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OVERVIEW

Active-Semi’s HYDRA-X23/X23S development platform is a complete hardware solution enabling users not only to evaluate the PAC5223 device, but also develop power applications revolving around this powerful and versatile Cortex M0 based microcontroller. The module contains a PAC5223 power application microcontroller and all the necessary circuitry to properly energize the MCU and its internal peripherals once power is applied.

Throughout this document, HYDRA-X23 refers to the PAC5223 HYDRA-X board implemented around a Step Down (Buck) switching regulator topology, whereas HYDRA-X23S refers to the PAC5223 HYDRA-X board implemented around a Step Up / Step Down (Buck-Boost) switching regulator topology.

To aid in the application development The HYDRA-X23/X23S offers access to each and every one of the PAC5223 device’s signals by means of a series of female header connectors. Whereas the HYDRA-X23/X23S module is referred to as the HYDRA-X Body, subsequent daughter card modules can be interfaced through these female connectors by merging both boards together. Throughout the rest of this documentation, said attachable daughter cards will be referred to as Heads.

The HYDRA-X23/X23S Body also contains all the necessary circuitry to connect the module to a PC computer through a conventional USB port which can then be used in the communication efforts by taking advantage of the PAC5223’s UART interface. Graphical User Interface (GUI) software suites can be employed to externally control particular application’s features.

The final block within the HYDRA-X23/X23S Body is a complete Serial Wire Debug (SWD) module which allows the microcontroller to be both programmed and debugged in real time. This SWD debugger block follows the CoLinkEx architecture and is compatible with the CooCox Integrated Development Environment (IDE).

Both the USB to UART and SWD debugger can be disconnected from the PAC5223 device in case the user wishes to utilize a different means of serial communications or SWD debugging.

Active-Semi’s HYDRA-X23/23S Body kit consists of the following:

- HYDRA-X23/X23S Body module
- HYDRA-X23/X23S User’s Guide
- Schematics, BOM and Layout Drawings
Solution Benefits:

- Ideal for general purpose power applications and controllers
- Single-IC PAC5223 with 10 PWM outputs, 13 ADC inputs, I2C, UART, SPI and GPIO.
- Gate driving for up to three half H Bridge (tri phase) inverter.
- USB to UART communication blocks allows communications with a PC computer
- Integrated SWD debugger allows both programming and in real time debugging
- Footprint compatible with Arduino platform offerings
- Schematics, BOM, Layout drawings available

The following sections provide information about the hardware features of Active-Semi’s HYDRA-X23/X23S turnkey solution.
HYDRA-X23/X23S BODY RESOURCES

Header Descriptions

The following table shows the female header descriptions for the HYDRA-X23/X23S Body module.

<table>
<thead>
<tr>
<th>Header</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>J1</td>
<td>1</td>
<td>PAC5223 secondary SWD port power (5V).</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>PAC5223 secondary SWD port data input/output.</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>PAC5223 secondary SWD port clock.</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>PAC5223 secondary SWD port ground (GND).</td>
</tr>
<tr>
<td>J2</td>
<td>1-10</td>
<td>Refer to HYDRA-X23/X23S pinout diagram</td>
</tr>
<tr>
<td>J3</td>
<td>1-8</td>
<td>Refer to HYDRA-X23/X23S pinout diagram</td>
</tr>
<tr>
<td>J4</td>
<td>1-20</td>
<td>Refer to HYDRA-X23/X23S pinout diagram</td>
</tr>
<tr>
<td>J5</td>
<td>1-6</td>
<td>Refer to HYDRA-X23/X23S pinout diagram</td>
</tr>
<tr>
<td>J6</td>
<td>1-10</td>
<td>Refer to HYDRA-X23/X23S pinout diagram</td>
</tr>
<tr>
<td>J7</td>
<td>-</td>
<td>VIN Power Input barrel connector (X23 = 16V to 48V); (X23S = 8V to 32V)</td>
</tr>
<tr>
<td>J8</td>
<td>-</td>
<td>USB to UART USB connector.</td>
</tr>
<tr>
<td>J9</td>
<td>-</td>
<td>USB to SWD debugger connector.</td>
</tr>
</tbody>
</table>

HYDRA-X23/X23S Pinout and Signal Connectivity

The following diagram shows the female header pinout for the HYDRA-X23/X23S Body module, as seen from above:

![HYDRA-X23/X23S Pinout Diagram](image)

*Figure 2 HYDRA-X23/X23S Pinout*
Power Input

Power to the Hydra-X23/X23S Body module can be applied to the J7 barrel connector or to the J5 female header connector’s VIN and GND terminals. Power to the HYDRA-X23 module should not exceed 48V. Power to the HYDRA-X23S should not exceed 32V.

