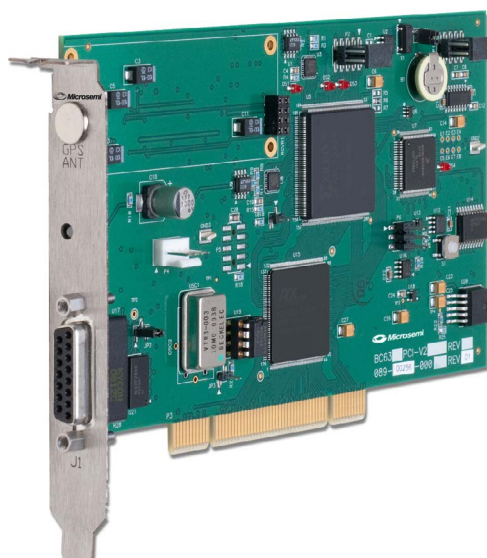# bc635PCI-V2
PCI Time and Frequency Processor

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 <<1PPS to 100MPPS DDS rate synthesizer output/interrupt

- 1, 5, or 10MPPS rate generator output

- 1PPS and 10 MHz inputs

- Three external event time capture/interrupts

- External event time capture/interrupt

- Programmable time compare 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)

- CE(RoHS)-compliant

- Linux, Solaris, and Windows software drivers/SDKS included

The Microsemi bc635PCI-V2 timing module provides unparalleled precise time and frequency to the host computer and peripheral data acquisition systems. Time is typically acquired from time code signals such as IRIG B.

Central to the operation of the module is a disciplined 10 MHz oscillator that is either an on-board TCXO (or optional OCXO) or an off-board External oscillator that can provide 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 generator 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 real time clock (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-artDDS 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 bc635PCI-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 bc635PCI-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 bc635PCI-V2 timing functions.

The bc635PCI-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 2000/XP, Linux, or Solaris.
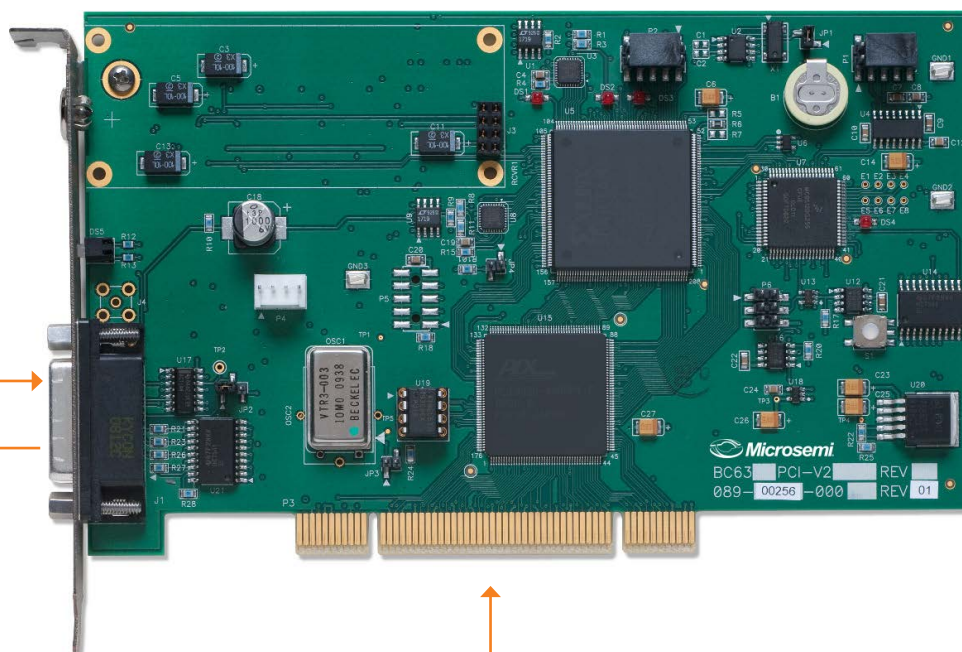
Precision Time and Frequency in the PCI Form Factor

Inputs

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

Outputs

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

*100 ns Precision

Over the PCIe Bus

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

Reading the Precise Time

The bc635PCI-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 bc635PCI-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 occurence of three independent external events occur. Bus interrupts instantly notify the CPU that the measurements are made and waiting. Similarly, host application-generated interrupts to the bc635PCI-V2 card over the bus can be precisely timestamped for precise host application-based processes.

