

# HYDRA-X BLDC Head

*Power Application Controllers™*

PAC5220 Expansion - HYDRA-X BLDC Head User's Guide



[www.active-semi.com](http://www.active-semi.com)

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## OVERVIEW

Active-Semi's HYDRA-X BLDC Head is an expansion board for the Hydra-X20 Body board, providing a complete motor solution. Although developed to control tri-phase Brushless DC (BLDC) motors, the module can be utilized to drive other motor topologies including, but not limited to, brushed DC motors.

The HYDRA-X BLDC Head has been designed to accommodate a robust power stage made of six power MOSFETs rated at 60V and a maximum of 192A. The module contains all of the passive components required to properly polarize and protect the switch elements.

This module was designed taking into consideration two BLDC control methodologies: Hall Sensor BLDC and BEMF Detection sensorless. A connector is provided to connect hall sensor signals. In parallel to these connections, the board provides phase output voltage dividers required to implement BEMF sensorless algorithms. All that is required from the user is to download the pertinent firmware into the Hydra-X20 Body board, and establish the respective motor connections.

Other resources made available to prospective developers are a potentiometer which could be used to control motor speed, two push buttons, and a series of connectors which could be used to add external switches. A placeholder for a thermistor was designed into the system allowing developers to add their own version of a thermal protection directly interfaced at the FET block.

Active-Semi's HYDRA-X BLDC Head kit consists of the following:

- HYDRA-X BLDC Head module
- HYDRA-X BLDC Head User's Guide
- Schematics, BOM and Layout Drawings

