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PCM Encoders and Signal Conditioning Products

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PCU-800 Series I Programmable Conditioning Unit

The PCU-800 Series I products provide the acquisition, encoding, and transmission of data in commercial, industrial, and military environments. The equipment housing is populated with plug-in cards which are selected and configured to meet exact requirements of a particular test, yet have the flexibility to be adapted to other test scenarios through field reprogramming or reconfiguration. The system is fully programmable via windows-based ADASWARE software which is provided with the unit. Typical hardware applications include:

- **Real-time data acquisition for analysis,**
- **Remote data logging,**
- **Remote telemetry,**
- **Flight Test Instrumentation**
- **Aircraft and Missile Development**
- **Aerospace and Commercial Launch Systems**
- **Avionics and other Operational Applications**
- **Communications Systems**

Key Features

- **Integrated PCM Encoder & Signal Conditioner**
- **Operation to 5.0 Mbps (10.0 Mbps optional)**
- **12-bit resolution ADC w/ programmable gain/offset**
- **Plug-in, High Performance Signal Conditioning Cards**
- **Analog and Digital types available with full interchangeability**
- **+/-0.5% Standard Accuracy over Temperature Range**
- **2-, 4-, 8-, and 16-slot Chassis Versions Available**
- **EEPROM Programmable format & channel parameters via RS-232/422**
- **Format Size up 32,000 Words per Major Frame**
- **Configuration as a Master, Remote, or Stand-Alone Unit**
- **Distributed System Capability with expansion up to 40 units**
- **Compatible with many other Aydin Vector products**
- **Small Size: 5.250" x 5.375" x 11.375" (PCU-816)**
- **Light Weight: 11 pounds (PCU-816)**
- **Uses low cost "D" and "DD" connectors**

- **Military parts levels and screening available**
- **Aircraft and Missile Applications**

Applications

- **Flight Test & Aerospace**
- **Launch Vehicle Instrumentation**
- **Telemetry Recording & Transmission**
- **Laboratory and Industrial Monitoring**
- **Airliner Certification**

Channel Capacity

The PCU-800 Series I is available in four standard chassis sizes:

- **PCU-816 with 16 slots**
- **PCU-808 with 8 slots**
- **PCU-804 with 4 slots**
- **PCU-802 with 2 slots**

Most applications utilize the PCU-816, however if space is limited, the PCU-808, PCU-804, or PCU-802 can be used. The channel capacity for a given configuration depends on the quantity and type of plug-in signal conditioning cards because each card has a unique number of input channels. For example, a PCU-816 with 16 AMC-132 cards has a channel capacity of 512 channels.

Distributed Systems

The PCU-800 Series I is normally configured to operate as a stand-alone unit, i.e. all input and output connections are made to a single PCU-800 chassis. However, certain applications call for more than one PCU-800 chassis which are interwired as a "distributed system." Reasons to consider using a distributed system include:

- **Reduce system interwiring (reduce cost & increase performance)**
- **Extend channel capacity beyond that of a single PCU-800**
- **Instrumentation for Multi-stage vehicles**
- **Implement a Redundant system for higher reliability**
- **Intermix PCU-800 with other Aydin Vector hardware types**

The PCU-800 Series I hardware can operate as a master, stand-alone, or slave unit depending on the connector wiring as defined during installation. All circuitry is built-in to operate in any of these modes which provides the user with full flexibility and minimizes the number of spare units required to support operations.

A single PCU-800 "master" unit can control up to 7 external "remote" units (or up to 39 remote units when the optional TTE-100 Expansion card is used).

Master/Remote Communication

The PCU-800 Series I can be configured as a "master/remote" system in which a single chassis (called the "master unit") exercises control over a number of remotely located chassis (called "remote units"). The interconnection between the master/remote units is made via a 10-wire command/response bus (called the 10 Wire Interface, or 10 WIF). The master unit has full control over all system sampling activity, however, each remote unit contains the signal conditioning cards required for the sensors and measurements in each remote region.

Programming

The PCU-800 Series I is programmed from and IBM PC compatible computer through either RS-232 (single-ended) or RS-422 (differential) serial data communication. If a notebook computer is used as the programming device near the aircraft, RS-232 is recommended. If long lines are used between the computer and the aircraft, RS-422 is recommended. Aydin Vector's PCA-800 Programmable Checkout Assembly is also available to support programming.

The PCU-800 contains non-volatile EEPROM memory which can be programmed and erased many times. Channel gain, offset, and sample rate are controlled by using the ADASWARE software provided with the hardware.

If distributed system architecture is used, system programming is achieved through a single programming port located on the PCU-800 master unit. The entire distributed system can be programmed from this central point, thereby simplifying system pretest operations.