The barrel connector power input is protected against voltage reversal. However, the VIN input at the J5 connector is not. Heads interfacing to the HYDRA-X23/X23S should observe correct voltage polarity.

Barrel Connector J7 correct polarity is with the center pin connected to VIN and the shell connected to GND.

![Figure 3 Barrel Connector J7 Polarity](image)

The HYDRA-X23 is optimized to operate with voltages ranging from 16V to 48V. When the VIN input voltage goes above 16V, the system exits UVLO protection and all subsystems, including voltage regulators, analog front end and microcontroller, are enabled.

The HYDRA-X23S is optimized to operate with voltages ranging from 8.5V to 32V. When the VIN input voltage goes above 8.5V, the system exits UVLO protection and all subsystems, including voltage regulators, analog front end and microcontroller, are enabled.

On either module, when an operational voltage is applied, LED D2 will light up. This is the LED which notifies VSYS (5V) rail is up and running. 3.3V and 1.8V regulators will also be operating at this point in time. Module is ready for use.

**Operating the HYDRA-X23/X23S Body in No Switching Regulator Mode**

The HYDRA-X23 and HYDRA-X23S modules have been designed to operate with their switching regulator modules enabled. As such, aforementioned voltage ranges must be observed. There is a third mode which can be induced by disabling the switching regulator and removing a few components. It allows either module to operate with a voltage range from 5V to 18V. This mode is desirable on battery based applications such as those powered from a 2S, 3S or 4S battery power source.

In order to operate the module at these lower voltages, the user must follow these three steps in its entirety:

1. Apply a short between the VHM and VP terminals.
2. Remove the Inductor L1.
3. Remove the Transistor Q1.

With these changes in place, the system will generate the internal 5V, 3.3V and 1.8V voltage rails. Note that VP will equal VIN and power transistor driving will be subjected to these values. Whereas this is not much of a problem at any voltage higher than 10V, RDSon usually increase with a weaker gate drive.
LED’s

The HYDRA-X23/X23S module incorporates a small number of LEDs for diagnostic purposes. These LED functions cannot be controlled by the user application. If the user requires the usage of LEDs, these can be added to the available GPIO resources.

The following table shows the available LEDs and their associated diagnostic function.

<table>
<thead>
<tr>
<th>LED</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>USB Voltage. Lights up when an USB link is present at the J8 connection. Driven by the USB's 5V</td>
</tr>
<tr>
<td>D2</td>
<td>VSYS (5V). Light up when the PAC5223 device is successfully powered up by VIN.</td>
</tr>
<tr>
<td>D3</td>
<td>VIN. Lights up as VIN voltage is applied.</td>
</tr>
<tr>
<td>D4</td>
<td>USB to UART TX. Lights up with data transmission to the microcontroller</td>
</tr>
<tr>
<td>D5</td>
<td>USB to UART RX. Lights up with data transmission from the microcontroller.</td>
</tr>
</tbody>
</table>
SWD Debugging

The HYDRA-X23/X23 module comes equipped with a fully operational and ready to be used CoLinkEx compatible SWD debugger. User can utilize this link to download code to the PAC5223 device through the CooCox IDE or CoFlash FLASH loader application. Both of these applications, along with the CoLinkEx USB driver, can be downloaded from the www.coocox.org website.

In the event the user desired to utilize a different debugger, connector J1 offers access to the PAC5223 SWD lines. The CoLinkEx debugger must be separated. Separation can be obtained by flipping the S2 DIP switches 3 and 4 to the OFF position.

![Figure 4 S2 DIP Switch Debugger Selection](image)

The integrated SWD module is powered from the PAC5223’s 3.3V regulator.

