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This document provides a technical overview of the Pronto4 Series 4 (P4S4) hardware components.

P4S4 Configuration

The Pronto4 Series 4 (P4S4) was designed with a services-based architecture. A single backbone runs the length of the P4S4 and distributes power, various communication busses, and discrete signaling. A range of modules plug into the backbone adding standardized and custom capabilities. All modules can be rapidly removed from the P4S4 as a pluggable unit.

There are two backbone options. Both option must have Computing and Service modules, and most often have three (3) servo modules. The Mini supports a total of four (4) utility modules. With a standard configuration, this includes servo modules and one video or other auxiliary services module. The Planar supports a total of eight (8) modules. This typically includes the same modules as the Mini, plus additional servo, video, and other auxiliary services modules.

Computing Module

The Computing Module contains an ETX computing platform. It also contains a 7 port and 4 port USB hub, a 5 port Ethernet Switch, video management, wheel odometry, and user interface (VGA, PS/2 Key/Mouse, etc.).

In addition to the other benefits of its modularity, the Computing Module serves as a rapid removal method to declassify an optionally unmanned ground vehicle.

All software and operation data is removed when this module is removed.

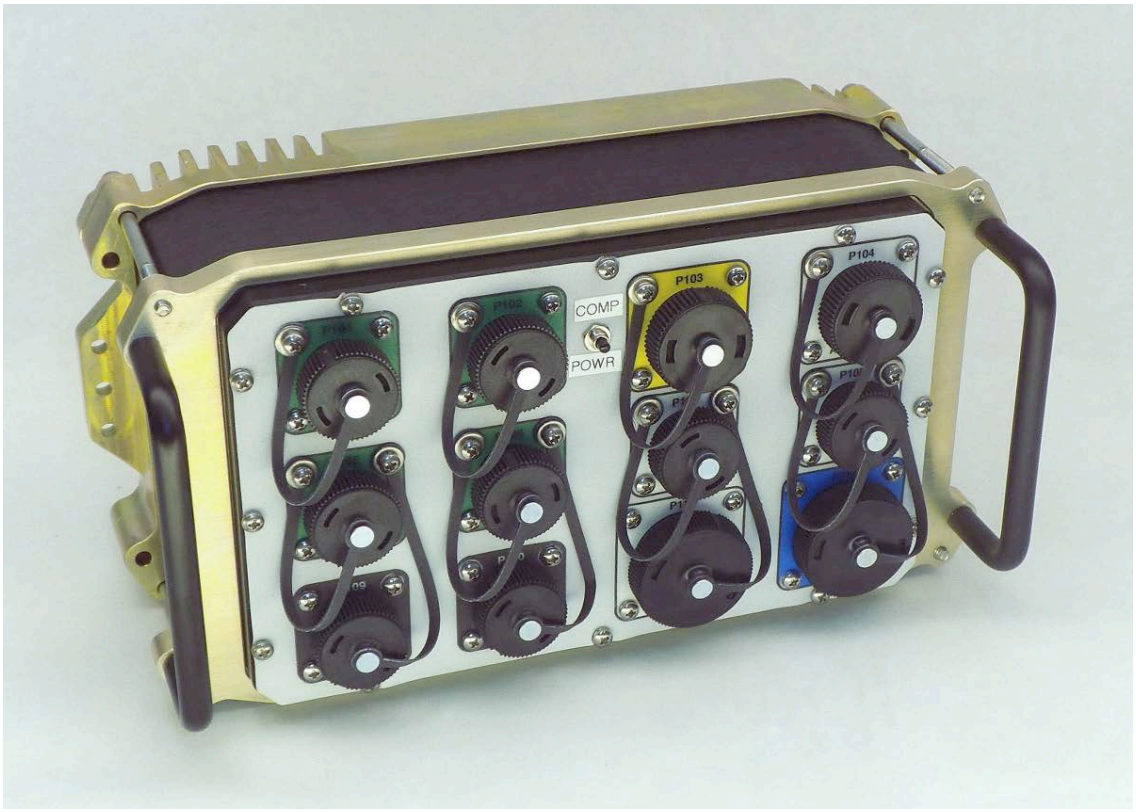


Figure A-1: Standard Computing Module

Services Module

The Services Module contains the local controller with a FORTH based digital signal processor (DSP). It is similar in nature to the P4S3 but can be modularly changed. The connection compliment is initially similar to the P4S3 as well. Local motor control, some safety logic, and other mainframe common services are performed in this module.



Figure A-2: Services Module

Utility Modules

Utility Modules plug into the P4S4 mainframe in either the Mini or Planar configurations. They communicate with the Services Module through one of several serial device busses (SPI, I2C, and PWM). They communicate with the Computer Module through ethernet and USB. Protected power is provided to the module.