Data Outputs

The PCU-800 Series I provides a serial data stream output which conforms to the requirements of IRIG-106 standards, and as described in PCM tutorial. This data stream contains the results of all channel sampling throughout the system. The output stream follows the principles of time-division multiplexing as described in the tutorial.

The PCM output code can be selected by the user to achieve the following coding formats:

- **NRZ-L**
- **NRZ-M**
- **NRZ-S**
- **RNRZ-L**
- **Bi Phase-L**
- **Bi Phase-M**
- **Bi Phase-S**

A premodulation filter is provided with the hardware for those applications in which the data is recorded or telemetered. The user can adjust the filter's cutoff frequency, amplitude and offset by way of standard resistor installation. The PCM output code for the premodulation filter output is either NRZ-L, or can be set to match the PCM output code described above.

The following diagnostic outputs are provided through differential line drivers:

- **Major Frame Clock**
- **Minor Frame Clock**
- **Word Clock**
- **Bit Clock**
- **Two Times Bit Clock**
- **PCM (coded)**
- **NRZ-L (fixed code)**

Time Code

The PCU-800 Series I can be configured with a TTE-100 Time Code Reader/Generator card. this card accepts a serial IRIG A, B, or G input signal, synchronizes to the signal with a resolution of one micro-second, and generates IRIG time. The time information can be inserted into the output PCM data streams or extracted for time tagging of avionics data (such as ARINC or MIL-STD-1553). If the external time code source is removed, the TTE card will continue to generate time from its internal time base (flywheel). If the external time code input remains connected, the TTE card will continue to operate synchronously with the source. An external 5V battery (not included) can be connected to the card to prevent loss of time in the event of a power failure.

Individual time words (BCD) can be extracted under program control using the ADASWARE software provided with the system. The user can select any or all of the time information for placement in the PCM output format. The following time words are available:

- **microseconds,**
- **milliseconds,**
- **seconds,**
- **minutes,**
- **hours, and**
- **days.**

The TTE-100 outputs an IRIG time code signal (D.C. only) for use by other subsystems. Three event latches are also provided for storing and reporting the time of a discrete event input. The time of the events can be latched on either a positive or negative level.

Analog Signal Inputs

All analog inputs to the PCU-800 will generally come from one of two sources:

1. **subsystem preconditioned inputs, or**
2. **sensor and transducer inputs.**

Preconditioned Inputs

Subsystem preconditioned inputs are generally acquired by the PCU-800 with an analog multiplexer card such as the AMC-132 or AMC-216. Since the preconditioning is provided by the user's circuitry external to the PCU-800, the interface is easily achieved through a simple analog switch (analog multiplexer). The PCU-800 can apply a limited amount of gain/offset to these input signals under software control.

Sensor and Transducer Inputs

Sensor and transducer inputs to the PCU-800 will require an appropriate signal conditioner card which has been selected to match that specific type of sensor or transducer. Aydin Vector has a complete family of signal conditioning cards which are available to accommodate most types of sensors and transducer commonly in use today. In general, these analog signal conditioning cards provide the following capabilities:

- **excitation,**
- **configurable front-end signal conditioning,**
- **programmable amplification,**
- **selectable or programmable low-pass presample filtering**
- **single-pole noise filtering (optional), and**
- **output buffering.**

The PCU-800 Series I Analog Selection Guide is provided to help the user select the appropriate configuration of plug-in signal conditioning cards.

System Calibration

The PCU-800 Series I supports two levels of calibration (Cal 1 and Cal 2). Cal 1 is typically zero calibration and Cal 2 is typically voltage substitution or bridge shunt calibration depending on the signal conditioning card features.

Analog Overhead Circuitry

The PCU-800 Series I contains programmable offset circuitry, a secondary programmable gain amplifier, and A/D converter which operate on the acquired analog data samples from the signal conditioning cards installed in the chassis. The programmable offset circuit allows software control of 4096 offsets. The secondary programmable amplifier offers software control of 4 gains (in addition to the programmable gain provided on the signal conditioning cards). Signal conditioning cards such as the SCC-108 Bridge Conditioner provide 8 gains resulting in a total of 32 user-programmable gains.

The A/D converter used in the PCU-800 Series I has a resolution of 12 bits with a maximum sampling rate of 416K samples per second. This allows the A/D converter to operate at the full data rate of the system.

