

# DroneCAN Protocol Specification

BLA15/21/34 Series

Rev 1.11

## —— Request ——

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## 1 Application

This document is the communication interface specifications for BLA series (BLA21-\*\*U, BLA15-\*\*U, BLA34-\*\*U, etc.).

## 2 CAN Interface

The chapter describe the DroneCAN v1 (formerly UAVCAN v0) interface implemented the servo. The outline and common specification of DroneCAN protocol put on the official website.

DroneCAN URL: <https://dronecan.github.io/>

### 2.1 Communication Interface

The servo is applied to DroneCAN v1. For the specification of the communication interface, refer to the following table.

If configuration parameter 0x46: UAVCAN Node ID is other than 0, it assign Node ID. If the parameter is 0 (default), the bus requires to assign dynamic Node ID.

Table 2-1 Communication Interface Specification

Protocol	DroneCAN v1	
Transmission Speed	1	[Mbps]
Sample Point	87.5	[%]
Node ID	1~127	

### 2.2 Data type Overview

The servo supports the Data type in the following table.

Table 2-2 UAVCAN Broadcast Message

Data type	Transmission Interval [ms]	Priority	Remarks
uavcan.protocol.NodeStatus	1,000	16(Medium)	
uavcan.protocol.dynamic_node_id.Allocation	600~1,000 0~400	24(Low)	Only initialization
uavcan.equipment.actuator.Status	100	16(Medium)	

Table 2-3 UAVCAN Subscribe Message

Data type	Remarks
uavcan.protocol.dynamic_node_id.Allocation	Only initialization
uavcan.equipment.actuator.ArrayCommand	

Table 2-4 UAVCAN Unicast Service

Data type	Remarks
uavcan.protocol.GetNodeInfo	
uavcan.protocol.RestartNode	
uavcan.protocol.param.ExecuteOpcode	
uavcan.protocol.param.GetSet	

## 2.3 Data type Detail

- **uavcan.protocol.GetNodeInfo**

Default data type ID: 1

Data type signature: 0xee468a8121c46a9e

It respond to the request of the extended information regarding the Node to distinguish and detect the Node connecting the bus.

Table 2-5 uavcan.protocol.GetNodeInfo Service request (Client side)

Index※		Field	Type	Remarks
Byte	Bit			
0	-	empty	uint8	

Table 2-6 uavcan.protocol.GetNodeInfo Service response (Servo side)

Index※		Field	Type	Remarks
Byte	Bit			
0...3	-	uptime sec	uint32	Operating time from booting up [s]
4	0...1	health	uint2	Connecting State
4	2...4	mode	uint3	Mode State
4	5...7	sub mode	uint3	Unused
5...6	-	vender specific status code	uint16	Unused
7...8	-	software version	uint8[2]	
9	-	optional field flags	uint8	Unused
10...13	-	vcs commit	uint32	Unused
14...21	-	Image crc	uint64	Unused
22...23	-	hardware version	uint8[2]	
24...39	-	unique ID	uint8[16]	
40	-	Certificate of authenticity	uint8	Unused
41...41+n	-	name	uint8[n]	n: name_len

※Byte order and bit order notation

Byte index	0								1								2							
Bit index	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
Bit position	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Value (bin)	0	0	0	1	0	1	0	0	0	1	1	1	1	1	0	1	1	0	0	0	1	0	1	0
Value (hex)	14								7D								8A							

- **uavcan.protocol.dynamic\_node\_id.Allocation**

Default data type ID: 1

Data type signature: 0x0b2a812620a11d40

If configuration parameter 0x46:UAVCAN Node ID is 0 (default), the servo request to assign dynamic Node ID. Other features of the UAVCAN interface will not work until a valid node ID has been assigned. When the servo requests a unique node ID as an anonymous node, the allocator that manages the bus dynamically assigns the node ID.

The servo sends the first 6 bytes of unique IDs at random intervals of 600-1,000 [ms] to avoid conflicts with other device node ID assignment requests.

If the allocator responds with the unique ID sent so far, the servo sends a 6-byte unique ID for the second time and a 4-byte unique ID for the third time. The second and third transmissions change the random interval from 0 to 400 [ms] not to be interrupted by the node ID assignment request of other devices. It assigns a node ID to the servo on the third response from the client.

Table 2-7 uavcan.protocol.dynamic\_node\_id.Allocation Confidential Message (servo side)

1 <sup>st</sup> /2 <sup>nd</sup> time		3 <sup>rd</sup> time		Field	Type	Remarks
Index						
Byte	Bit	Byte	Bit			
0	0...6	0	0...6	node id	uint8	0 at anytime
0	7	0	7	first part of unique id	bool	1 <sup>st</sup> time:1、2nd/3rd:0
1...6	-	1...4	-	data	int64	The unique ID 16 bytes is divided into 6/6/4 bytes and sent.

Table 2-8 uavcan.protocol.dynamic\_node\_id.Allocation Message (Allocator side)

1 <sup>st</sup> time		2 <sup>nd</sup> time		3 <sup>rd</sup> time		Field	Type	Remarks
Index								
Byte	Bit	Byte	Bit	Byte	Bit			
0	0...6	0	0...6	0	0...6	node id	uint8	1 <sup>st</sup> /2 <sup>nd</sup> time:0 / 3 <sup>rd</sup> time:assign Node ID
0	7	0	7	0	7	first part of unique id	bool	0 at anytime
1...6	-	1...12	-	1...16	-	data	int64	Unique ID obtained so far

- **uavcan.protocol.RestartNode**

Default data type ID: 5

Data type signature: 0x569e05394a3017f0

If the specified magic number is correct, it restarts the servo. If the specified magic number is an error, it set the OK field to 0 and respond. The reboot required to apply some parameter changes.

Table 2-9 uavcan.protocol.RestartNode Service Request (Client side)

Index		Field	Type	Remarks
Byte	bit			
0...4	-	magic number	uint32	Specify 0xACCE551B1E

Table 2-10 uavcan.protocol.RestartNode Service Response (Servo side)

Index		Field	Type	Remarks
Byte	bit			
0	0	ok	bool	0:Fail / 1:Pass

- **uavcan.protocol.param.ExecuteOpcode**

Default data type ID: 10

Data type signature: 0x3b131ac5eb69d2cd

This message can save the configuration parameters of the RAM area in the ROM area in a batch or reset them to the initial values in a batch according to the Opcode setting.

Table 2-11 uavcan.protocol.param.ExecuteOpcode Service Request (Client side)

Index		Field	Type	Remarks
byte	bit			
0	-	opcode	uint8	
1...6	-	argument	int48	0 at anytime

Table 2-12 Opcode Specification

Opcode		Remarks
SAVE	0	Write the parameters to ROM at once
ERASE	1	Initialize the parameter to factory setting at once

Table 2-13 uavcan.protocol.param.ExecuteOpcode Service Response (Servo side)

Index		Field	Type	Remarks
Byte	bit			
0...5	-	argument	int48	0 at anytime
6	0	ok	bool	0: Fail / 1: Pass



- **uavcan.protocol.param.GetSet**

Default data type ID: 11

Data type signature: 0xa7b622f939d1a4d5

The value of the specified configuration parameter in the RAM area is got or set by name or index.

If the request passes, both read and write respond with the current value. If the request fails, the servo doesn't return the current value.

If writing to ROM is required, a separate request is required to write all parameters to ROM.

Table 2-14 uavcan.protocol.param.GetSet Service Request (Client side)

In reading		In writting		Field	Type	Remarks
Index						
Byte	Bit	Byte	Bit			
0	0...7	0	0...7	index	uint13	Index number of configuration parameter、the same as name
1	0...4	1	0...4			
1	5...7	1	5...7	tag	uint3	Reading/Writing setting
-	-	2...9	-	val	int64	<In reading>       None <In writing>       The set value of configuration parameter
2...5	-	10...13	-	name	uint8[4]	Configuration Parameter. ASCII string of [0x**]

Table 2-15 Tag Specification

Tag		Remarks	
EMPTY	0	<request side> <response side>	Reading value of configuration parameter val: None
INTEGER VALUE	1	<request side> <response side>	Writing value of configuration parameter val: integer
REAL VALUE	2	Unused	
BOOLEAN VALUE	3	Unused	
STRING VALUE	4	Unused	

Table 2-16 uavcan.protocol.param.GetSet Service Response (Servo side)

fail		pass		Field	Type	Remarks
Index						
Byte	Bit	Byte	Bit			
0	0...4	0	0...4	-	void5	0 at anytime
0	5...7	0	5...7	tag	uint3	
-	-	1...8	-	val	int64	<fail> None <pass> Reading value of configuration parameter
1	0...4	9	0...4	-	void5	0 at anytime
1	5...7	9	5...7	default_value	uint3	Unused
2	0...5	10	0...5	-	void6	0 at anytime
2	6...7	10	6...7	max_value	uint2	Unused
3	0...5	11	0...5	-	void6	0 at anytime
3	6...7	11	6...7	min_value	uint2	Unused
-	-	12...15	-	name	uint8[4]	Configuration Parameter Name ASCII string of [0x**]

- **uavcan.protocol.NodeStatus**

Default data type ID: 341

Data type signature: 0x0f0868d0c1a7c6f1

Operating time of servo, health of node and current mode are broadcasted every second. These are used to manage the node connecting the bus.

Table 2-17 uavcan.protocol.NodeStatus Message (Servo side)

Index		Field	Type	Remarks
Byte	Bit			
0...3	-	uptime sec	uint32	Operation time from booting up [s]
4	0...1	health	uint2	
4	2...4	mode	uint3	
4	5...7	sub mode	uint3	Unused
5...6	-	vender specific status code	uint16	Unused

Table 2-18 Health Specification

Health		Remarks
OK	0	Operating normally
WARNING	1	Abnormality information informs warning level
ERROR	2	Abnormality information informs failure level
CRITICAL	3	Unused

Table 2-19 Mode Specification

Mode		Remarks
OPERATIONAL	0	Operating normally
INITIALIZATION	1	Assigning Node ID
MAINTENANCE	2	Unused
SOFTWARE UPDATE	3	Software update in progress
OFFLINE	7	Unused

- **uavcan.equipment.actuator.ArrayCommand**

Default data type ID: 1010

Data type signature: 0xd8a7486238ec3af3

Controls the servo specified servo ID. You can command up to 15 servo IDs in a single message. If the actuator id of the message is set to 255, the servo ID is ignored and the servo is controlled.

