![IRIS Iris Dynamics Ltd.]

Orca™ IO SmartHub
User Guide 230424

Version 1.1, Feb 2024

This document applies to the following Orca Series motor firmware:

- 6.2.8

For more recent firmware versions, please download the latest version of this user guide at https://irisdynamics.com/downloads

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Revision History

Version	Date	Author	Reason
1.0	May, 2023	sj	Initial Release
1.1	Dec, 2023	rm, sj	Rebranding, support with v6.1.8 orca firmware
1.2	Feb, 2024	sj, rm, kc	Update diagrams and renders

Overview

This document is intended for users who intend to control an Orca Series motor using the Orca IO SmartHub. The Orca IO SmartHub allows for control of Orca Series motors in Force, Position, and Kinematic Modes through simple digital and analog inputs. Real-time force and position data are also fed back from the motor to the Orca IO SmartHub and provided as analog outputs. The Orca IO SmartHub handles the high-speed digital communication with the motor, allowing easier integration with existing industrial control methods such as PLCs with 4-20 mA current loop outputs.

This document is specifically about the operation and installation of the Orca IO SmartHub device. For information on operation of Orca Series motors themselves, please consult the Orca Series Motor Reference Manual.
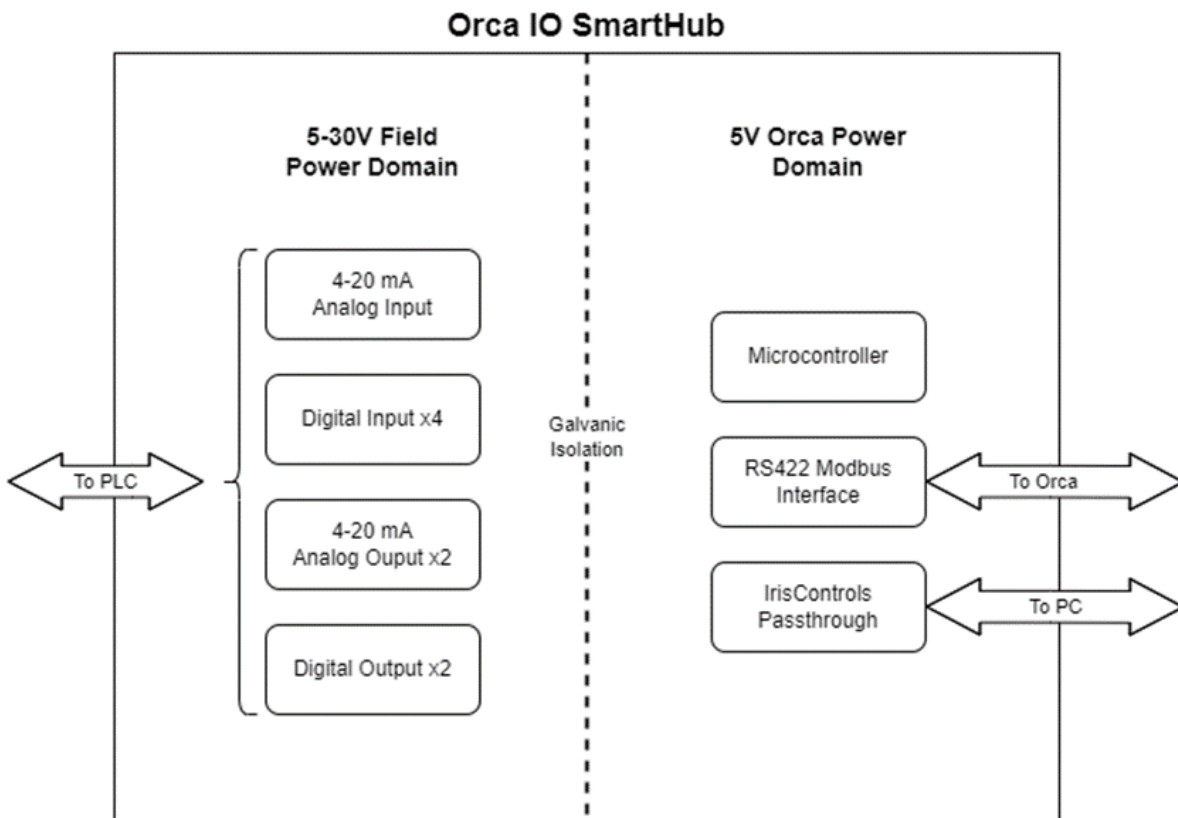