Flexible Rate Generation

The direct digital synthesizer on board bc635PCI-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

bc635PCI-V2
PCI Time and Frequency Processor

Frequency Outputs

Precise clocks are excellent sources of frequency outputs. The bc635PCI-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 bc635PCI-V2 to be derived from an external oscillator such as a 10 MHz Cesium or Rubidium standard. This creates an extremely stable PCI based clock for all bc635PCI-V2 timing functions. For closed loop control, an external oscillator may be disciplined using DAC voltage control output from the bc635PCI-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 timestamps, the bc635PCI-V2 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 bc635PCI-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, Linux, and Solaris SDKs Speed PCI Integration

The PCI card includes standard full-featured software development kits, and speed the integration of Microsemi 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 inter-facing to a Microsemi 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 accelerating the integration of Microsemi PCI cards into applications, saving both time and money. The SDK functions address each Microsemi 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 Microsemi's timing expertise and confidently integrate a Microsemi PCI card into your application.

License Free

Distribution of embedded Microsemi software in customer applications is royalty free.

Driver Comparison

Windows SDK and Driver	Linux SDK and Driver	Solaris SDK and Driver
• Windows XP/Vista/7 • Windows Server 2003/2008 • 32- and 64-bit support • Kernel mode driver • Code examples • Test application program • Complete documentation • Timekeeping utility program	• Up to Linux Kernel 4.6 • 32- and 64-bit kernel support • Code examples • Test application program • Complete documentation	• Solaris kernel mode driver • 64-bit Solaris 8-10 • Code examples • Test application program • Complete documentation

The Windows SDK for bc635PCI-V2 cards include a Windows XP/Vista/Server/7 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 Microsemi'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
• 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

The Linux SDK for bc635PCI-V2 cards includes PCIe kernel mode device drivers for both 32-bit and 64-bit kernels, an interface library accessing all bc635PCI-V2 features, and example programs with he source code.

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

Also included is Microsemi'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 Kernel 4.6

Hardware

x86 processor

Memory

32 MB

Development Environment

GNU GCC recommended

Microsemi'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 and 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 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 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 bc635PCI-V2 card. The commands cover basic operational functions, event management, oscillator controls, and mode related functions.

The following list is an overview of the Solaris SDK's ioctl functions.

- 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 and 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 1990s. To preserve the customer's time and money investments in integrating bc635PCI cards into their systems, Microsemi 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
- 3.3 V and 5.0 V universal signaling backward compatibility retained

bc635PCI-V2
- 2008
- Electronics updated backward compatibility retained

bc635PCI-V2
- 2010
- Electronics updated backward compatibility retained

bc635PCI-V2
PCI Time and Frequency Processor

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.
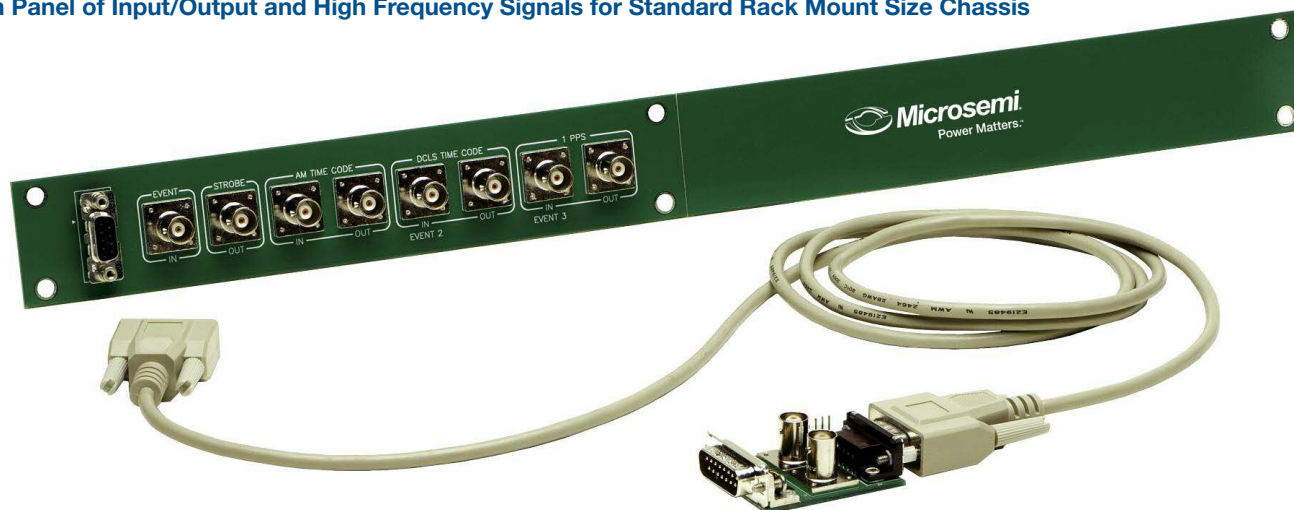
For more integrated rack mount systems that require easy access to timing signals, the 1U patch panel and high frequency signal breakout exposes all available signals. The panel provides an organized and professional appearance to the external timing I/O of the PCI card functions. The 1U panel fits with 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.

