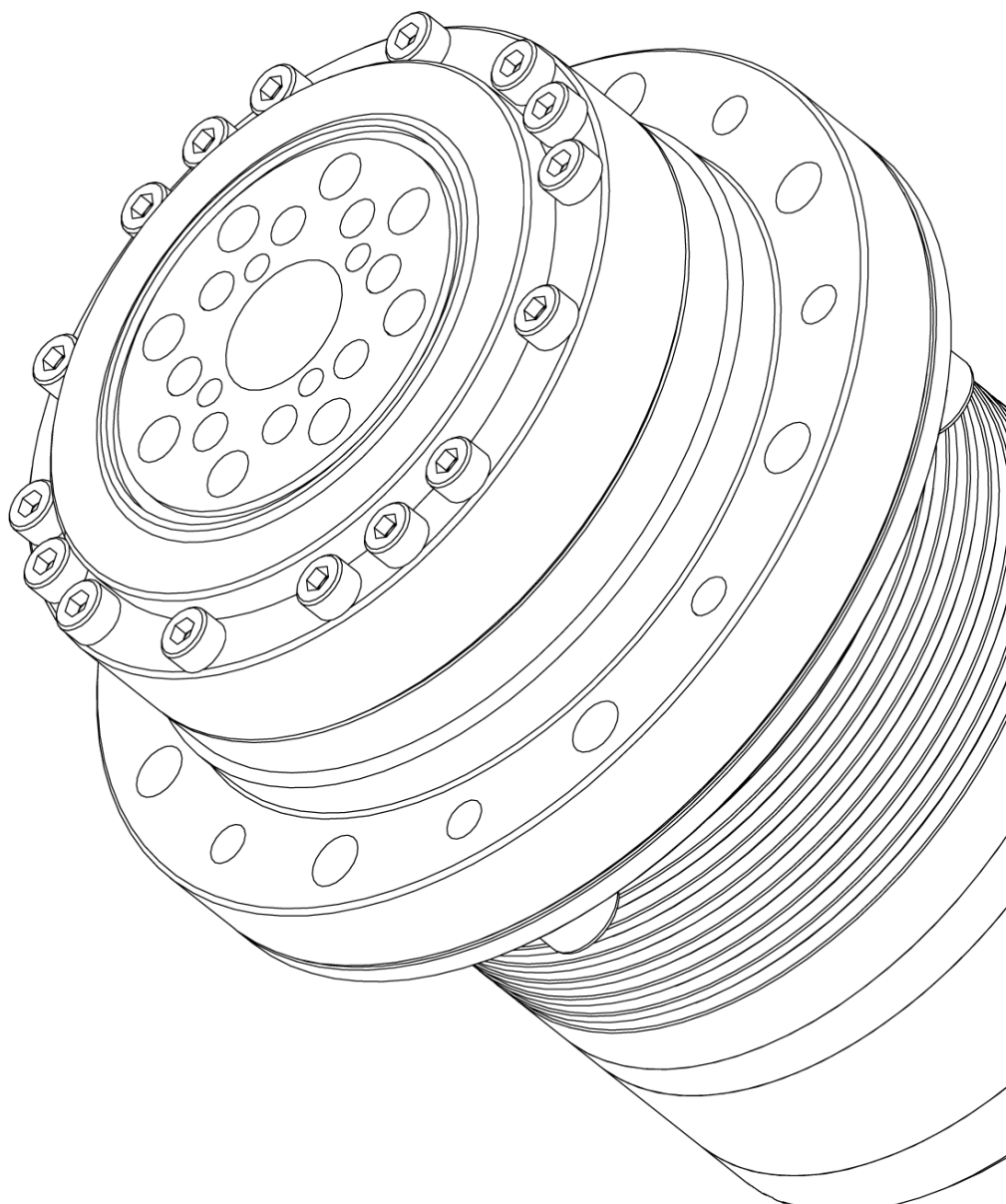


umbratek

ADRA ACTUATOR

USER MANUAL

HR / DD Type



DATE: APR 2022

VER: 0.2.1

Warnings and Note



DANGER

(May cause serious injury or death)

- Never place items containing water, flammables, and solvents near product.
- Never place fingers, arms, toes, and other body parts near product during operation.
- Cut power off if product emits strange odors or smoke.
- Keep product out of reach of children.
- Check the power's polarity before wiring.



CAUTION

(May cause injury or damage to product)

- Do not operate the product at a temperature exceeding -5 ~ +55 [°C] range.
- Do not insert sharp blades nor pins during product operation.



ATTENTION

(May cause injury or damage to product)

- Do not disassemble or modify product.
- Do not drop or apply strong shock to product.

Limitation of Liability

Any information given in this manual regarding safety must not be construed as a warranty by Umbratek that the ADRA actuator will not cause injury or damage even if all safety instructions are complied with.

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Features

Characteristics

High precision, zero backlash, complete models

Hollow design

Optional light weight, high rigidity or compact harmonic reducer

Drive, brake, servo motor, reducer integrated design (Customizable)

Umbratek Assistant

Online parameter setting

Calibration encoder

Test of each mode

Upgrade firmware online or offline

Real-time graphical curve and data display

Data Bus (RS485/CAN)

Up to 32 actuators can be connected on a Bus

RS485 up to 12us communication response time, up to 11.25Mbps communication rate (adjustable)

RS485 supports broadcast mode at the same time to send instructions to control multiple actuators

RS485 can simultaneously obtain feedback data from multiple actuators in broadcast mode

CAN interface up to 1Mbps communication rate

Development (open source)

SDK (Python, C/C++, C#)

ROS, ROS2

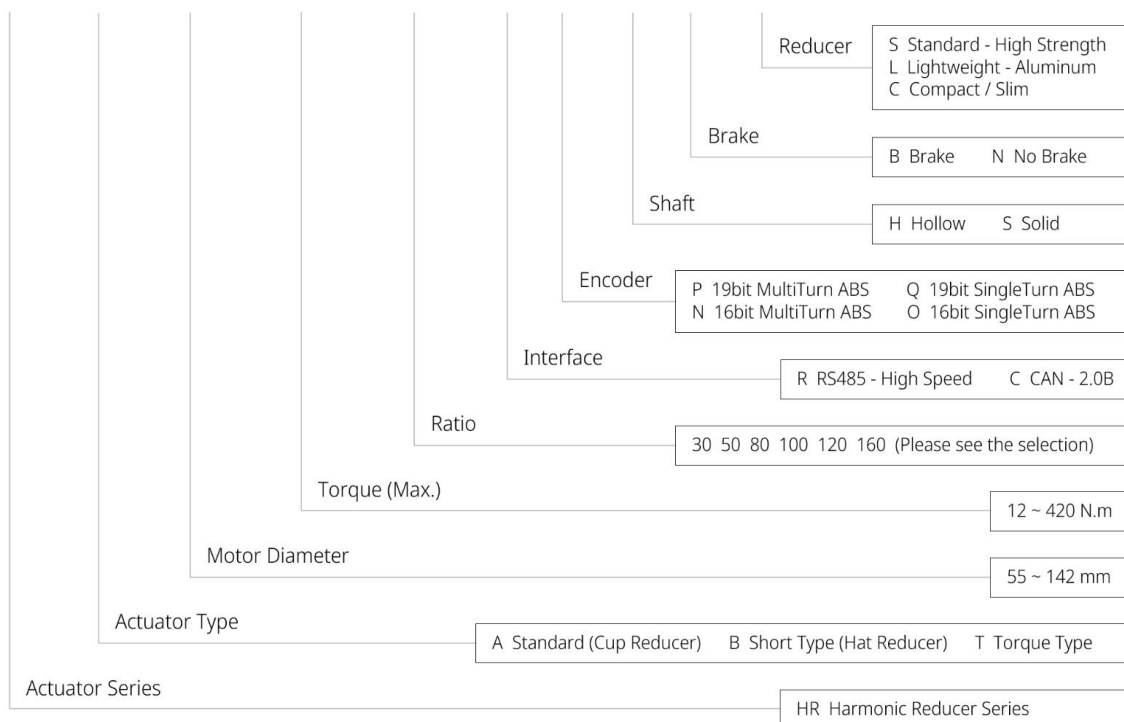
Arduino SDK

STM32 SDK

Selection and Specification

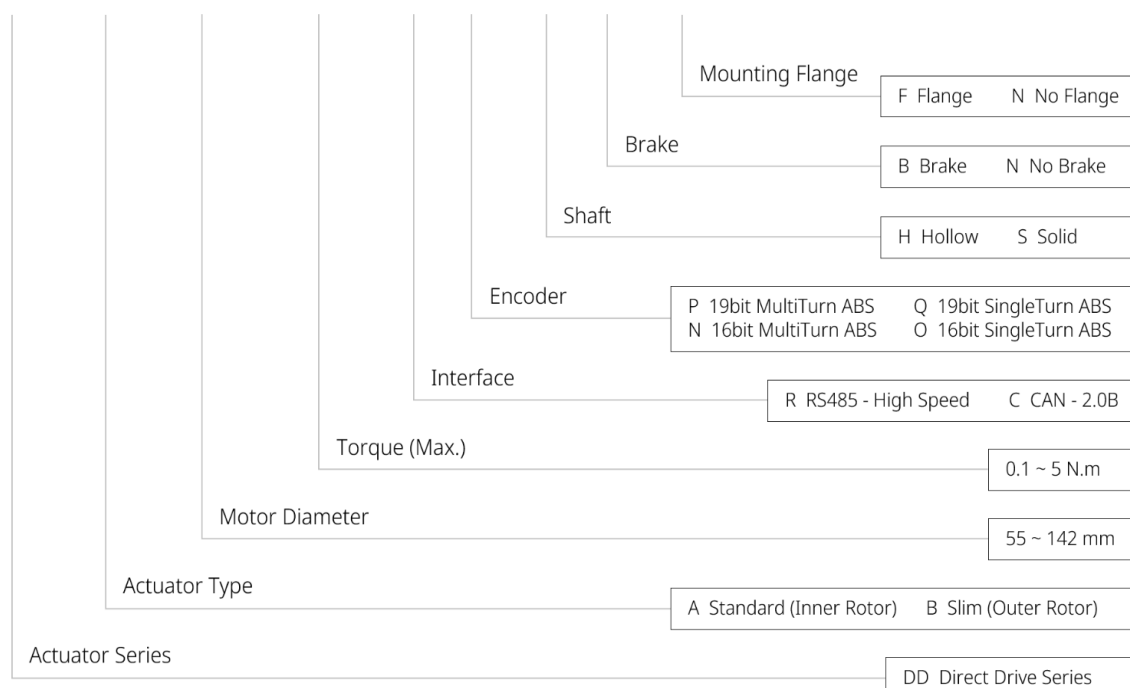
HR Series Model Rule

HR - A - 056 - 035 - 100 - R N - H B - L



DD Series Model Rule

DD - A - 055 - 005 - R N - H B - F



HR-A056 Technical Data (L/S Type Flange Reducer)

Ratio	50:1		80:1		100:1	
Reducer Type	Light Weight	High Strength	Light Weight	High Strength	Light Weight	High Strength
MAX Torque (N·m)	18	18	23	28	28	35
AVG Torque (N·m)	6.9	9	11	14	11	14
Rated Velocity (RPM)	68		43		34	
Inertia (kg·m²)	0.000014					
Rated Current (A _{RMS})	2.3	2.6	2.0	2.4	1.9	2.3
MAX Current (A _{RMS})	5.2	6.0	4.6	5.8	4.5	5.5
Weight - Brake (g)	790	990	790	990	790	990
Weight - No Brake (g)	695	895	695	895	695	895
Size (mm)	Motor d56, Flange D73, Height H86, Hole 7					
Power Voltage	Rated DC48V (Operating Range DC19-52V)					
Backup Battery	16bit Encoder Battery DC3V, 19bit Encoder Battery DC3.6V					
Standby Current	Driver < 35mA, Encoder Battery < 2.9uA					
Pole Pairs	7					
Backlash	±0.007° (±25 Arcsec)					
Encoder & Resolution	Multi-turn Absolute Magnetic Encoder, 65536 x Ratio (16bit) / 524288 x Ratio (19bit) Pulse/Rev.					
Interfaces	RS485 / CAN / Pulse / EtherNet (Add an External Module)					
Feedback	Position / Speed / Current / Voltage / Temperature					
Operating Mode	Torque / Velocity / Position					
Safety Design	Overload Protection, Over/Low voltage Protection, Temperature Protection, ESD Protection, Torque / Velocity / Position Protection					
Materials	Aviation Aluminum, Steel					
Ambient Conditions	Operation 5 to 40°C, Storage 0 to 45°C, Humidity 20 to 75% (non-condensing)					
Protection Rating	IP30					

HR-A063 Technical Data (L/S Type Flange Reducer)

Ratio	50:1		80:1		100:1	
Reducer Type	Light Weight	High Strength	Light Weight	High Strength	Light Weight	High Strength
MAX Torque (N·m)	34	35	43	56	54	70
AVG Torque (N·m)	26	34	27	35	39	51
Rated Velocity (RPM)	50		31		25	
Inertia (kg·m²)	0.000028					
Rated Current (A _{RMS})	5.0	5.3	4.0	5.0	3.9	5.0
MAX Current (A _{RMS})	10.9	11.5	8.6	11.2	8.5	11.0
Weight - Brake (g)	1030	1250	1030	1250	1030	1250
Weight - No Brake (g)	900	1120	900	1120	900	1120
Size (mm)	Motor d63, Flange D79, Height H94, Hole 7					
Power Voltage	Rated DC48V (Operating Range DC19-52V)					
Backup Battery	16bit Encoder Battery DC3V, 19bit Encoder Battery DC3.6V					
Standby Current	Driver < 35mA, Encoder Battery < 2.9uA					
Pole Pairs	10					
Backlash	±0.007° (±25 Arcsec)					
Encoder & Resolution	Multi-turn Absolute Magnetic Encoder, 65536 x Ratio (16bit) / 524288 x Ratio (19bit) Pulse/Rev.					
Interfaces	RS485 / CAN / Pulse / EtherNet (Add an External Module)					
Feedback	Position / Speed / Current / Voltage / Temperature					
Operating Mode	Torque / Velocity / Position					
Safety Design	Overload Protection, Over/Low voltage Protection, Temperature Protection, ESD Protection, Torque / Velocity / Position Protection					
Materials	Aviation Aluminum, Steel					
Ambient Conditions	Operation 5 to 40°C, Storage 0 to 45°C, Humidity 20 to 75% (non-condensing)					
Protection Rating	IP30					

HR-A072 Technical Data (L/S Type Flange Reducer)

Ratio	50:1		80:1		100:1		120:1	
Reducer Type	Light Weight	High Strength	Light Weight	High Strength	Light Weight	High Strength	Light Weight	High Strength
MAX Torque (N·m)	50	50	74	80	82	100	87	110
AVG Torque (N·m)	34	44	47	61	49	64	49	64
Rated Velocity (RPM)	40		25		20		17	
Inertia (kg·m²)	0.000061							
Rated Current (A _{RMS})	6.4	6.6	6.0	6.4	5.2	6.3	4.8	6.0
MAX Current (A _{RMS})	15.6	15.8	14.6	15.5	12.7	15.4	11.5	14.6
Weight - Brake (g)	1450	1790	1450	1790	1450	1790	1450	1790
Weight - No Brake (g)	1275	1615	1275	1615	1275	1615	1275	1615
Size (mm)	Motor d72, Flange D93, Height H101, Hole 10							
Power Voltage	Rated DC48V (Operating Range DC19-52V)							
Backup Battery	16bit Encoder Battery DC3V, 19bit Encoder Battery DC3.6V							
Standby Current	Driver < 35mA, Encoder Battery < 2.9uA							
Pole Pairs	10							
Backlash	±0.007° (±25 Arcsec)							
Encoder & Resolution	Multi-turn Absolute Magnetic Encoder, 65536 x Ratio (16bit) / 524288 x Ratio (19bit) Pulse/Rev.							
Interfaces	RS485 / CAN / Pulse / EtherNet (Add an External Module)							
Feedback	Position / Speed / Current / Voltage / Temperature							
Operating Mode	Torque / Velocity / Position							
Safety Design	Overload Protection, Over/Low voltage Protection, Temperature Protection, ESD Protection, Torque / Velocity / Position Protection							
Materials	Aviation Aluminum, Steel							
Ambient Conditions	Operation 5 to 40°C, Storage 0 to 45°C, Humidity 20 to 75% (non-condensing)							
Protection Rating	IP30							