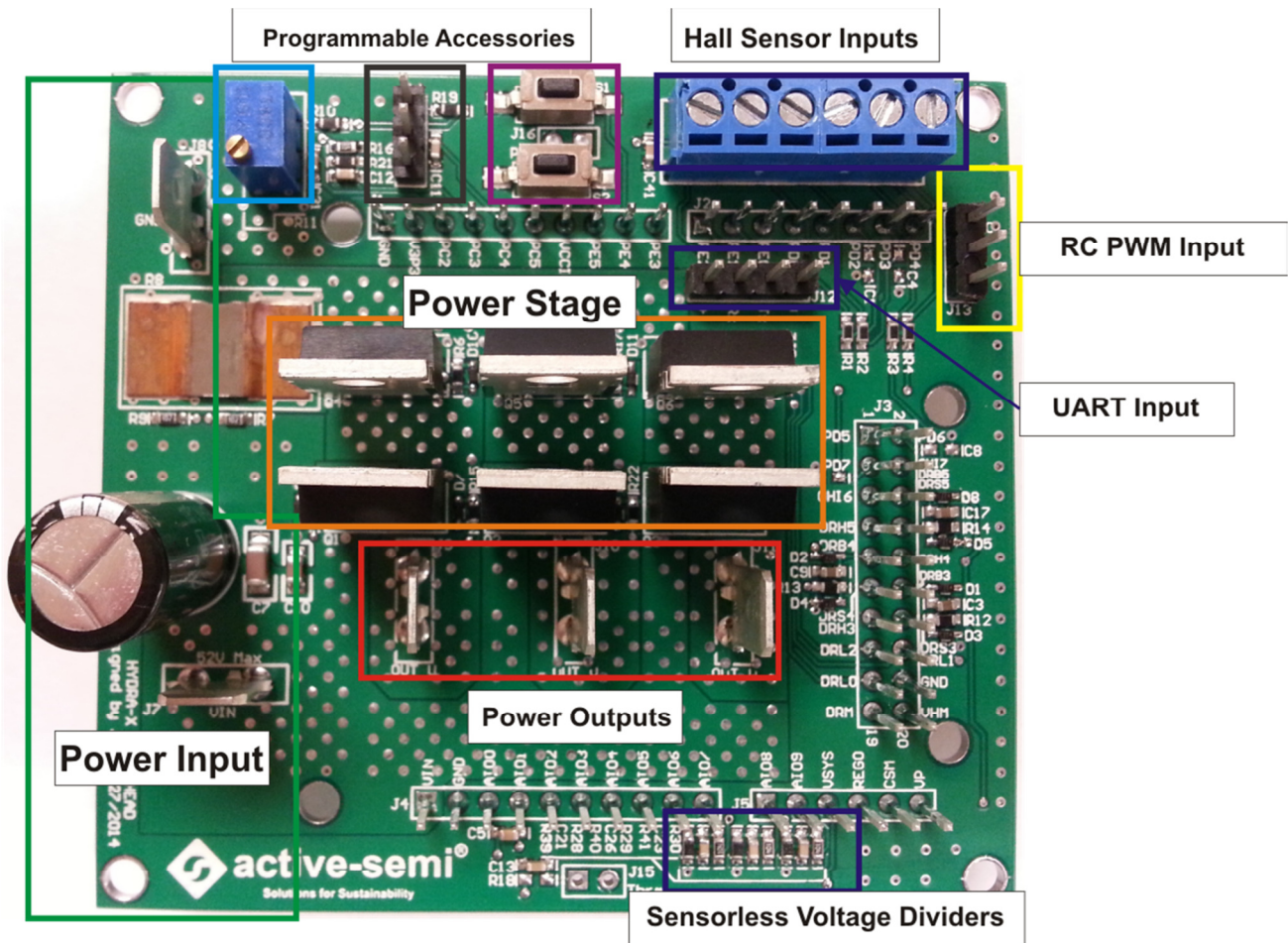


Figure 1: HYDRA-X BLDC Head Block Diagram

**Solution Benefits:**

- Ideal for most medium voltage and high current motor driving applications
- Six powerful FET switches allow for high current motor driving.
- Motor can be controlled remotely through an RC radio or an UART based serial communications channel such as a BlueTooth module (Bluetooth module not included).
- Can be programmed to drive BLDC motors in sensed or sensorless implementations.
- Schematics, BOM, Layout drawings available

The following sections provide information about the hardware features of Active-Semi's HYDRA-X BLDC Head turnkey solution.

## HYDRA-X BLDC HEAD RESOURCES

### Header Descriptions

The following table shows the female header descriptions for the HYDRA-X10 Body module.

Header	Pin	Description
<b>J1</b>	1-10	Refer to HYDRA-X20 pinout diagram
<b>J2</b>	1-8	Refer to HYDRA-X20 pinout diagram
<b>J3</b>	1-20	Refer to HYDRA-X20 pinout diagram
<b>J4</b>	1-10	Refer to HYDRA-X20 pinout diagram
<b>J5</b>	1-6	Refer to HYDRA-X20 pinout diagram
<b>J6</b>	-	Hall Sensor Inputs
	1	Hall Sensor VCC (5V)
	2	Hall Sensor U Phase
	3	Hall Sensor V Phase
	4	Hall Sensor W Phase
	5	Optional Hall Sensor Input (FG)
	6	Hall Sensor GND
<b>J7</b>	-	VIN Power Input -Spade connector (16V to 48V)
<b>J8</b>	-	GND Power Input – Spade Connector
<b>J9</b>	-	U Phase Output – Spade Connector
<b>J10</b>	-	V Phase Output – Spade Connector
<b>J11</b>	-	W Phase Output – Spade Connector
<b>J12</b>	-	Extern UART connector.
	1	UART VCC (5V)
	2	UART RX
	3	UART TX
	4	UART GND
<b>J13</b>	-	External RC PWM connector.
	1	RC PWM Signal Digital Input (PD4)
	2	RC PWM VCC (5V)
	3	RC PWM GND
<b>J14</b>	-	External Potentiometer Input
	1	External Potentiometer VCC (Voltage Divided VCC = 5V)
	2	External Potentiometer Analog Input (PC4)
	3	External Potentiometer GND
<b>J15</b>	-	Optional Thermistor connector
	1	Thermistor Analog Input (AIO2)
	2	Thermistor GND
<b>J16</b>	-	External Push Button
	1	External Push Button Digital Input (PE5)
	2	Extern Push Button GND