Figure 1: Orca IO SmartHub Block Diagram
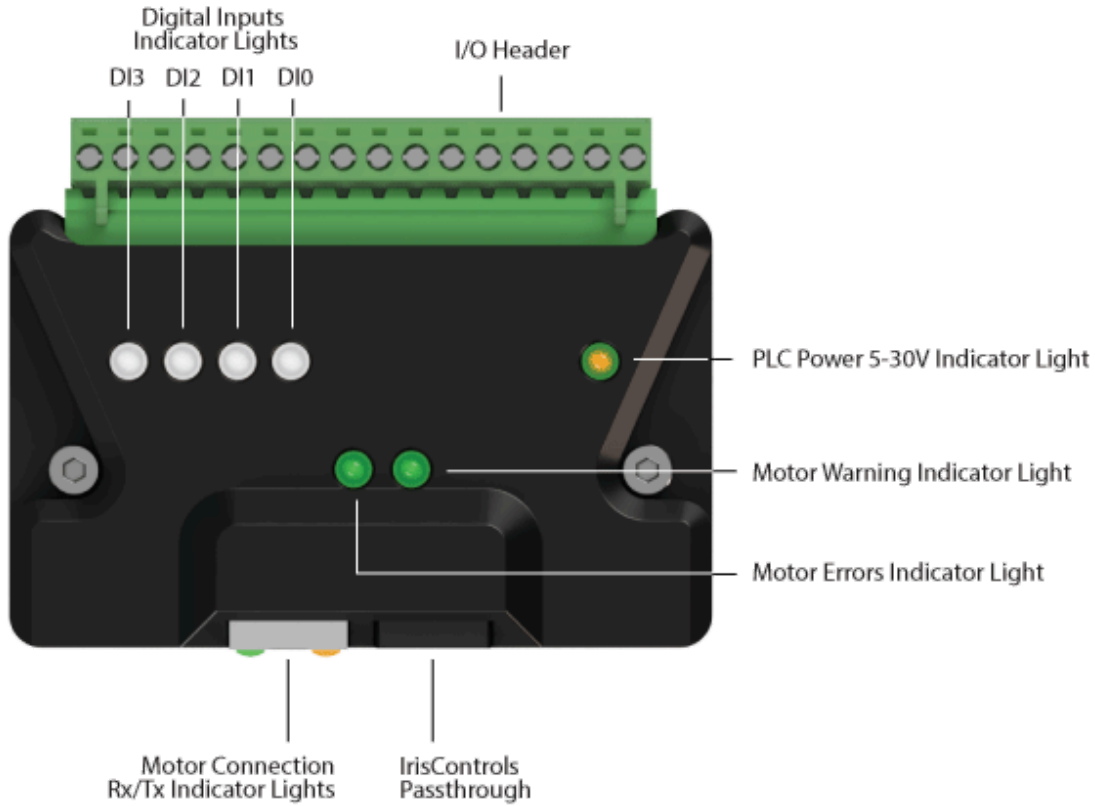
Figure 2: Device Overview

Feature	Description	
Digital Input Indicator Lights 0-3	White Off	= High Input = Low Input
I/O Header	Pluggable terminal block socket for connection to PLC.	
PLC Power 5-30V Indicator Light	Amber Off	= Powered = Not Powered
Motor Warning Indicator Light	Green Yellow Off	= No Warning = Warning = No Motor Connection / Power
Motor Errors Indicator Light	Green Red Off	= No Motor Errors = Motor Errors = No Motor Connection / Power
Motor Connection Rx/Tx Indicator Lights	Green Yellow	= Rx = Tx
IrisControls Passthrough	For connecting to Orca Series motor GUI through IrisControls.	