HR-A086 Technical Data (L/S Type Flange Reducer)

Ratio	50:1		80:1		100:1		120:1		160:1	
Reducer Type	Light Weight	High Strength	Light Weight	High Strength	Light Weight	High Strength	Light Weight	High Strength	Light Weight	High Strength
MAX Torque (N·m)	98	100	137	160	157	200	167	217	176	229
AVG Torque (N·m)	55	72	87	113	108	140	108	140	108	140
Rated Velocity (RPM)	40		25		20		17		13	
Inertia (kg·m²)	0.000181									
Rated Current (A _{RMS})	12.5	13.0	10.9	12.7	10.0	12.6	9.0	11.7	7.0	9.0
MAX Current (A _{RMS})	30.1	31.7	26.6	31.0	24.2	31.0	22.0	28.5	17.1	22.2
Weight - Brake (g)	2800	3200	2800	3200	2800	3200	2800	3200	2800	3200
Weight - No Brake (g)	2500	2900	2500	2900	2500	2900	2500	2900	2500	2900
Size (mm)	Motor d86, Flange D107, Height H136, Hole 10									
Power Voltage	Rated DC48V (Operating Range DC38-52V)									
Backup Battery	16bit Encoder Battery DC3V, 19bit Encoder Battery DC3.6V									
Standby Current	Driver < 35mA, Encoder Battery < 2.9uA									
Pole Pairs	10									
Backlash	±0.007° (±25 Arcsec)									
Encoder & Resolution	Multi-turn Absolute Magnetic Encoder, 65536 x Ratio (16bit) / 524288 x Ratio (19bit) Pulse/Rev.									
Interfaces	RS485 / CAN / Pulse / EtherNet (Add an External Module)									
Feedback	Position / Speed / Current / Voltage / Temperature									
Operating Mode	Torque / Velocity / Position									
Safety Design	Overload Protection, Over/Low voltage Protection, Temperature Protection, ESD Protection, Torque / Velocity / Position Protection									
Materials	Aviation Aluminum, Steel									
Ambient Conditions	Operation 5 to 40°C, Storage 0 to 45°C, Humidity 20 to 75% (non-condensing)									
Protection Rating	IP30									

HR-A113 Technical Data (L/S Type Flange Reducer)

Ratio	50:1		80:1		100:1		120:1		160:1	
Reducer Type	Light Weight	High Strength	Light Weight	High Strength	Light Weight	High Strength	Light Weight	High Strength	Light Weight	High Strength
MAX Torque (N·m)	210	210	304	330	333	420	353	450	372	480
AVG Torque (N·m)	108	140	167	217	216	281	216	281	216	281
Rated Velocity (RPM)	30		19		15		13		10	
Inertia (kg·m²)	0.000546									
Rated Current (A _{RMS})	18.5	18.5	16.5	17.9	14.0	17.6	13.0	16.5	10.5	13.5
MAX Current (A _{RMS})	53.5	53.5	50.0	52.5	41.9	52.0	38.4	49.0	31.0	40.2
Weight - Brake (g)	4800	5800	4800	5800	4800	5800	4800	5800	4800	5800
Weight - No Brake (g)	4400	5400	4400	5400	4400	5400	4400	5400	4400	5400
Size (mm)	Motor d113, Flange D138, Height H147, Hole 10									
Power Voltage	Rated DC48V (Operating Range DC38-52V)									
Backup Battery	19bit Encoder Battery DC3.6V									
Standby Current	Driver < 35mA, Encoder Battery < 2.9uA									
Pole Pairs	14									
Backlash	±0.007° (±25 Arcsec)									
Encoder & Resolution	Multi-turn Absolute Magnetic Encoder, 524288 x Ratio (19bit) Pulse/Rev.									
Interfaces	RS485 / CAN / Pulse / EtherNet (Add an External Module)									
Feedback	Position / Speed / Current / Voltage / Temperature									
Operating Mode	Torque / Velocity / Position									
Safety Design	Overload Protection, Over/Low voltage Protection, Temperature Protection, ESD Protection, Torque / Velocity / Position Protection									
Materials	Aviation Aluminum, Steel									
Ambient Conditions	Operation 5 to 40°C, Storage 0 to 45°C, Humidity 20 to 75% (non-condensing)									
Protection Rating	IP30									

HR-A055/A062/A071 Technical Data (C Type Compact Reducer)

Model	HR-A055		HR-A062		HR-A071	
Reducer Type	Compact Type, Non-hollow and Flange					
Ratio	50:1	100:1	50:1	100:1	50:1	100:1
MAX Torque (N·m)	12	19	23	37	39	57
AVG Torque (N·m)	4.8	7.7	18	27	24	34
Rated Velocity (RPM)	70	35	52	26	44	22
Rated Current (A _{RMS})	1.1	1.4	1.9	2.8	3.3	4.1
MAX Current (A _{RMS})	2.2	3.2	4.2	6.3	7.2	9.3
Inertia (kg·m ²)	0.000014		0.000028		0.000061	
Weight - Brake (g)	770		1000		1415	
Weight - No Brake (g)	675		870		1240	
Size D x H (mm)	55 x 80		62 x 86		71 x 96	
Pole Pairs	7		10		10	
Power Voltage	Rated DC48V (Operating Range DC38-52V)					
Backup Battery	16bit Encoder Battery DC3V, 19bit Encoder Battery DC3.6V					
Standby Current	Driver < 35mA, Encoder Battery < 2.9uA					
Backlash	±0.007° (±25 Arcsec)					
Encoder & Resolution	Multi-turn Absolute Magnetic Encoder, 65536 x Ratio (16bit) / 524288 x Ratio (19bit) Pulse/Rev.					
Interfaces	RS485 / CAN / Pulse / EtherNet (Add an External Module)					
Feedback	Position / Speed / Current / Voltage / Temperature					
Operating Mode	Torque / Velocity / Position					
Safety Design	Overload Protection, Over/Low voltage Protection, Temperature Protection, ESD Protection, Torque / Velocity / Position Protection					
Materials	Aviation Aluminum, Steel					
Ambient Conditions	Operation 5 to 40°C, Storage 0 to 45°C, Humidity 20 to 75% (non-condensing)					
Protection Rating	IP30					

DD-A Series Technical Data (Direct Drive Actuator)

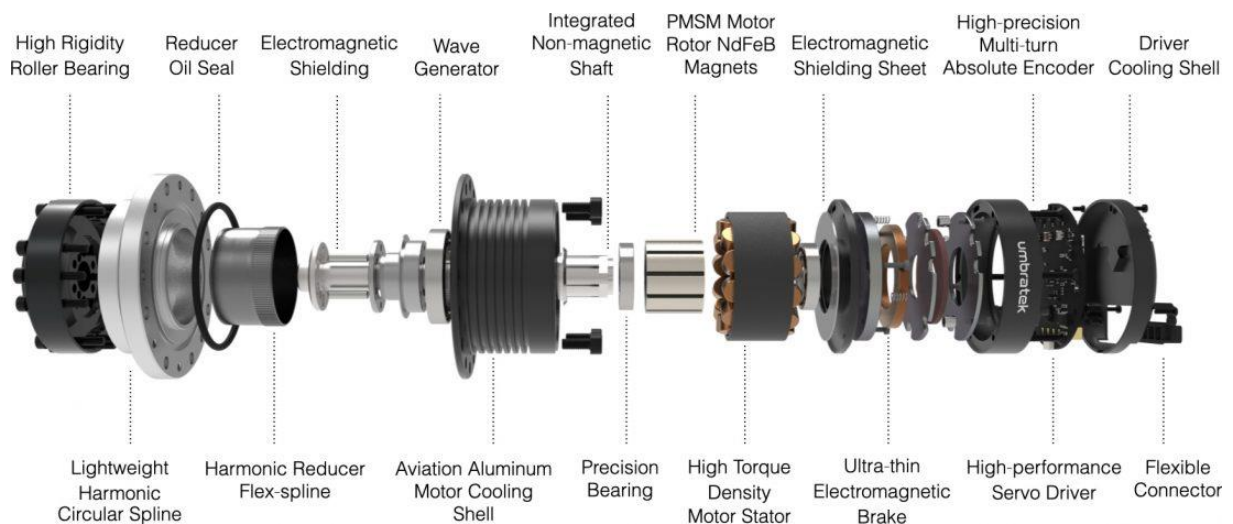
Model	A055	A056	A062	A063	A071	A072	A085	A086	A112	A113
MAX Torque (N·m)	1.10		2.50		2.70		5.90		8.35	
AVG Torque (N·m)	0.35		0.70		1.00		2.50		4.80	
Rated Velocity (RPM)	3500		2600		2200		2000		1500	
Inertia (kg·m ²)	0.000012		0.000023		0.000049		0.000150		0.000437	
Rated Current (A _{RMS})	2.3		5.0		6.3		12.6		19.0	
MAX Current (A _{RMS})	5.3		11.0		15.4		30.8		52.7	
Torque Constant (N·m / A)	0.0743		0.106		0.109		0.148		0.128	
Pole Pairs	7		10		10		10		14	
Weight - Brake (g)	417	420	540	539	763	765	1667	1680	2487	2500
Weight - No Brake (g)	322	325	410	409	588	590	1377	1390	2097	2110
Size (mm)	d55 H57	d56/D73 H54	d62 H62	d63/D79 H58	d71 H68	d72/D93 H64	d85 H95	d86/D107 H90	d112 H96.3	d113/D138 H91
Hole Diameter (mm)	7		7		10		10		10	
Axial/Radial Load (kN)	1.26/1.26		1.26/1.26		2.47/2.47		2.95/2.95		2.95/2.95	
Power Voltage	Rated DC48V (Range DC19-52V)						Rated DC48V (Range DC38-52V)			
Backup Battery	16bit Encoder Battery DC3V, 19bit Encoder Battery DC3.6V									
Standby Current	Driver < 35mA, Encoder Backup Battery < 2.9uA									
Encoder & Resolution	Multi-turn Absolute Magnetic Encoder, 65536 (16bit) / 524288 (19bit) Pulse/Rev.									
Interfaces	RS485 / CAN / Pulse / EtherNet (Add an External Module)									
Feedback	Position / Speed / Current / Voltage / Temperature									
Operating Mode	Torque / Velocity / Position									
Safety Design	Overload Protection, Over/Low voltage Protection, Temperature Protection, ESD Protection, Torque / Velocity / Position Protection									
Materials	Aviation Aluminum, Steel									
Ambient Conditions	Operation 5 to 40℃, Storage 0 to 45℃, Humidity 20 to 75% (non-condensing)									
Protection Rating	IP30									

Introduction

Description

Each ADRA Actuator is built to last and comes with a high-precision harmonic reducer made of high-strength aviation aluminum and high-carbon chromium steel. A high-torque density, and compact structure, enable the motor to be integrated into the actuator and lessens the actuator weight.

Actuator integrated design, also equipped with brake, off-axis multi-turn absolute encoder, high-performance driver, FOC controller and ADRC controller. with DC bus over-voltage, DC bus under-voltage, current overload, motor over-temperature, motor under-temperature, reverse connection, short circuit, blocking and other protection functions.



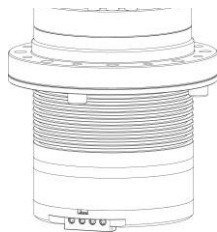
Warning

1. Do not charge the battery.
2. Ensure all the cables are properly connected
3. Ensure the actuator is securely mounted
4. Avoid damage to the cables or wires, as it may negatively affect the performance.
5. The temperature of motor would keep rising when the output torque is high. Although this is normal, take caution to avoid overheating
6. Please use the actuator strictly in accordance with the operating environment and the maximum allowable temperature range specified in this document
7. DO NOT disassemble the actuator, as this may negatively affect the accuracy of the motor and may lead to permanent malfunction.

8. Always keep the actuator away from strong magnetic environment, iron products and other magnetic materials when installing or using, otherwise the actuator may start to vibrate violently.
9. Store the actuator and accessories in a dry, ventilated and clean environment under room temperature.
10. Avoid impact and dramatic vibration during transportation, loading and unloading.

Packing List

1. Actuator x 1



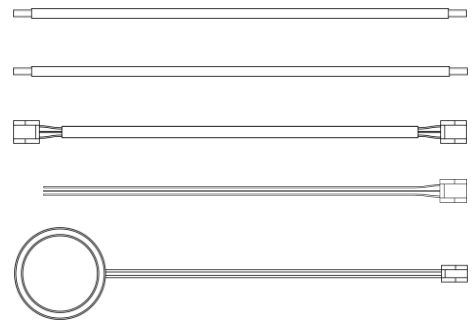
2. Power Cable (Red) x1

3. Power Cable (Black) x1

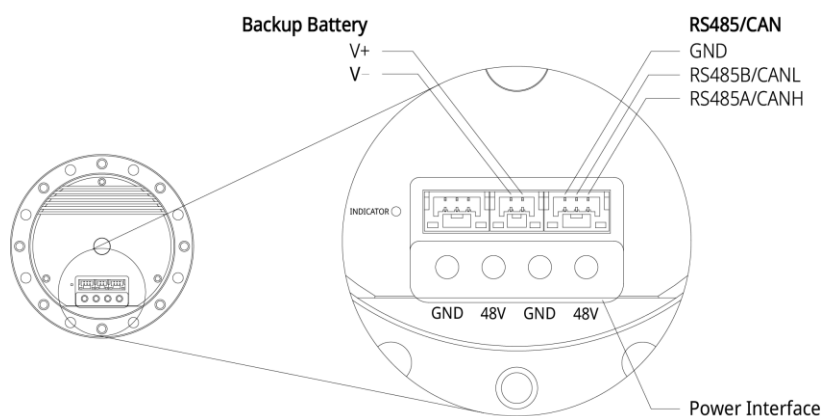
4. Dual-plug Data Cable x1

5. Single-plug Data Cable x1

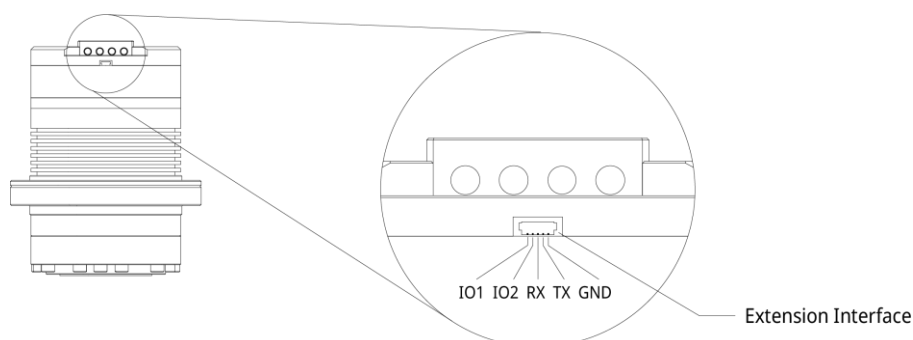
6. Backup Battery x1



Define of Interface



Power and Communication Interfaces



Extended Interfaces

Power Interfaces

Connect the actuator to a DC48V power supply through power cables. Each actuator integrates double power supply interface, multiple actuators can be used in series. The cable diameter (Conductor) of the interface is 2.5mm.

