS
- GPS (bc637PCle model)

### Outputs

- AM Time Codes
- DCLS Time Codes
- Programmable Alarm (Strobe/Time Compare)
- <<1PPS to 100 MPPS rates
- 1PPS
- 1,5,10 MPPS
- 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 bc635PCle 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 bc635PCle 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 bc635PCle 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 bc635PCle 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 bc635PCle offers 1, 5 or 10 MPPS 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 bc635PCle 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 bc635PCle timing functions. For closed loop control, an external oscillator may be disciplined via DAC voltage control output from the bc635PCle.

### 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 bc635PCle 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 bc635PCle 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 inter-

facing to a Symmetricom PCIe card straightforward and help keep your software development focused on the end application.

### SDKs Save Time and Money

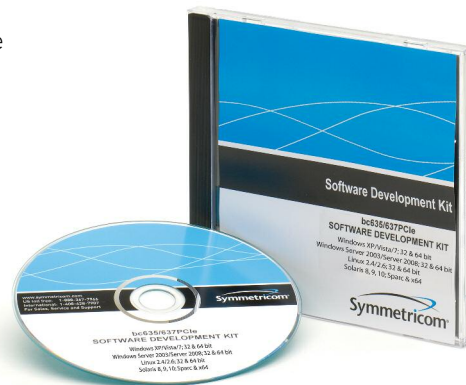
Programmers will find the SDK an invaluable resource in accelerating the integration of Symmetricom PCI cards into applications, saving both time and money. The SDK functions address each Symmetricom PCIe timing card feature, and the function names and parameters provide insight into the capability of 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 bc635PCIe 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 bc635PCIe cards includes PCIe kernel mode device drivers for both 32-bit and 64-bit kernels, an interface library accessing all bc635PCIe 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 PCIe 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.
- bcReadDPRReg/ bcWriteDPRReg 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

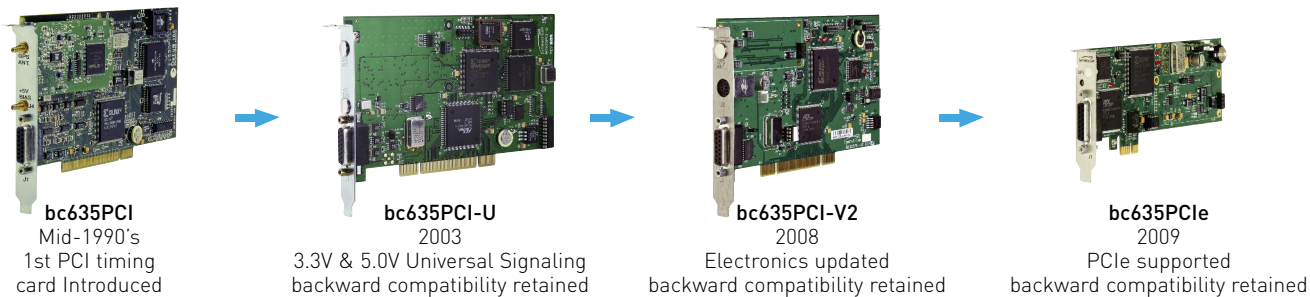
The Solaris SDK uses custom IOCTL commands to facilitate easy communication and control of the bc635PCIe card. The commands cover basic operational functions, event management, oscillator controls, and mode related functions.

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**



The PCI based bc635 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 bc635PCI cards into their

systems, Symmetricom has maintained the features and software interface to the bc635PCI 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 bc635PCI 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**

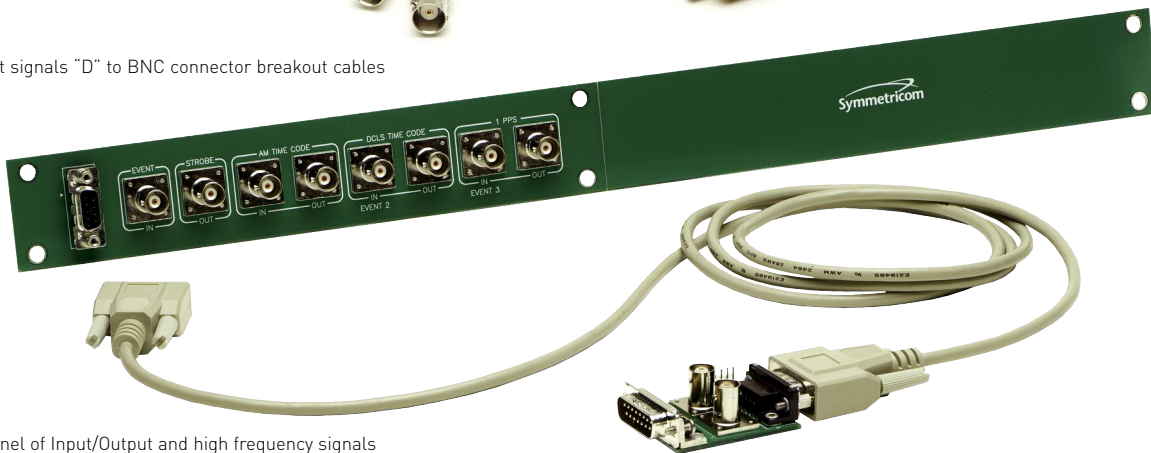
Breakout cables with BNC connectors simplify access to the in and out timing signals of the PCIe card. These labeled cables mitigate the need to create special cables during project development and assure the correct timing signals are being accessed.