The command is chosen between the four such as no unit, target angle, target torque and target speed.

If the command value is positive, the servo rotates CW. If the command value is negative, the servo rotates CCW.

Table 2-20 uavcan.equipment.actuator.ArrayCommand Message (Client side)

len Unusing		len Using		Field	Type	Remarks
Index						
Byte	Bit		Bit			
-	-	0	0...3	len	uint4	Setting the number of commanded servo ID at a once (n:1~15)
4(n-1)	-	0+4(n-1) 1+4(n-1)	4...7 0...3	actuator id	uint8	Setting commanded servo ID(1~254) 255: Broadcast
1+4(n-1)	-	1+4(n-1) 2+4(n-1)	4...7 0...3	command type	uint8	Specify the unit of Command value
2+4(n-1)	-	2+4(n-1) ... 4+4(n-1)	4...7 ... 0...3	command value	float16	Specify command value depending on the setting of command type.

Table 2-21 Command type Specification

Command type		Remarks
UNITLESS	0	Translate -1~+1 from angle range -180~+180°
POSITION	1	Command Angle [0.001/0.1°]
FORCE	2	Command Torque [%]
SPEED	3	Command Speed [rpm]

- **uavcan.equipment.actuator.Status**

Default data type ID: 1011

Data type signature: 0x5e9bba44faf1ea04

Current Angle is broadcasted every 100[ms].

Table 2-22 uavcan.equipment.actuator.Status Message (Servo side)

Index		Field	Type	Remarks
Byte	Bit			
0	-	actuator id	uint8	Servo ID (0...254)
1...2	-	position	float16	Current Angle [0.1°/0.001]
3...4	-	force	float16	Not used
5...6	-	speed	float16	Not used
7	0	-	void1	-
7	1...7	power rating pct	uint7	Not used

### 3 Configuration Parameter

This chapter describes the parameters which the servo supports. These parameters can be written and read in RAM area using `uavcan.protocol.param.GetSet` or saved and reversed default value in ROM area using `uavcan.protocol.param.ExecuteOpcode`.

#### 3.1 Configuration Parameter List

Table 3-1 Configuration Parameters List (Command)

Name	Description	Default	Min	Max	Unit	R/W
0x00	Command Angle	0	-360,000,000	+360,000,000	0.1°	R/W
0x01	Command Speed		(See Table 3-12)		rpm	R/W
0x02	Command Torque	0	-100	100	%	R/W
0x03	Reserve	0	-	-	-	-
~						
0x07	Reserve	0	-	-	-	-

Table 3-2 Configuration Parameters List (Status)

Name	Description	Default	Min	Max	Unit	R/W
0x08	Current Angle	***	-360,000,000	+360,000,000	0.1°	R
0x09	Current Speed	***	-300	300	rpm	R
0x0A	Current Torque	***	-150	150	%	R
0x0B	Current Temperature	***	-40	120	°C	R
0x0C	Current Voltage	***	0	500	0.1V	R
0x0D	Reserve	0	-	-	-	-
0x0E	Reserve	0	-	-	-	-
0x0F	Reserve	0	-	-	-	-

\*\*\* the default value of the parameter such as Current are none because these are updated continuously

Table 3-3 Configuration Parameters List (Operation)

Name	Description	Default	Min	Max	Unit	R/W
0x10	Initialization	0	0	1	-	W
0x11	Reboot	0	0	1	-	W
0x12	Writing ROM	0	0	1	-	W
0x13	Reserve	0	-	-	-	-
~	Reserve					
0x17	Reserve	0	-	-	-	-

Table 3-4 Configuration Parameter List (Abnormality Information)

Name	Description	Default	Min	Max	Unit	R/W
0x18	Occurrence Overview	All bit"0"	All bit"0"	All bit"1"	-	R
0x19	Notification Level Information	All bit"0"	All bit"0"	All bit"1"	-	R
0x1A	Warning Level Information	All bit"0"	All bit"0"	All bit"1"	-	R
0x1B	Failure Level Information	All bit"0"	All bit"0"	All bit"1"	-	R
0x1C	Reserve	0	-	-	-	-
~						
0x1F	Reserve	0	-	-	-	-

Table 3-5 Configuration Parameter List (Configuration Parameter)

Name	Description	Default	Min	Max	Unit	R/W
0x20	Torque ON/OFF	0	0	2	-	R/W
0x21	Soft Start ON/OFF	1	0	1	-	R/W
0x22	Smoothing ON/OFF	1	0	1	-	R/W
0x23	Reverse ON/OFF	0	0	1	-	R/W
0x24	Extended Angle Calculation ON/OFF	0	0	1	-	R/W
0x25	Speed/current control ON/OFF	0	0	1	-	R/W
0x26	Timeout Operation	1	0	2	-	R/W
0x27	Timeout detection time	1,000	1	60,000	msec	R/W
0x28	Reserve	0	-	-	-	R/W
0x29	Reserve	0	-	-	-	-
0x2A	Overcurrent protection Current value	(See Table 3-12)-			0.1A	R/W
0x2B	Reserve	0	-	-	-	-

Table 3-6 Configuration Parameter List (Control Parameter)

Name	Description	Default	Min	Max	Unit	R/W
0x2C	Angle Control Proportional Gain	(See Table 3-12)			-	R/W
0x2D	Angle Control Derivative Gain	(See Table 3-12)			-	R/W
0x2E	Angle Control Dead Band	(See Table 3-12)			0.1°	R/W
0x2F	Angle control Boost	(See Table 3-12)			0.1%	R/W
0x30	Speed Control Proportional Gain	(See Table 3-12)			-	R/W
0x31	Speed Control Integral Gain	(See Table 3-12)			-	R/W
0x32	Speed Control Dead Band	(See Table 3-12)			-	R/W
0x33	Speed Control Integral Limit	(See Table 3-12)			-	R/W

Table 3-7 Configuration Parameter List (PWM Input)

Name	Description	Default	Min	Max	Unit	R/W
0x34	Neutral Pulse Width	(See Table 3-12)			usec	R/W
0x35	Pulse width input range	(See Table 3-12)			usec	R/W
0x36	Command value output range (angle/speed)	(See Table 3-12)			0.1°/rpm	R/W
0x37	Operation Mode	(See Table 3-12)			-	R/W

Table 3-8 Configuration Parameter List (Limit)

Name	Description	Default	Min	Max	Unit	R/W
0x38	Operation Angle Limit CW	1,799	0	+360,000,000	0.1°	R/W
0x39	Operation Angle Limit CCW	-1,800	-360,000,000	0	0.1°	R/W
0x3A	Operation Speed Limit CW	(See Table 3-12)			rpm	R/W
0x3B	Operation Speed Limit CCW	(See Table 3-12)			rpm	R/W
0x3C	Operation Torque Limit CW	100	0	100	%	R/W
0x3D	Operation Torque Limit CCW	-100	-100	0	%	R/W
0x3E	Operation Temperature Upper Limit	80	20	80	°C	R/W
0x3F	Operation Temperature Lower Limit	-40	-40	20	°C	R/W
0x40	Operation Voltage Upper Limit	(See Table 3-12)			0.1V	R/W
0x41	Operation Voltage Lower Limit	(See Table 3-12)			0.1V	R/W
0x42	Reserve	0	-	-	-	-
0x43	Reserve	0	-	-	-	-

Table 3-9 Configuration Parameter List (Option)

Name	Description	Default	Min	Max	Unit	R/W
0x44	The Origin Point	0	-1,800	1,799	0.1°	R/W
0x45	Servo ID	0	0	254	-	R/W
0x46	UAVCAN Node ID	0	0	127	-	R/W
0x47	Reserve	0	-	-	-	-
0x48	Reserve	0	-	-	-	-
0x49	Boot loader	0	-	-	-	R/W
0x4A	Reserve	0	-	-	-	-
~						
0x4F	Reserve	0	-	-	-	-

Table 3-10 Configuration Parameter List (Product information)

Name	Description	Default	Min	Max	Unit	R/W
0x50	Model Number	(See Table 3-12)			-	R
0x51	Product Number	*****	-	-	-	R
0x52	Firmware version	1000	-	-	-	R
0x53	Hardware version	(See Table 3-12)-			-	R
0x54	Reserve	0	-	-	-	-
~	Reserve	0	-	-	-	-
0x57	Reserve	0	-	-	-	-

The [0x52] firmware version is the latest version at the time of manufacture.

Table 3-11 Configuration Parameter List (Production date)

Name	Description	Default	Min	Max	Unit	R/W
0x58	Production year	****	-	-	Year	R
0x59	Production month	**	-	-	Month	R
0x5A	Production day	**	-	-	Day	R
0x5B	Production hour	**	-	-	Hour	R
0x5C	Production minute	**	-	-	minute	R
0x5D	Reserve	0	-	-	-	-
~						
0x5F	Reserve	0	-	-	-	-



Table 3-12 Parameter list for each model

## 【 Common to BLA21-\*\*U series 】

Name	Description	Default	Min	Max
0x01	Command speed	0	-300	300
0x2C	Angle control proportional gain	40	1	100
0x2D	Angle control Differential gain	40	0	100
0x2E	Angle control Dead band	3	0	3,600
0x2F	Angle control Boost	0	0	100
0x30	Speed control Proportional gain	50	1	100
0x31	Speed control Integral gain	1	0	100
0x32	Speed control Dead band	600	0	2,000
0x33	Speed control Integral limit	2,000	1	500,000
0x34	Neutral Pulse Width	(suffix)-A0*	0	0
		(suffix)-AB*	1,520	10,000
0x35	Pulse width input range	(suffix)-A0*	0	0
		(suffix)-AB*	700	10,000
0x36	Command value output range (angle/speed)	(suffix)-A0*	0	0
		(suffix)-AB*	700	3,600
0x37	Operation Mode	(suffix)-A0*	0	0
		(suffix)-AB*	0	1
0x3A	Operating speed limit CW	300	0	300
0x3B	Operating speed limit CCW	-300	-300	0
0x50	Model No.	61	-	-

## 【 BLA21-06U-A\*\* 】

Name	Description	Default	Min	Max
0x2A	Overcurrent protection Current value	120	60	120
0x40	Operating voltage upper limit	100	74	120
0x41	Operating voltage lower limit	40	35	74
0x53	Hardware version	(suffix)-A0*	6010	-
		(suffix)-AB*	6050	-