RS485/CAN Interfaces

Connect the RS485/CAN interface to the external control device through signal cable. Through RS485/CAN, the external control device can send control instructions to the actuator and get feedback from the actuator. The default baud rate for the RS485 bus is 921600bps, and the default baud rate for the CAN bus is 1Mbps. Each actuator has two parallel interfaces, and multiple actuators can be used in series. The model of the interface seat is BM03B-GHS-TBT.

Battery Interfaces

Through this interface, an external battery can be used to power the multi-turn encoder. Note that you need to use Umbratek Assistant to calibrate the encoder every time you plug in the battery (Assistant will automatically prompt you to connect the actuator, just follow the prompts). The model of the interface seat is BM02B-GHS-TBT.

Extend I/O Interfaces

The extended I/O port provides pulse signal control and high-speed debugging data output. For details, see "Extended I/O". The type of the interface seat is SM05B-SURS-TF, and can be connected using a type 05SUR-32S connector.

Indicator LED

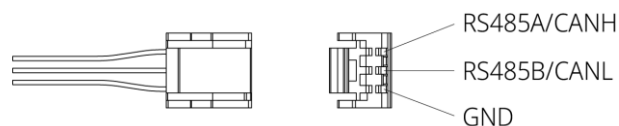
Indicates the current status of the actuator. See "Indicator" for details.

Power Cable

Red: +48V

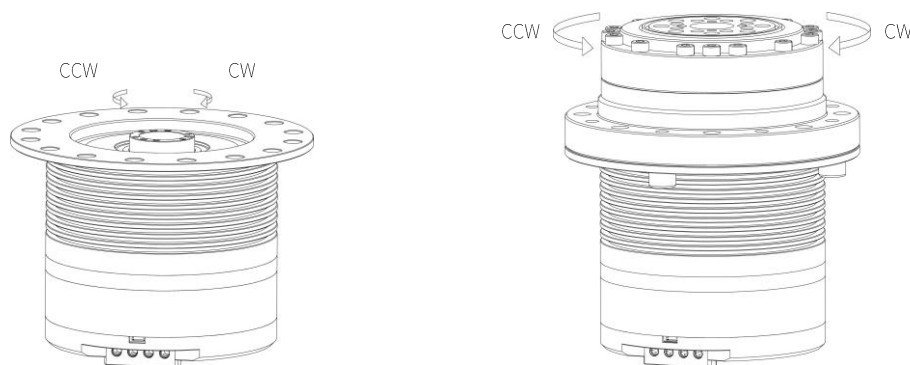
Black: GND

RS485/CAN Cable



Connector type: GHR-03V-S (pitch 1.25mm 3Pin)

Rotation Direction



Direction of actuator rotation

When viewed from the top of the output axis: counterclockwise rotation (CCW) is called the positive direction (+) and clockwise rotation (CW) is called the reverse direction (-).

Status LED

The status LED is used to indicate the operational status of the motor. Note: the driver automatically cuts off the output stream when it is in abnormal status.

Indicator	Status	Description
Breathing	Normal	Standby
Always on	Normal	Enabled
Blinks 3Hz	Fault	Error, check error code
Blinks 10Hz	Normal	Boot mode

Extended I/O

The interfaces are IO1, IO2, RX, TX and GND from left to right. Note that the extended I/O is an I/O with a TTL level of 3.3~5V. Different modes have different functions as well as input and output features.

1. Pulse Position Mode (Not released yet, need to update the firmware)

IO1: TTL input mode, controls the actuator movement direction. High level is in the positive direction and low level is in the opposite direction.

IO2: TTL input mode, controls the actuator movement Angle. Each pulse movement 360/65535 degrees.

RX: TTL input mode, controls actuator enable status. High level enables actuator, low level disables actuator.

TX: TTL output mode, debugging information output serial port. For details, see “debugging COM Information”.

2. Position/Speed/Torque Mode (Not released yet, need to update the firmware)

IO1: TTL output mode, encoder ABZ output phase A.

IO2: TTL output mode, encoder ABZ output phase B.

RX: TTL output mode. High level indicates that the actuator is enabled, and low level indicates that the actuator is disabled.

TX: TTL output mode. debugging information output serial port. For details, see “debugging COM Information”.

3. Debug Mode (Not released yet, need to update the firmware)

IO1: TTL output mode, test the current sampling time of the current loop. High level indicates the start of sampling, low level indicates the end of sampling.

IO2: TTL output mode, test the calculation start and end time of position/speed loop. High level indicates the start of calculation, low level indicates the end of calculation.

RX: TTL output mode, test the encoder sampling time. High level indicates the start of sampling, low level indicates the end of sampling.

TX: TTL output mode. debugging information output serial port. For details, see “debugging COM Information”.

Umbratek Assistant

Preparations

As an app dedicatedly designed for Umbratek Components. Compatible with the ADRA Series, FLXI Series, Communication Modules and more. Umbratek Assistant is compatible with a variety of operating systems, including Windows, MacOS and Linux.

1. Download and install Umbratek Assistant from the official website:

<https://www.umbratek.com/download-center>

2. Select a tool based on the interface type of the actuator (USB-RS485 / USB-CAN / EtherNet-RS485 / EtherNet-CAN), connect the actuator to the computer. DataLink series high-speed modules are available from Umbratek



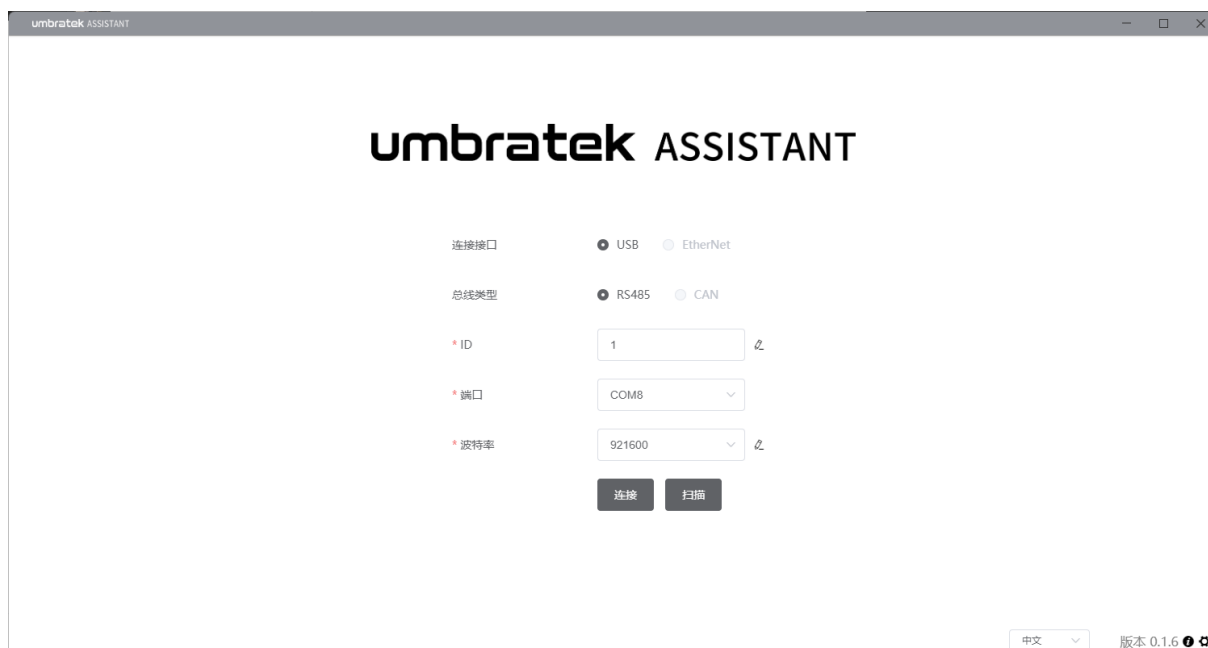
3. Start Umbratek Assistant
4. Scan and connect the ADRA actuator to enter the control interface, see "actuator connection" for details
5. Use Assistant to test, tune, calibrate, or upgrade the actuator, as described in the following sections.

Actuator Connection

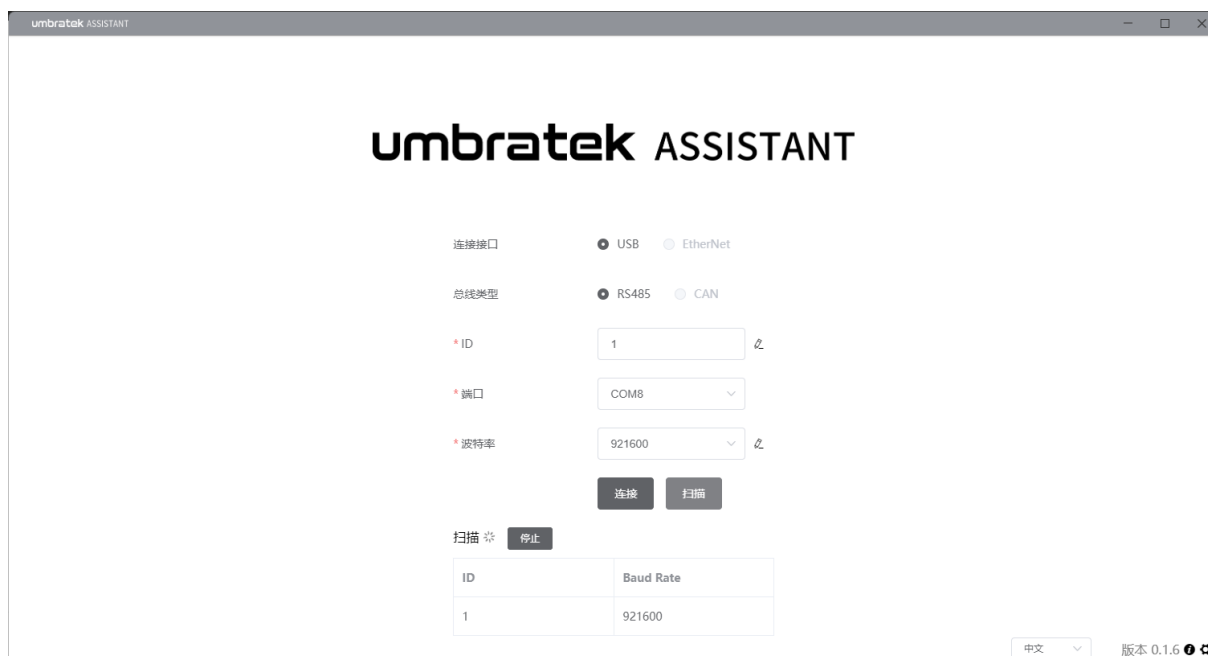
1. Select USB or EtherNet to connect the communication device to the computer. (Figure: Assistant connection interface 1)
2. Click "Scan", the software will automatically identify the computer port, actuator ID, actuator baud rate. When the actuator is identified, it will be displayed in a list. The ID, port, and baud rate of the interface will also be automatically set. (Figure: Assistant connection interface 2)
3. Click Connect to connect the first actuator in the list.

Note: If you use the encoder battery for the first time or replace/plug the encoder battery for the first

time, you will be reminded that the multi-turn encoder is abnormal when connecting to Assistant. You only need to calibrate the encoder as prompted by the software, and power on the actuator again after calibration.



Assistant Connection Interface 1



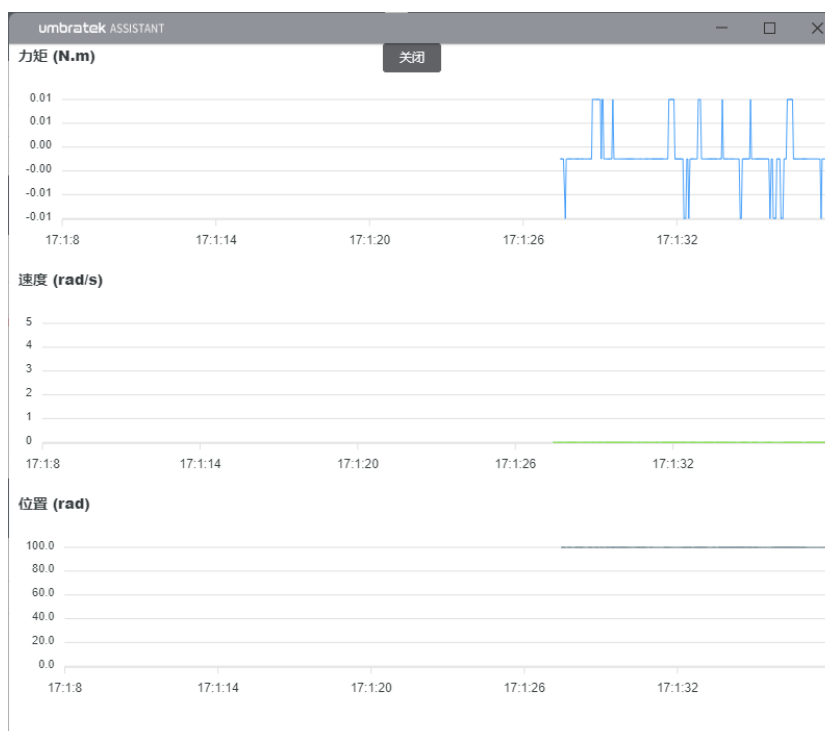
Assistant Connection Interface 2

Indicator

1. In the following figure, the status bar on the right will display the current status: battery voltage, actuator voltage, current, temperature, torque, speed, position and reduction ratio. The data will be refreshed at a frequency of 2Hz.
2. The oscilloscope button is in the upper right corner of the status bar. Click it to display the current position, speed and torque of the actuator in real time in the form of curves.