These modules use 48 pin EuroCard connectors to interface to the spine of the P4S4.

In the future, the electrical interfaces will be replaced with an optical bus. The only connection to the module **not** using the optical bus will be power. At that point it would be possible for the bus to be electrically isolated from the P4S4 mainframe.

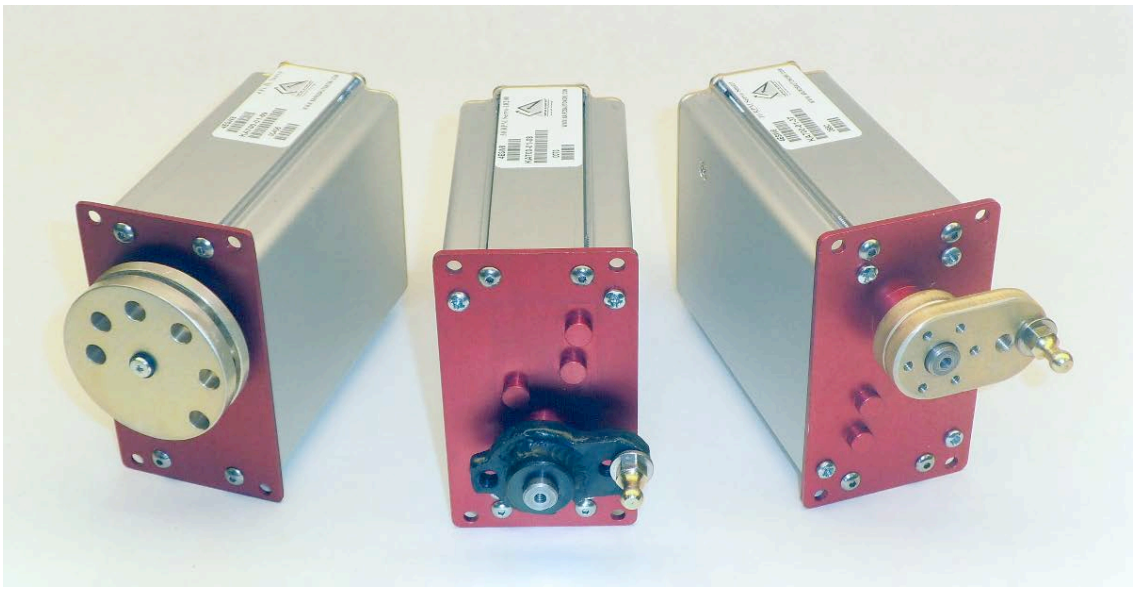


Figure A-3: Standard Servo Utility Modules

A few of the Utility Modules are:

- 10, 15, 30, 45, and 200 RPM Motor Actuator Module – Pronto4 system actuators contained in utility modules that have the ability to integrate with a standard Pronto4 system. These actuators primarily enable the actuation of brake & transmission controls.
- Relay Out Transmission Module (Electric) – Replaces a standard transmission module motor to enable electric relay and control of the vehicle's transmission.
- Standard PWM RC Servo module – Pronto4 system actuators contained in utility modules that have the ability to integrate with a standard Pronto4 system. These actuators primarily enable the actuation of throttle controls.
- Direct wheel drive motor (primarily for portable unmanned ground vehicles) –

- External Motor Control Module – Provides the ability to drive an external motor or drive, such as a pilot valve.
- Video Encoder modules – Allow for one of up to six video channels to be viewed at a time. Multiple video streams are available for video switching via the standard Pronto4 system video multiplexer. The video server outputs H.264 and MJPG and connects to the Pronto4 system via Ethernet through the Pronto4 backplane. Power is provided to the video encoder from the Pronto4 system.
- Video Overlay module – Provides a single channel video server delivering H.264 or MJPG video over the radio data link, as well as an overlay of vehicle positioning data on the video image.
- External I/O Module – Provides four (4) analog inputs, four (4) digital I/O points and two (2) analog outputs for real-world interfacing with external sensors or other devices on the Pronto4 system. The module also includes software for interfacing to the ProntoMimic software suite.
- CANbus Interface – Enables the Pronto4 to send and receive J1939 CANbus messages for enhanced vehicle control
- OBD-II / CAN Interface – Enables connection to and feedback from a vehicle's ODB-II or CAN port, and transfers data to and from the Pronto4 system. This module enables desired information (such as speed, revolutions per minute, fuel level, engine temperature, trouble codes, etc.) from the vehicle to be available via the Pronto4 system.
- Communications modules (including Ethernet Switch, USB, Serial) – Connects various network components of the Pronto4 system into a common Local Area Network (LAN).
- Power over Ethernet (PoE) Injector – Converts the 12 VDC from a power supply into a regulated power supply up to 24 VDC via an RJ45-based Cat 5 cable.
- Multi-function Module (Video, PoE, OBD-II) — Provides a single channel video server providing H.264 video over the radio data link; a Power over Ethernet connection for a radio data link; and an OBD-II port for integrating with the vehicle to obtain additional vehicle diagnostics or information.
- Custom user modules – Because of the modular nature of the Pronto4 system, additional utility modules and external modules can be designed and produced for custom user needs.

