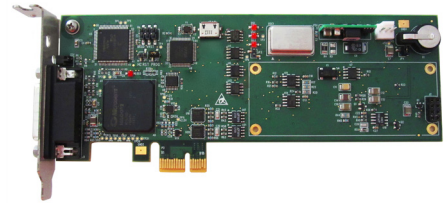


# bc635PCIe

## PCI Express (PCIe®) Time and Frequency Processor



### Summary

The Microchip 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 efficient through the use of the full-featured standard Windows® and Linux® software development kits (SDKs)/drivers included 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 are 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 TCXO 10 MHz oscillator that provides the timing module a 100 ns clock. Current time (days to 100 ns) can be accessed across the PCIe bus with no PCIe bus wait states, which allows for high speed and low latency time requests. The 10 MHz oscillator drives the module frequency and time code generator circuitry. If the input reference is lost, the module continues to maintain time (flywheel) based on the 10 MHz oscillator's drift rate. If power is lost, a battery backed Real-Time Clock (RTC) maintains the time. The module has a state-of-the-art Direct Digital Synthesizer (DDS) rate synthesizer with a range from 0.0000001PPS to 100MPPS. 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 can be used 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 64-bit Linux.

### Features

- 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 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 external event time capture/interrupts
- Programmable time compare output/interrupt
- Zero latency time reads
- Battery-backed Real-Time Clock (RTC)
- Low-profile PCIe form factor
- Linux and Windows software drivers/SDKs included
- Superior user interface and documentation

### Benefits

- Precise sub-microsecond time available to host computer applications
- Easy integration facilitated by included Windows and Linux SDKs and drivers
- Extremely fast time reads
- Programmable time and 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
- Well documented for easy and fast system integration

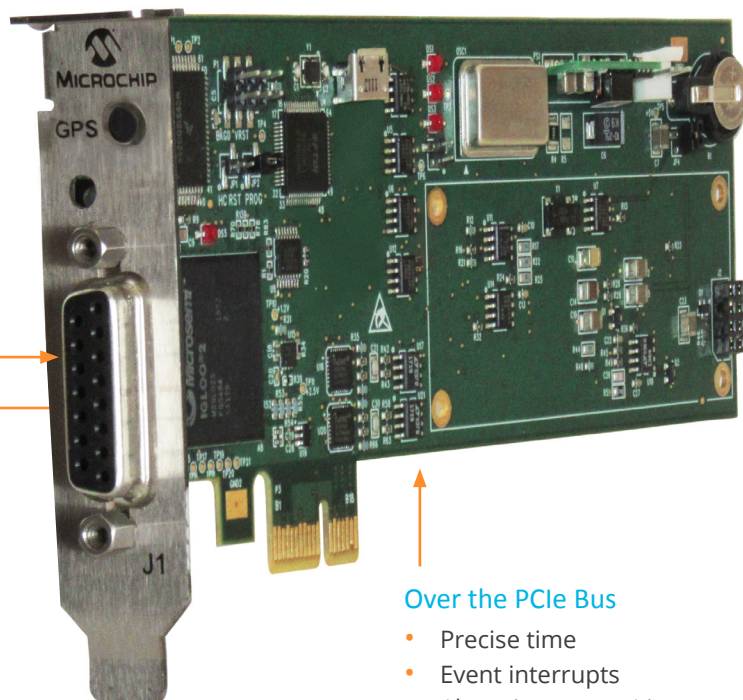
## Precision Time and Frequency in the PCIe Form Factor (100-Nanosecond Precision, TCXO Oscillators)

### Inputs

- AM time codes
- DCLS time codes
- External events (3×)
- 10 MHz
- 1 PPS
- GPS (bc637PCIe model)

### Outputs

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



### Over the PCIe Bus

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

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

### Reading the Precise Time

The bc635PCIe 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 bc635PCIe 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 independent external events. Bus interrupts instantly notify the CPU that the measurements are made and waiting. Similarly, host application-generated interrupts to the bc635PCIe card over the bus can be precisely time stamped for precise host application-based processes.

### Flexible Rate Generation

The DDS on the bc635PCIe 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 Hz.

## Frequency Outputs

Precise clocks are excellent sources of frequency outputs. The bc635PCIe 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 that allows the time and frequency of the bc635PCIe to be derived from an external oscillator such as a 10 MHz Cesium or Rubidium standard. This creates an extremely stable PCIe-based clock for all bc635PCIe timing functions. For closed loop control, an external oscillator may be disciplined using DAC voltage control output from the bc635PCIe.