Digital Signal Inputs

The PCU-800 has a wide variety of digital signal conditioning cards. These cards typical provide the interface for the following types of inputs:

- **discrete (bi-level) data,**
- **serial digital data,**
- **parallel digital data,**
- **serial RS232 data (UART interface),**
- **avionics data (MIL-STD-1553, ARINC-429, etc.)**
- **LVDT/RVDT,**
- **many more.**

The PCU-800 Series I Digital Selection Guide is provided to help the user select the appropriate configuration of plug-in signal conditioning cards.

Mechanical Construction

The PCU-800 is a ruggedized assembly utilizing metal-plate construction and plug-in printed wiring boards. This configuration allows quick and efficient change-over and reconfiguration in the field. The power supply is separately partitioned from the overhead and I/O cards providing effective EMI shielding. Internal boards are fully supported on each side by mechanical grooves in the side walls, and at each end through interface connectors. Cards have captive end plates which fasten the card to the side walls with captive hardware. An internal motherboard assembly provides interconnection between the overhead electronics and each plug-in I/O card as well as providing additional mechanical support. The user interface connector is attached to the plug-in I/O card resulting in a very efficient utilization of available space.

The components on printed wiring boards consist of discrete electrical components and hybrid microcircuits manufactured by Aydin Vector. All interfacial drivers and receivers are implemented in their "discrete" form to enable field replacement in the event of component failure.

The case, cover and internal partitions are fabricated from high strength aluminum alloy, type 6061, T651. Printed wiring boards are coated to resist moisture and eliminate fatigue and stress related problems during exposure to environmental extremes.

The entire package is finished using chemical film per MIL-C-5541, Class 3 for protection against corrosion and allowing low electrical resistance thru mounting surfaces. Baseplate mounting is secured with four (4) No. 10 bolts. The use of supplemental "Class R" bonding straps is recommended. All units of the same part number are physically and functionally interchangeable without selection or fit. Nameplates and product markings are in accordance with MIL-STD-130.

Specifications for the PCU-800 Series I

Parameter	Specification
Chassis Sizes	PCU-816 (16 Slot), PCU-808 (8 Slot), PCU-804 (4-slot), and PCU-802 (2-slot) versions available.
Configuration	The PCU-800 Series I operates as a standalone, master unit, or remote unit; field selectable by the user.
Output data:	Primary PCM output in RS-422 levels. Seven (7) output codes, user selectable (NRZ-L/M/S, Bi-phase-L/M/S, and RNRZ-L.
Test Points	RS-422 2XBCLK, BCLK, WCLK, MNFCLK, and MJFCLK. RS-422 NRZL output is also provided which contains the same data as the primary PCM output.
Filtered Output	A single-ended filtered output is provided. The output coding is user-selectable at NRZL or to match the coding used on the primary PCM output. Uses a 6-pole Bessel response filter. Fco and output amplitude/offset is user selected via resistors which are mounted on a plug-in header. Data rates up to 2.0 Mbps are supported. A Filter with programmable cutoff frequencies is also available as an option.
Bit Rate	Programmable. Maximum bit rate is 5.0 Mbps (standard), and 10 Mbps (optional - digital data only).
Resolution	Programmable. 8-, 10- and 12-bits per word. All words within a frame are constant length.

Extended Resolution	Data words which require extended resolution are represented in the output format as two consecutive words (e.g. 1553, synchro, counter data, time, etc.)
Format	Stores up to four PCM format definitions, each containing 8K words, or a single 32K word format or two 16K word formats.
Amplifier	A common second-stage amplifier provides gain programmability on all analog samples prior to digitization.
Primary Gains	Most signal conditioning cards are provided with a number of programmable gains. Refer to the PCU-800 Analog Conditioning Card Selection Guide.
Secondary Gains	1, 1.4, 1.8, & 2.2, programmable.
Offset	+/-50% in 4,096 steps, programmable.
Accuracy	+/-0.5% of full scale (including gain, offset, and ADC errors)
Input Power	+28 +/-4 VDC. PCU-816 Series I chassis supports up to 100 watts. Refer to card selection guide for power dissipation of individual cards.
Temperature	-20C to +80C (standard); -35C to +85C (optional); oper & storage
Altitude	0 to +50,000 feet.
Vibration	10g random, 50 to 2,000 Hz.
Shock	100g, 11mS, 1/2-Sine.
EMI	MIL-STD-461/462
Connectors	Overhead and Signal Conditioners - "D" and "DD".
Weight	PCU-816: 11 pounds; PCU-808: 7 pounds; PCU-804: 5 pounds; PCU-802: 4.3 pounds.
Dimensions	PCU-816: 5.250" x 5.375" x 11.375"; PCU-808: 5.250" x 5.375" x 6.975"; PCU-804: 5.250" x 4.775" x 5.375"; PCU-802: 5.250" x 2.90" x 5.375".