状态		🔍
母线电压	47.79 V	
母线电流	0.00 A	
多圈编码器电压	(正常电量)2.60 V	
电机温度	27.00°C	
当前力矩	-0.01 N.m	
当前速度	-0.003 rad/s	
当前位置	99.899 rad	
执行器减速比	1.00	

Assistant Actuator Status



Assistant Status Oscillograph

Position Mode

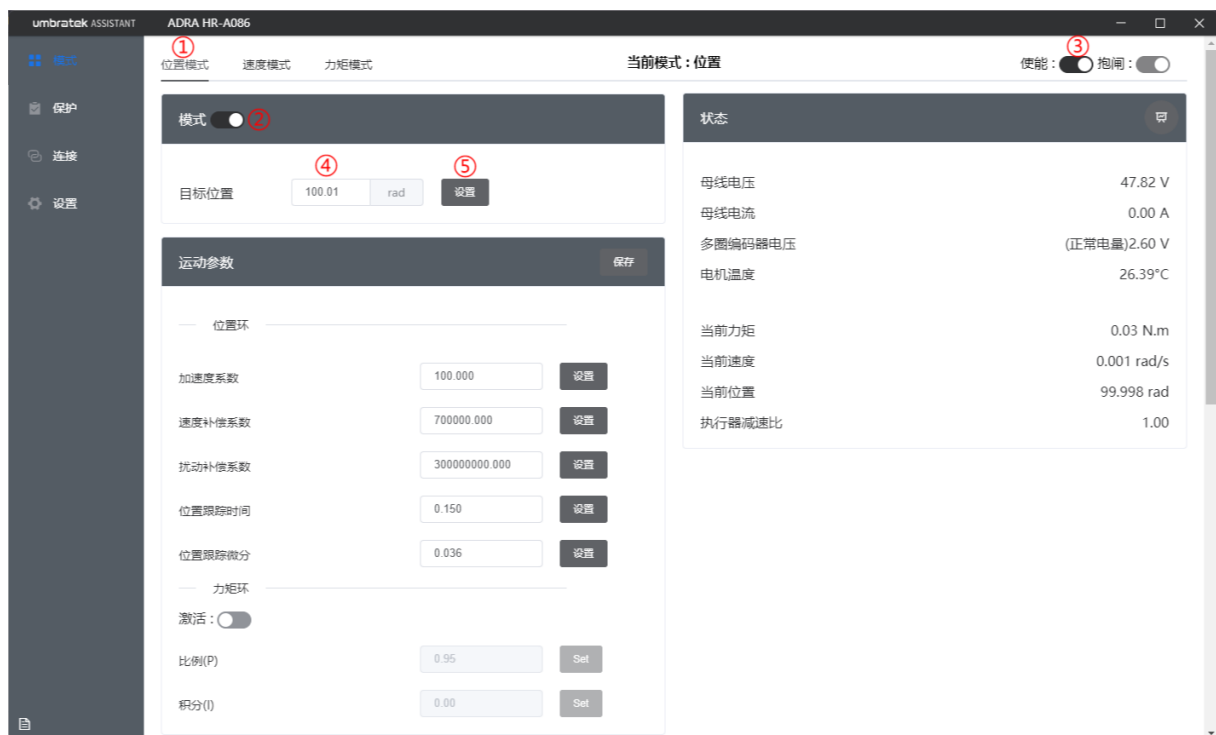
Function: When the target position is set, the actuator will move to the target position at the maximum speed that has been set. If multiple target points are set, regardless of whether the actuator moves to the previously set target position, it will abandon the previous target point and move to the last set target position at the maximum speed that has been set.

Velocity planning: acceleration and deceleration planning is similar to s-curve at start and stop, and the acceleration is proportional to the parameter "acceleration coefficient".

Max speed: The factory default value is the maximum speed of the actuator. You need to adjust this parameter based on your requirements.

Assistant Quick Test

- ① Select position mode => ② Enable the current mode => ③ Enable actuator => ④ Input target position => ⑤ Set the target position



Assistant Position Mode

Steps for API usage

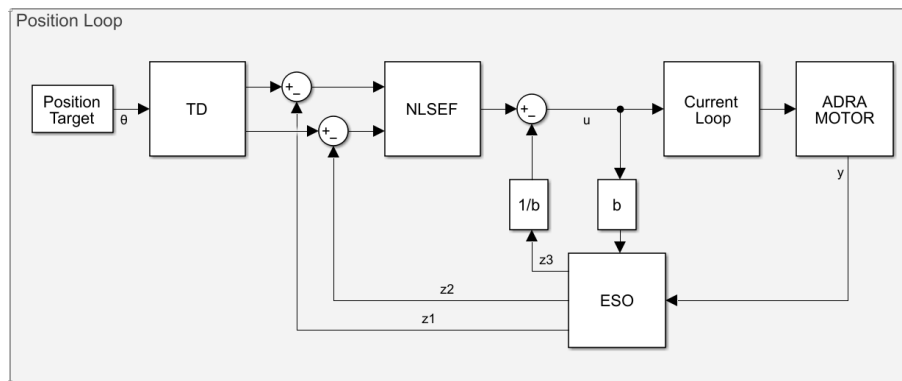
1. Set motion mode to position mode `set_motion_mode()`
2. Enable the actuator `set_motion_enable()`
3. Set target position `set_pos_target()`

Note: See "SDK API" for details. There are routines in source code and documentation for reference.

Control Algorithms

The position loop of the ADRA series actuators supports Active Disturbance Rejection Control (ADRC)

and Proportion Integration Differentiation (PID) control algorithms. The factory default algorithm is ADRC algorithm.



Position Loop ADRC Algorithms

Parameters Bar

1. Display and set motion/general parameters of the position loop.
2. All parameters of the actuator will be refreshed every time you enter the "Position Mode" interface.
3. The parameters will take effect immediately after being set. Please pay attention to whether the parameters are reasonable. If the parameters are inappropriate, the actuator will vibrate violently or even break.
4. Click save after parameter setting, otherwise the setting will be lost after power off.

Parameter	Description
Acceleration Coefficient	Acceleration coefficient of position loop. The smaller the value, the smaller the acceleration, the gentler the start and stop. The acceleration and deceleration of actuator motion will carry out speed planning similar to S curve, and this coefficient adjusts the magnitude of acceleration and deceleration of S curve speed planning.
Speed Compensation Coefficient	Velocity compensation coefficient of position loop. The higher the value, the stronger the velocity tracking, and the more pronounced the vibration/jitter may be
Interference Compensation	Disturbance compensation coefficient of position loop. The higher the value, the stronger the position rigidity, and the more pronounced the vibration/jitter may be.
Position Tracking Time	Position tracking time of position loop. The higher the value, the slower the position tracking, the weaker the position rigidity. Similar to the PID parameter P (ratio), but opposite to the polarity of P (larger P, more rigid).
Position Tracking Differential	Position tracking differential of position loop. D, like PID.
KP	Proportional parameters of the current loop. (The activation button needs to be enabled for setting operation)

KI	Integral parameter of current loop. (The activation button needs to be enabled for setting operation)
Max Diff	Maximum tracking error allowed by position. If the error between the current position and the planned position is greater than this value, the actuator will report an error.
Smooth Cycle	Position command smoothing cycle. If set to N, after a new target position is set, each position control period only takes effect for 1/N relative target positions. The larger the value, the smoother the motion and slower the response.
Electronic Ratio	Electron deceleration ratio N. The default value is 1. If set to N, the actual moving position = target position *N.

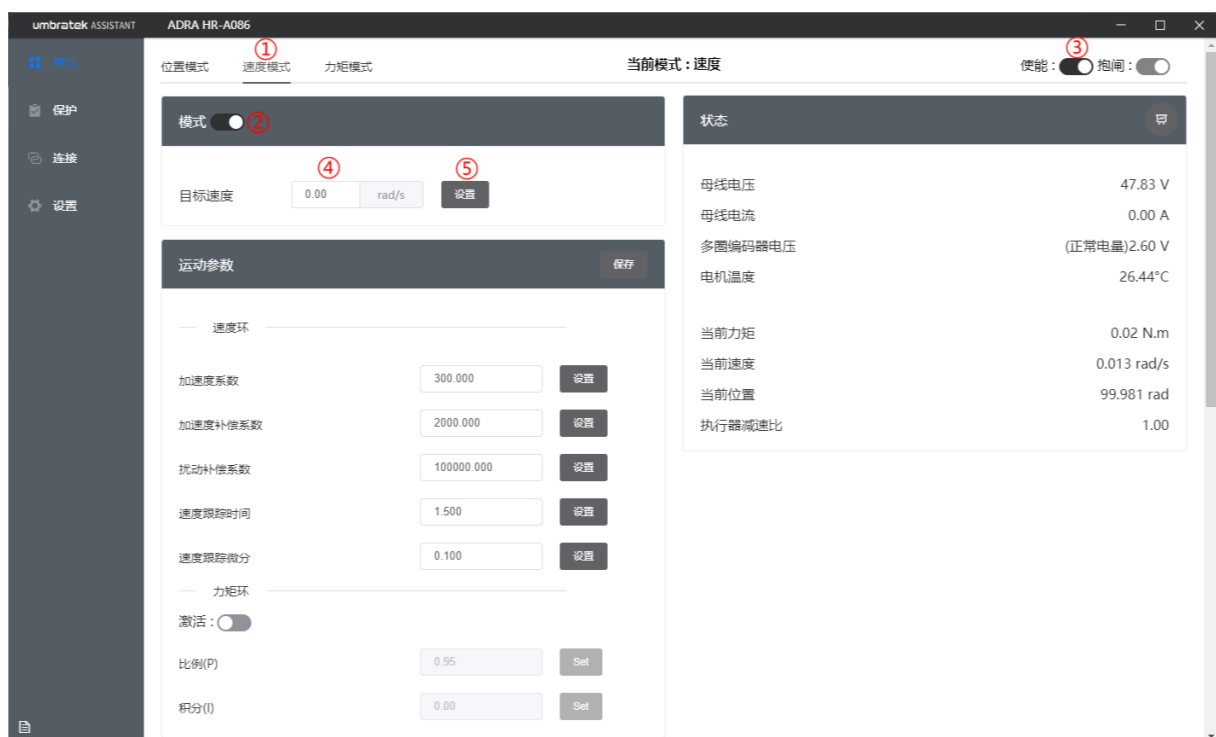
Speed Mode

Function: When the target speed is set, the actuator will run at that speed constantly.

Velocity planning: The acceleration and deceleration planning of the start and stop is similar to the S-curve, and the acceleration is proportional to the parameter "acceleration coefficient".

Assistant Quick Test

①Select speed mode => ②Enable the current mode => ③Enable actuator => ④Input target velocity => ⑤Set the target velocity



Assistant Speed Mode

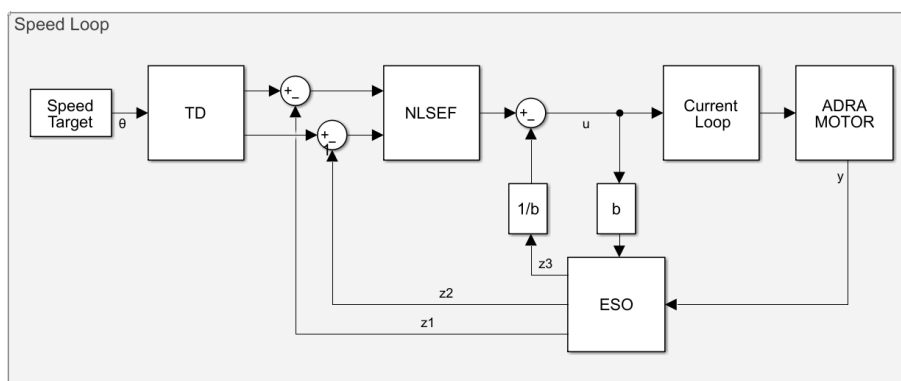
Steps for API Usage

1. Set motion mode to speed mode `set_motion_mode()`
2. Enable the actuator `set_motion_enable()`
4. Set target velocity `set_vel_target()`

Note: See "SDK API" for details. There are routines in source code and documentation for reference.

Control Algorithms

The Speed loop of the ADRA series actuators supports Active Disturbance Rejection Control (ADRC) and Proportion Integration Differentiation (PID) control algorithms. The factory default algorithm is ADRC algorithm.



Speed Loop ADRC Algorithms

Parameters Bar

1. Display and set motion/general parameters of the Speed loop.
2. All parameters of the actuator will be refreshed every time you enter the "Speed Mode" interface.
3. The parameters will take effect immediately after being set. Please pay attention to whether the parameters are reasonable. If the parameters are inappropriate, the actuator will vibrate violently or even break.
4. Click save after parameter setting, otherwise the setting will be lost after power off.

Parameter	Description
Acceleration Coefficient	Acceleration coefficient of speed loop. The smaller the value, the smaller the acceleration, the gentler the start and stop. The acceleration and deceleration of actuator motion will carry out speed planning similar to S curve, and this coefficient adjusts the magnitude of acceleration and deceleration of S curve speed planning.
Acceleration Compensation Coefficient	Acceleration compensation coefficient of speed loop. The higher the value, the stronger the velocity tracking, and the more pronounced the vibration/jitter may be
Interference Compensation	Disturbance compensation coefficient of speed loop. The higher the value, the stronger the speed rigidity, and the more pronounced the vibration/jitter may be.
Speed Tracking Time	Speed tracking time of speed loop. The higher the value, the slower the speed tracking, the weaker the speed rigidity. Similar to the PID parameter P (ratio), but opposite to the polarity of P (larger P, more rigid).
Speed Tracking Differential	Speed tracking differential of position loop. D, like PID.

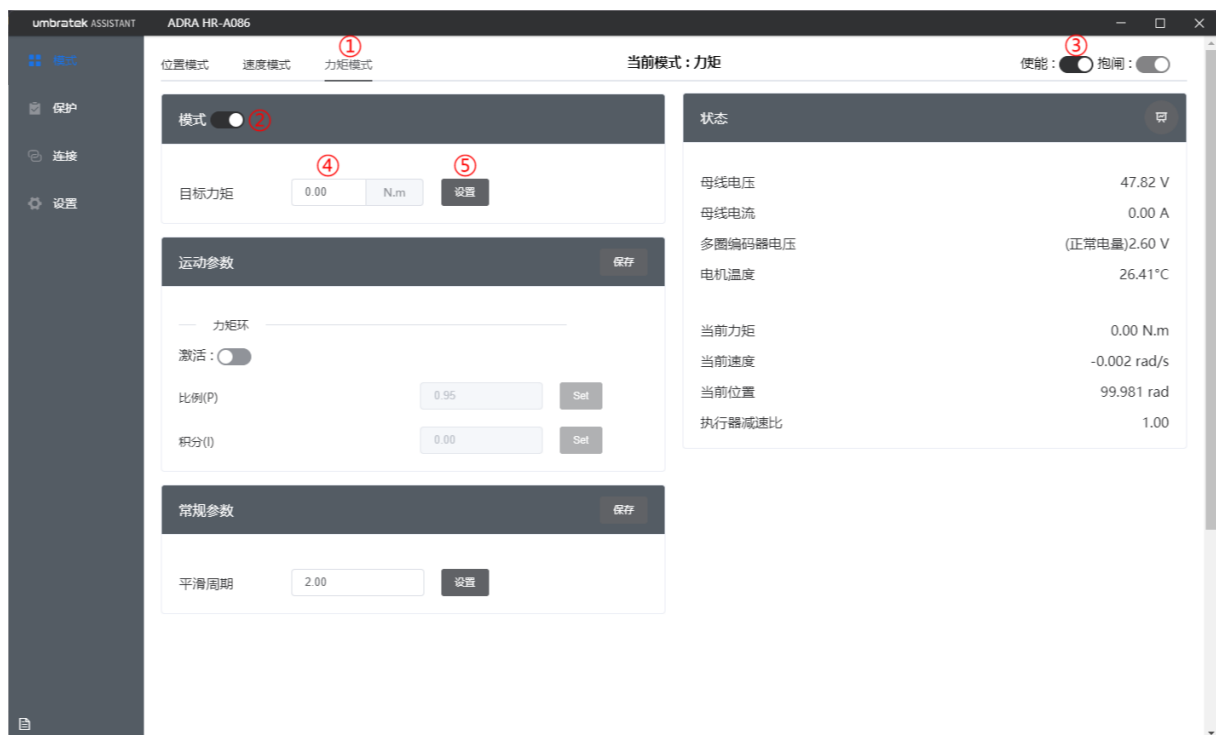
KP	Proportional parameters of the current loop. (The activation button needs to be enabled for setting operation)
KI	Integral parameter of current loop. (The activation button needs to be enabled for setting operation)
Smooth Cycle	Speed command smoothing cycle. If set to N, after a new target speed is set, each speed control period only takes effect for 1/N relative target speed. The larger the value, the smoother the motion and slower the response.
Electronic Ratio	Electron deceleration ratio N. The default value is 1. If set to N, the actual moving speed = target speed *N.

Torque Mode

Function: When the target torque is set, the actuator will output that torque. If the load is not enough, it may continue to accelerate until an error is reported.

