CAN 2.0A/B / DroneCAN Servo Control Protocol Manual

Revision 2.03_EN

HITEC RCD, INC.

INDEX

1 CAN SERVO Control Protocol

1-1 Protocol

Using CAN SERVO Control Protocol, you can write or read data in the registers of CAN Servos.

1-2 Communication System

CAN communication is a Multi Master Network, and all CAN controllers sharing a communication bus can act as a Master. CAN communication is resistant to noise by the Differential communication method using Two Wire Twist Pair. It supports CAN protocol standard CAN (2.0A) and extended CAN (2.0 B) and can communicate at speeds up to 1Mbps (ISO11898).

1-3 Test Configuration

SERVO setting and TEST are available by connecting to PC using DPC-CAN provided separately. (DPC-CAN Communication: Baud rate - 115,200bps, stop bit - 1, parity – none)

1-4 New Packet Format (Recommended)

Removed REG Length and Check Sum from the (OLD) Normal Packet Format and extended the function with the separator of Message ID.

It is recommended to use this Packet format in TURN MODE situation.

ex) Write 2 x Data (Position New, Turn New),

Read 2 x Data (Position Now, Turn Count)

Read Long DATA (32bit position)

This format is divided into 6 areas, Message Id, ID, Address A, B, DATA A, B as follows.

- **Custom Write**
  - Data write to SERVO

Message ID 'w'	ID 0xXX	Address 0xXX	Data Low 0xXX	Data High 0xXX

    - Lowercase 'w'

- Data write to SERVO (2 Address Data)

Message ID 'W'	ID 0xXX	Address A 0xXX	Data Low A 0xXX	Data High A 0xXX	Address B 0xXX	Data Low B 0xXX	Data High B 0xXX

    - Uppercase 'W'

    - If you use 'x' or 'X' instead of 'w' or 'W', CAN SERVO processes the read after writing. In other words, it sends a Return after writing.

- **Custom Read**
    - Request a data to SERVO

Message ID 'r'	ID 0xXX	Address 0xXX

- Response from SERVO

Message ID 'v'	ID 0xXX	Address 0xXX	Data Low 0xXX	Data High 0xXX

- Request 2 data to SERVO (2 Address Data)

Message ID 'R'	ID 0xXX	Address A 0xXX	Address B 0xXX

- Response from SERVO (2 Address Data)

Message ID 'V'	ID 0xXX	Address A 0xXX	Data Low A 0xXX	Data High A 0xXX	Address B 0xXX	Data Low B 0xXX	Data High B 0xXX

1-4.1 Message ID

A start Byte of Custom Packet. Message Id values are identified by the characters 'w', 'W', 'x', 'X', „r', 'R', 'v' and 'V'.

Message ID	ID	Address A	Data Low A	Data High A	Address B	Data Low B	Data High B

1-4.2 **ID**

A Byte which represents the ID of SERVO to receive the packet.

The corresponding packet is recognized only in the servo that matches the ID of the packet. Unmatched servos will not respond. ID can be specified from 0 to 255. 0 is broadcasting.

Message ID	ID	Address A	Data Low A	Data High A	Address B	Data Low B	Data High B

- Packets whose ID is set to 0 (0x00) are recognized as the same parameters in all servos regardless of CAN SERVO's unique ID.

1-4.3 **Address**

Register Address Byte.

Registers of SERVO are configured in 2-byte units, and Register Address has Even value.

Message ID	ID	Address A	Data Low A	Data High A	Address B	Data Low B	Data High B

1-4.4 **Data**

The data you want to write to the Register.

Data is 2 bytes or 2x2 bytes and follows Little Endian rules. Data [0] has Low Byte among 2 Byte data and Data [1] has High Byte.

Message ID	ID	Address A	Data Low A	Data High A	Address B	Data Low B	Data High B

1-5 OLD Normal Packet Format (Not Recommended)

Normal Packet Format is divided into 6 areas such as Header, ID, Address, REG Length, Data, Check Sum as follow.

- Data format - Little Endian
- Check Sum = (ID + Address + REG Length + Data Low + Data High) & 0xFF

- **Normal Write**
  - Data write to SERVO

Write Header	ID	Address	REG Length	Data Low	Data High	Check Sum
0x96	0xXX	0xXX	0x02	0xXX	0xXX	0xXX

● **Normal Read**

- Request a response to SERVO

Write Header 0x96	ID 0xXX	Address 0xXX	REG Length 0x00	Check Sum 0xXX

- Response from SERVO

Return Header 0x69	ID 0xXX	Address 0xXX	REG Length 0x02	Data Low 0xXX	Data High 0xXX	Check Sum 0xXX

1-5.1 Header

Packet starts with Byte.

Every Protocol Packet should start with Header Byte.

Packets sent from the controller to SERVO begin with 150 (0x96), and packets returned by the SERVO to the controller begin with 105 (0x69).

Header	ID	Address	REG Length	Data Low	Data High	Check Sum

1-5.2 ID

It shows Byte which represents the unique ID of CAN SERVO to receive the packet. The corresponding packet is recognized only in the servo that matches the ID of the packet. Unmatched servos will not respond. ID can be specified from 0 to 255.