External Modules

External Modules are modules that are external to the Pronto4 frame and which provide services that cannot be provided exclusively through a utility module. They can connect through ports on the Computer Module, Services Module, utility modules, or directly to other components. A few of the Utility Modules are:

- Vehicle Integration Module – Tethered to the vehicle and Services Module. Used to:
  - switch the power to the Pronto4 system on and off
  - switch between Auto and Manual mode, when a safety rider is in the optionally unmanned vehicle
  - force brake actuator to Manual control
  - display headlight and starter settings
- OCU E-Stop – Connected to the Operator Control Unit (OCU). Enables a remote OCU operator to perform a hardwired e-stop that can be transmitted via data link connectivity.
- Stand-alone Steering Ring Control Module – Connected directly to a Kairos Steering Ring. Allows the Steering Ring to be controlled independently from a Pronto4 system. It includes serial, power, and signal connections, and includes the ServoPod software application for motor control.

Block Diagram Descriptions

P4S4 Module Pinouts (Figure A-5)

The Physical diagram shows the standard pinout for each utility bays on either a Pronto4 Mini or Planar system. The Logical diagram provides a rudimentary summary of the logical layout of each bay's connections.

The Communications Interfaces include:

- Serial Peripheral Interface Bus (SPI)
- Universal Serial Bus (USB)
- Controller Area Network (CAN)
- Inter-Integrated Circuit (I^2C)
- Ethernet

P4S4 Safety Wiring (Figure A-6)

The central diagram shows the physical pinout of all safety-related communication connections. The matching diagrams show how the pinouts are conceptually used by their corresponding components.

The External E-Stop System (radio) and External E-Stop Buttons (hardwire) perform the same functions. The External E-Stop System works through a radio relay, while the External E-Stop Buttons are connected, via hardwire, to the Pronto4 unit.

P201 is designed for connection to normally closed buttons mounted on the exterior of the vehicle. P203 is designed for connection to a remote safety system that can command an estop event and a pause event. The estop function is run in series through both P201 and P203. An open connection on any of those connections will cause a hardware estop event. An open connection on the pause circuit over the remote safety system will trigger the software to execute a pause event.

P201 and P203 must have a closed circuit for the system to operate, therefore either an E-Stop mechanism or Loopback **must** be in place on both ports.

The SonAlert and flashing strobe safety alerts are optional.

The VIM's Pause circuit is equivalent to the Radio E-Stop "Remotely Driven Pause Relay". If there is not a Radio E-Stop, then the Radio E-Stop Loopback must connect pin 3 to pin 4 and pin 5 to pin 6.

P4S4 Power Flow B (Figure A-7)

Shows power distribution within a Pronto4 unit and connected components.

Power is brought into both the Computer Module and Service Module at 12V nominal, then stepped down to and distributed to most systems as regulated 12V, 6V, & 5V. The primary exception is servo motors. Servo motors use Uninterrupted Power Supply (UPS) which is un-regulated battery voltage. UPS is available in all utility bays, but not used by most utility modules. An upcoming exception is the Ethernet Safety Module, which uses the Auxiliary Battery's unregulated 13V nominal.

P4S4 Data Flow (Figure A-8)

Signals available from either the Computer Module or Service Module to each discrete utility bay and directly between the Computer Module and Service Module.

P4S4 Actuator Configuration (Figure A-9)

Data is initially processed by the Computer Module, then passed to the Service Module for dissemination to each utility bay and components. Data is then passed from the utility bays and components, either directly or through the Service Module, back to the Computer Module. The Computer Module then sends out data, as needed.

P4S4 Control Examples (Figure A-10)

Four possible configurations:

- The "Legacy Direct PWM Control Scheme (no local feedback)" represents a typical system, with a standard configuration.
- The "Legacy Direct PWM Control Scheme (Local feedback)" represents a system that can, with correct software and hardware, modify motor rotation endpoints (e.g., the 0% position can be modified at the servo module level).
- The "Addressed Device Comms Protocol (Low level control)" represents a Pronto4 unit with a steering ring, but without servos (i.e. lacking PWM signals).
- The "Addressed Device Comms Protocol No low level control)"[sic] represents a stand-alone steering controller and a steering ring, but no Pronto4 unit.