Assistant Quick Test

①Select torque mode => ②Enable the current mode => ③Enable actuator => ④Input target torque => ⑤Set the target torque



Assistant Torque Mode

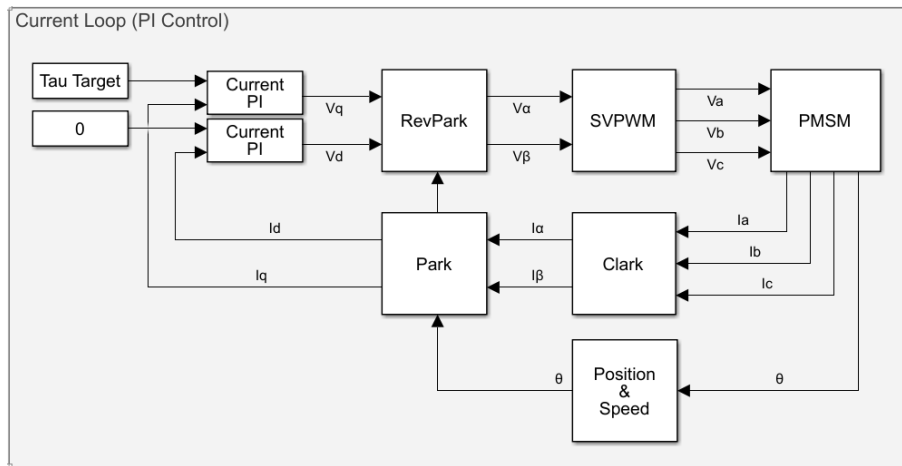
Steps for API Usage

1. Set motion mode to torque mode `set_motion_mode()`
2. Enable the actuator `set_motion_enable()`
3. Set target torque `set_tau_target()`

Note: See "SDK API" for details. There are routines in source code and documentation for reference.

Control Algorithms

The torque loop of the ADRA series actuators supports Active Disturbance Rejection Control (ADRC) and Proportion Integration Differentiation (PID) control algorithms. The factory default is PID control algorithm.



Torque Loop ADRC Algorithms

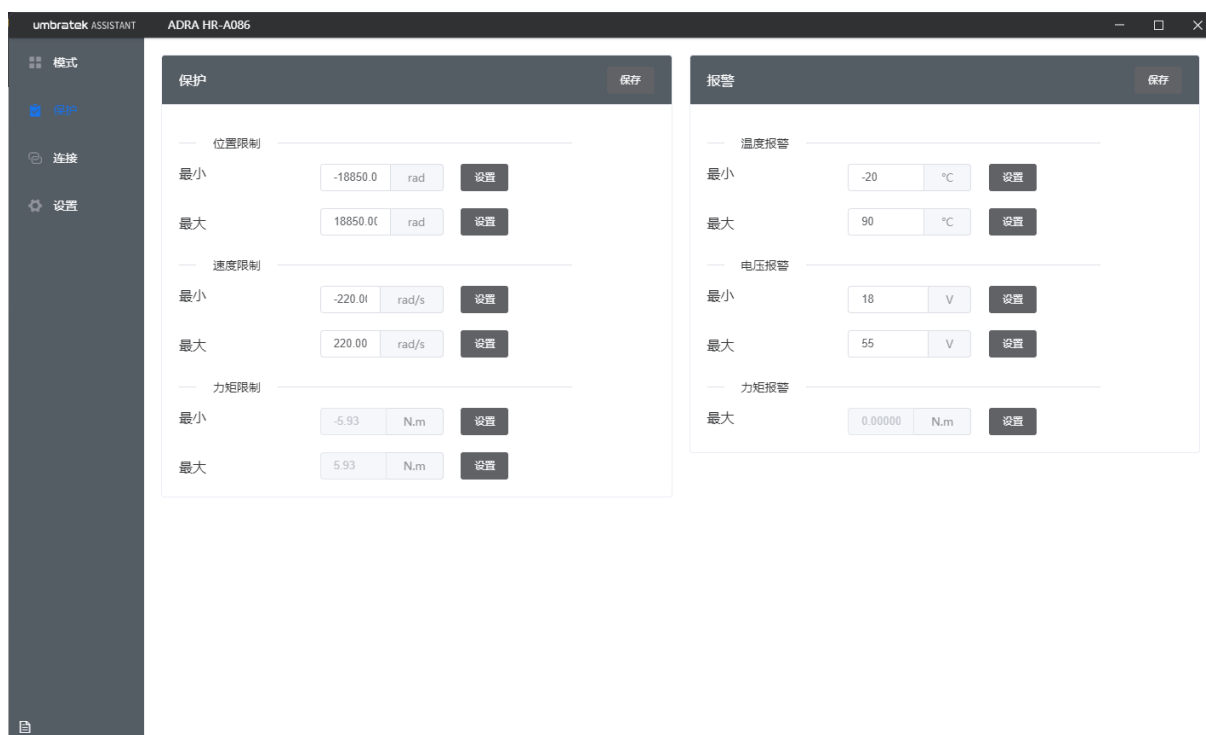
Parameters Bar

1. Display and set motion/general parameters of the torque loop.
2. All parameters of the actuator will be refreshed every time you enter the "Torque Mode" interface.
3. The parameters will take effect immediately after being set. Please pay attention to whether the parameters are reasonable. If the parameters are inappropriate, the actuator will vibrate violently or even break.
4. Click save after parameter setting, otherwise the current setting will be lost after power off.

Parameter	Description
KP	Proportional parameters of the current loop. (The activation button needs to be enabled for setting operation)
KI	Integral parameter of current loop. (The activation button needs to be enabled for setting operation)
Smooth Cycle	Torque command smoothing cycle. If set to N, after a new target torque is set, each torque control period only takes effect for 1/N relative target torque. The larger the value, the smoother the motion and slower the response.

Security Parameters

1. Set security protection parameters for the actuator.
2. The parameters will take effect immediately after being set. Please pay attention to whether the parameters are reasonable. If the parameters are inappropriate, the actuator will vibration violently or even be damaged.
3. Click save after parameter setting, otherwise the current setting will be lost after power off.



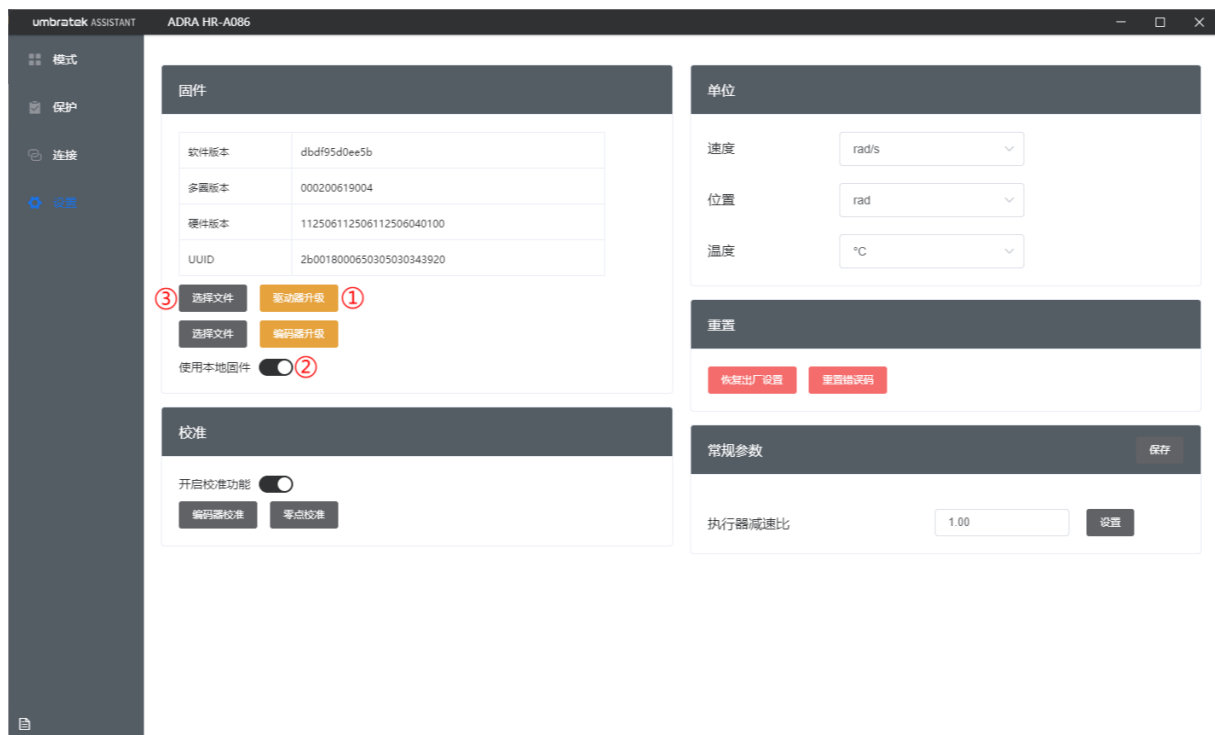
Assistant Safety Interface

Parameter	Description
Min Position Limit	Position minimum value. This applies to position mode, but not to speed and torque mode
Max Position Limit	Position maximum value. This applies to position mode, but not to speed and torque mode
Min Speed Limit	Speed minimum value. This applies to position and speed modes, but not to torque modes
Max Speed Limit	Speed maximum value. This applies to position and speed modes, but not to torque modes
Min Torque Limit	Torque minimum value. This applies to position, speed and torque modes. (This parameter has not been published yet)
Max Torque Limit	Torque maximum value. This applies to position, speed and torque modes. (This

	parameter has not been published yet)
Min Temperature Error	Minimum temperature error. If the temperature is lower than this value, the actuator reports an error.
Max Temperature Error	Maximum temperature error. If the temperature is higher than this value, the actuator reports an error.
Min Voltage Error	Minimum voltage error. If the voltage is lower than this, the actuator will report an error.
Max Voltage Error	Maximum voltage error. If the voltage is higher than this, the actuator will report an error.
Max Torque Error	Maximum torque error. If the torque is higher than this, the actuator will report an error.

Firmware Update

Upgradeable actuator firmware and multiturn encoder firmware. Multiturn encoder firmware normally does not need to be upgraded. You can view the current actuator firmware version in Software Version under Firmware, and determine whether to update the firmware based on the firmware published on the official website.



Firmware Upgrade Interface

Online Upgrade Actuator

1. Click ① "Upgrade Driver" to upgrade the firmware as prompted.
2. After entering the upgrade mode, the LED will blink quickly. After about 3 seconds, the LED will blink slowly, indicating that the upgrade is in progress. After the upgrade is complete, the indicator turns to breathing. (If the indicator still blinks slowly, determine whether the upgrade is complete according to the prompts of the software.)
3. Do not power off or disconnect communication during the upgrade. Otherwise, the upgrade may fail or the online firmware upgrade cannot be restored.
4. After upgrade, please power on the actuator again and check parameters that has been set. You may need to reset parameters if the previous setting has been cleared.

Abnormal situation

1. If the online upgrade fails due to an interruption during the upgrade, you can use the local upgrade

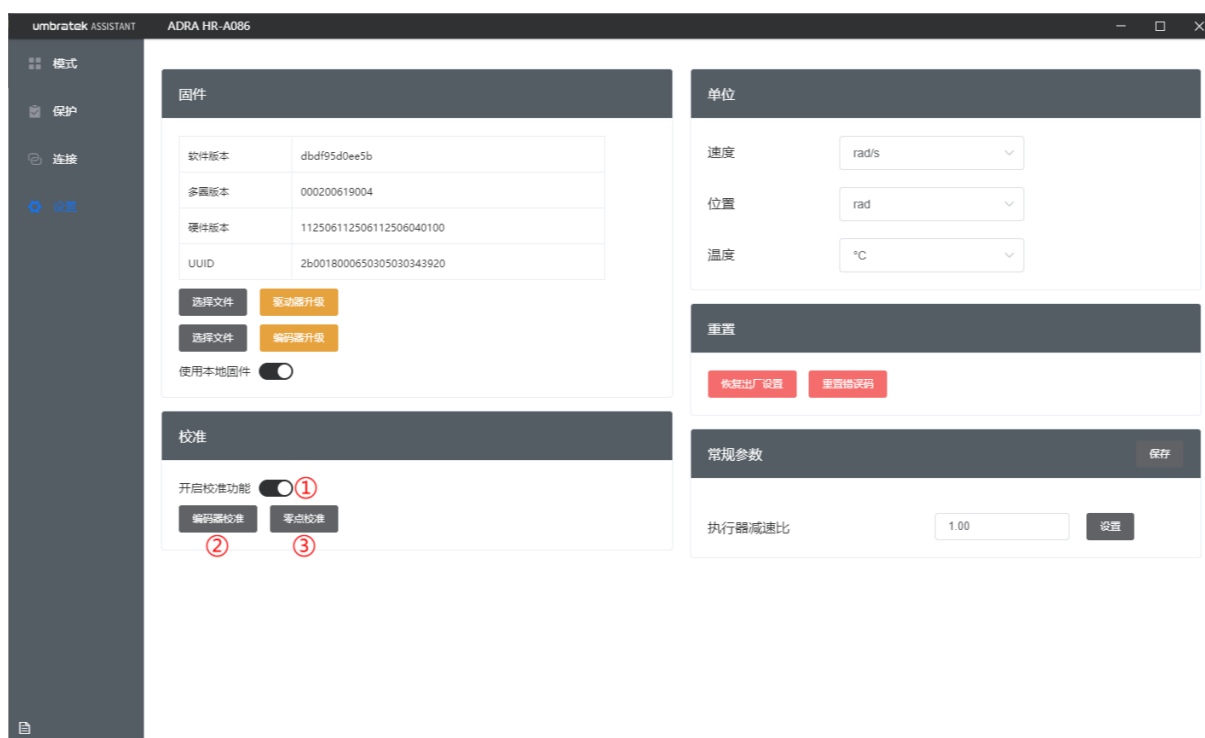
to upgrade the firmware and restore it.

2. Download the firmware of your actuator type from the official website.
3. Enable the ②“local update” button.
4. Select the actuator firmware file.
5. Click ①“Upgrade Driver” to upgrade the firmware as prompted.
6. For follow-up operations, see Step 1 to Step 4 in Online Firmware Upgrade for an Actuator.

Actuator Calibration

Encoder and zero position can be calibrated. (Only 16bit encoder version supports encoder calibration, 19bit encoder can only be returned to factory calibration)

The encoder of the actuator has been calibrated and strictly tested before delivery. Normally users do not need to perform encoder calibration. However, if the actuator is abnormal, such as after an impact or going through abnormal vibration that caused by unreasonable parameter Settings, try to calibrate the encoder to repair it.



Calibration Interface

Steps for Encoder Calibration

1. Enable ①“Turn On calibration”
2. Click ②“encoder Calibration”, and the calibration time is about 5 minutes according to the software prompt.
3. After the software prompts completion of calibration, please power on again before use.
4. Do not power off or cut off communication during the upgrade. Otherwise, the encoder calibration

may be failed.

5. If the calibration fails or other interruptions occur during the calibration, power on and calibrate again until the software prompts that the calibration succeeds.

Step of Zero Calibration

1. Click ③ “Zero calibration”, and the calibration time is about 5 seconds according to the software prompt.
2. After the software prompts completion of calibration, please power on again before use.
3. Do not power off or cut off communication during the upgrade. Otherwise, memory malfunction may occur.
4. If the calibration fails or other interruptions occur during the calibration, power on and calibrate again until the software prompts that the calibration succeeds.

Other Settings

Actuator ID

On the Settings interface, after setting the ID, restart the actuator.

Baud Rate

On the Settings interface, after setting the baud rate, restart the actuator.