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
Outputs				
Time code (AM)	•	•	•	•
Time code (DCLS)			•	•
1, 5, 10MPPS				•
Periodic/DDS				•
Strobe				•
1PPS	•	•	•	•
Oscillator control voltage				•
Inputs				
Time code (AM)	•	•	•	•
Time code (DCLS); event2				•
External event1	•	•	•	•
External 1PPS; event3		•	•	•
External 10 MHz				•

Input/Output Signals D to BNC Connector Breakout Cables

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

bc635PCI-V2
PCI Time and Frequency Processor

Specifications

Electrical

- 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   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 V_{pp} to 8 V_{pp}
  - AM input impedance   >5 kΩ
  - DCLS input   5 V HCMOS >2 V high, <0.8 V low, 270 Ω
- 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 V_{pp} ±0.5 V_{pp} into 50 Ω
  - DCLS amplitude   5 V HCMOS, >2 V high, <0.8 V low into 50 Ω
- Timing functions (outputs are rising edge on time)
  - 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   1 µs through days
  - Output amplitude   5 V HCMOS, >2 V high, <0.8 V low into 50 Ω, 1 µs pulse
  - 1PPS output   5 V HCMOS, >2 V high, <0.8 V low into 50 Ω, 60 µs pulse

- 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, 0.5 V_{pp} to 8 V_{pp}, >10 kΩ
- 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 10 MHz 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
- PCI 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, OCXO: 5 V at 350 mA, 1.1 A at start-up
- Connector
  - Firmware update port   6 pin, PS2 mini-DIN J2
  - Timing I/O   15-pin 'DS' J1
- The bc635PCI-V2 includes the Microsemi bc635pcidemo.exe application program for Windows 2000/XP. Using this program

Environmental
- Temperature
  - Operating   0 ℃ to 70 ℃
  - Storage   –30 ℃ to 85 ℃
- Humidity
  - Operating   5% to 95% non-condensing
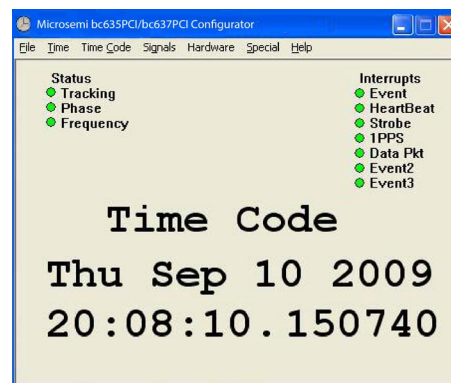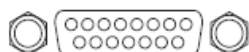 - Operating altitude   Up to 18,000 m MSL

- Certifications
    - FCC — Part 15, Subpart B.
    - CE — 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.microsemi.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

Software

you can review the bc635PCI-V2 card status and adjust board configuration and output parameters. An additional clock utility program, TrayTime, is provided that can be used to update the host computer's clock.

Product Includes

bc635PCI-V2 time and frequency processor board, standard height and low-profile cover plates, one year warranty, PCI user guide CD, Windows, Linux, and Solaris SDK/driver software CD.

Ordering Information

bc635PCI-V2 PCI time and frequency processor

Connector accessories that can be ordered.

- D connector to x5-BNCs adapter (provides TC in, TC out, 1PPS out, event in, periodic out) BC11576-1000
- D connector to x5-BNCs adapter with 1PPS in (provides TC in, TC out, 1PPS in, 1PPS out, event in) BC11576-9860115
- D connector to x6-BNCs adapter (provides TC in, TC out, 1PPS in, 1PPS out, event in, DCLS out) PCI-BNC-CCS

For GPS synchronization, see bc637PCIe PCI Express Time and Frequency Processor data sheet

Contact Microsemi for pricing and availability.

Microsemi Corporation (Nasdaq: MSCC) offers a comprehensive portfolio of semiconductor and system solutions for aerospace & defense, communications, data center and industrial markets. Products include high-performance and radiation-hardened analog mixed-signal integrated circuits, FPGAs, SoCs and ASICs; power management products; timing and synchronization devices and precise time solutions, setting the world's standard for time; voice processing devices; RF solutions; discrete components; enterprise storage and communication solutions, security technologies and scalable anti-tamper products; Ethernet solutions; Power-over-Ethernet ICs and midspans; as well as custom design capabilities and services. Microsemi is headquartered in Aliso Viejo, California and has approximately 4,800 employees globally. Learn more at www.microsemi.com.