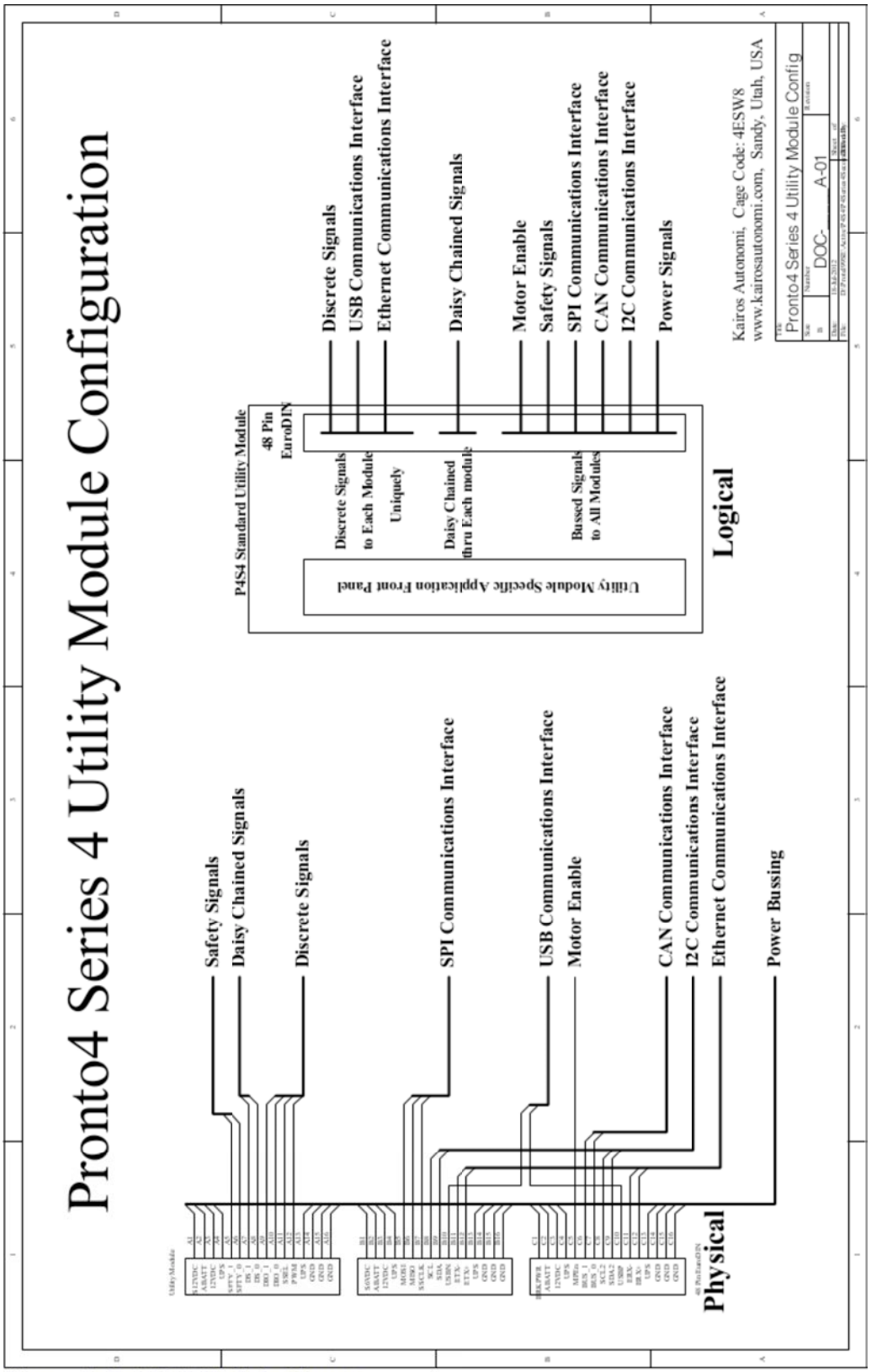


Figure A-5: P4S4 Module Pinouts

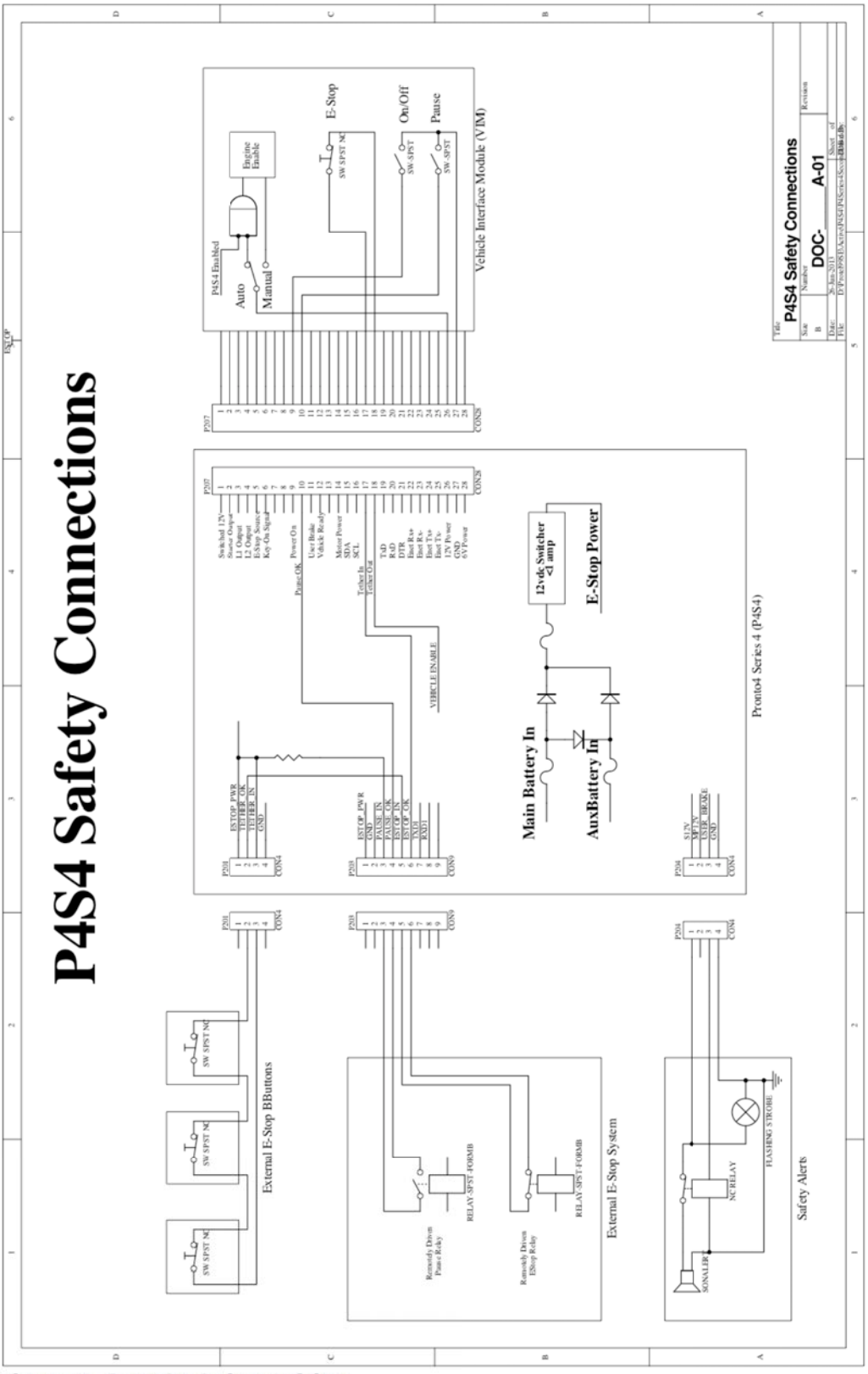