Reduction Ratio

On the Settings interface, can set the actuator speed ratio, after setting the parameters take effect immediately. Click save in the upper right corner, otherwise the parameters will be lost after the shutdown. The factory default reduction ratio is 1:1.

Reset Error Code

On the Settings interface, Actuator errors can be reset without restart.

Factory Reset

On the Settings interface, can restore actuator parameters to factory Settings (except encoder calibration data)

Open Brake Separately

In the Position/Velocity/Torque Mode" interface, turn off "Enable" in the upper right corner and turn on "Brake" in the upper right corner. At this time, the actuator will be in the state of free dragging. When there is a load, be careful about falling.

Software Functions

SDK API

ADRA series actuators supports platforms such as Python, C/C++ and Arduino.

Document Python: https://umbratek.com/wiki/en/#!adra/adra_api_python.md

Document C/C++: https://umbratek.com/wiki/en/#!adra/adra_api_c.md

Document Arduino: https://umbratek.com/wiki/en/#!adra/adra_api_arduino.md

Document C#: https://umbratek.com/wiki/en/#!adra/adra_api_csharp.md

Source Code Python: https://github.com/umbratek/ut_sdk_python

Source Code C/C++: https://github.com/umbratek/ut_sdk_cpp

Source Code Arduino: https://github.com/umbratek/adra_sdk_arduino

Source Code C#: https://github.com/umbratek/ut_sdk_csharp

Communication Protocol

ADRA series actuators support standard RS485 and CAN electrical interfaces. The RS485 port uses the UTRC protocol, and the CAN port uses the UTCC protocol.

Document UTRC: https://umbratek.com/wiki/en/#!adra/utrc_communication_protocol.md

Document UTCC: https://umbratek.com/wiki/en/#!adra/utcc_communication_protocol.md

Communication Register

ADRA series actuators open most of the registers, the user can operate the actuator directly according to the communication protocol and the actuator's documentation

Document Register: https://umbratek.com/wiki/en/#!adra/adra_communication_register.md

Advanced API Features

Refer to the Assistant section and the API documentation for basic functions, but only the advanced functions are described here. Currently, only the RS485 actuator supports the following advanced functions, but the CAN interface does not. These functions are added for the application scenarios of

robots and help improving the control performance of robots.

Broadcast Mode Reads / Writes Multiple Actuator Rules

1. When reading/writing actuators in broadcast mode, the actuators ID that are concatenated on the bus must be unique and contiguous. For example, if three actuators are connected in series, the ID cannot be 1, 6, or 7. The ID must be 1, 2, or 3, or 6, 7, or 8, or other consecutive IDs.
2. If only one actuator is used, set the start ID and end ID to the actuator ID.
3. In broadcast mode, after receiving the broadcast write command, the actuator would not respond and would record the number of received broadcast write commands.
4. In broadcast mode, after receiving the broadcast read command, the actuator replies the data to the host in ascending order based on the ID. The reply data includes: requested data and the number of received broadcast write commands. After replying, the recorded number of broadcast write commands will be cleared.
5. The host can check whether the number of broadcast write commands is correct based on Rules 3 and 4, and determine whether the broadcast write commands are lost.

Broadcast Mode Sets Multiple Actuator Target Positions

- * Register address is 0x60, API function `set_cpos_target(uint8_t sid, uint8_t eid, float* pos)`
- * Broadcast mode (a packet) sets the target position of multiple actuators (sequential ids). For example, if the target positions of the three actuators ID1, ID2, and ID3 are set at the same time, the three actuators will parse data according to their IDS to obtain the target positions and execute the broadcast commands after receiving the broadcast commands. All actuators that receive broadcast commands do not reply, but will record the number of broadcast write commands that has been received.
- * Example of setting the target position of actuators 1 to 6.

```
AdraApiSerial *adra = new AdraApiSerial( "/dev/ttyUSB0", 921600);
adra->into_motion_mode_pos(1);
adra->into_motion_enable(id);
float pos[6] = {1, 2, 3, 6, 7, 2};
adra->set_cpos_target(1,6, pos);
```

Broadcast Mode Sets Multiple Actuator Target Torque

- * Register address is 0x61, API function `set_ctau_target(uint8_t sid, uint8_t eid, float* tau)`
- * Broadcast mode (a packet) sets the target torque of multiple actuators (sequential ids). For example, if the target torque of the three actuators ID1, ID2, and ID3 are set at the same time, the three actuators will parse data according to their IDS to obtain the target torque and execute the broadcast commands after receiving the broadcast commands. the three actuators will parse data according to their IDS to obtain the target positions and execute the broadcast commands after receiving the

broadcast commands. All actuators that receive broadcast commands do not reply, but will record the number of broadcast write commands that has been received.

* Example of setting the target torque of actuators 1 through 6.

```
AdraApiSerial *adra = new AdraApiSerial( "/dev/ttyUSB0", 921600);
adra->into_motion_mode_pos(1);
adra->into_motion_enable(id);
float tau[6] = {0.3, 0.3, 0.3, 0.2, 0.2, 0.2};
adra->set_ctau_target(1,6, tau);
```

Broadcast Mode Sets Multiple Actuator Target Position and Feedforward Torque

* Register address is 0x62, API function set_cpostau_target(uint8_t sid, uint8_t eid, float* pos, float* tau)

* Broadcast mode (a packet) sets the target position and feedforward torque of multiple actuators (sequential ids). All actuators that receive broadcast command do not reply, but record the number of broadcast write commands that has been received.

* Example of setting the target position and feedforward torque of actuators 1 through 6.

```
AdraApiSerial *adra = new AdraApiSerial( "/dev/ttyUSB0", 921600);
adra->into_motion_mode_pos(1);
adra->into_motion_enable(id);
float pos[6] = {1, 2, 3, 6, 7, 2};
float tau[6] = {0.3, 0.3, 0.3, 0.2, 0.2, 0.2};
adra->set_cpostau_target(1,6, pos, tau);
```

Polling Mode Gets Single Actuator Position and Torque

* Register address is 0x68, API function get_spostau_current(int id, int* num, float* pos, float* tau)

6. * Obtain the current position and torque and the number of received broadcast write commands at the same time, and the recorded number of broadcast write commands will be cleared.

* Example, get ID 1 current position, current torque, and number of broadcast setup instructions.

```
AdraApiSerial *adra = new AdraApiSerial( "/dev/ttyUSB0", 921600);
float pos = 0 , tau = 0;
int num = 0;
adra->get_spostau_current(1, &num, &pos, &tau);
```

Broadcast Mode Gets Multiple Actuators Current Position and Torque

* Register address is 0x69, API function get_cpostau_current(uint8_t sid, uint8_t eid, int* num, float*

pos, float* tau, int* ret)

7. * Broadcast mode (a packet) gets the current position and torque of multiple actuators (sequential IDs). After receiving the broadcast read command, the actuator replies data to the host in ascending order based on the ID. The returned data includes the current position, current torque, and number of received broadcast write commands. At the same time, the recorded number of broadcast write commands will be cleared.

* Example of getting the current position and torque of actuators 1 through.

```
AdraApiSerial *adra = new AdraApiSerial( "/dev/ttyUSB0", 921600);  
float pos[6] = {0};  
float tau[6] = {0};  
Int num[6] = {0};  
adra->get_cpstau_current(1, 6, num, pos, tau);
```

Communication Detection Cycle

* Register address is 0x12, API function set_iwdg_cyc(int id, int cyc)

* Set the maximum interval between broadcast read commands. The unit is torque loop cycle time. When reading actuator data in broadcast mode, you must send a broadcast read command within a specified period. If the communication interruption period exceeds the specified period, the actuator reports an error. If this function is not required, set it to 0 to disable it.

* For example, because the control cycle of the torque loop is 20KHz, if the communication detection cycle is set to 10000 and the actuator data is obtained by broadcasting, the instruction of actuator data must be obtained by broadcasting continuously, and the interval must be less than 0.5 seconds (10000/20khz). If the communication detection period is set to 0, the data of the actuator can be obtained in a discontinuous broadcast mode.

Debug COM Data

debug mode register is 0x79, API function set_debug_mode().

1. Debug Mode 51

Set the debug mode to 51 and output the data of position loop ADRC control algorithm.

2. Debug Mode 52

Set the debug mode to 52 and output the data of speed loop ADRC control algorithm.

3. Debug Mode 53

Set the debug mode to 53 and output the data of torque loop ADRC control algorithm 1.

4. Debug Mode 54

Set the debug mode to 54 and output the data of torque loop ADRC control algorithm 2.

5. Debug Mode 63

Set the debug mode to 63 and output the data of torque loop PID control algorithm.

Error Code

Error codes 31-80 can be reset automatically by enable the actuator. Other error codes need to set the register or restart to clear the reset.

Code	Description	Solution
1	Flash error	Contact after-sales service
2	Pre-driver communication error	Contact after-sales service
3	Multi-turn communication error	Contact after-sales service
4	Current sampling error	Contact after-sales service
5	EEPROM error	Contact after-sales service
6	Storage data error	Reset parameters and save
7	Battery voltage too low	Replace the battery and connect to assistant and follow assistant's instructions
8	encoder calculate error	Power on again, and keep the motor stationary during power on
9	Encoder error1	Contact after-sales service
10	Encoder error2	Contact after-sales service
11	electrical angle error	Use the assistant to calibrate encoder
12	Encoder linear error	Use the assistant to calibrate encoder
13	Multi-turn calibrate error	Use the assistant to calibrate encoder
14	Zero calibrate error	Use the assistant to calibrate position zero
15	Hall calibration error	Use the assistant to calibrate encoder
16	Encoder calculate error	Use the assistant to calibrate encoder
17	Encoder calculate error	Use the assistant to calibrate encoder
18	MU communication error	Contact after-sales service
19	MU status error	1. Replace the battery and connect to assistant and follow assistant's instructions 2.Contact after-sales service
21	Pre-drive alarm	Contact after-sales service
22	Multi-turn calculate error	Contact after-sales service
23	current temperature out of range	1. Whether the ambient temperature is within the normal working range 2. Check whether the load and speed are within the normal range
24	current voltage out of range	1.Check for missing brake resistance modules

		2. Check whether the power supply is stable 3. Check whether the power supply wiring is connected and stable 4. Check whether the diameter of the power cord is appropriate 5. Check whether the load and speed are within the normal range 6. Check whether the load is consistent Control parameter matching
25	Phase A alarm	Contact after-sales service
26	Phase B alarm	Contact after-sales service
27	Phase C alarm	Contact after-sales service
31	Position following alarm	1. Check whether the set following error limit value is too small 2. Check whether the load and speed are within the normal range 3. Check whether the power supply voltage is stable 4. Check whether the load is consistent Control parameter matching
32	Current speed out of range	1. Check whether the load and speed are within the normal range 2. Check whether the power supply voltage is stable 3. Check whether the load is consistent Control parameter matching
33	Current power out of range	1. Check whether the load and speed are within the normal range 2. Check whether the power supply voltage is stable 3. Check whether the load is consistent Control parameter matching
34	Target position out of range	1. Check that the target position is within the limits 2. The limit threshold is set too small
35	Target speed out of range	1. Check that the target speed is within the limits 2. The limit threshold is set too small
36	Target torque out of range	1. Check that the target torque is within the limits 2. The limit threshold is set too small
37	Current position out of range	1. Check that the target position is within the limits. 2. Calibrate the zero point of mechanical position.
40	Register address error	Check that communication instructions are correct.
41	Register value error	Check that communication instructions are correct.
42	Broadcast read command timed out	1. The broadcast communication cycle time is set to a larger value 2. The broadcast communication cycle time is set to a larger value.
91	Encoder speed error	Contact after-sales service

Electrical

Regenerative Braking Module

When the actuator is in deceleration motion, the kinetic energy is converted into electrical energy to charge the capacitor of the actuator. The higher the deceleration rate and the higher the load, the higher the charging power. When the power supply voltage increases and exceeds the maximum operating voltage of the driver, the actuator will report an error and stop working. In this situation, we recommend you to use Regenerative Braking Module here, or you can choose the following treatment scheme according to the actual situation.

1. Regenerative Braking Module

A Regenerative Braking Module is added to the DC power of the actuator, which will detect the voltage of the power in real time. When the voltage of the power supply is higher than the rated voltage, the part of excessive energy will be released through the brake resistance, and so the voltage is stabilized. The module is available for purchase at the Umbratek website.

2. Use Battery Power

Battery can absorb the excessive power and thus to stabilize the voltage.

3. Adding a Supercapacitor

The supercapacitor is added to the power of the actuator to absorb the excessive electric energy by charging, thus to stabilize the voltage. Note: The capacity of the capacitor must be calculated based on actual situations.

Brake

The default actuator of ADRA series is equipped with brake module, and the locking torque of the brake is greater than the rated torque of the actuator. Do not use external forces to try to rotate the actuator when the brake is locked, otherwise it may damage the actuator.

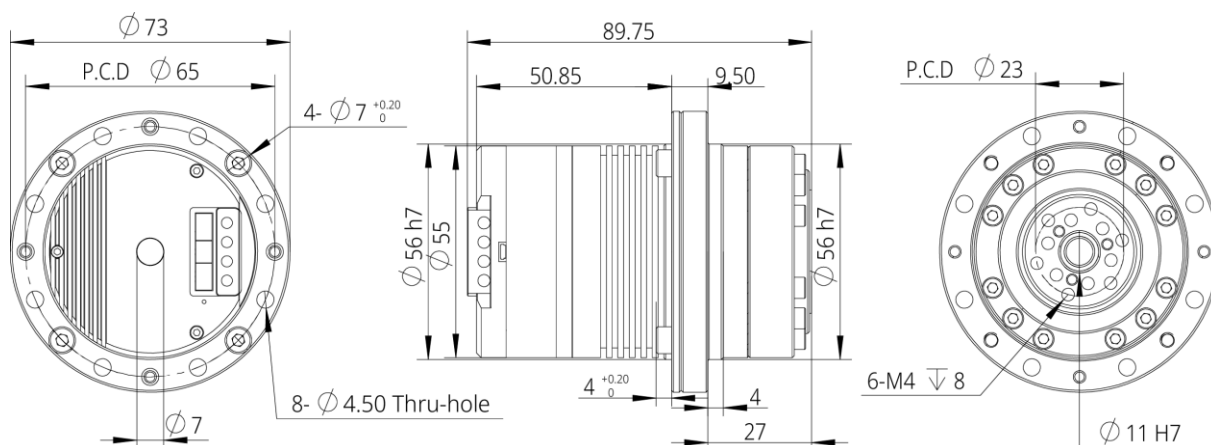
Mechanical

Mounting

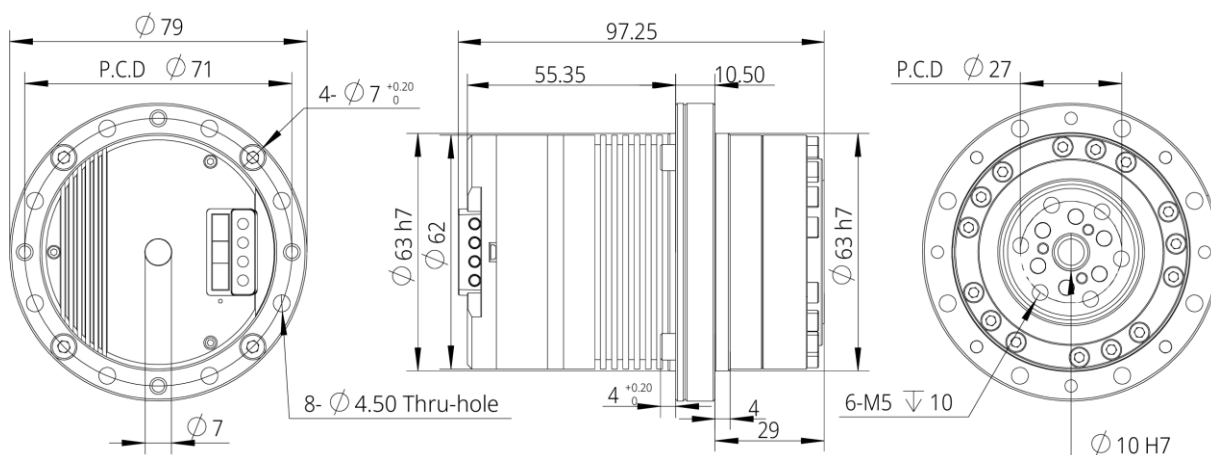
The 3D model of this product can be downloaded from the official website:

<https://www.umbratek.com/download-center>

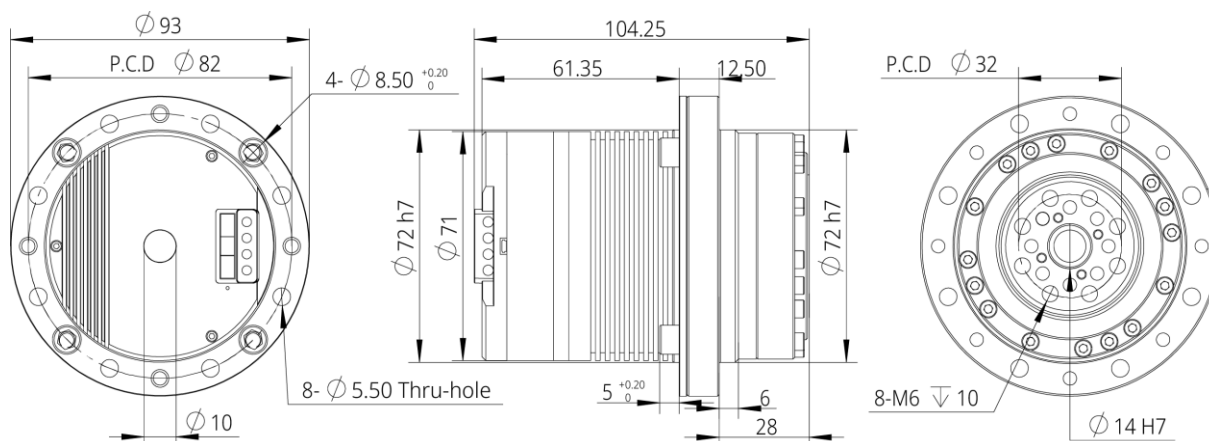
ADRA HR-A056 Dimension (Unit: mm)



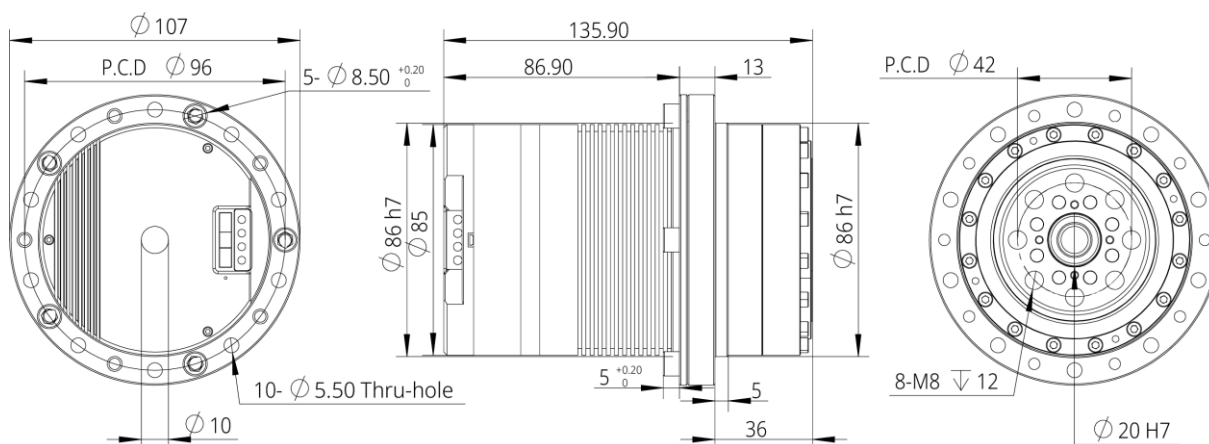
ADRA HR-A063 Dimension (Unit: mm)



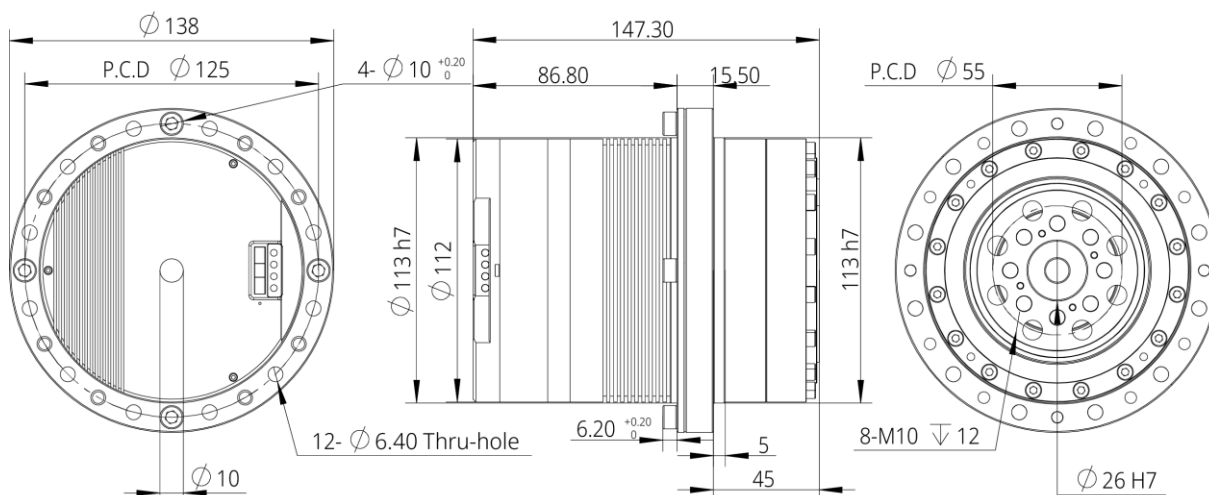
ADRA HR-A072 Dimension (Unit: mm)



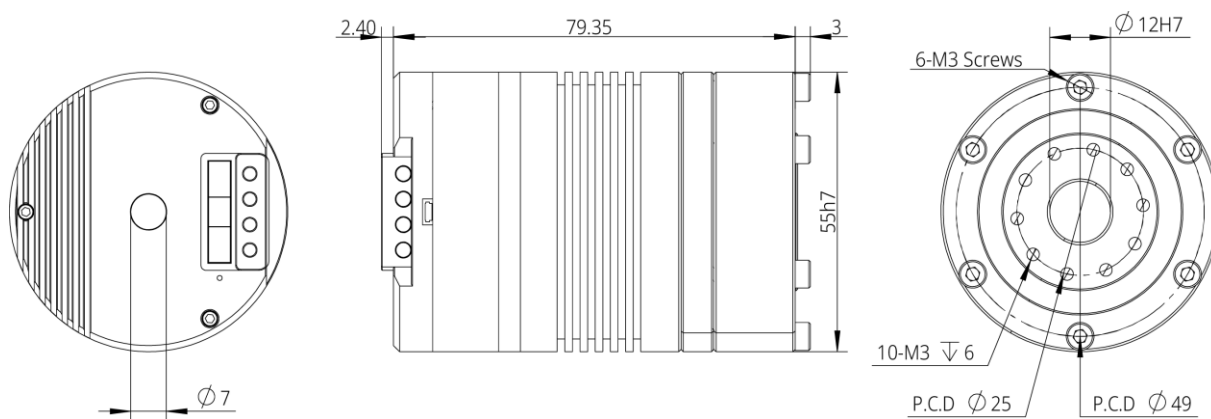
ADRA HR-A086 Dimension (Unit: mm)



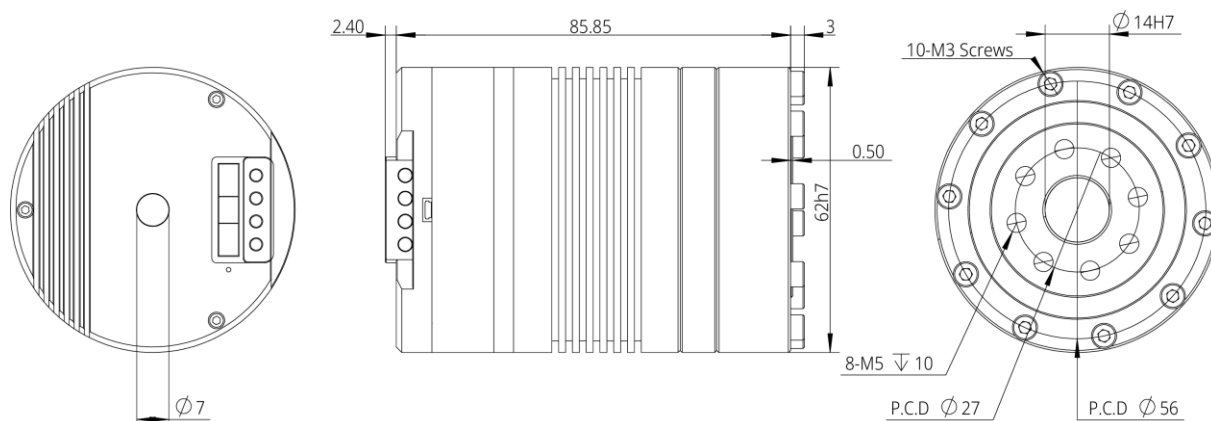
ADRA HR-A113 Dimension (Unit: mm)



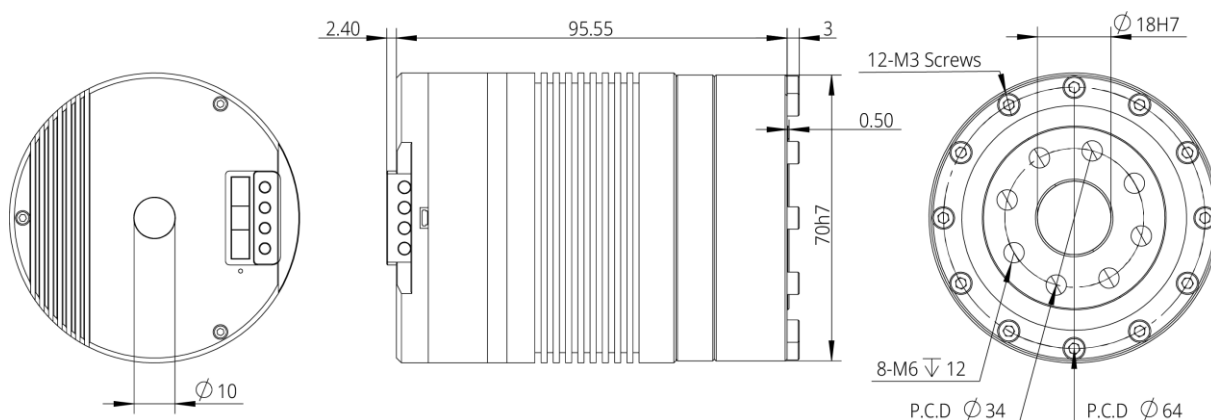
ADRA HR-A055 Dimension (Unit: mm)



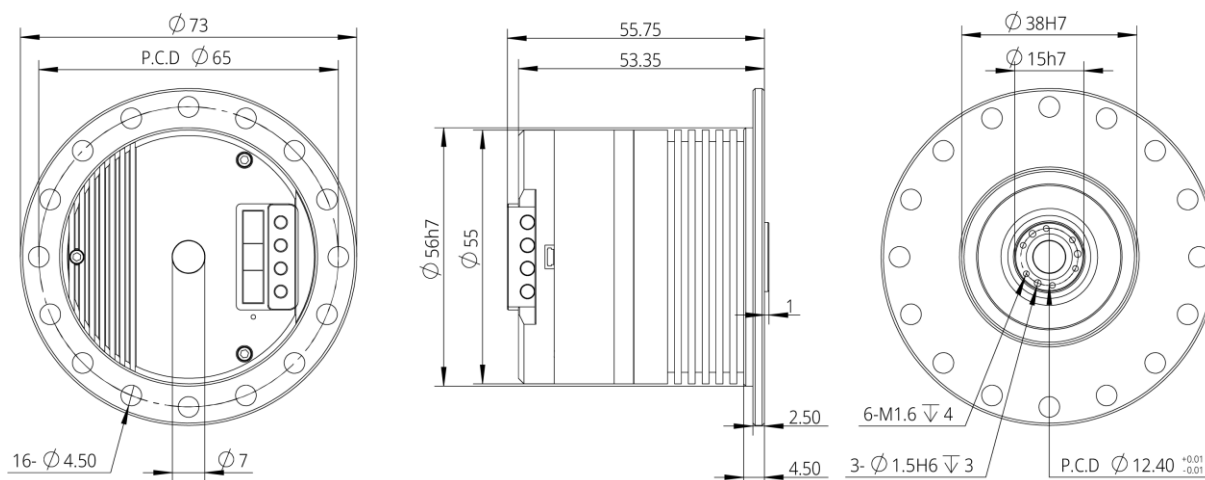
ADRA HR-A062 Dimension (Unit: mm)



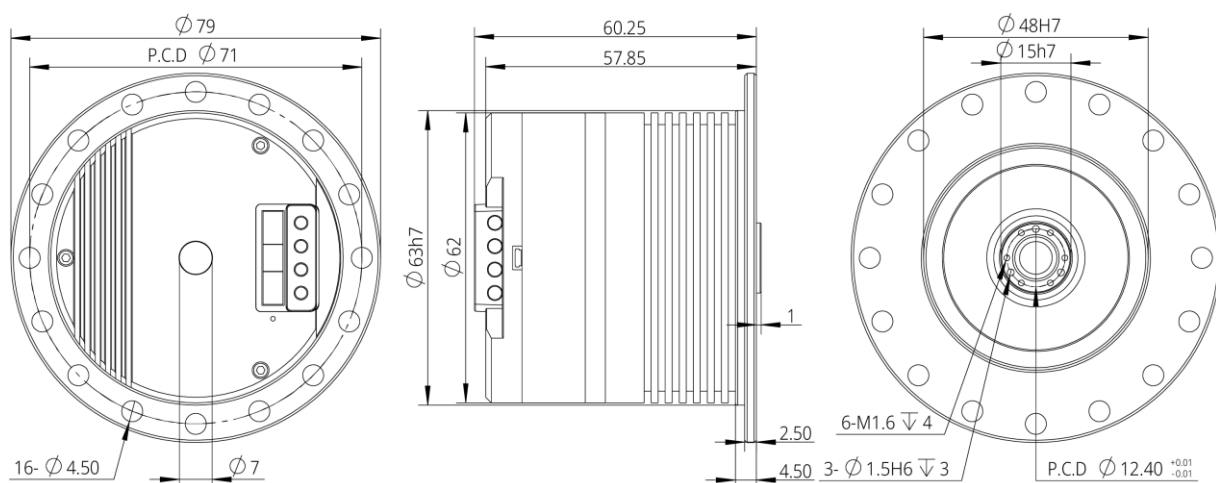
ADRA HR-A071 Dimension (Unit: mm)