## 【 BLA21-12U-A\*\* 】

Name	Description	Default	Min	Max
0x2A	Overcurrent protection Current value	63	35	70
0x40	Operating voltage upper limit	200	120	240
0x41	Operating voltage lower limit	40	35	120
0x53	Hardware version	(suffix)-A0*	12010	-
		(suffix)-AB*	12050	-

## 【 BLA21-28U-A\*\* 】

Name	Description	Default	Min	Max
0x2A	Overcurrent protection Current value	24	16	32
0x40	Operating voltage upper limit	400	280	500
0x41	Operating voltage lower limit	40	35	280
0x53	Hardware version	(suffix)-A0*	28010	-
		(suffix)-AB*	28050	-

【 Common to BLA15-\*\*U series 】

Name	Description	Default	Min	Max
0x01	Command speed	0	-150	150
0x2C	Angle control proportional gain	60	1	100
0x2D	Angle control Differential gain	30	0	100
0x2E	Angle control Dead band	3	0	3,600
0x2F	Angle control Boost	30	0	100
0x30	Speed control Proportional gain	15	1	100
0x31	Speed control Integral gain	1	0	100
0x32	Speed control Dead band	300	0	2,000
0x33	Speed control Integral limit	25,000	1	500,000
0x34	Neutral Pulse Width	0	0	0
0x35	Pulse width input range	0	0	0
0x36	Command value output range (angle/speed)	0	0	0
0x37	Operation Mode	0	0	0
0x3A	Operating speed limit CW	150	0	300
0x3B	Operating speed limit CCW	-150	-300	0
0x50	Model No.	62	-	-

【 BLA15-06U-A\*\* 】

Name	Description	Default	Min	Max
0x2A	Overcurrent protection Current value	21	10	30
0x40	Operating voltage upper limit	100	74	120
0x41	Operating voltage lower limit	40	35	74
0x53	Hardware version	6010	-	-

【 BLA15-12U-A\*\* 】

Name	Description	Default	Min	Max
0x2A	Overcurrent protection Current value	10	7	15
0x40	Operating voltage upper limit	200	120	240
0x41	Operating voltage lower limit	40	35	120
0x53	Hardware version	12010	-	-

【 Common to BLA34-\*\*U-AB\* series 】

Name	Description	Default	Min	Max
0x01	Command speed	0	-80	80
0x2C	Angle control proportional gain	50	1	100
0x2D	Angle control Differential gain	1	0	100
0x2E	Angle control Dead band	3	0	3,600
0x2F	Angle control Boost	0	0	100
0x32	Speed control Dead band	600	0	2,000
0x34	Neutral Pulse Width	1,520	100	10,000
0x35	Pulse width input range	1,100	10	10,000
0x36	Command value output range (angle/speed)	1,100	0	3,600
0x37	Operation Mode	0	0	1
0x3A	Operating speed limit CW	80	0	80
0x3B	Operating speed limit CCW	-80	-80	0
0x50	Model No.	86	-	-

【 BLA34-12U-AB\* 】

Name	Description	Default	Min	Max
0x2A	Overcurrent protection Current value	63	35	63
0x30	Speed control Proportional gain	25	1	100
0x31	Speed control Integral gain	50	0	100
0x33	Speed control Integral limit	300	1	500,000
0x40	Operating voltage upper limit	200	120	240
0x41	Operating voltage lower limit	40	35	120
0x53	Hardware version	12050	-	-

【 BLA34-28U-AB\* 】

Name	Description	Default	Min	Max
0x2A	Overcurrent protection Current value	24	16	24
0x30	Speed control Proportional gain	10	1	100
0x31	Speed control Integral gain	10	0	100
0x33	Speed control Integral limit	680	1	500,000
0x40	Operating voltage upper limit	400	280	400
0x41	Operating voltage lower limit	40	35	280
0x53	Hardware version	28050	-	-

## 4 Parameter Detail

This chapter describes the parameter detail of "3 Configuration Parameter"

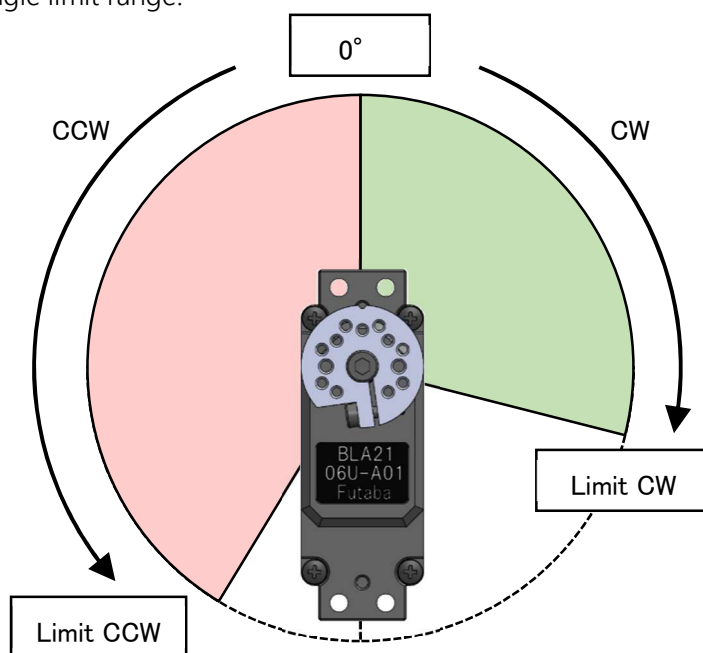
In the following description, the initial values and ranges of values are those of BLA21-06U-A01. Please refer to "3 Configuration Parameters" for the initial values and ranges for each model.

### 4.1 Command Angle

Name	Description	Default	Min	Max	Unit	R/W
0x00	Command Angle	0	-360,000,000	+360,000,000	0.1°	R/W

The servo operates to specified angle. The notch of the servo horn is 0 degrees, the clockwise (CW) direction is "+" and the counterclockwise (CCW) direction is "-" when viewed from the top surface of the servo (the surface with the name plate). The angle can be commanded by 0.1 degree.

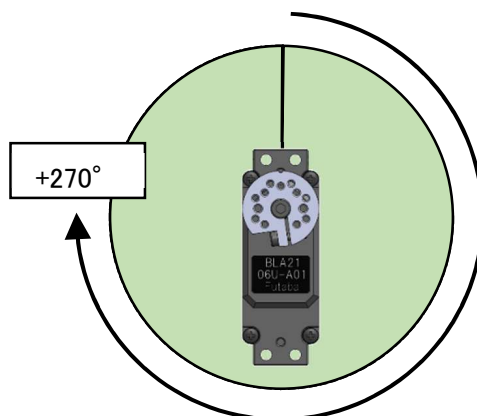
If the angle larger than the operating angle limit CW / CCW [0x38 / 0x39] is input as the command value, it operates only within the operating angle limit range.



When the command speed / torque is input, the command angle value is overwritten with "555,555,555 (dummy data)". If you enter the command angle again, it will operate to the command angle.

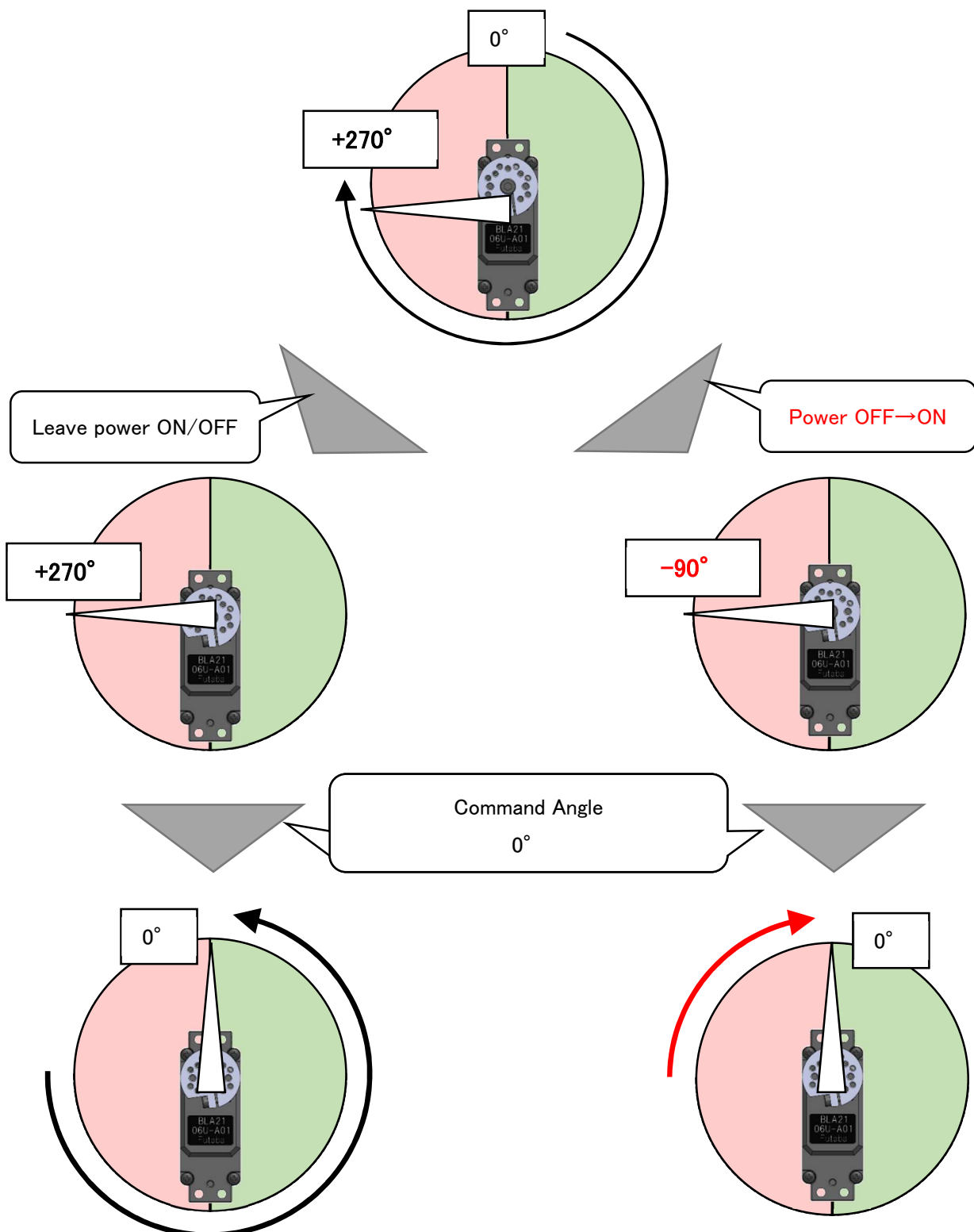
Command values of  $\pm 180$  degrees or more can also be operated. For example, if the command value is +270 degrees, it will rotate to an angle of 270 degrees in the CW direction.