## HYDRA-X20 BLDC System Pinout and Signal Connectivity

The following diagram shows the male header pinout for the HYDRA-X BLDC Head module, as seen from above:

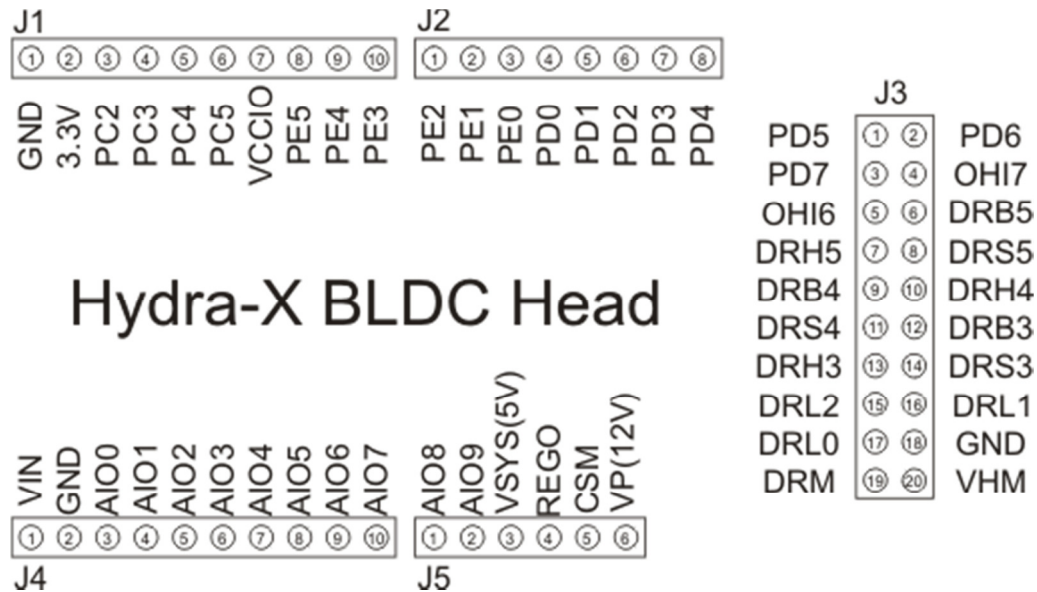


Figure 2 HYDRA-X BLDC Head Pinout

The HYDRA-X BLDC Head module interfaces with the HYDRA-X20 Body module.