## 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 a point in time has just occurred.

## Over-the-Bus Features

In addition to precise time stamps, the bc635PCIe 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 bc635PCIe 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 PCIe Integration

The PCIe card includes standard full-featured software development kits, speeding the integration of Microchip 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 Microchip PCIe card straightforward and help keep the software development focused on the end application.

### SDKs Save Time and Money

Programmers find the SDK an invaluable resource in accelerating the integration of Microchip PCIe cards into applications, saving both time and money. The SDK functions address each Microchip 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 Microchip's timing expertise and confidently integrate a Microchip PCIe 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 bc635PCIe cards include a Windows XP/Vista/Server/7/10 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 application 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 bc637PClcfg application program that can be used to ensure proper operation of the PCIe 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

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

The Linux SDK for bc635PCIe cards includes PCIe kernel mode device drivers for 64-bit kernels, an interface library accessing all bc635PCIe 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 bc63xPClcfg application program, which ensures 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 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.
- 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.
- bcSetTcln Sets time code format for time code decoding mode.
- bcSetTclnEx Sets time code and subtype for time code decoding mode.
- bcSetTclnMod 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.

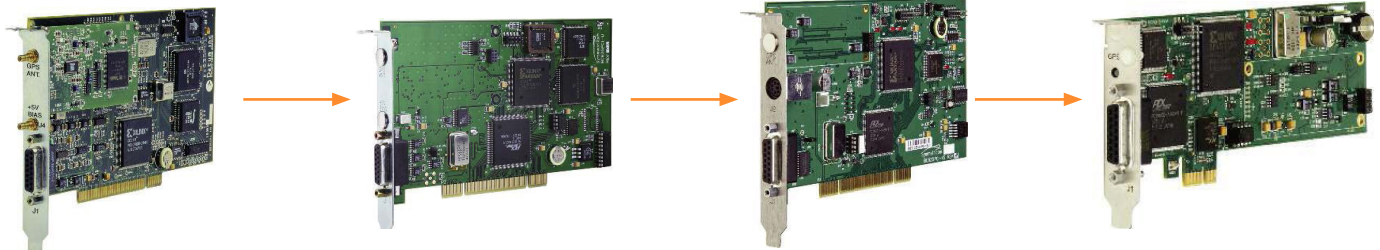
## Real-Time Clock (RTC) Functions

- 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 bc635 cards have long product lifecycles since the first introduction of PCI timing cards in the mid 1990s. To preserve the customer's time and money investments in integrating bc635PCI cards into their systems, Microchip has maintained the bc635PCI 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 bc635PCI cards integrate smoothly into any workstation currently available in the market with little to no impact on customer application software.

## PCI Card Developments



### bc635PCI

- Mid-1990s
- First PCI timing card introduced

### bc635PCI-U

- 2003
- 3.3V and 5.0V universal signaling backward compatibility retained

### bc635PCI-V2

- 2008
- Electronics updated backward compatibility retained

### bc635PCIe

- 2009
- PCIe supported backward compatibility retained

## Optional Accessories to Speed, Test, and Simplify Integration

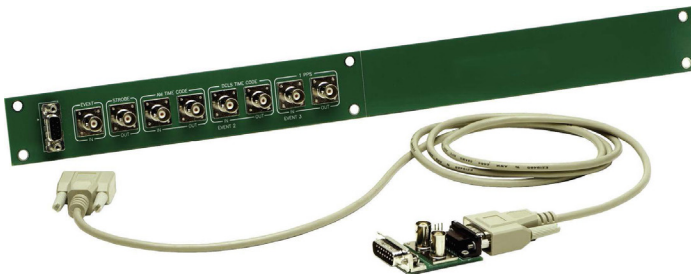
Breakout cables with BNC connectors simplify access to the in and out timing signals of the PCIe card. These labeled cables mitigate the need to create special cables during project development and ensure that the correct timing signals are being accessed.

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 Input/Output (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.

### 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/Breakout
<b>Outputs</b>				
Time code (AM)	✓	✓	✓	✓
Time code (DCLS)			✓	✓
1, 5, or 10MPPS				✓
Periodic/DDS	✓			✓
Strobe				✓
1PPS	✓	✓	✓	✓
Oscillator control voltage				✓
<b>Inputs</b>				
Time code (AM)	✓	✓	✓	✓
Time code (DCLS); event2				✓
External event1	✓	✓	✓	✓
External 1PPS; event3		✓	✓	✓
External 10 MHz				✓