In this case, the initial value of the movement angle limit CW/CCW [0x38/0x39] is  $\pm 180$  degrees, so the movement angle limit CW/CCW [0x38/0x39] must first be expanded to  $\pm 270$  degrees or more.



【 Caution when the angle command over  $\pm 180^\circ$  】

- $\pm 180$  degrees in the specification sheet means  $+179.9^\circ \sim -180.0^\circ$  degrees.
- The servo motor cannot detect over  $\pm 180$  degrees. Angle information over  $\pm 180$  degrees is a pseudo expansion angle obtained by calculation inside the servo motor.
- Angle information over  $\pm 180$  degrees is reset when the power is turned off. For example, if the power is turned on again at  $+270$  degrees, the servo motor will recognize the current angle as  $-90$  degrees.
- -The above operation changes the rotation direction at the time of the next angle command.



## 4.2 Command Speed

Name	Description	Default	Min	Max	Unit	R/W
0x01	Command Speed	0	-300	300	rpm	R/W

The servo rotates at the commanded speed. The direction of rotation is the same as the command angle. It can be commanded by 1 rpm. If the command value is "0", the motor doesn't rotate and the output shaft is braking.

### 【Input conditions】

The command speed is valid only when speed/torque control ON/OFF [0x25] is ON. When speed/torque control ON/OFF [0x25] is OFF, the command speed is ignored.

### 【Maximum speed】

The maximum rotation speed depends on the power supply voltage, load and control gain. If the power supply voltage is 7.4V, no load and the default parameter, it is about 150rpm. The minimum rotation speed is the same and under the same conditions as above, it will be about 10 rpm.

### 【Speed Limit】

The command value can be input up to  $\pm 300$  rpm, but if the speed faster than the operating speed limit CW / CCW [0x3A / 0x3B] is input as the command value, it doesn't operate at the speed higher than the speed limit.

### 【When other types of commands are input】

When the command angle / command torque is input, the command speed value is overwritten with "555,555,555 (dummy data)". If you enter the command speed again, it rotates at the command speed.

## 4.3 Command Torque

Name	Description	Default	Min	Max	Unit	R/W
0x02	Command Torque	0	-100	100	%	R/W

Rotates at the torque commanded by the servo. The torque is controlled pseudo actively by controlling the amount of motor current. The direction of rotation is the same as the command angle. When the command value is "0", the motor does not rotate and the output shaft is braked.

### 【Input Condition】

The command torque is valid only when speed/torque control ON/OFF [0x25] is ON. When speed/torque control ON/OFF [0x25] is OFF, the command torque is ignored.

### 【Maximum torque】

The command value can be input up to 100%, with the maximum torque that can be output being 100%. Please refer to the spec sheet for details on the maximum torque. The actual output torque depends on the power supply and load, so the command value should be used as a rough guide.

### 【Torque limit】

Command values can be input up to  $\pm 100\%$ , but if a torque higher than the operating torque limit CW/CCW [0x3C/0x3D] is input as a command value, no torque higher than the limit torque will be output.

### 【When other types of commands are input】

When the command angle / command torque is input, the command speed value is overwritten with "555,555,555 (dummy data)". If you enter the command speed again, it rotates at the command speed.

#### 4.4 Current Angle

Name	Description	Default	Min	Max	Unit	R/W
0x08	Current	***	-360,000,000	+360,000,000	0.1°	R

This parameter reads the current angle of the servo. The angle can be read by 0.1 degree.

Angles of  $\pm 180$  degrees or more can be read, but it is a pseudo expansion angle calculated internally by the servo motor. Refer to 4.1 Command Angle for details.

Readings can also be taken when command speed or command torque is input. In this case, whether to calculate a pseudo angle of  $\pm 180$  degrees or more or to present an absolute angle within  $\pm 180$  degrees can be selected with extended angle calculation [0x24].

Last command	Extended Angle Calculation OFF	Extended Angle Calculation ON
Angle command	Calculation of extended angle over $\pm 180$ degrees regardless of setting	
Speed command	Absolute angle presentation within $\pm 180$ degrees	Calculation of extended angle over $\pm 180$ degrees
Torque command		

#### 4.5 Current Speed

Name	Description	Default	Min	Max	Unit	R/W
0x09	Current Speed	***	-300	300	rpm	R

This parameter reads the current rotation speed of the servo. The speed can be read by 1 rpm.

It can be read even when the command angle / command torque is input.

The current speed can be read even when the speed/torque control ON/OFF [0x25] is OFF.

#### 4.6 Current Torque

Name	Description	Default	Min	Max	Unit	R/W
0x0A	Current Torque	***	-150	150	%	R

This parameter reads the current torque generated by the servo. Torque can be read by 1%.

It can be read even when the command angle / command speed is input.

The current speed can be read even when the speed/torque control ON/OFF [0x25] is OFF.

## 4.7 Current Temperature

Name	Description	Default	Min	Max	Unit	R/W
0x0B	Current Temperature	***	-40	120	°C	R

This parameter reads the temperature on the servo board. The temperature can be read by 1 ° C. There is an error of about  $\pm 5$  ° C due to individual differences in the temperature sensor.

When the operating temperature upper / lower limit [0x3E / 0x3F] is exceeded, the servo automatically turns off the motor output. When the temperature returns to the temperature limit range, the motor output is turned on. The operation when the motor output is ON differs depending on the final operation command.

Last command	Motion	Description
Angle command	Holding current angle	Overwrite the command angle [0x00] with the value of the current angle [0x08]
Speed command	Non rotation (breaking)	Overwrite the value of command speed / torque [0x01/02] with 0
Torque command		

## 4.8 Current Voltage

Name	Description	Default	Min	Max	Unit	R/W
0x0C	Current Voltage	***	0	500	0.1V	R

This parameter reads the power supply voltage supplied to the servo. The voltage can be read in 0.1V units. If the power supply voltage is 6.0V, the data will be "60". There is an error of about  $\pm 0.5$ V due to individual differences of the voltage sensor.

When the operating voltage upper / lower limit [0x40 / 0x41] is exceeded, the servo automatically turns off the motor output. When the voltage returns to the voltage limit range, the motor output is turned on. The operation when the motor output is ON is the same as the operation within the limit temperature.

If the power supply voltage (about 3V) or less at which the servo internal circuit does not operate, the servo will not respond to the read and cannot read.



## 4.9 Initialization

Name	Description	Default	Min	Max	Unit	R/W
0x10	Initialization	0	0	1	-	W

Entering "1" returns the servo parameters to their default values. Operation parameters such as the command position also return to the initial values, so be careful when initializing during operation.

The data saved in the servo is initialized. To initialize the stored data, execute ROM Write [0x12] after entering Initialize.

## 4.10 Rebooting

Name	Description	Default	Min	Max	Unit	R/W
0x11	Rebooting	0	0	1	-	W

If you enter "1", the servo is rebooted. After restarting, it will be in the same state as when the power was turned on again.

## 4.11 Writing in ROM

Name	Description	Default	Min	Max	Unit	R/W
0x12	Writing in ROM	0	0	1	-	W

If you enter "1", the current parameters is saved. The saved parameters are as follows.

Name	Save	Description
0x00~0x1F	Not saved	Position command / current angle etc. are not saved.
0x20~0x4F	Saved	Operation settings / restricted range etc. are saved.
0x50~0x5F	(Can't be saved)	The model number / manufacturing date and time cannot be overwritten.

It takes about 0.05 seconds from commanding the ROM write to completing the saving. During saving, all operations stop and communication isn't possible. After the save is complete, the servo automatically restarts and you are able to operate and communicate.

**\* Do not turn off the power of the servo during saving.**

## 4.12 Abnormality Information

Name	Description	Default	Min	Max	Unit	R/W
0x18	Occurrence Overview	All bit"0"	All bit"0"	All bit"1"	-	R
0x19	Notification Level Information	All bit"0"	All bit"0"	All bit"1"	-	R
0x1A	Warning Level Information	All bit"0"	All bit"0"	All bit"1"	-	R
0x1B	Failure Level Information	All bit"0"	All bit"0"	All bit"1"	-	R

This parameter reads the servo error status. The bit corresponding to the content of the abnormality is "1". The bit returns to "0" when the abnormality disappears, but some bits hold "1" until the power is turned off. The information on each item is as follows.

Type	Description	Example	Dealing with
Occurrence Overview	Notify / Warning / Notify summary information in the event of a failure	---	•If the outline of occurrence is all bits "0", there is no abnormality.
Notification Level	Information notification within the normal range. No deterioration in function and performance.	Parameter input over the limit angle	•Used as usage / operation information
Warning Level	It can be used normally, but performance degradation / protection operation occurs.	Rise to a temperature above the limit temperature → Motor output OFF	•Review of usage / operation method •Voluntary inspection
Failure Level	Functional loss. Some functions are restricted because normal operation cannot be expected.	Damaged motor control circuit → Motor output OFF	•Discontinuation and repair

The outbreak summary [0x18] only notifies you of the presence or absence of information so that you can easily check the abnormal status. Normally, it is assumed that only the [0x18] occurrence summary is monitored and the corresponding level of information is confirmed when any bit becomes "1".

Level	Group	Bit	Item	In the condition that Bit is "1"
Overview	Hardware	0	Notification level info.	It has notification level information about hardware
		1	Warning level info.	It has warning level information about the hardware
		2	Failure level info.	It has failure level information about the hardware
		3-7	---	---
	Software	8	Notification level info.	It has notification level information about software
		9	Warning level info.	It has warning level information about the software
		10	Failure level info.	It has failure level information about the software
		11-15	---	---
	Communication	16	Notification level info.	It has notification level information about the communication
		17	Warning level info.	It has warning level info. about the communication
		18	Failure level info.	It has failure level info. about the communication
		19-23	---	---
	Other	24	Notification level info.	It has notification level information about other
		25	Warning level info.	It has warning level information about other
		26	Failure level info.	It has failure level information about other
		27-31	---	---

It holds 32bit (4byte) of information for each level. 0-7bit (0byte) is hardware information, 8-15bit (1byte) is software information, 16-23bit (2byte) is communication information, and 24-31bit (3byte) is other information.