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 (BC11576-1000)	"D" to 5-BNC BC11576-9860115	"D" to 6-BNC	Patch/Breakout
<b>Outputs</b>				
Time Code (AM)	✓	✓	✓	✓
Time Code (DCLS)			✓	✓
1, 5, 10 MPPS				✓
Periodic/DDSP				✓
Strobe				✓
1 PPS	✓	✓	✓	✓
Oscillator Control Voltage				✓
<b>Inputs</b>				
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

## bc635PCIe SPECIFICATIONS

### ELECTRICAL SPECIFICATIONS

- Real Time Clock
  - Bus request resolution: 100 nanoseconds
  - Latency: Zero
  - Major time format: Binary or BCD
  - Minor time format: Binary
- Synchronization sources: Time code, 1 PPS
- Time code translator (inputs)
  - Time code formats: IRIG A, B, G, E, IEEE 1344, NASA 36, XR3, 2137
  - Time accuracy: <math>< 5 \mu\text{S}</math> (AM carrier frequencies 1 kHz or greater)  
<math>< 1 \mu\text{S}</math> (DCLS)
  - AM ratio range: 2:1 to 4:1
  - AM Input amplitude: 1 to 8V p-p
  - AM Input impedance: >5k $\Omega$
  - DCLS Input, Event2: 5V HCMOS >2V high, <math>< 0.8\text{V}</math> 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 50 $\Omega$
  - DCLS amplitude: 5V HCMOS, >2V high, <math>< 0.8\text{V}</math> low into 50 $\Omega$
- Timing functions (outputs are rising edge on time)
  - DDS rate synthesizer
    - Frequency range: 0.000001 PPS to 100 MPPS
    - Output amplitude: 5V HCMOS, >2V high, <math>< 0.8\text{V}</math> low into 50 $\Omega$ , square wave
    - Jitter: <math>< 2 \text{ nS p-p}</math>
  - Legacy pulse rate synthesizer (Heartbeat, aka Periodic)
    - Frequency range: <math>< 1 \text{ Hz}</math> to 250 kHz
    - Output amplitude: 5V HCMOS, >2V high, <math>< 0.8\text{V}</math> low into 50 $\Omega$ , square wave
  - Time compare (Strobe)
    - Compare range: 1  $\mu\text{S}$  through days
    - Output amplitude: 5V HCMOS, >2V high, <math>< 0.8\text{V}</math> low into 50 $\Omega$ , 1  $\mu\text{S}$  pulse
  - 1 PPS Output: 5V HCMOS, >2V high, <math>< 0.8\text{V}</math> low into 50 $\Omega$ , 60  $\mu\text{S}$  pulse
  - 1 PPS Input, Event3: 5V HCMOS, >2V high, <math>< 0.8\text{V}</math> low
  - External Event Input: 5V HCMOS, >2V high, <math>< 0.8\text{V}</math> low, zero latency
  - External 10 MHz oscillator: Digital 40% to 60% or sine wave, 0.5 to 8Vp-p, >10k $\Omega$
  - 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, <math>< 0.8\text{V}</math> low into 50 $\Omega$
  - 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 @ 250 mA (TCXO), 350 mA (OCXO)

- Connector 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 MPPS
14	input	External 1 PPS; Event3
15	output	Heartbeat/DDS



bc635PCIe Low profile and standard cover panels

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

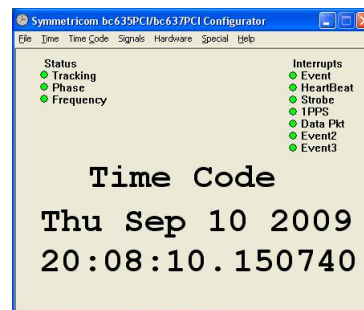
### ENVIRONMENTAL SPECIFICATIONS

- Environment
  - Temperature:
    - Operating: 0 $^{\circ}\text{C}$  to 70 $^{\circ}$
    - Storage: -30 $^{\circ}\text{C}$  to 85 $^{\circ}$
  - Humidity
    - Operating: 5% to 95% non-condensing
  - Operating altitude: Up to 18,000 meters MSL

- Certifications: FCC, CE(RoHS)

### SOFTWARE

- The bc635PCIe 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 bc635PCIe 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 bc635PCIe 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 bc635PCIe firmware is easily field-upgradeable over the PCIe bus.



### PRODUCT INCLUDES

- bc635PCIe Time & Frequency Processor board; Standard height and low-profile cover plates; one year warranty; PCIe User's Guide CD; Windows, Linux and Solaris SDK/Driver software CD.

### OPTIONS

- GPS synchronization, see bc637PCIe product
- OXCO (oven controlled crystal oscillator) for extended holdover
- 15-Pin 'D' connector (J1) to BNC adapter cables