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PCU-800 Series II Programmable Conditioning Unit

The PCU-800 Series II combines precision analog and digital signal conditioning and acquisition circuitry along with a 12-bit, high performance PCM Encoder. Data acquired by the system is conditioned, digitized, and encoded in accordance with IRIG-106 telemetry standards. Multiple, simultaneous outputs are provided to support RF telemetry, recording, or diagnostic requirements. The user has full software control of all system features including channel gain, offset, and sample rate. Some additional features are controlled via connector strapping and/or plug-in jumpers on the system's internal control panel. Aydin Vector's ADASWARE software is included with the hardware allowing a non-technical operator to control the system's operation. The software is hosted on the user's PC-based computer using the DOS environment.

The PCU-800 Series II is derived from the PCU-800 Series I products. Enhancements include circular military interface connectors, greater field maintainability, and simplified access to user-selectable features. Applications include: aerospace vehicles, launch vehicles, and flight test vehicles where the convenience and added reliability of circular connectors is important.

Key Features

- **High Performance, Integrated Signal Conditioner and PCM Encoder**
- **16 card slots (8-slot option available)**
- **Configuration Flexibility**
- **EEPROM Programmable via RS232/422; ADASWARE software**
- **Format Size up to 32K words/frame**
- **+/-0.5% Standard Accuracy over Temp**
- **Stand alone or Master/Slave Operation**
- **12-bit ADC w/ Gain & Offset**
- **Bit Rate: 5 Mbps (10 Mbps option)**
- **User selectable features via plug-in headers (card removal not necessary)**
- **Full Military Parts/Screening available**
- **Wide temp range: -35C to +80C**
- **Ruggedized Package**

- **Circular MIL connectors on overhead (std) & "D"/"DD" on signal conditioners**
- **Fully Serviceable and Maintainable**
- **Dimensions (PCU-816 Series II): 5.25" W x 5.535" H x 14.545" L**
- **Weight (PCU-816 Series II): 15 lbs**

Applications

- **Flight Test & Aerospace**
- **Launch Vehicle Instrumentation**
- **Telemetry Recording & Transmission**
- **Laboratory and Industrial Monitoring**
- **Airliner Certification**

Signal Conditioning Cards

There are many types of signal conditioning cards for the PCU-800 Series II (refer to the PCU-800 Analog Conditioning Cards Selection Guide). Two styles are available:

Standard "D" and "DD" connectors:

> **Signal conditioning cards are available with standard "D" and "DD" style connectors for analog and digital inputs. Coax, twinax, and triax style connectors are provided for piezo transducers, accelerometers, and bus connections.**

Circular Military connectors:

> **The PCU-800 Series II signal conditioning cards are also available with circular military connectors. Special mechanical flanges are provided on these cards to support the larger circular connectors. When this option is selected, the signal conditioning cards are mechanically joined together in pairs in combinations specified by the user at the time of order. For example, a joined pair of SCC-108 cards results in a 16-channel signal conditioning module. Each PCU-816 Series II chassis accepts up to eight (8) pairs of signal conditioners (16 cards per chassis).**

System Design

The PCU-800 Series II uses modular architecture to handle a wide range of requirements. Systems with several hundred channels can be configured within a single PCU-800 Series II chassis. The chassis accepts up to 16 plug-in signal conditioning cards. Cards are available for many types of sensors.

If the number of channels required in an application exceeds the capacity of a single chassis, multiple chassis can be configured together as a "system." One PCU-816 Series II chassis is designated the system "master controller" and the remaining chassis are designated as "remote units." Using this method, systems are configured to handle in excess of 5,000 channels. The master and remote units can be separated from each other by distances up to 150 cable feet. This "distributed system approach" is achieved with no compromise in system performance, and indeed can result in performance improvements (refer to next section).

Distributed System Advantages

The "Distributed System" is the best system configuration to use when there are a large number of channels spread throughout the physical regions of the vehicle. This is most often the case in launch vehicles, multi-stage vehicles, or large aircraft. The Distributed System approach places one or more PCU-800 Series II remote units in each vehicle region, and a single PCU-800 Series II master unit in a centrally located area. The sensors and transducers in each region are conditioned locally and the digitized results are sent to the master unit over a high speed digital communication bus. The benefits of this approach are obvious:

Sensor-to-Conditioner Distance

> **Reduce distance between transducer and conditioner resulting in better performance and reduced wiring costs. Shorter sensor-to-conditioner cabling reduces the amount of noise pickup and minimizes signal degradation.**