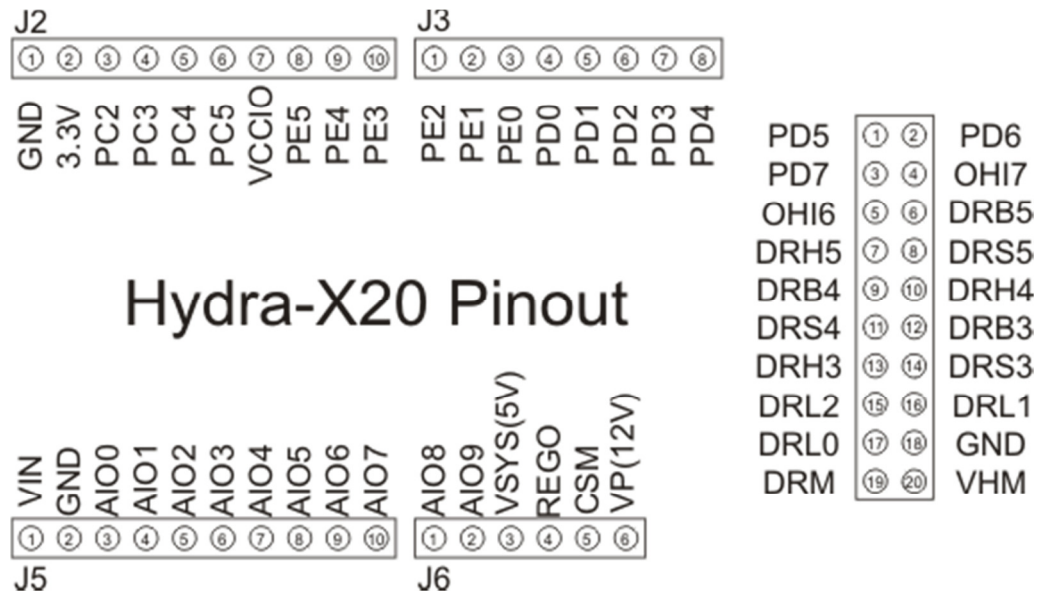


Figure 3 HYDRA-X20 Body Pinout

More information on the HYDRA-X20 Body module, and its respective User's Guide, can be downloaded from the HYDRA-X website at [www.active-semi.com/hydra](http://www.active-semi.com/hydra).

## Power Input

Power to the Hydra-X BLDC Head module should be applied to the J7/J8 Spade connectors. Power to the module should not exceed 48V.

Powering the HYDRA-X BLDC Head through the J7/J8 connectors will power the HYDRA-X20 Body board. Power to the body board is applied through the J4 VIN and GND terminal.

NOTE: Applying power to the HYDRA-X BLDC system through the HYDRA-X20 J7 connector is not recommended. Since this is a high current application, and the header connectors are not rated to handle such high currents, it is crucial that current is supplied through the spade connectors into the headers and not vice versa.

The HYDRA-X BLDC Head is not protected against voltage reversal. Voltage polarity must be observed before applying power to the module. Failing to follow correct voltage polarity connections will adversely affect HYDRA-X BLDC Head power FETs.

## External and Internal Resources

The following table illustrates the systems resources utilized

Header	Pin	Description	GPIO Resource
<b>J6</b>	2	Hall Sensor U Phase	PD2
<b>J6</b>	3	Hall Sensor V Phase	PD3
<b>J6</b>	4	Hall Sensor W Phase	PD6
<b>J6</b>	5	Optional Hall Sensor Input (FG)	PD7
<b>J12</b>	2	UART RX	PE2
<b>J12</b>	3	UART TX	PE1
<b>J13</b>	1	RC PWM Signal Digital Input	PD4
<b>J14</b>	2	External Potentiometer Analog Input	PC4
<b>J15</b>	1	Thermistor Analog Input	AIO2
<b>J16</b>	1	External Push Button Digital Input	PE5
<b>Internal</b>	-	VIN Analog Input	PC3
<b>Internal</b>	-	R11 Potentiometer Analog Input	PC2
<b>Internal</b>	-	S1 Push Button Digital Input	PE4
<b>Internal</b>	-	S2 Push Button Digital Input	PE5
<b>Internal</b>	-	PHASE U Output (Voltage Divided)	AIO7
<b>Internal</b>	-	PHASE V Output (Voltage Divided)	AIO8
<b>Internal</b>	-	PHASE W Output (Voltage Divided)	AIO9
<b>Internal</b>	-	SENSE Resistor + Terminal	AIO1
<b>Internal</b>	-	PHASE U Low Side FET Gate Drive	DRL0
<b>Internal</b>	-	PHASE U High Side FET Gate Drive	DRH3
<b>Internal</b>	-	PHASE U Boot Strap	DRB3
<b>Internal</b>	-	PHASE U High Side Source	DRS3
<b>Internal</b>	-	PHASE V Low Side FET Gate Drive	DRL1
<b>Internal</b>	-	PHASE V High Side FET Gate Drive	DRH4
<b>Internal</b>	-	PHASE V Boot Strap	DRB4
<b>Internal</b>	-	PHASE V High Side Source	DRS4
<b>Internal</b>	-	PHASE W Low Side FET Gate Drive	DRL2
<b>Internal</b>	-	PHASE W High Side FET Gate Drive	DRH5
<b>Internal</b>	-	PHASE W Boot Strap	DRB5
<b>Internal</b>	-	PHASE W High Side Source	DRS5