Level	Group	Bit	Item	In the condition that Bit is "1"
Notification	Hardware	0-7	---	---
	Software	8	Limit angle CW	[0x08] Current position is higher than [0x38] operation angle limit CW.
		9	Limit angle CCW	[0x08] Current position is lower than [0x39] operation angle limit CCW
		10	Limit speed CW	[0x09] Current speed is higher than [0x3A] operation speed limit CW
		11	Limit speed CCW	[0x09] Current speed is higher than [0x3B] operation limit CCW.
		12	Limit torque CW	[0x0A] Current torque is higher than [0x3C] operation torque limit CW.
		13	Limit torque CCW	[0x0A] Current torque is lower than [0x3D] operation torque CCW.
	Communication	14-15	---	---
		16-19	---	---
		20	No PWM input	No PWM input signal [*1]
		21	PWM pulse lower limit	PWM pulse width less than or equal to [0x35] input range [*1]
		22	PWM pulse high limit	PWM pulse width is greater than or equal to the [0x35] input range [*1]
	Other	23-31	---	---
		24-31	---	---

Level	Group	Bit	Item	In the condition that Bit is "1"
Warning	Hardware	0-3	---	---
		4	Angle sensor warning 1	The magnetism of the magnetic angle sensor is weak (operation is possible)
		5	Angle sensor warning 2	The magnetism of the magnetic angle sensor is strong (operation is possible)
		6-7	---	---
	Software	8	Temperature upper limit	[0x0B] Current temperature is higher than [0x3E] Operation temperature upper limit
		9	Temperature lower limit	[0x0B] Current temperature is lower than [0x3F] operation temperature lower limit.
		10	Voltage upper limit	[0x0C] Current voltage is higher than [0x40] operation voltage upper limit.
		11	Voltage lower limit	[0x0C] Current voltage is lower than [0x41] operation voltage lower limit.
		12-14	---	---
		15	ROM save abnormal	[0x12] Data saved by ROM writing cannot be loaded normally (initial value is loaded) [Steady] [*2]
	Communication Other	16-31	---	---

Level	Group	Bit	Item	In the condition that Bit is "1"
Failure	Hardware	0	Motor driver	Motor driver stops due to overload, etc.
		1	Brushless motor	Abnormal rotation signal of brushless motor
		2-4	---	---
		5	Angle sensor failure	The magnetism of the magnetic angle sensor cannot be read (it cannot operate)
		6-7	---	---
	Software	8	Clock	It was rebooted because there was something wrong with the CPU clock [*2]
		9	Watchdog	It was rebooted because there was something wrong with the CPU operation [*2]
		10	---	---
		11	RAM	It was rebooted because there was something wrong with the CPU RAM [*2]
		12-15	---	---
	Communication Other	16-31	---	---

[\*1] In the case of models that do not support PWM, the corresponding bit is always set to "0".

[\*2] The servo is initialized/restarted by itself as a result of an abnormality. This is not the current abnormal state. If the same error does not occur again, the corresponding bit will be set to "0" at the next start-up.

#### 4.13 Torque ON/OFF

Name	Description	Default	Min	Max	Unit	R/W
0x20	Torque ON/OFF	0	0	2	-	R/W

This parameter controls the output ON / OFF to the motor. The relationship between the command value and the output is shown in the table below.

Input value	Output	Description
0x00	Output ON	The motor rotates according to the command value of angle / speed / torque.
0x01	Output OFF	It becomes no output to the motor regardless of the command value.
0x02	Braking	It becomes no output to the motor, but a weak brake is applied.

When the output is turned off or the output is turned on from the brake state, the command value up to the last minute is discarded and the state becomes as follows.

Last command	status
Angle command	Holds the <u>current angle</u> when the output ON command is received
Speed command	The command value becomes "0" and the brake is activated.
Torque command	

##### ■ Example 1

Step	1	2	3
Command	Command Angle +45.0°	Output OFF	Output ON
Motion	Moving to +45.0°	Output OFF	Hold current angle

##### ■ Example 2

Step	1	2	3	4
Command	Command Angle +45.0°	Output OFF	Rotated the output angle to 0° by hand	Output ON
Motion	Moving to +45.0°	Output OFF	Rotation to 0°	Hold 0°

##### ■ Example 3

Step	1	2	3	4
Command	Command Angle +45.0°	Output OFF	Command Speed -50rpm	Output ON
Motion	Moving to +45.0°	Output OFF	Output OFF	Speed 0rpm

Writing this setting to ROM [0x12] can set the torque ON / OFF when the power is turned on after the next time. If you want to keep the torque off after turning on the power, set this setting value to "1" and execute ROM writing.

#### 【About torque OFF release by protection function】

- If the torque is turned off by the protection function such as the torque off due to the outside of the operating voltage range, the protection function has priority. In this case, remove the factor that protects the function

#### 4.14 Soft Start

Name	Description	Default	Min	Max	Unit	R/W
0x21	Soft Start ON/OFF	1	0	1	-	R/W

This parameter sets whether or not to operate slowly only for the first operation after the power is turned on.

Input value	Soft Start	Description
0	OFF	Turn on the torque at the position the power is turned on.
1	ON	It moves slowly toward the 0° position.

When soft start is ON, it moves slowly toward the 0-degree position. If the home position [0x44] setting has been changed, it moves to the 0-degree position set by the home position [0x44].

The following parameters are temporarily changed during soft start operation.

- Speed/torque control ON/OFF [0x25] is ON
- Operating speed limit CW/CCW [0x3A/0x3B] is  $\pm 30$  rpm
- Operating torque limit CW/CCW [0x3C/0x3D] is  $\pm 30\%$

The above will return to the original values after the soft-start operation ends.

The conditions for the end of soft start operation are as follows.

- Operated to around the 0 degree position (about  $\pm 1$  degree)
- Another motion command [\*] is input during soft start operation.
- Torque OFF/brake due to communication timeout operation/judgment time
- Other motor stop factors occurred, such as voltage/temperature out of range

##### 【Other motion commands】

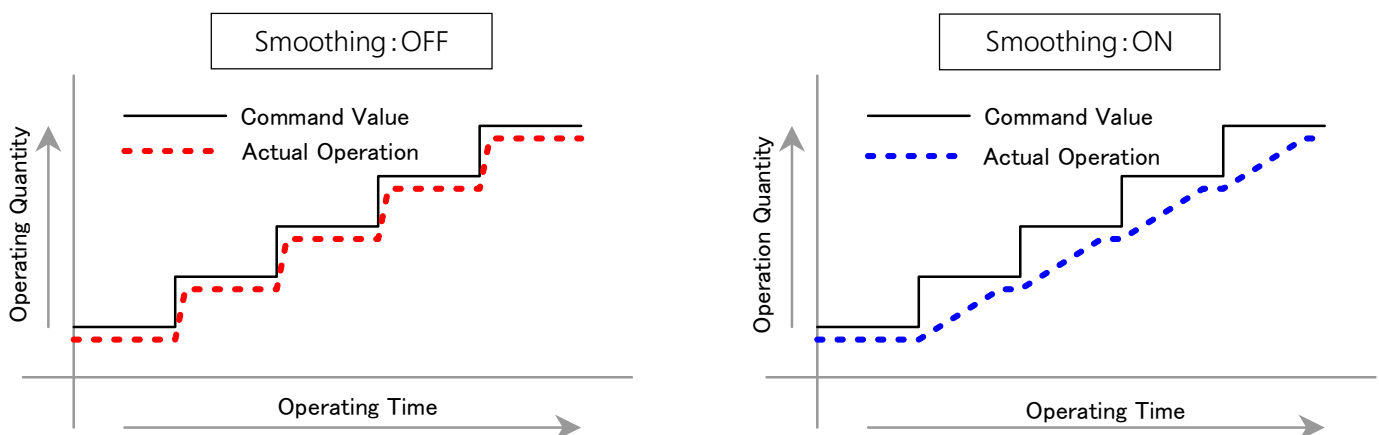
- Command angle [0x00]
- Command speed [0x01]
- Command torque [0x02]
- Torque ON/OFF [0x20]
- PWM input signal (supported models only)

#### 4.15 Smoothing

Name	Description	Default	Min	Max	Unit	R/W
0x22	Smoothing ON/OFF	1	0	1	-	R/W

This parameter sets whether or not to smooth the movement of the servo.

Input value	Smoothing	Motion	Effect
0	OFF	Follow the command value	It also follows sudden fluctuations in command values.
1	ON	Leveling fluctuations in command values	Smoothly follows fluctuations in command values.



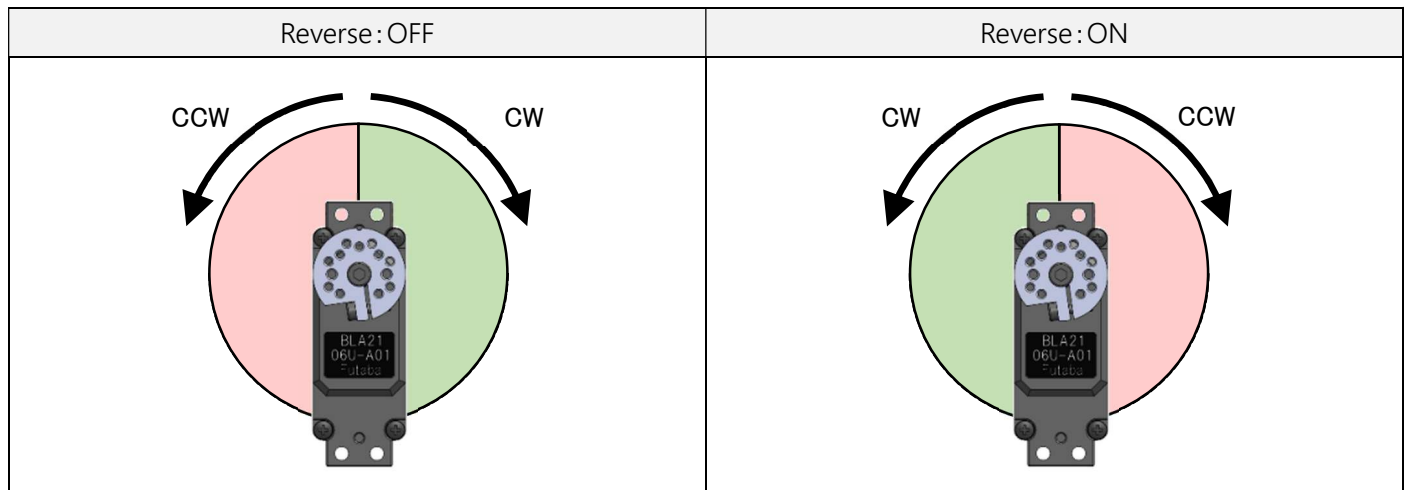
In the case of smoothing OFF, there is possibility to be jerky motion because the stepwise change of the command value is directly reflected in the operation. We recommend using smoothing, especially in manual operations.