Pinout

Pin Number	Pin Name	Function
1	V+	+5-30V power supply terminal.
2	V-	0V power supply terminal.
3	AI+	Analog input positive current terminal.
4	AI-	Analog input return current terminal.
5	AO1	Analog output 1 positive current terminal.
6	G1	Common current return terminal for AO1 and AO2 pins.
7	AO2	Analog output 2 positive current terminal.
8	WRN	Warning signal digital output.
9	G2	Common terminal for WRN and ERR pins.
10	ERR	Error signal digital output.
11	DI0	Digital input signal 0.
12	G3	Common terminal for DI0 and DI1 pins.
13	DI1	Digital input signal 1.
14	DI2	Digital input signal 2.
15	G4	Common terminal for DI2 and DI3 pins.
16	DI3	Digital input signal 3.

Shaded groups of pins share an isolated common pin that must be connected to the appropriate ground for the circuit they are interfacing with.

Pin Numbers

External Connections

PLC or Controller

Digital I/O, Analog I/O,
PLC Power

Power Supply (24-48 VDC)

L N ⏚ V- V+

RS485 - USB to PC
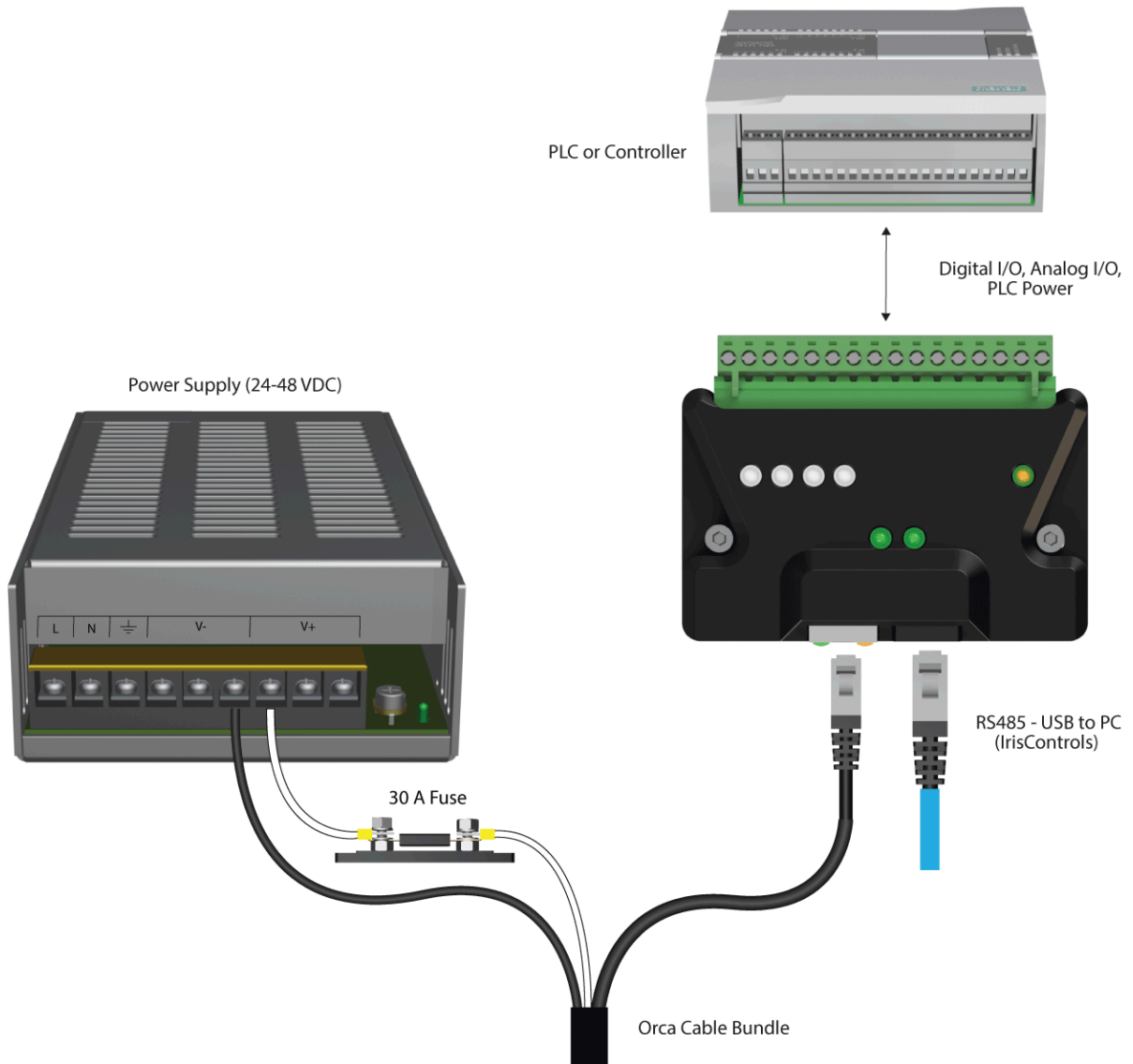(IrisControls)

