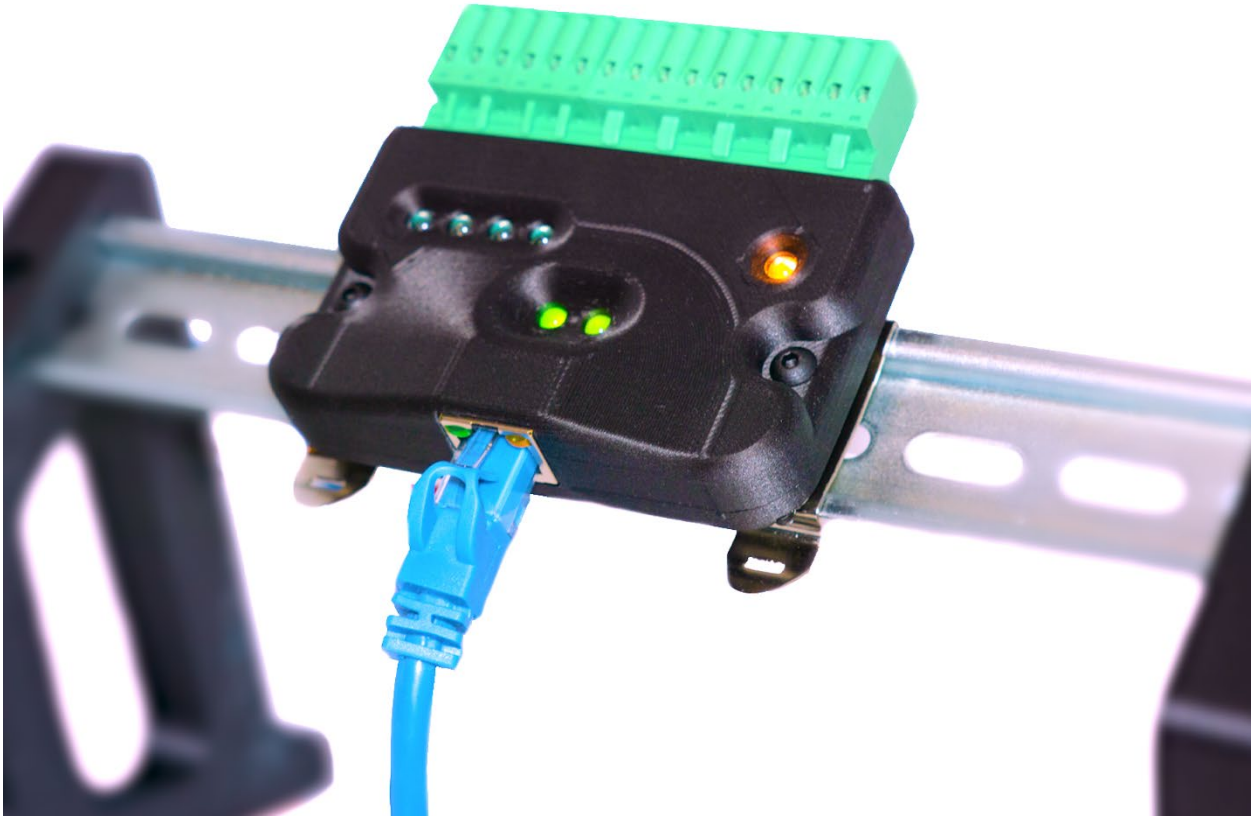
ORCA ANALOG INTERFACE

User Guide 230424

Version 1.0, May 2023



This document applies to the following Orca Series motor firmware:

- 6.1.7

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

REVISION HISTORY

Version	Date	Author	Reason
1.0	May, 2023	sj	Initial Release

CONTENTS

OVERVIEW

This document is intended for users who intend to control an Orca Series motors using the Orca Analog Interface. The Orca Analog Interface 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 Orca to the Orca Analog Interface and provided as analog outputs. The Orca Analog Interface handles the high-speed digital communication with the Orca, 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 Analog Interface device. For information on operation of Orca Series motors themselves, please consult the Orca Motor Reference Manual.