#### 4.16 Reverse

Name	Description	Default	Min	Max	Unit	R/W
0x23	Reverse ON/OFF	0	0	1	-	R/W

This parameter reverses the direction of rotation of the servo. Both the command and the current value are reversed.

When reverse is turned on, the clockwise direction is treated as "-" (CCW), and the counterclockwise direction is treated as "+" (CW) when viewed from the top surface of the servo (the surface with the name plate).



#### 4.17 Extended Angle Calculation

Name	Description	Default	Min	Max	Unit	R/W
0x24	Extended Angle Calculation ON/OFF	0	0	1	-	R/W

This parameter sets whether to calculate extended angle data of  $\pm 180$  degrees or more or to present an absolute angle of  $\pm 180$  degrees or less during continuous rotation operation with command speed / command torque input. This setting is ignored when the command angle is input.

Input value	Extended Angle Calculation	Current Angle data
0	OFF	Show absolute angle within $\pm 180^\circ$
1	ON	Calculation extended angle over $\pm 180^\circ$

#### ■ Example: rotating 10 times at the command speed +100rpm

Extended Angle Calculation	Current Angle data	Input command angle $0^\circ$
OFF	$0^\circ$	Holding the angle
ON	$+3,600^\circ$	Rotates 10 times in CCW direction, then hold $0^\circ$

#### 4.18 Speed/Torque Control ON/OFF

Name	Description	Default	Min	Max	Unit	R/W
0x25	Speed/Torque Control ON/OFF	0	0	1	-	R/W

Sets the motor control method inside the servo motor. You can select the method according to the equipment to be used.

Input Value	Speed/Torque Control	Feature	Motor Control Method
1	ON	• Angle/speed/torque can be controlled individually	Angle control → Speed control → Torque control → Motor output
0	OFF	• Smoother operation from speed/torque control ON (Suitable for manual drone control, camera gimbal, etc.)	Angle control → Motor output (Speed/torque control not available)

When this setting is OFF, command speed [0x01] and command torque [0x02] are ignored.

#### 4.19 Communication Timeout Operation/Detect time

Name	Description	Default	Min	Max	Unit	R/W
0x26	Timeout Operation	1	0	2	-	R/W
0x27	Timeout Detect Time	1,000	1	60,000	ms	R/W

The parameter set to automatically change the motor output when the servo is not commanded for a certain period of time. The command indicate the command angle [0x00], command speed [0x01], command torque [0x02], and torque ON / OFF [0x20].

Input value	Output	Description
0x00	Holding	It holds the last command state before the communication timeout.
0x01	Output OFF	It becomes no output to the motor regardless of the command value.
0x02	Breaking	It becomes no output to the motor, but a weak brake is applied.

When the command inputs to the servo again, it returns to the state before the communication timeout.

#### 4.20 Overcurrent protection Current value

Name	Description	Default	Min	Max	Unit	R/W
0x2A	Overcurrent protection Current value	120	60	120	0.1A	R/W

Sets the upper limit of the amount of current flowing to the motor. By lowering this amount of current, the amount of instantaneous current flow during motor operation can be lowered.

Setting value	Advantages	Disadvantages
small	Less load on the power supply unit/battery Less voltage drop during motor operation	Maximum torque is reduced
large	Maximum torque increases	Increased load on power supply equipment/battery Voltage drop during motor operation will increase

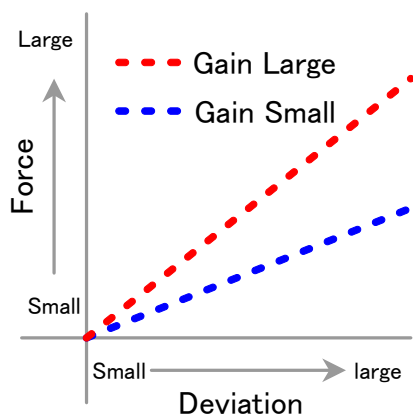
If the power supply voltage of the equipment used tends to drop, a system shutdown may occur due to voltage drop. Lowering this setting may reduce the amount of voltage drop.

This setting is valid even when speed/torque control ON/OFF [0x25] is OFF.

#### 4.21 Angle Control Proportional Gain

Name	Description	Default	Min	Max	Unit	R/W
0x2C	Angle Control Proportional Gain	40	1	100	-	R/W

The holding characteristics during the angle holding operation with the command angle [0x00] is set. The larger the difference (deviation) between the current angle and the command angle, the stronger the force of the servo to move to the command angle. The ratio of deviation and force is adjusted by proportional gain.



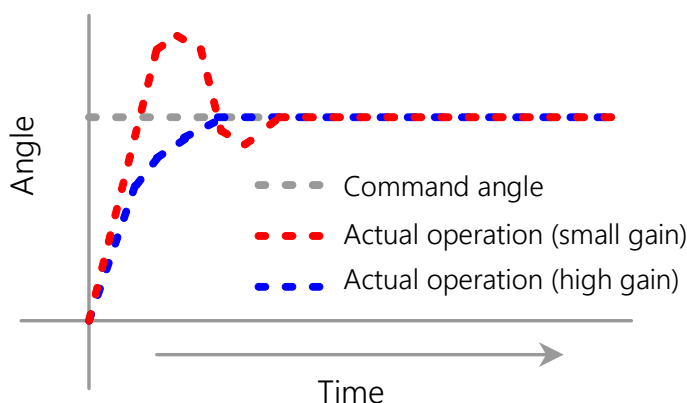
Gain	Holding Power	Hunting <sup>1</sup>
Large	Increasing	High probability
Small	Decreasing	Low probability

This setting is valid only when the angle is held by the command angle [0x00]. This setting is ignored when operating at the command speed [0x01] or command torque [0x02].

#### 4.22 Angle control Differential gain

Name	Description	Default	Min	Max	Unit	R/W
0x2D	Angle control Differential gain	40	0	100	-	R/W

Sets the operation characteristics when the motor is operated by the command angle [0x00] and approaches the command angle.



Gain	Motion
Large	Braking from before the stop position
Small	Overshoot (go too far and then back)

##### 【Input Conditions】

The differential gain is valid only when all of the following conditions are met.

- During angle holding operation by command angle [0x00]
- Speed/torque control ON/OFF [0x25] is ON

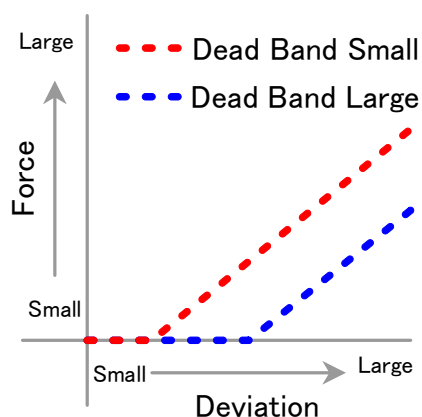
<sup>1</sup> The phenomenon in which the output shaft behaves like a spasm. The degree of generation differs depending on the load attached to the output shaft.



## 4.23 Angle Control Dead Band

Name	Description	Default	Min	Max	Unit	R/W
0x2E	Angle Control Dead Band	3	0	3,600	0.1°	R/W

The dead band of the stop position during the angle holding operation by the command angle [0x00] is set. By preventing the servo from operating below a certain deviation amount (dead band), it absorbs rattling and errors inside the servo and prevents malfunctions such as hunting<sup>1</sup>.

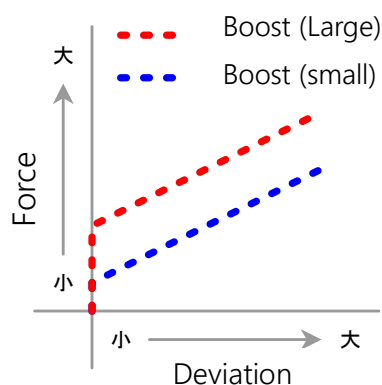


DeadBand	For small deviations	Hunting <sup>2</sup>
Small	responsive	High probability
Large	Hard to react	Low probability

## 4.24 Angle control Boost

Name	Description	Default	Min	Max	Unit	R/W
0x2F	Angle control Boost	0	0	100	0.1%	R/W

Sets the amount of boost to be added to the motor output during angle hold operation by command angle [0x00]. Adding a boost amount to the motor output value makes it easier to respond to small deviations. The maximum motor output value is 100%. The amount of boost can be set up to 10%.



Boost	For small deviations	Hunting <sup>3</sup>
Small	responsive	High probability
Large	Hard to react	Low probability

#### 4.25 Speed Control Proposal Gain

Name	Description	Default	Min	Max	Unit	R/W
0x30	Speed Control Proposal Gain	50	1	100	-	R/W

The speed characteristics during operation with the command angle [0x00] / command speed [0x01] is set.

The larger the difference (deviation) between the current speed and the target speed, the stronger the force to rotate at the target speed. The ratio of deviation and force is adjusted by proportional gain.

We recommend that you do not change this item with the initial value (or our recommended value).

#### 4.26 Speed Control Integral Gain

Name	Description	Default	Min	Max	Unit	R/W
0x31	Speed Control Integral Gain	1	0	100	-	R/W

The speed characteristics during operation with the command angle [0x00] / command speed [0x01] is set.

If the speed deviation remains, gradually increase the output so that the deviation disappears. The amount of output increase per hour is adjusted by the integrated gain.

We recommend that you do not change this item with the initial value (or our recommended value).