SWD Jumper/Shunt and Push Button

<table>
<thead>
<tr>
<th>Jumper</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>JP1</td>
<td>Used to program U3 microcontroller with CoLinkEx SWD firmware. In Factory use only.</td>
</tr>
<tr>
<td>S1</td>
<td>SWD MCU Reset Push Button</td>
</tr>
</tbody>
</table>

The S1 push button resets the SWD MCU. In the event SWD communications are not operational while all voltages are present, pushing the button may restore SWD functionality.

NOTE: It is highly recommended the JP1 to never be populated with a shunt. Doing so will configure the SWD MCU to behave like an USB storage device. This mode is only meant to be employed when programming the SWD MCU with the CoLinkEx firmware.
Serial Communications

The HYDRA-X23/X23S module also contains a fully operational USB to UART serial communications link the user can utilize to communicate with the PAC5223’s serial port. This connection is enabled by default at the factory. In the event the user desires to utilize a different serial communications source, the S2 DIP switch must be configured to separate the USB 2 UART resource from the PAC5223 microcontroller.

Figure 5 depicts how to flip the S2 DIP switches 1 and 2 depending on which UART serial communications source is to be employed.

![Figure 5 S2 DIP Switch UART Channel Selection](image)
HYDRA-X23/X23S Setup

The setup for the HYDRA-X23/X23S Body module requires up to three simple connections.

1. Connect the VIN power source via barrel connector J7. When VIN power is present, the LED D3 will light up. If VIN voltage is larger than 16V (8V for X23S), the PAC5223’s Multi Mode Power Manager will be engaged and the VSYS (5V) regulator will be enabled. This event will result in LED D2 lighting up.
2. Connect the USB Serial Communications to J8: ensure the board’s USB cable is connected to a PC computer. LED D1 will light up when the connection is made.
3. Connect the USB SWD to J9. Ensure the board’s USB cable is connected to a PC computer. Coocox IDE will signal connection status.

Figure 6: HYDRA-X23/X23S Connections
HYDRA-X HEADS

HYDRA-X Prototype Heads

Active-Semi provides three different prototype heads which allow the HYDRA-X Body module to be expanded by the user’s applications particular set of requirements. The three prototype heads are named after their size as:

**HYDRA-XPROTOS**: Small size Prototyping Board (observes the same footprint as the HYDRA-X Body)

**HYDRA-XPROTOM**: Medium size Prototyping Board (measuring 2.75” x 3.0”)

**HYDRA-XPROTOL**: Large size Prototyping Board (measuring 4” x 4”)

![Figure 8 HYDRA-X PROTOS Prototype Board (2.1” x 2.7”)](image)

![Figure 9 HYDRA-X PROTOM Prototype Board (2.75” x 3”)](image)
Figure 10 HYDRA-X PROTOL Prototype Board (4” x 4”)

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Rev 1.0 June 2014
HYDRA-X Head Design

HYDRA-X users can take advantage of the female connectors which accept male header connectors to expand the Body module functionality. Whereas Active-Semi provides a number of existing Heads, users can are exhorted to design their own when possible. Measurements on where mounting holes and interface connectors are to be placed are shown below.

Figure 11 HYDRA-X Floor Plan and Dimensions
ABOUT ACTIVE-SEMI

Founded in 2004 in Silicon Valley and headquartered in Allen, Texas, Active-Semi is a rapidly emerging leader in the multi-billion dollar power management IC and intelligent digital motor drive IC markets. The company's portfolio of analog and mixed signal SoCs (systems-on-chips) are scalable core platforms used in charging, powering and embedded digital control systems for end applications such as industrial, commercial and consumer equipment. The company offers power application microcontrollers, DC/DC, AC/DC, PMU and LED drivers that significantly reduce solution size and cost while improving system-level reliability. Active-Semi’s turnkey solutions deliver energy-saving power conversion architectures that minimize energy usage and compress system development cycle-time by greater than 50 percent. Active-Semi ships 50 million power ICs per quarter and reached the "one billion units shipped" milestone in May 2012. The multi-national company focuses on commercializing industry leading power management IC solution platforms and has developed broad intellectual property with over 150 patents granted and pending. For more information visit: http://active-semi.com/

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