## HYDRA-X BLDC HEAD HARDWARE

### External Potentiometer (J14)

For applications wanting to utilize an external potentiometer, the 3 pin header connector gives access to analog input PC4. The potentiometer resource is pulled up via a 5.1K resistor. In the event the external potentiometer requires a different pull up resistance, resistor R19 can be modified accordingly with a 0603 package of suitable resistive value.

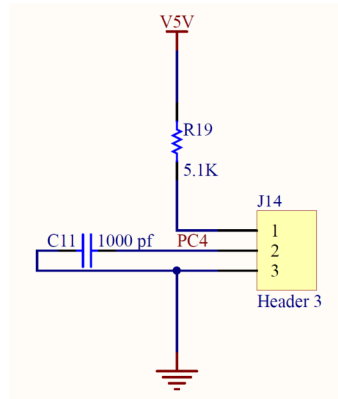


Figure 3 External Potentiometer Circuitry

### External Thermistor (J15)

In order to protect power FETs from being adversely affected by extremely high temperatures, a thermistor input is provided. Thermistor temperature can be sampled through analog input AIO2.

By default, the thermistor's pull up resistor is a Non Populate component. User can select appropriate pull up resistor (0603 package) and populate at the R18 footprint location.

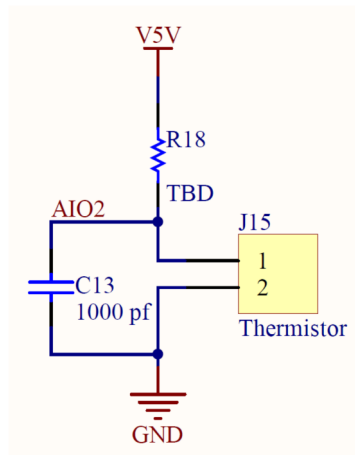
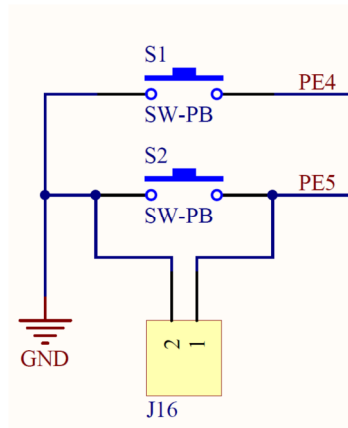


Figure 4 External Thermistor Circuitry

## S1 and S2 Push Buttons

Two push buttons (S1 and S2) are made available for users requiring to add further control functionality to the motor drive system. Push button S1 is assigned to resource PE4 whereas push button S2 is assigned to resource PE5.

Alternatively, a non populated two pin connector (J16) is made available in order to allow for an external switch to be added at a later time, if required.

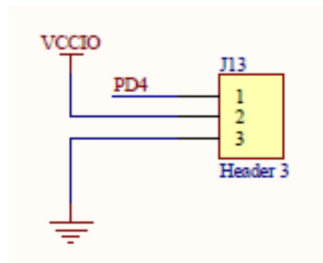


**Figure 5 External Thermistor Circuitry**

## RC PWM Remote Control Input (J13)

Users wanting to control a motor by employing an off the shelf Remote Control (RC) radio, can take advantage of the 3 pin header connector J13. This pin provides 5V power to the receiver module and accepts the typical 1.0 to 2.0 ms PWM signal. Firmware decoding the RC PWM signal is part of our sample code made available at the HYDRA-X Blog.

RC PWM control signal can be sampled via the PD4 resource.