#### 4.27 Speed Control Dead Band

Name	Description	Default	Min	Max	Unit	R/W
0x32	Speed Control Dead Band	600	0	2,000	-	R/W

The speed characteristics during operation with the command angle [0x00] / command speed [0x01] is set.

By preventing it from operating below a certain speed deviation, malfunctions can be prevented. The range of deviations that do not work is adjusted by the dead band.

We recommend that you do not change this item with the initial value (or our recommended value).

#### 4.28 Speed Control Integral Limit

Name	Description	Default	Min	Max	Unit	R/W
0x33	Speed Control Integral Limit	2,000	1	500,000	-	R/W

The speed characteristics during operation with the command angle [0x00] / command speed [0x01] is set.

If the speed deviation does not disappear even if the output increases due to the integrated gain [0x31], the amount of output increase is prevented from becoming abnormally large. Adjust the upper limit of the output increase amount by the integration limit.

We recommend that you do not change this item with the initial value (or our recommended value).

## 【About PWM input setting】

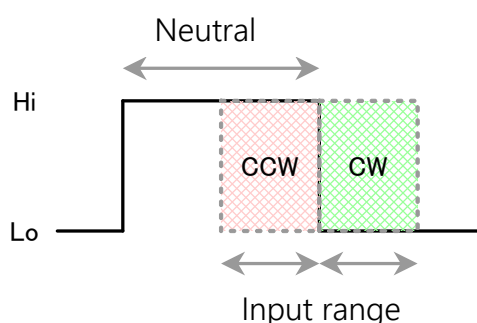
Items 4.29 and 4.30 can be set only for models that support PWM input.

(Models whose model name ends with -\*B\*, e.g. BLA21-12U-AB2.)

### 4.29 Neutral Pulse Width/Pulse Width Input Range

Name	Description	Default	Min	Max	Unit	R/W
0x34	Neutral Pulse Width	1,520	100	10,000	usec	R/W
0x35	Pulse width input range	700	10	10,000	usec	R/W

Sets the 0-degree position (neutral) and input range of the PWM signal input. If the pulse width is wider than the neutral pulse width, the servo rotates in the CW direction; if the pulse width is narrower than the neutral pulse width, the servo rotates in the CCW direction.



### 4.30 Command value output range (angle/speed)/operation mode

Name	Description	Default	Min	Max	Unit	R/W
0x36	Command value output range (angle/speed)	700	0	3,600	0.1°/rpm	R/W
0x37	Operation Mode	0	0	1	-	R/W

Sets the servo motor motion relative to the neutral pulse width/pulse width input range [0x34/0x35].

Angle command or speed command can be selected by setting the operation mode [0x37].

Input value	Operation Mode	Meaning of instruction value [0x36]
0	Angle command	Angle [0.1°]
1	Speed command	Speed [rpm]

Sets the operation range according to the pulse width input range [0x35] by the command value output range (angle/speed) [0x36].

Some example settings are shown on the next page.

The PWM pulse width is converted to command angle [0x00]/command speed [0x01] according to the settings of 0x34 to 0x37. The operating angle range and rotation direction follow the other configuration parameter settings.

## 【When the command angle [0x00]/command speed [0x01] and PWM are input simultaneously via CAN communication】

- CAN communication has priority and the PWM signal is ignored.
- If CAN communication is not input for more than the communication timeout operation/judgment time [0x27], the PWM signal is accepted.

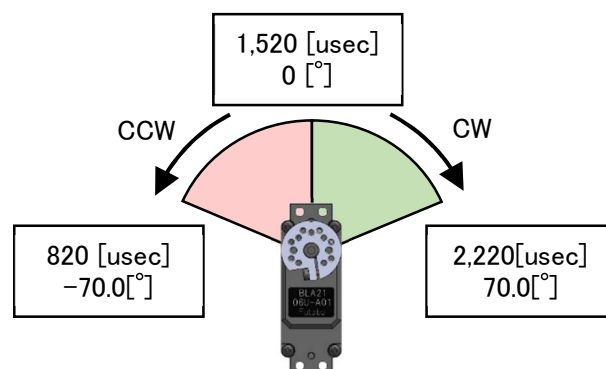
## 【Operation when the pulse width is out of the input range or when no pulse is input】

- The corresponding bit of the error information [0x18~] is set to "1" according to the pulse status.
- The corresponding bit of the error information [0x18~] is set to "1" depending on the pulse status.

## 【Example of PWM setting】

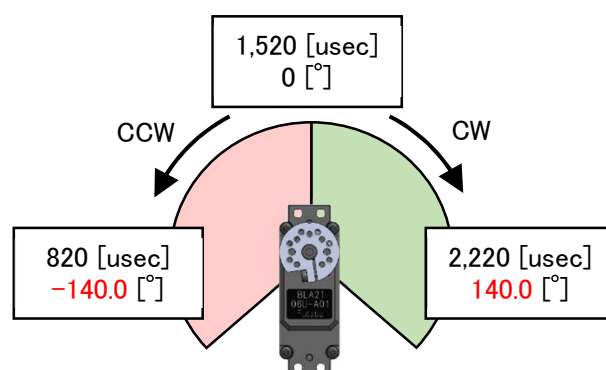
### ■ Example 1 (default setting)

Name	Description	Default
0x34	Neutral Pulse Width	1,520
0x35	Pulse width input range	700
0x36	Command value output range	700
0x37	Operation mode	0



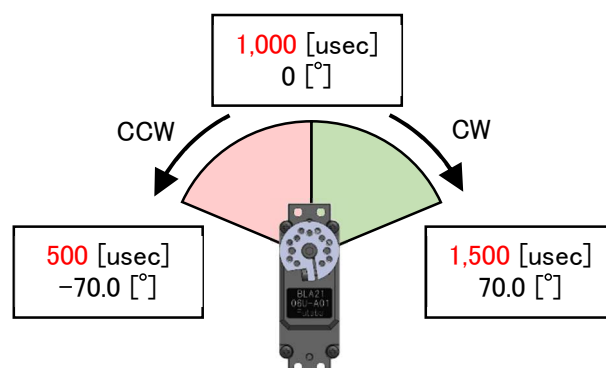
### ■ Example 2 (Expansion of operating angle range)

Name	Description	Default
0x34	Neutral Pulse Width	1,520
0x35	Pulse width input range	700
0x36	Command value output range	1,400
0x37	Operation mode	0



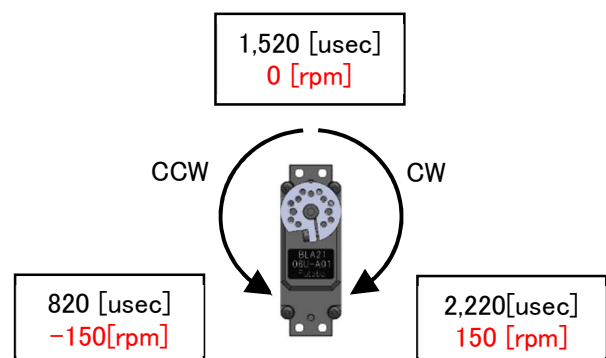
### ■ Example 3 (PWM neutral/width change)

Name	Description	Default
0x34	Neutral Pulse Width	1,000
0x35	Pulse width input range	500
0x36	Command value output range	700
0x37	Operation mode	0



### ■ Example 4 (speed control)

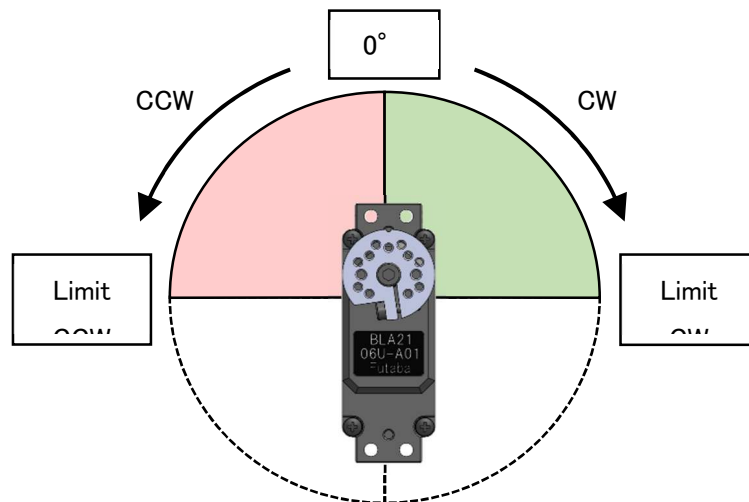
Name	Description	Default
0x34	Neutral Pulse Width	1,520
0x35	Pulse width input range	700
0x36	Command value output range	150
0x37	Operation mode	1



#### 4.31 Operation Angle Limit CW/CCW

Name	Description	Default	Min	Max	Unit	R/W
0x38	Operation Angle Limit CW	1,799	0	+360,000,000	0.1°	R/W
0x39	Operation Angle Limit CCW	-1,800	-360,000,000	0	0.1°	R/W

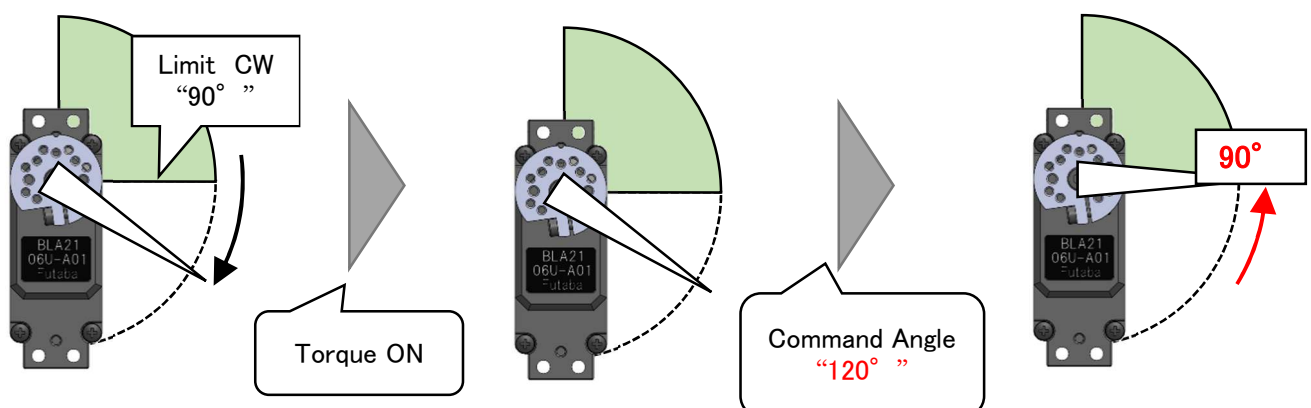
Limits the movement range by the command angle [0x00]. If the command angle value exceeds the movement angle limit, the position at the limit angle is held. In this case, bit 8/9 of the error information [0x19] notifies that the angle limit has been exceeded.