Figure A-6: P4S4 Safety Wiring

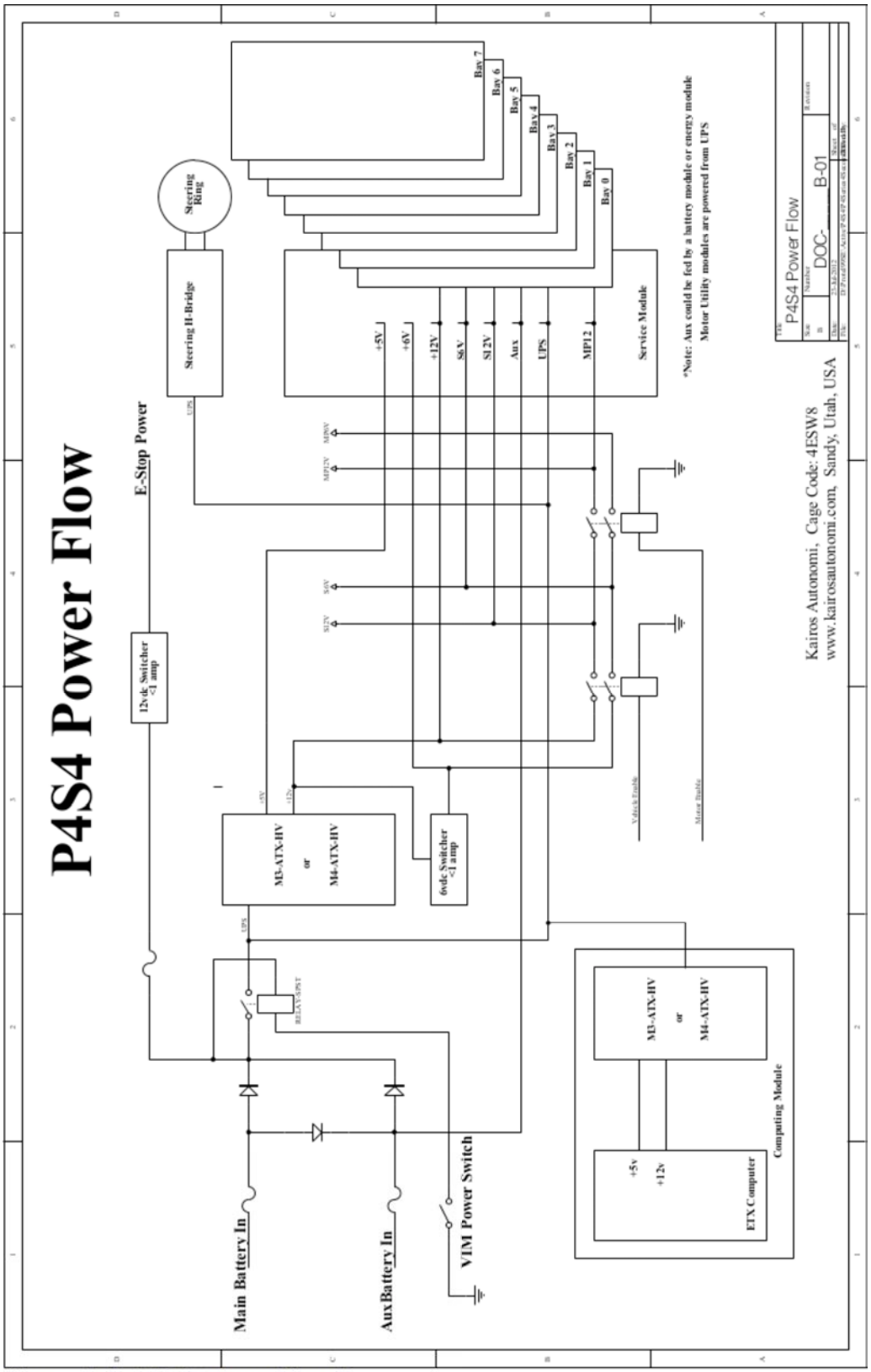