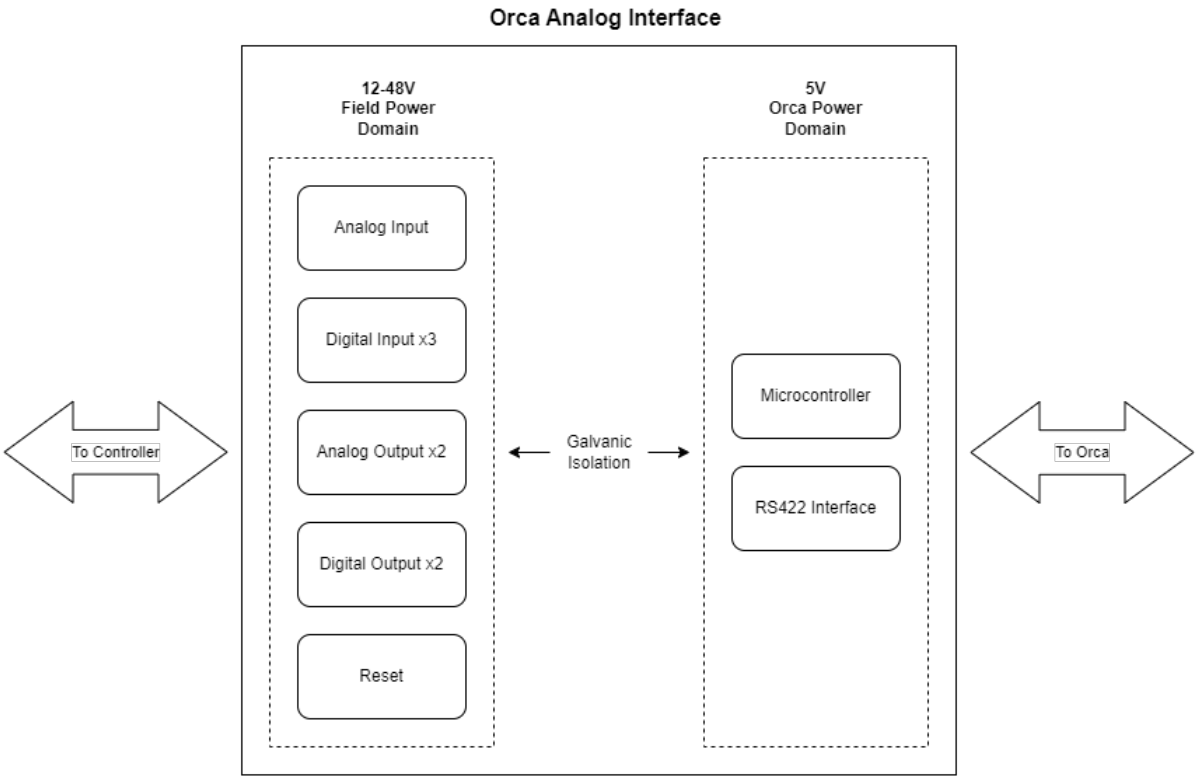


Figure 1: Orca Analog Interface Block Diagram

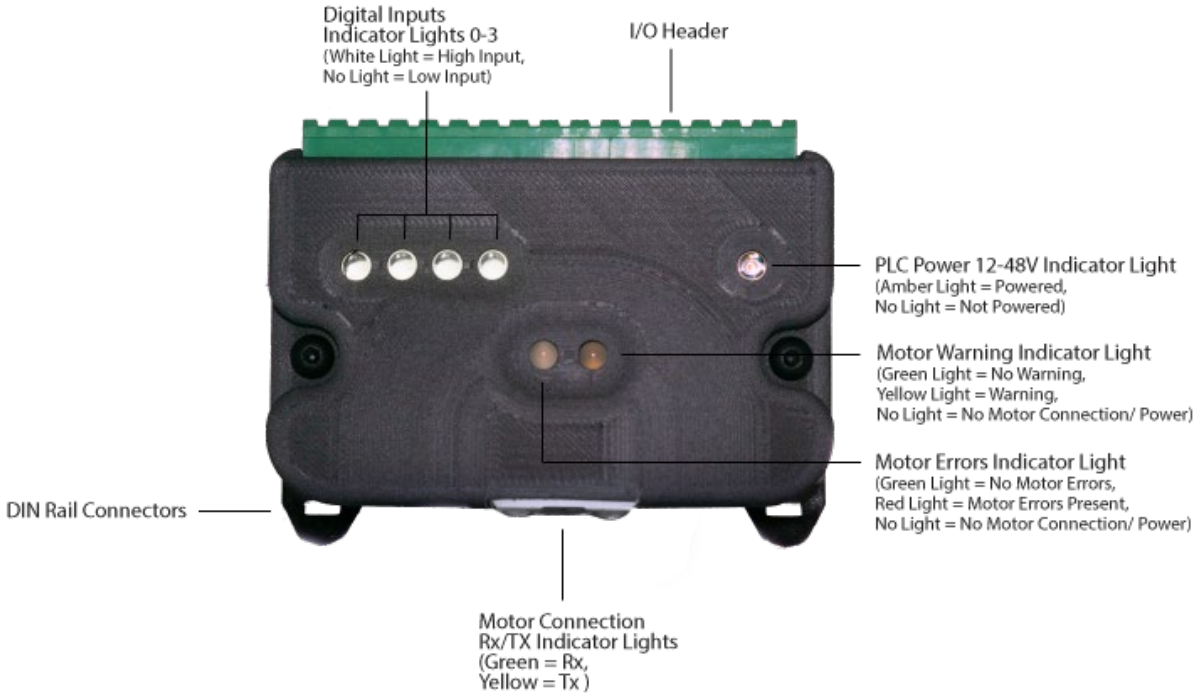


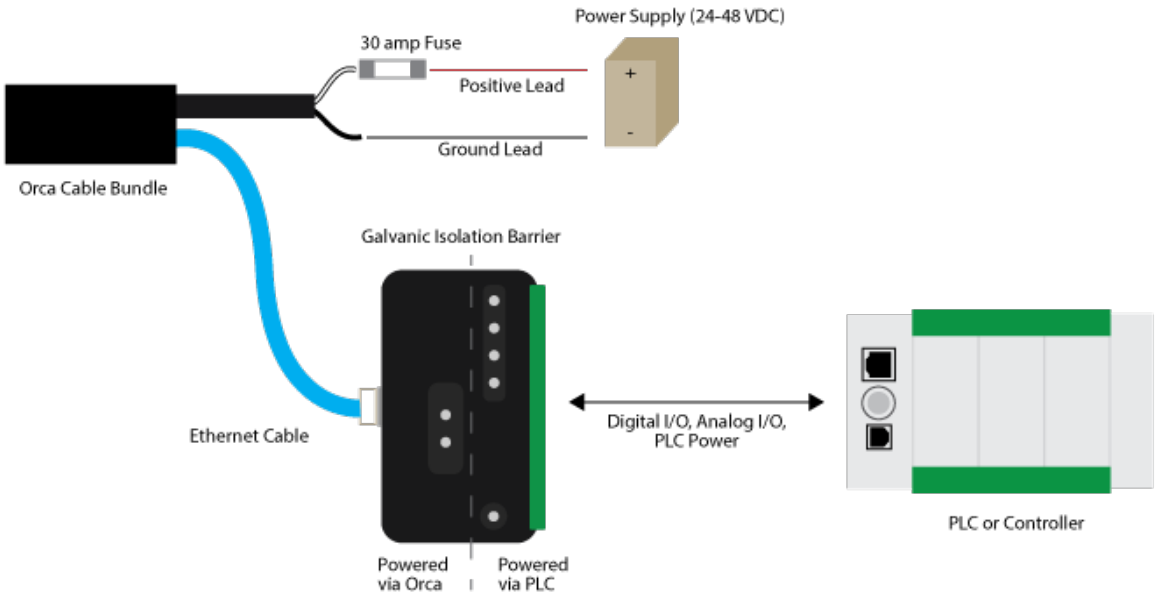
Figure 2: Device Overview

PINOUT

Pin Name	Function
V+	+12-48V power supply terminal.
V-	0V power supply terminal.
AI+	Analog input positive current terminal.
AI-	Analog input return current terminal.
AO1	Analog output 1 positive current terminal.
G1	Common current return terminal for AO1 and AO2 pins.
AO2	Analog output 2 positive current terminal.
WRN	Warning signal digital output.
G2	Common terminal for WRN and ERR pins.
ERR	Error signal digital output.
RST	Device reset pin.
G3	Common terminal for RST and DI1 pins.
DI1	Digital input signal 1.
DI2	Digital input signal 2.
G4	Common terminal for DI2 and DI3 pins.
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.

EXTERNAL CONNECTIONS