This setting is ignored when command speed [0x01] / command torque [0x02] is input.

#### 【 Cautions when operating torque ON / OFF outside the angle limit 】

- In the case of output OFF / braking, output OFF / braking is maintained even if the vehicle moves out of the limit angle due to an external force. It doesn't control it so that it does not go out of the limit range.
- If you command output ON in this state, the holding operation resumes at the current angle.
- If the next command angle is outside the operating angle limit, the servo operates to the angle closest to the command angle within the operating angle limit.



#### 4.32 Operation Speed Limit CW/CCW

Name	Description	Default	Min	Max	Unit	R/W
0x3A	Operation Speed Limit CW	300	0	300	rpm	R/W
0x3B	Operation Speed Limit CCW	-300	-300	0	rpm	R/W

Limits the operating speed range by command angle [0x00]/command speed [0x01]. When the speed exceeds the operation speed limit, the speed limit is held. In this case, bit 10/11 of the error information [0x19] notifies that the speed limit has been exceeded.

This setting is ignored when command torque [0x02] is input or when speed/torque control ON/OFF [0x25] is OFF.

#### 4.33 Operation Torque Limit CW/CCW

Name	Description	Default	Min	Max	Unit	R/W
0x3C	Operation Torque Limit CW	100	0	100	%	R/W
0x3D	Operation Torque Limit CCW	-100	-100	0	%	R/W

Limits the range of torque by command angle [0x00]/command speed [0x01]/command torque [0x02]. When the torque exceeds the operating torque limit, the limited torque output is held. In this case, bit 12/13 of the error information [0x19] notifies that the torque limit has been exceeded.

When speed/torque control ON/OFF [0x25] is OFF, this setting is ignored.

When speed/torque control ON/OFF [0x25] is ON, this setting is valid for all commands: [0x00] command angle, [0x01] command speed, and [0x02] command torque.

#### 4.34 Operation Temperature Upper/Lower Limit

Name	Description	Default	Min	Max	Unit	R/W
0x3E	Operation Temperature Upper Limit	80	20	80	°C	R/W
0x3F	Operation Temperature Lower Limit	-40	-40	20	°C	R/W

This parameter limits the operating temperature range. If this range is exceeded, the servo will automatically turn off the motor output. For specific operation, refer to 4.7 Current temperature.

#### 4.35 Operation Voltage Upper/Lower Limit

Name	Description	Default	Min	Max	Unit	R/W
0x40	Operation Voltage Upper Limit	100	74	120	0.1V	R/W
0x41	Operation Voltage Lower Limit	40	35	74	0.1V	R/W

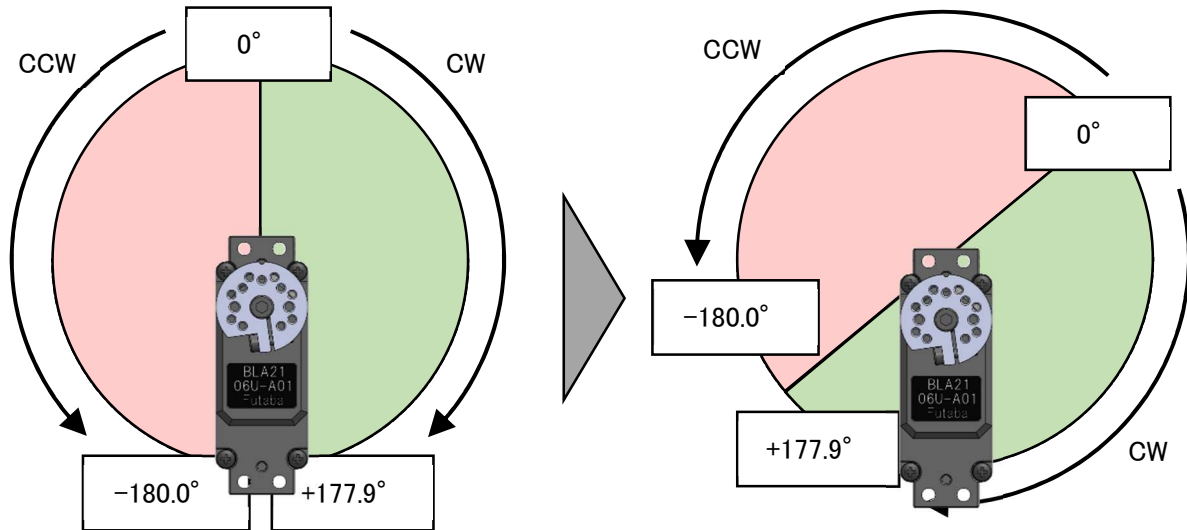
This parameter limits the operating voltage range. If this range is exceeded, the servo will automatically turn off the motor output. For specific operation, refer to 4.7 Current temperature.

#### 4.36 Origin point

Name	Description	Default	Min	Max	Unit	R/W
0x44	Origin Point	0	-1,800	1,799	0.1°	R/W

The origin point of servo change if you would like to change the origin point from the notch part of the horn.

■ Setting Example: 450 (+45.0°)



#### 4.37 Servo ID

Name	Description	Default	Min	Max	Unit	R/W
0x45	Servo ID	0	0	254	-	R/W

It is a unique number for instructing individual servos in one communication system by `uavcan.equipment.actuator.ArrayCommand`.

You can command up to 15 servo IDs in a message. If the command side specifies servo ID: 255, the servo ID is ignored and the servo is controlled.

#### 4.38 UAVCAN Node ID

Name	Description	Default	Min	Max	Unit	R/W
0x46	UAVCAN Node ID	0	0	127	-	R/W

It is a unique number for exchanging data between each node connected to one UAVCAN communication system. If the UAVCAN node ID is set to a value other than 0, the set value will be the own node ID. If set to 0 (default), request node ID assignment and use the dynamically assigned node ID.

#### 4.39 Booting Loader

Name	Description	Default	Min	Max	Unit	R/W
0x49	Booting Loader	0	-	-	-	R/W

It uses to update the software. Never write number in the place.

The values after this item [0x50-] can only be read, not written.

#### 4.40 Model Number

Name	Description	Default	Min	Max	Unit	R/W
0x50	Model Number	61	-	-	-	R

Model number is unique number to distinguish our products series. The number of BLA21 series is "61". This and the following items are only reading can't be written.

#### 4.41 Production number

Name	Description	Default	Min	Max	Unit	R/W
0x51	Production number	*****	-	-	-	R

Production number is assigned unique number in producing. Every products of the same model (BLA21-06U-A01) is different number.

#### 4.42 Firmware version

Name	Description	Default	Min	Max	Unit	R/W
0x52	Firmware version	1000	-	-	-	R

It represent the firmware version inside servo. The version changed depending on the production period.

#### 4.43 Hardware version

Name	Description	Default	Min	Max	Unit	R/W
0x53	Hardware version	6010	-	-	-	R

It represent the hardware version inside servo. The version changed depending on the production period.

#### 4.44 Production date

Name	Description	Default	Min	Max	Unit	R/W
0x58	Production year	****	-	-	Year	R
0x59	Production month	**	-	-	Month	R
0x5A	Production day	**	-	-	Day	R
0x5B	Production hour	**	-	-	Hour	R
0x5C	Production minute	**	-	-	Minute	R

It represents production date such as year, month and day.

■ e.g., if manufactured on June 22, 2020 at 3:30 p.m.

	Production year [0x58]	Production month [0x59]	Production day [0x5A]	Production hour [0x5B]	Production minute [0x5C]
set value	2020	6	22	15	30



## 5 Firmware version management table

Ver	Model (Period)	Changes
1.010	<ul style="list-style-type: none"> <li>•BLA21-**U-A0* (1/2021~12/2023)</li> <li>•BLA15-06U-A01 (5/2021~12/2023)</li> </ul>	<ul style="list-style-type: none"> <li>•New firmware</li> </ul>
1.100	<ul style="list-style-type: none"> <li>•BLA21-**U-AB2 (10/2021~4/2022)</li> </ul>	<ul style="list-style-type: none"> <li>•Implementation Speed/Torque Control ON/OFF [0x25]. Speed/Torque Control is OFF by default.</li> <li>•Implementation Overcurrent protection [0x2A].</li> <li>•implementation PWM input setting [0x34] to [0x37]. (Only for models that support PWM input)</li> </ul>
1.200	<ul style="list-style-type: none"> <li>•BLA21-**U-AB2 (5/2022~12/2023)</li> <li>•BLA15-12U-A01 (9/2022~12/2023)</li> </ul>	<ul style="list-style-type: none"> <li>•Implementation Angle control Boost [0x2F].</li> </ul>
1.300	<ul style="list-style-type: none"> <li>•BLA21-**U-A** (1/2024~5/2024)</li> <li>•BLA15-**U-A01 (1/2024~5/2024)</li> </ul>	<ul style="list-style-type: none"> <li>•Improved behavior</li> </ul>
1.400	<ul style="list-style-type: none"> <li>•BLA21-**U-A** (6/2024~)</li> <li>•BLA15-**U-A01 (6/2024~)</li> </ul>	<ul style="list-style-type: none"> <li>•Fixed a bug that caused the servo to stall during low speed operation.</li> </ul>
1.500	<ul style="list-style-type: none"> <li>•BLA34-**U-AB1 (5/2025~)</li> </ul>	<ul style="list-style-type: none"> <li>•New firmware</li> </ul>

## 6 Revision history

Rev.	Revision items	Date of issue
1.00	For web publication Added 5.firmware version management table	December 28 <sup>th</sup> , 2023
1.10	Added parameters for BLA34-**U series in Table 3-12. Updated firmware version management table. Added notation of byte order and bit order.	May 7 <sup>th</sup> , 2025
1.11	4.3 Corrected the description of the maximum torque command.	October 10 <sup>th</sup> , 2025