Figure A-7: P4S4 Power Flow B

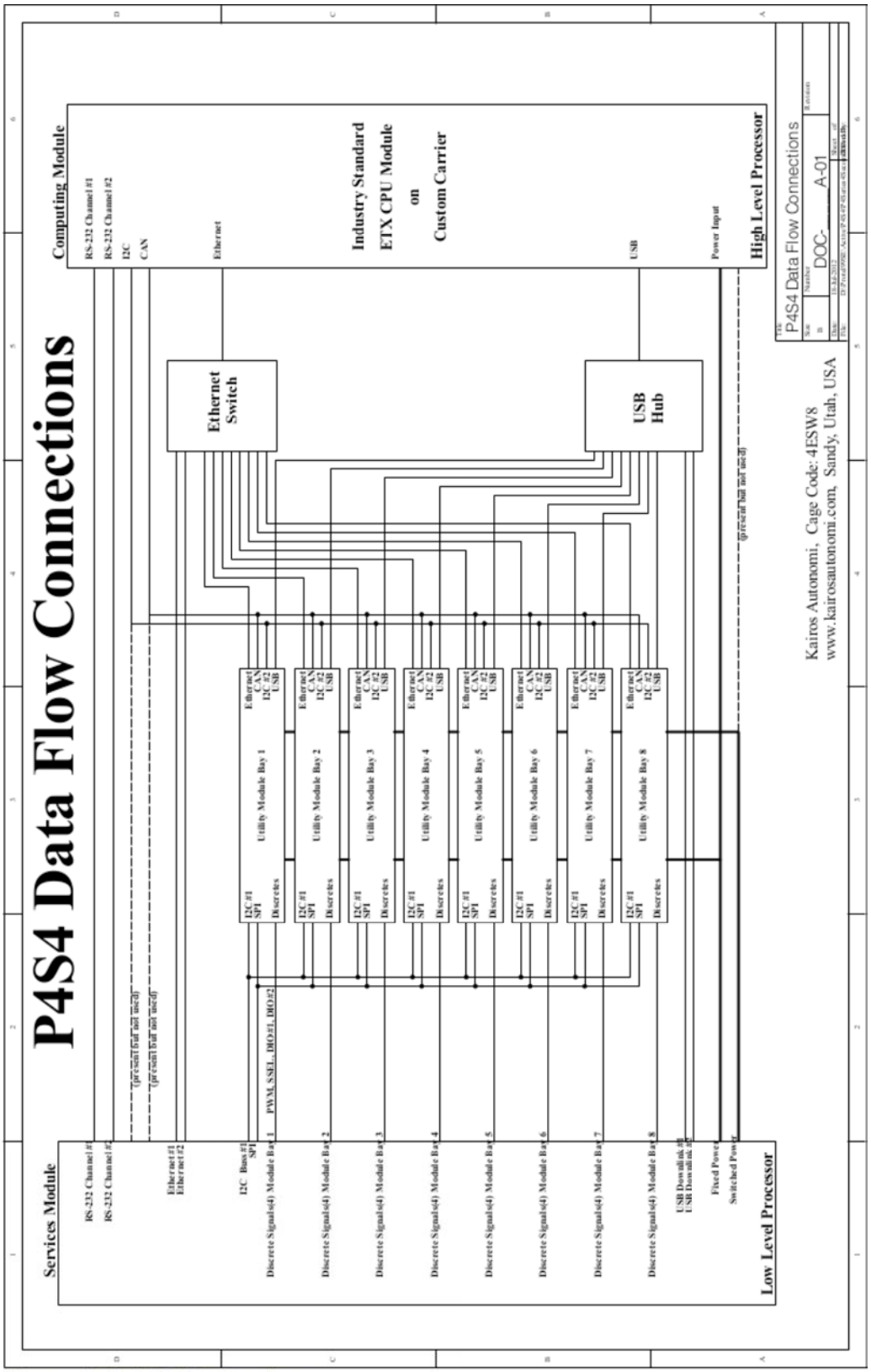


Figure A-8: P4S4 Data Flow