## Specifications

### Electrical

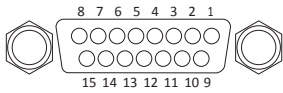
- Real-Time Clock (RTC)
  - Bus request resolution 100 ns
  - Latency Zero
  - Major time format Binary or BCD
  - Minor time format Binary
- Synchronization sources Time code, 1 PPS
- Time code translator (inputs)
  - Time code formats IRIG A, B, G, E, IEEE 1344, NASA 36, XR3, 2137
  - Time accuracy <5  $\mu$ S (AM carrier frequencies 1 kHz or greater) <1  $\mu$ S (DCLS)
  - AM ratio range 2:1 to 4:1
  - AM input amplitude 1 V<sub>PP</sub> to 8 V<sub>PP</sub>
  - AM input impedance >5 k $\Omega$
  - DCLS input, event2 5V HCMOS >2V high, V <0.8 low
- Time code generator (outputs)
  - Time code format IRIG A, B, G, E, IEEE 1344, NASA 36, XR3, 2137
  - AM ratio 3:1  $\pm$ 10%
  - AM amplitude 3.5 V<sub>PP</sub>  $\pm$ 0.5 V<sub>PP</sub> into 50 $\Omega$
  - DCLS amplitude 5V HCMOS, >2V high, <0.8V low into 50 $\Omega$
- Timing functions (outputs are rising edge on time)
- DDS rate synthesizer
  - Frequency range 0.000000 1 PPS to 100 MPPS
  - Output amplitude 5V HCMOS, >2V high, <0.8V low into 50 $\Omega$ , 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 50 $\Omega$ , square wave
- Time compare (strobe)
  - Compare range 1  $\mu$ s through days
  - Output amplitude 5V HCMOS, >2V high, <0.8V low into 50 $\Omega$ , 1  $\mu$ s pulse
  - 1PPS output 5V HCMOS, >2V high, <0.8V low into 50  $\Omega$ , 60  $\mu$ s pulse
  - 1PPS input, event3 5V HCMOS, >2V high, V <0.8 low
  - External event input 5V HCMOS, >2V high, <0.8V low, zero latency
  - External 10 MHz oscillator Digital 40% to 60% or sine wave, V<sub>O.5</sub> pp to 8 V<sub>PP</sub>, >10 k $\Omega$
  - Oscillator control voltage Jumper selectable 0 VDC-5 VDC or 0 VDC-10 VDC
- On-board disciplined oscillator
- Frequency 10 MHz
  - 1, 5, or 10 MPPS output 5V HCMOS, >2V high, <0.8V low into 50  $\Omega$
- Stability
- Standard TCXO:
  - 5.0 $\times$ 10<sup>-8</sup> short term "tracking" 5.0  $\times$  10<sup>-7</sup>/day long term "flywheeling"
- Real-Time Clock (RTC) Battery backed time and year information
- PCIe specification: Single lane PCIe interface, r1.0a compatible
- Size Standard height low-profile PCIe
- Power 3.3V at 400 mA 12V at 250 mA (TCXO)
- Connector
  - Timing I/O 15-pin DS software

## Environmental

- Temperature
  - Operating 0°C to 65°C
  - Storage -30°C to +85°C
- Humidity
  - Operating 5% to 95% non-condensing
- Certifications
  - FCC Part 15, Subpart B.
  - CE Emissions EN 55032
  - UKCA UK Conformity Assessed
- Immunity EN 55035
- RoHS compliance
  - EU RoHS 6/6 compliant
  - China RoHS compliant

## Pin Diagram

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, or 10 MPPS
14	Input	External 1 PPS; event3
15	Output	Heartbeat/DDS



## bc635PCIe Low-Profile and Standard Cover Panels



## Size

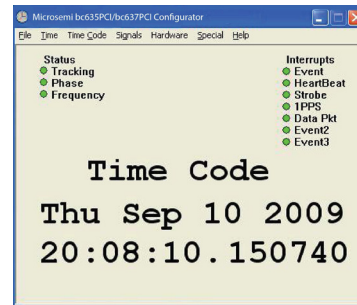
- 2.7 oz.
- Length: 7 ¼ inches
- Width: 3 ½ inches
- Height: ¾ inch

## Software

The bc635PCIe software includes the SDKs and drivers for the 32/64-bit versions of Windows and 64-bit version of Linux. 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 integrate 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.

## Control Panel Interface



## Additional Features

This product also includes a bc635PCIe time and frequency processor board, standard height and low-profile cover plates, one-year warranty and an insert sheet that explains how to download the user guide and SDK/driver software.

## Ordering Information

Part number: bc635PCIe PCIe time and frequency processor. These connector accessories 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 (provides 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

For more information about GPS synchronization, see bc637PCIe PCI Express Time and Frequency Processor data sheet.

Contact Microchip for pricing and availability.

Made in USA and TAA compliant

Complete specifications can be found in the manual located at [www.microchip.com](http://www.microchip.com).