30 A Fuse

Orca Cable Bundle
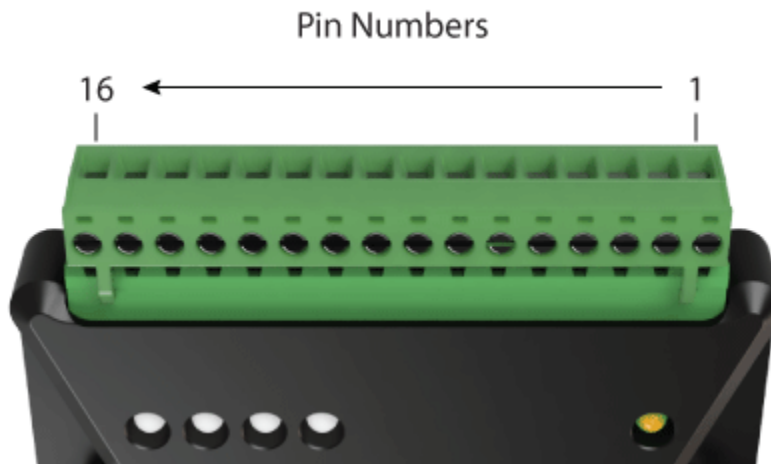
Figure 3: Orca IO SmartHub Connection Diagram

Connecting to an Orca Series Motor

To connect the Orca IO SmartHub to an Orca Series motor and establish communications, plug the male RJ45 connector from the motor into the shielded female RJ45 jack on the Orca IO SmartHub. Once the motor is powered with the appropriate power supply, the Orca IO SmartHub logic will receive power and attempt to establish a connection with the motor.

If there was a successful connection to the motor, the transmit and receive lights on the female RJ45 jack on the Orca IO SmartHub should appear solid. Please note that for proper operation, the Orca Series motor must be configured with the desired control settings. See the Configuration section of this guide for more information.

Connecting to a PLC / Microcontroller

The Orca IO SmartHub features a 16-pin header designed to fit 5.0 mm pitch swappable terminal blocks. Possible terminal block options include push-in spring and screw type terminals. This header provides access to all analog and digital inputs and outputs, as well as power terminals.

All inputs and outputs accessible from the header are galvanically isolated from the motor-supplied portion of the circuit that includes the digital logic. The device is tolerant to large ESD events on these pins.

The connections made to an external controller or PLC are application dependent. Any combination of the array of analog and digital input/outputs may be used at once. The functions of each of the inputs and outputs are dependent on the configured mode of operation and will be covered later in this guide.

As shown in the Pinout section of this guide, pairs of inputs and outputs share common pins, labeled G1, G2, G3, and G4. These pins must be connected to the appropriate ground for the circuit they are interfacing with. All inputs and outputs on the Orca IO SmartHub are in a sinking configuration and can tolerate 5-30 V DC.

At a minimum, the V+ and V- terminals of the Orca IO SmartHub must be connected to a 5-30 V power supply. If the Orca IO SmartHub is correctly connected to a 5-30 V power supply, the amber power light will be illuminated.

Troubleshooting Connections

No Connection to Orca Series Motor

- Ensure the motor is powered with the appropriate power supply for the model.
- Verify that the RJ45 connector is fully seated in the jack.
- Verify that the connected Orca Series motor firmware version is 6.2.8 or higher.