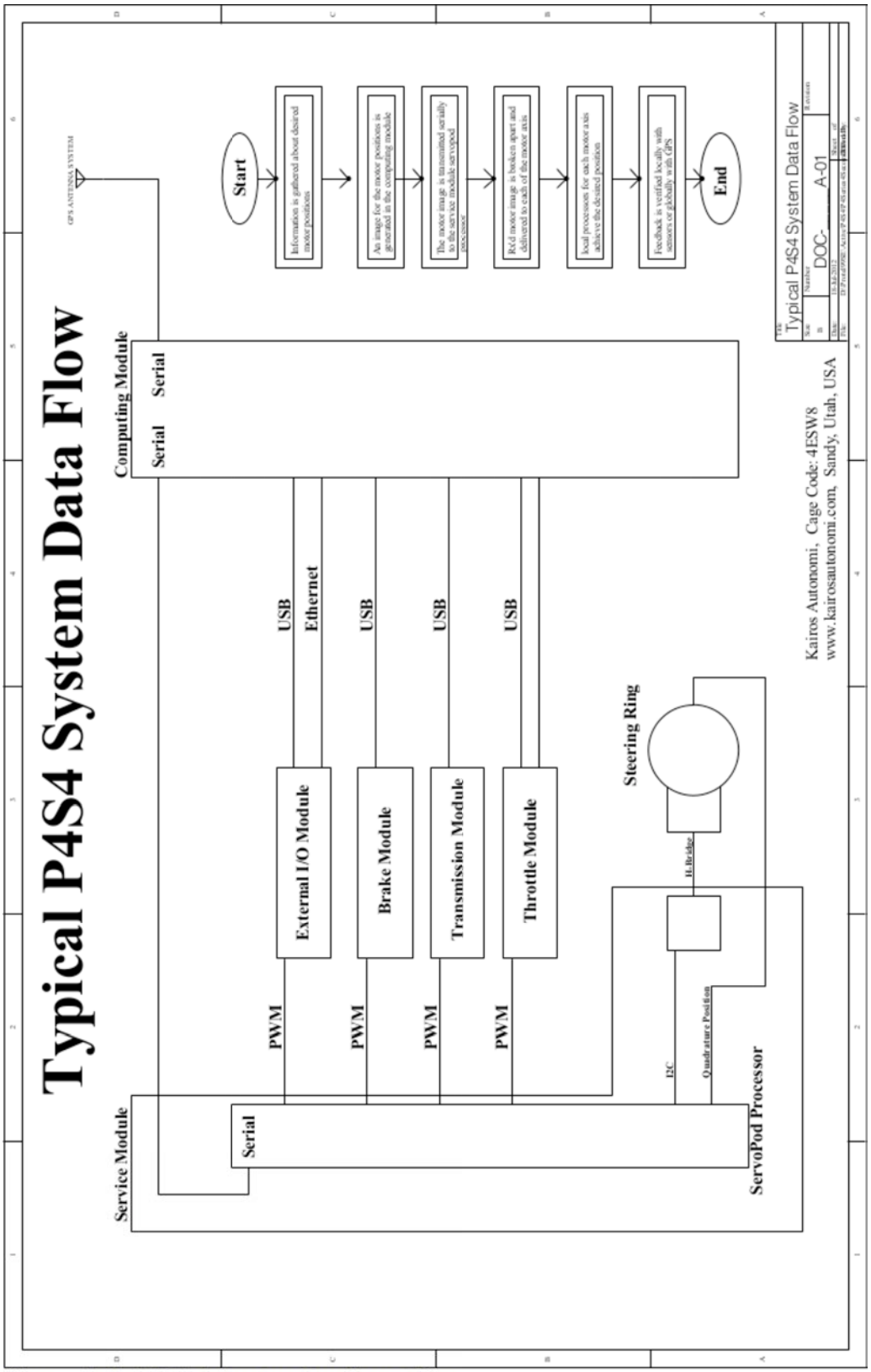


Figure A-9: P4S4 Actuator Configuration

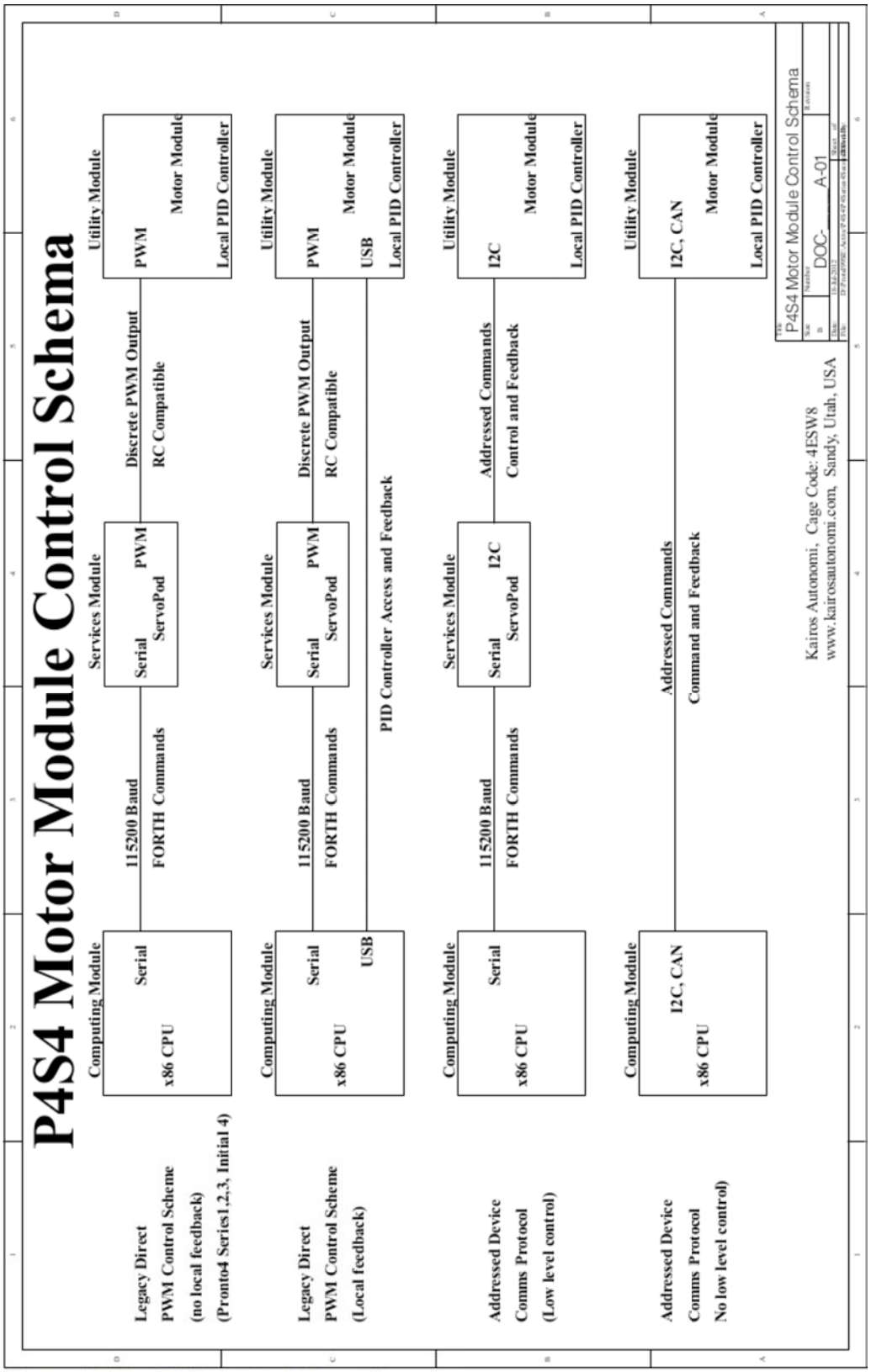


Figure A-10: P4S4 Control Examples

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