Connecting to an Orca Series motor

To connect the Orca Analog Interface to an Orca Series motor and establish communications, plug the male RJ45 connector from the Orca Series motor into the female RJ45 jack on the Orca Analog Interface. Once the motor is powered with the appropriate power supply, the Orca Analog Interface 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 Analog Interface 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 Controller

The Orca Analog Interface 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 Analog Interface are in a sinking configuration.

At a minimum, the V+ and V- terminals of the Orca Analog Interface must be connected to a 12-48V power supply, and the RST terminal must be held low. If the Orca Analog Interface is correctly connected to a 12-48V power supply, the amber power light will be lit.

External Reset Signal

Pulling the RST pin high will put the digital logic on the Orca Analog Interface into a reset state. During this time the device will not be able to establish a connection with an Orca Series motor. This pin can be used to fully reset the system, but it should be noted that the motor will no longer be under control of the Orca Analog Interface for the duration of the reset event.

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 motor firmware version is 6.1.7 or higher.

Incorrect Analog Input / Output Values

- Ensure the field powered side of the Orca Analog Interface is powered with 12-48V across the V+ and V- terminals.
- The Orca Analog Interface 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

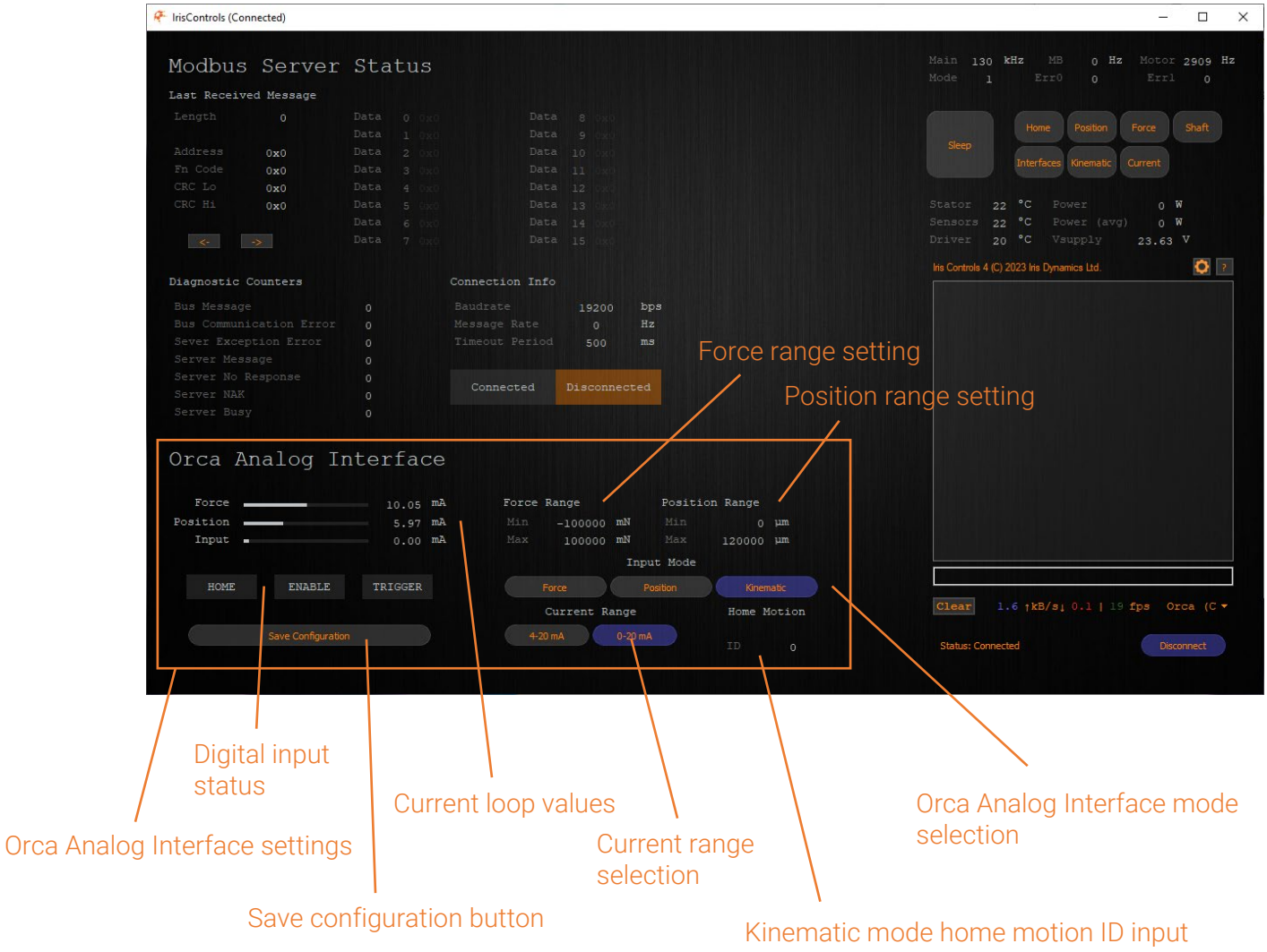
- Ensure the appropriate common terminal is connected for the signal of interest. Individual pins are described in the Pinout section of this guide.