**Figure 6 RC PWM Interface Circuitry**

# HYDRA-X BLDC HEAD SCHEMATIC

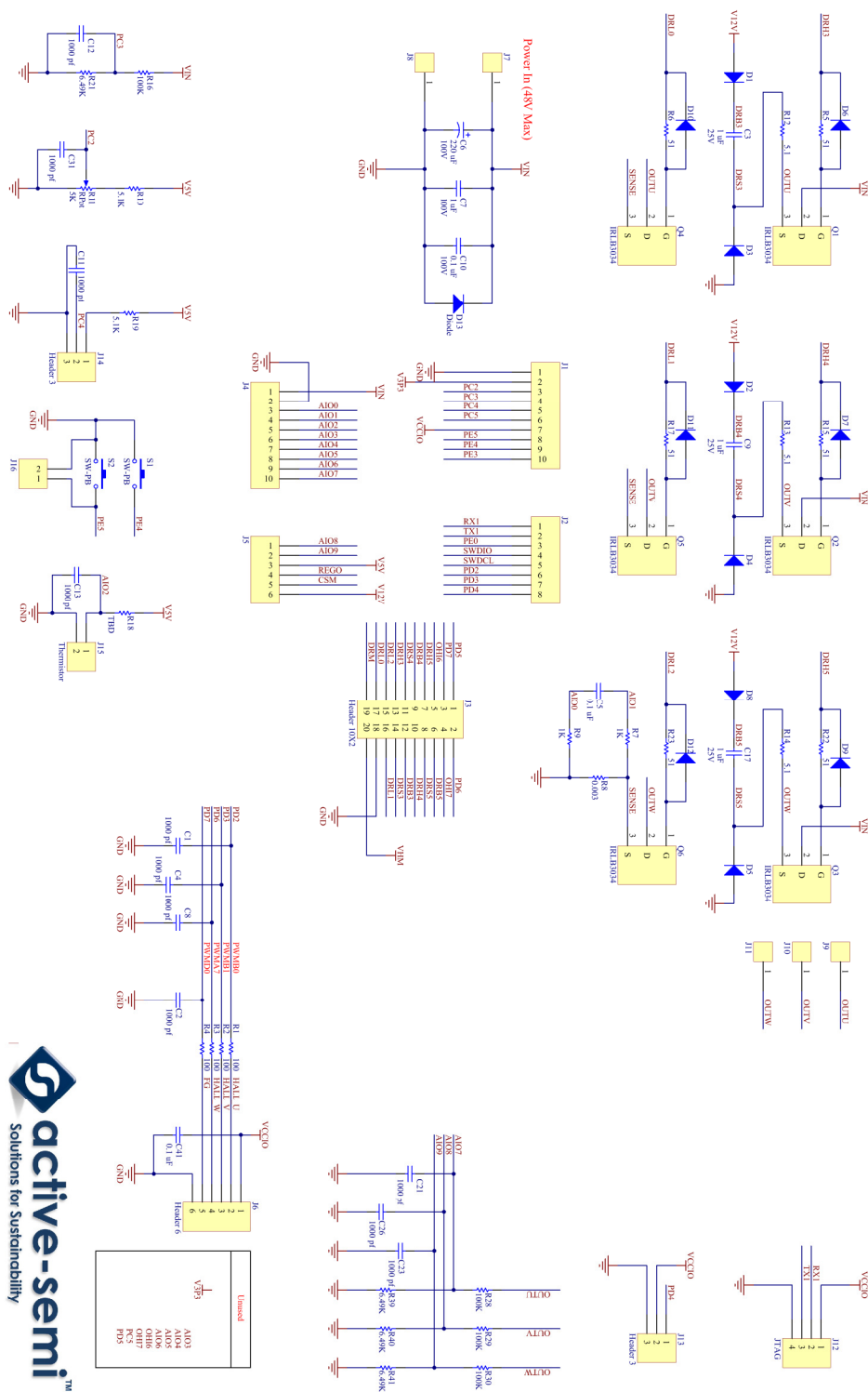


Figure 7:HYDRA-X BLDC Head Schematic Diagram



## 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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