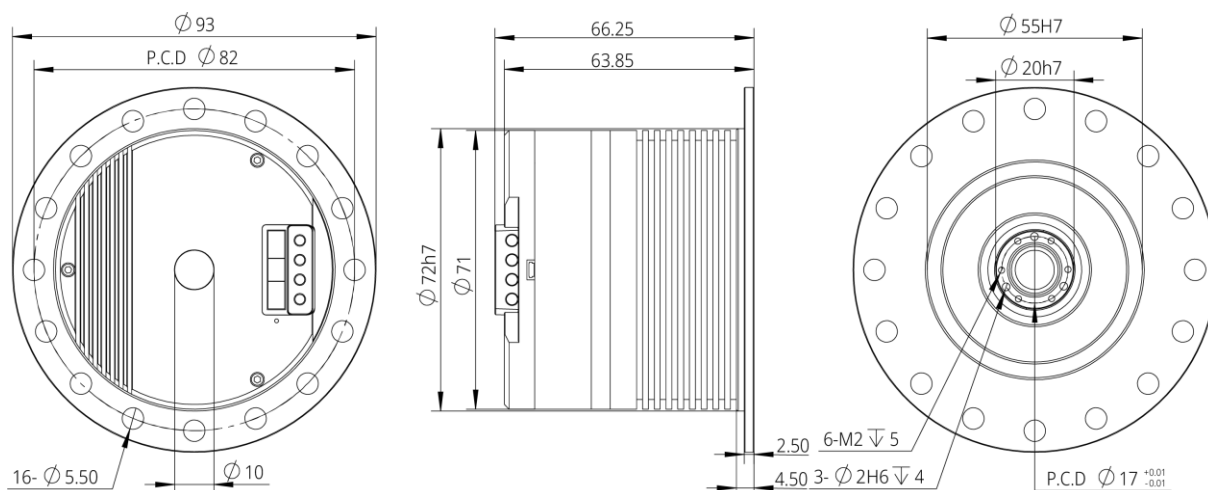
ADRA DD-A056 Dimension (単位: mm)



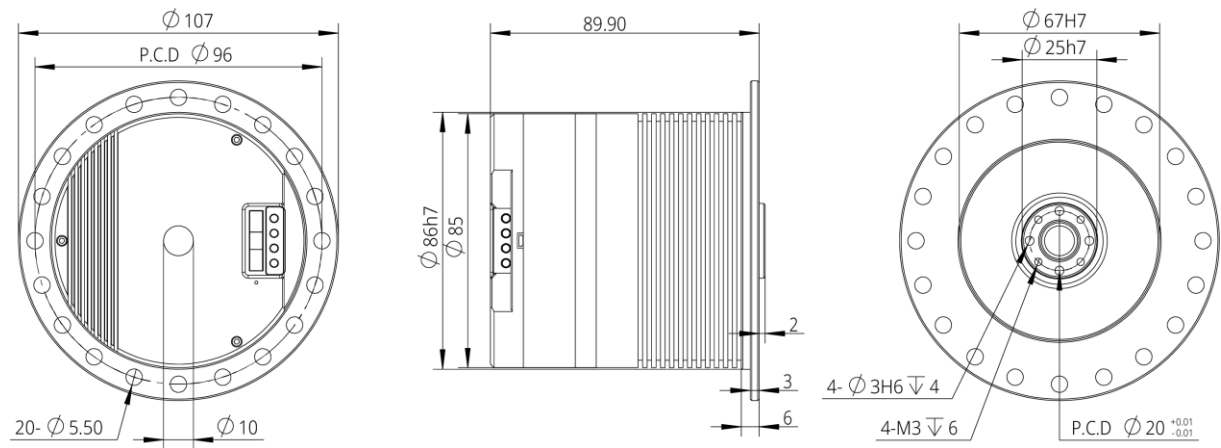
ADRA DD-A063 Dimension (Unit: mm)



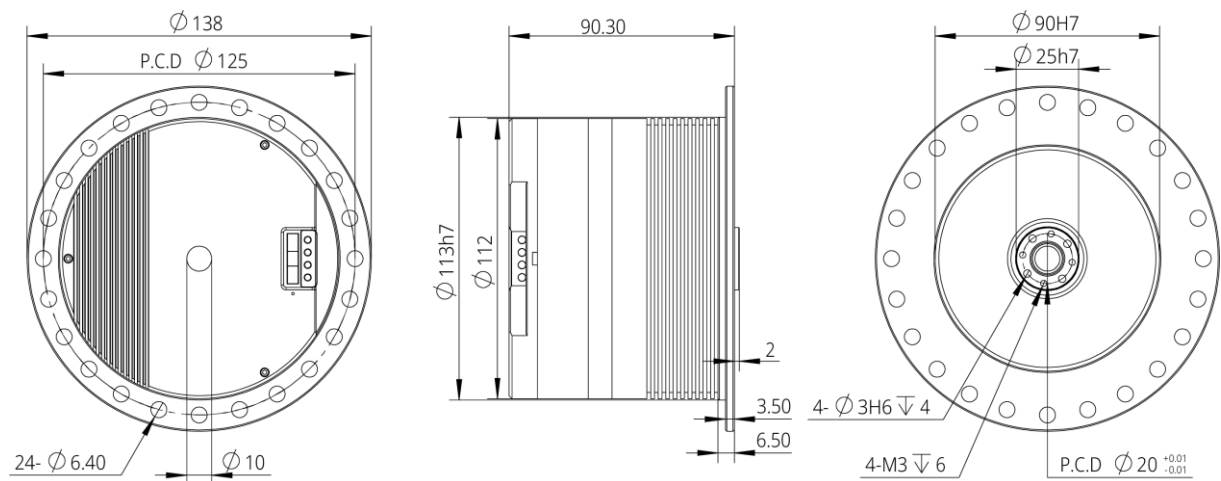
ADRA DD-A072 Dimension (Unit: mm)



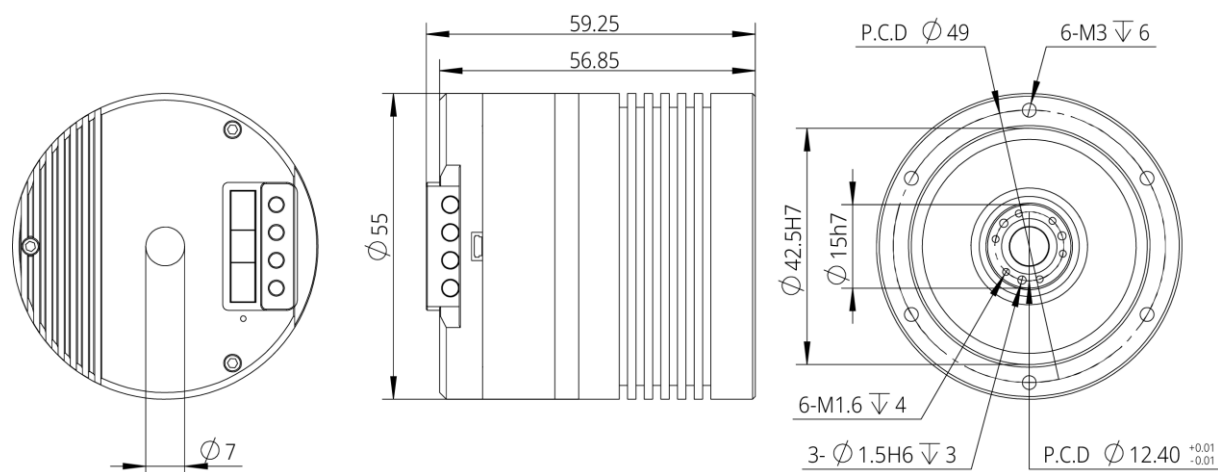
ADRA DD-A086 Dimension (Unit: mm)



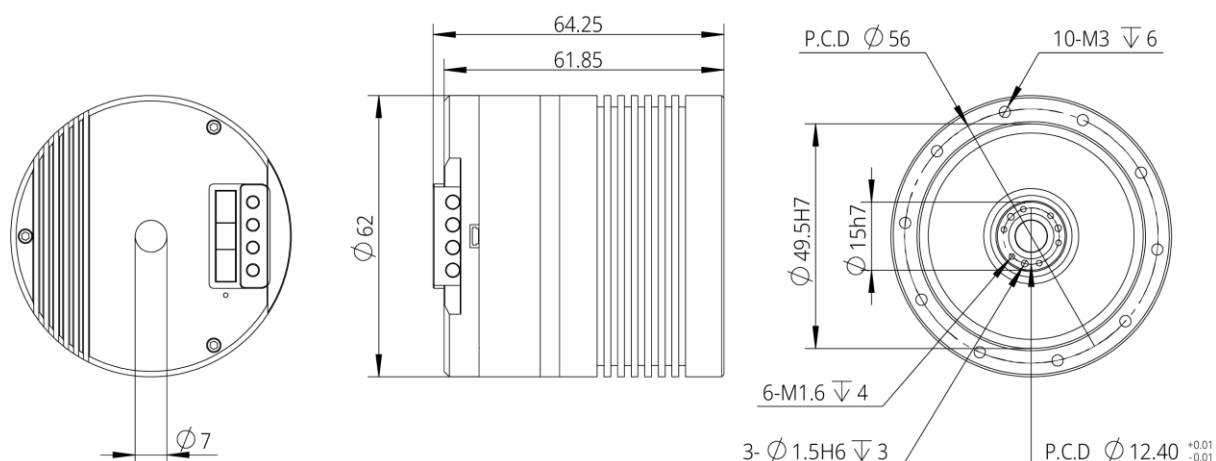
ADRA DD-A113 Dimension (Unit: mm)



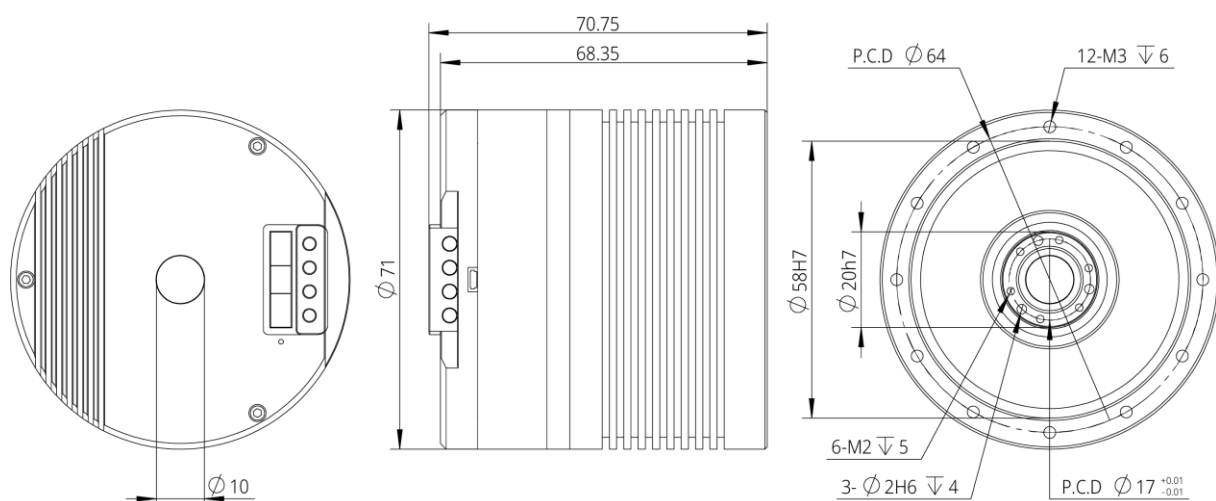
ADRA DD-A055 Dimension (Unit: mm)



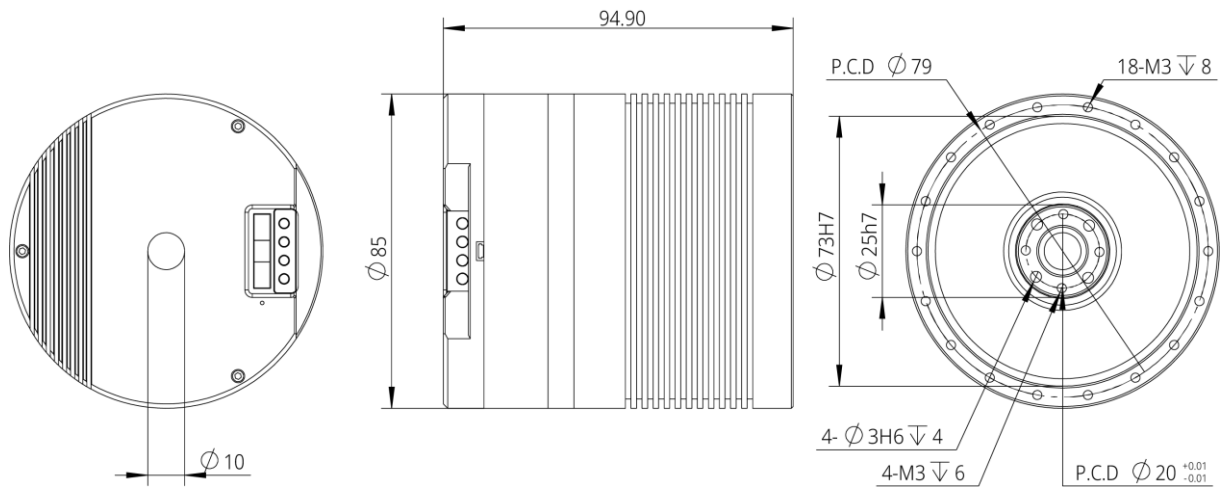
ADRA DD-A062 Dimension (Unit: mm)



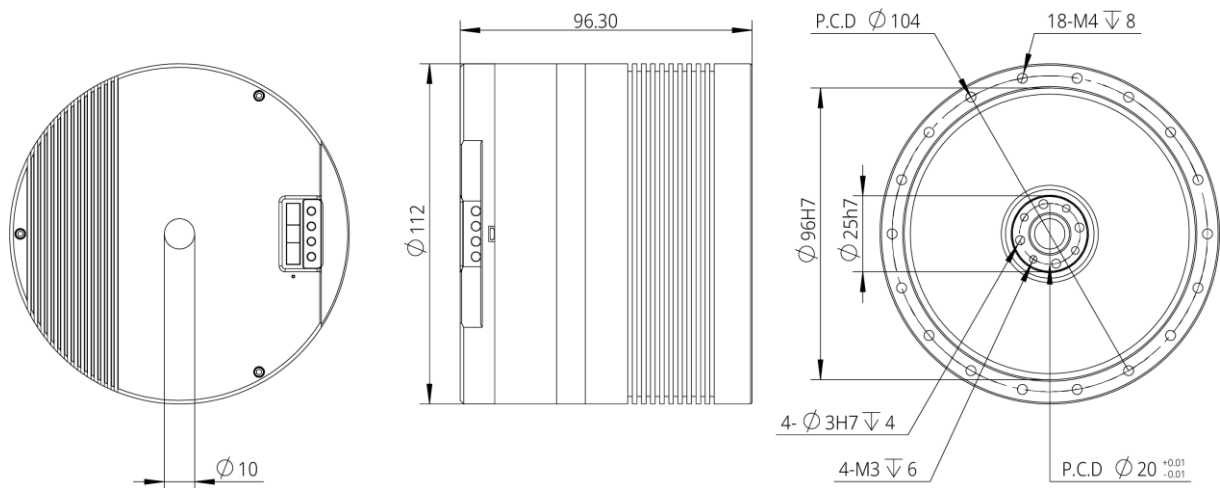
ADRA DD-A071 Dimension (Unit: mm)



ADRA DD-A085 Dimension (Unit: mm)



ADRA DD-A112 Dimension (Unit: mm)



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