CONFIGURATION

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

Orca Series motors can be configured either through a serial MODBUS connection (through the same RS422 connection used by the Orca Analog Interface) or through the IrisControls GUI. This guide will focus on the second option. For more information on how to read and write Orca Series motor's registers over MODBUS, please consult UG210912 – Orca Series MODBUS User Guide.

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 Analog Interface settings.



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 Orca motor to be output by the Orca Analog Interface. These values will update along with changing force and positions, even without connecting to an Orca Analog Interface.

The Input display shows the current measured by the Orca Analog Interface, reported back to the Orca 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 Orca 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 Analog Interface Mode Selection

Determines how the Orca 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 Home Motion ID Input

Selects the kinematic motion ID that will be triggered when a rising edge is seen on the Home digital input in kinematic mode.

INPUT MODES

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

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

	Force	Position	Kinematic
Digital Input 1	Reserved	Control Max Force	Trigger
Digital Input 2	Enable	Enable	Enable
Digital Input 3	Reserved	Reserved	Home
Analog Input	Force Command	Position Command (Max Force when digital 1 asserted)	Reserved

Force Mode

In Force mode, while connected to an Orca Analog Interface, 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 Analog Interface 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 Orca 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 Analog Interface, 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 Analog Interface 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 Orca position controller as a command.

While Digital Input 1 is held high, the Analog Input channel of the Orca Analog Interface 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 Orca 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 position target.

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

Kinematic Mode

In Kinematic mode, while connected to an Orca Analog Interface, 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 Orca 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 Motor Reference Manual for more information on how kinematic motions are configured.

A rising edge on the Trigger input will cause the next queued kinematic motion to start. This may trigger a chain of motions, or a single motion at a time, depending on the configuration on the Orca motor.

A rising edge on the Home input will cause a defined kinematic motion ID to start. This motion ID is configured and saved on the Orca motor. Though it can be used to trigger any sequence of motions, the Home function is most useful as a safe way to return to a known position at any time. Applications may include returning to home after completing enough repetitions of a motion sequence, or returning to home when a force threshold is exceeded.

WARNING AND ERROR SIGNALS

The Orca Analog Interface 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 Orca 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 Orca 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 Orca warnings please see the Orca 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 Orca errors, please see the Orca 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.