Incorrect Analog Input / Output Values

- Ensure the field powered side of the Orca IO SmartHub is powered with 5-30 V across the V+ and V- terminals.
- The Orca IO SmartHub only supports current loop signals, not voltage. A voltage input or output can be used, but must first be converted to a current of the appropriate range with a resistor or other dedicated circuitry.

Digital Input / Output Not Working

- Ensure the appropriate common terminal is connected for the signal of interest. Individual pins are described in the Pinout section of this guide.

Configuration

Configuration for operation with an Orca IO SmartHub is stored and saved in the nonvolatile memory of Orca Series motors, not the Orca IO SmartHub itself. The actual data transmitted between the Orca IO SmartHub and a motor does not change with configuration, only the way it is interpreted by the motor. This means that any Orca IO SmartHub can be plugged into a given motor and the same behaviour should be expected.

Information on connecting to the IrisControls GUI can be found in the Orca Series Quickstart Guide. Once connected, navigate to the Interfaces page to begin configuring the Orca IO SmartHub settings.

Figure 4: IrisControls Orca IO SmartHub Configuration Panel

GUI Element Descriptions

Current Loop Status

Displays the status of each of the three current loops.

The Force and Position current loop status displays the amount of current requested by the motor to be output by the Orca IO SmartHub. These values will update along with changing force and positions, even without connecting to an Orca IO SmartHub.

The Input display shows the current measured by the Orca IO SmartHub, reported back to the motor.

Digital Input Status

Displays the status of the three digital inputs. Digital inputs that are currently high will be displayed in orange, and digital inputs that are currently low will be displayed in grey.

Save Configuration Button

Saves all settings to the motor's nonvolatile memory to be retained through power cycles.

Force Range Setting

Determines the range of forces that are mapped to the current loop. This applies for both the force output current loop, and the input current loop if in force input mode.

The minimum force value is mapped to the low current value (either 0 or 4 mA) and the maximum value is mapped to 20 mA. Force values below the minimum or above the maximum will be clipped to their respective current.

Position Range Setting

Determines the range of positions that are mapped to the current loop. This applies for both the position output current loop, and the input current loop if in position input mode.

The minimum position value is mapped to the low current value (either 0 or 4 mA) and the maximum value is mapped to 20 mA. Position values below the minimum or above the maximum will be clipped to their respective current.

Orca IO SmartHub Mode Selection

Determines how the motor will respond to the analog and digital inputs. See the Input Modes section for more information.

Current Range Selection

Selects the current range that all force, position, and input values will be normalized to. This setting can either be 4-20 mA or 0-20 mA.

Kinematic Trigger Settings

Selects the kinematic motion IDs that will be triggering on rising and/or falling edges of digital input trigger signals.

Input Modes

Orca Series motors can be configured to communicate with Orca IO SmartHubs in three different modes. In this section each mode will be covered in detail.

Below is a table explaining how each input is used in each of the three modes.

	Force	Position	Kinematic
Digital Input 0	**Control Max Force**	*Reserved*	**Trigger 1**
Digital Input 1	*Reserved*	*Reserved*	**Trigger 2**
Digital Input 2	*Reserved*	*Reserved*	**Trigger 3**
Digital Input 3	**Enable**	***Enable***	**Enable**
Analog Input	**Force Command**	**Position Command (Max Force when DI1 high)**	*Reserved*

Force Mode

In Force Mode, while connected to an Orca IO SmartHub, an Orca Series motor will stay in Sleep Mode while the Enable input is held low. If the Enable line is held high, the motor will enter mode 8, Analog Force Mode.

Once in Analog Force Mode, the Analog Input channel of the Orca IO SmartHub that is being measured and transmitted to the motor will be converted into a force value F based on the force range setting, and the current range setting.

$$F = (I_{Input} - I_{Low}) / (20 - I_{Low}) * (F_{Max} - F_{Min}) + F_{Min}$$

Where I_{Low} may be 0 mA or 4 mA, and F_{Max} and F_{Min} are determined by the 'force range setting'. Once a force value is calculated, it is sent to the motor's force controller as a command.