Production Wiring

> **Allow penetration of production bulkheads (commercial vehicles), inter-stage segments (launch vehicles), captive carry payloads, or other physical barriers such as firewalls which will not normally support penetration of a large number of wires. The communication buses used by the PCU-800 Series II master/remote are 10 wires (standard) or 4 wires (optional) depending on the application.**

System Configuration Flexibility

> **Allow placement of special "ruggedized" remote units other than the PCU-800 Series II in extremely harsh environmental areas of the vehicle such as engines, landing gear, rotor blades, etc. The PCU-800-II can operate in conjunction with other Aydin Vector products (RPM/E, RTM/E, MMSC-800, etc.) allowing direct measurement in critical areas. The communication buses used can operate through slip rings in rotor vehicles.**

Simplify Wiring

Simplify wiring in large vehicles since the communication bus is designed to operate at distances up to 150 feet.

Specifications for the PCU-800 Series 2

Parameter	Specification
Chassis Sizes	PCU-816 (16 Slot) and PCU-808 (8 Slot) versions available.
Configuration	The PCU-800 Series II operates as a standalone, master unit, or remote unit; field selectable by the user.
Output data:	Primary PCM output in RS-422 levels. Seven (7) output codes, user selectable (NRZ-L/M/S, Bi-phase-L/M/S, and RNRZ-L.
Test Points	RS-422 2XBCLK, BCLK, WCLK, MNFCLK, and MJFCLK. RS-422 NRZL output is also provided which contains the same data as the primary PCM output.
Filtered Output	A single-ended filtered output is provided. The output coding is user-selectable at NRZL or to match the coding used on the primary PCM output. Uses a 6-pole Bessel response filter. Fco and output amplitude/offset is user selected via resistors which are mounted on a plug-in header. Data rates up to 2.0 Mbps are supported. A Filter with programmable cutoff frequencies is also available as an option.
Bit Rate	Programmable. Maximum bit rate is 5.0 Mbps (standard), and 10 Mbps (optional - digital data only).
Resolution	Programmable. 8-, 10- and 12-bits per word. All words within a frame are constant length.
Extended Resolution	Data words which require extended resolution are represented in the output format as two consecutive words (e.g. 1553, synchro, counter data, time, etc.)
Format	Stores up to four PCM format definitions, each containing 8K words, or a single 32K word format or two 16K word formats.
Amplifier	A common second-stage amplifier provides gain programmability on all analog samples prior to digitization.
Primary Gains	Most signal conditioning cards are provided with a number of programmable gains. Refer to the PCU-800 Analog Conditioning Card Selection Guide.
Secondary Gains	1, 1.4, 1.8, & 2.2, programmable.
Offset	+/-50% in 4,096 steps, programmable.
Accuracy	+/-0.5% of full scale (including gain, offset, and ADC errors)
Input Power	+28 +/-4 VDC. PCU-816 Series II chassis supports up to 100 watts. Refer to card selection guide for power dissipation of individual cards.
Temperature	-35C to +80C, oper. & storage.
Altitude	0 +50,000 feet.
Vibration	MIL-STD-810D, Method 514.3, Cat 10, Breakpoints of 0.04 G2/Hz, 10 Min/Axis.
Shock	MIL-STD-810D, Method 516.2, Proc 1, 15g, 11mS, 1/2-Sine.
EMI	MIL-STD-461/462, CE03/RE03/RS03.
Connectors	Overhead - MIL-C-38999, Series I; Signal Conditioners - "D" and "DD" (std); MIL-C-38999, Series I (option)
Weight	15 pounds.

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PMU-700 Series III Programmable Master Unit

The PMU-700 Series III Master Controller is Aydin Telemetry's "third generation" master controller unit. Earlier generations of this product have been successfully used throughout the world on dozens of flight test programs. All versions of the PMU-700 share a common mechanical design approach allowing the product's rich performance heritage to be shared by all users. Most users have used " qualification by similarity" or "delta qualification" rationale for use of the PMU-700 on their programs. The PMU-700 Series III Programmable Master Unit provides single-point system-wide control of programming, setup, calibration, data acquisition, and output formatting. Commands are sent to remote units distributed throughout the test vehicle. The data acquired from transducers, sensors, data buses, avionics, and many other sources are formatted into various types of outputs compatible with RF telemetry, recording, real-time monitoring, analog (strip chart) recording, etc.

The system is capable of operation at overall data rates up to 24 MBPS (2 MBPS for each 10 Wire I/F communication port). The PMU-700 Series III can be configured with up to twelve interface ports, each of which can handle up to 8 remote units of various kinds. The maximum configuration results in a total of 96 remote units per system with a capacity of well over 5,000 channels.