Digital 3 is reserved and has no function in this mode.

Position Mode

In Position Mode, while connected to an Orca IO SmartHub, an Orca Series motor will stay in Sleep Mode while the Enable input is held low. If the Enable line is held high, the motor will enter mode 9, Analog Position Mode.

Once in Analog Position Mode, the Analog Input channel of the Orca IO SmartHub that is being measured and transmitted to the motor will be converted into a position value P based on the position range setting, and the current range setting.

$$P = (I_{Input} - I_{Low}) / (20 - I_{Low}) * (P_{Max} - P_{Min}) + P_{Min}$$

Where I_{Low} may be 0 mA or 4 mA, and P_{Max} and P_{Min} are determined by the position range user setting. Once a position value is calculated, it is sent to the motor's position controller as a command.

While Digital Input 1 is held high, the Analog Input channel of the Orca IO SmartHub will instead be converted into a force saturation value F_{Sat}. The force saturation value is the maximum value of force in millinewtons that the position controller will exert. Forces above the saturation value will be clipped. The saturation value calculated is based on the maximum force range setting, and the current range setting.

$$F_{Sat} = (I_{Input} - I_{Low}) / (20 - I_{Low}) * (F_{Max})$$

Where I_{Low} may be 0 mA or 4 mA, and F_{Max} is determined by the force range setting. Once a force saturation value is calculated, it is sent to the motor's position controller and is effective immediately. While Digital Input 1 is high the position target will remain at the last value set when Digit Input 1 was low. It is recommended that the Digital Input 2 is low when toggling Digital Input 1 to avoid jumps in the position target.

Digital input 3 is reserved and has no function in this mode.

Kinematic Mode

In Kinematic Mode, while connected to an Orca IO SmartHub, an Orca Series motor will stay in Sleep Mode while the Enable input is held low. If the Enable line is held high, the motor will enter mode 10, Analog Kinematic Mode.

While in Analog Kinematic Mode, the Analog Input is not used. Instead, the motor will have been pre-configured with a set of kinematic motions which are queued with the Trigger and Home digital inputs. Please see the Orca Series Motor Reference Manual for more information on how kinematic motions are configured.

Two Trigger signals are available. They can be configured to be rising edge only triggers or both rising and falling edge triggers.
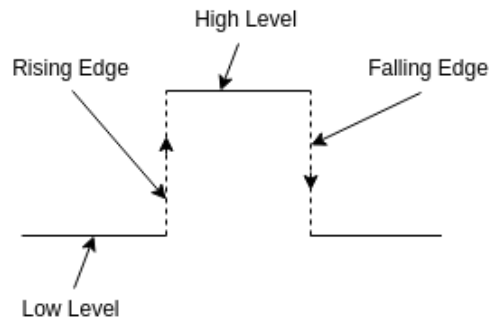
Figure 5: Signal Transitions

The kinematic motion ID for each trigger can be specified. This may trigger a chain of motions, or a single motion, depending on the kinematic motion's configuration.

Warning and Error Signals

The Orca IO SmartHub has two digital output pins assigned as warning and error. They act as signals that can be fed into an external controller to detect error states on the connected motor. Each signal also controls an LED for visual indication. The error signal light is red/green, and the warning light is yellow/green. During normal operation, both lights should appear green.

Warning Signal

If the warning output is asserted, the warning LED will transition to yellow. This signal is asserted when the motor indicates that a warning condition has occurred and will return to a cleared state if the warning is no longer present on the motor. For more information on configuring motor warnings, please see the Orca Series Motor Reference Manual.

Error Signal

If the error output is asserted, the error LED will transition to red. This signal will be asserted whenever the connected Orca Series motor experiences an error and will return to a cleared state if the error is no longer present on the motor. For more information on possible motor errors, please see the Orca Series Motor Reference Manual.

Clearing Error States

If an error output is detected, the error may be cleared by pulling the Enable input low. This will cause the motor to transition into Sleep Mode, which attempts to clear various errors. If the error condition still exists on the motor, the error signal will persist. In this case, further investigation on the state of the motor is required.