Header	**ID**	Address	REG Length	Data Low	Data High	Check Sum

● Packets whose ID is set to 0 (0x00) are recognized as the same parameters in all servos regardless of the SERVO's unique ID.

1-5.3 Address

Register Address Byte.

Registers of CAN SERVO are configured in 2-byte units, and Register Address has Even value.

Header	ID	**Address**	REG Length	Data Low	Data High	Check Sum

1-5.4 Register Length

A Byte that indicates the length of Data in the Packet.

Among the Packet Format (Header, ID, Address, REG Length, Data, Check Sum), Register Length means the number of Byte in the area of "Data".

Header	ID	Address	REG Length	Data Low	Data High	Check Sum

- Write Mode

    It indicates the number of Bytes behind REG Length. It is fixed to 2.

- Read Mode

    If the .REG Length is '0', it means that there is no data transmitted afterwards, which is used to read the data from the register corresponding to the packet address.

1-5.5 Data

The data you want to write to the Register.

When the Data is [Write Mode], the length is 2Byte. When the Data is [Read Mode], the length is 0 Byte. In other words, Data is omitted after REG Length in Packet.

When writing or reading 2 Byte Data value to register specified by Address of Packet, follow Little Endian rule as follows. Data [0] has 2 bytes of Low Byte and Data[1] has High Byte.

Header	ID	Address	REG Length	Data Low	Data High	Check Sum

1-5.6 Check Sum

A byte to verify the error of the packet. If CheckSum does not match, it recognizes as an error packet and does not respond to the corresponding packet. CheckSum is the lower 1 byte value of the sum of the bytes of all areas excluding the header in the packet.

Header	ID	Address	REG Length	Data Low	Data High	Check Sum

- Read Mode Check Sum Calculation

Check Sum = (ID + Address + Length) & 0xFF

- Write Mode Check Sum Calculation

Check Sum = (ID + Address + Length +Data [0] + Data [1]) & 0xFF

1-6 DroneCAN Protocol

The supported DroneCAN Data Types are:

Data Type	Note
Actuator.ArrayCommand	-
Actuator.Status	-
GetNodeInfo	-
NodeStatus	-
DNA	must F/W >= 1.6(2)
Param Service	must F/W >= 2.0
F/W Update	must F/W >= 2.0

In F/W versions below 1.6(2), RUN_MODE is ignored and operates in Servo Mode.

In F/W 1.6(2) or later, RUN_MODE is not ignored and operates in the set mode.

For more detailed information, please refer to the DroneCAN protocol data below.

https://legacy.uavcan.org/Specification/7._List_of_standard_data_types/

https://legacy.uavcan.org/Specification/4._CAN_bus_transport_layer/

https://uavcan.org/specification/UAVCAN_Specification_v1.0-beta.pdf   - Latest version document.

1-7 Save Process

The recommended SAVE procedure is as follows:

- Stop Servo
- Write 0xFFFF to Register 0x70(112)
- Wait 1 sec
- Reset Servo
- Check Parameters and Working

1-8 Save Verify Process (FW Ver >= 2.1)

In FW Ver 2.1, a confirmation procedure was added during the SAVE procedure.

Set State to Ready: Write 0x4321 to Register 0x70(112)

Read Save State: Read Register 0x06(6) bit 5:3
    C style: State = (Value >> 3) & 7

Send Save Command: Write 0xFFFF to Register 0x70(112)

Start

Set State to Ready

Wait 1 sec

State = 1 (Ready) — No → Stop: Check FW Version

Clear Save Counter

Send Save Command ← No — Save Counter > 10 — Yes → Stop: NG

Wait 1 sec

State = 2 (in saving) — Yes

Inc Save Counter

State = 4 (error) — Yes

State = 3 (OK) — Yes → Stop: OK

State = 0 (none) — Yes → Stop: FAIL (Servo Reseted)

Stop: ERROR

2 CAN SERVO Register Sheet

2-1 Address Table

This is the Address list of the registers based on F/W 1.4 or earlier.

Please note that added and modified contents due to F/W update are also indicated.

Address		Name	len	R/W	Range			Feature	Unit
					Default	min	max		
Status	0x48	REG_EMERGENCY_STOP	2	R	-	0	65535	Bit 8: Position min error.	0 = OK, 1 = Error
								Bit 9: Position max error.	0 = OK, 1 = Error
								Bit 10: MCU temper under error	0 = OK, 1 = Error
								Bit 11: MCU temper over error	0 = OK, 1 = Error
								Bit 13: Volt under error	0 = OK, 1 = Error
								Bit 14: Volt over error	0 = OK, 1 = Error
	0x0C	REG_POSITION	2	R	-	0	16383	Read the Position.	4096=90°
	0x0E	REG_VELOCITY	2	R	-	0	65535	Read the Velocity.	pos/100msec
	0x10	REG_TORQUE	2	R	-	0	4095	Read the Motor PWM Duty.	4095=100%
	0x12	REG_VOLTAGE	2	R	-	0	65535	Read the Input Voltage.	100 = 1.00V
	0x14	REG_MCU_TEMPER	2	R	-	-57	196	Read the MCU temperature.	℃
	0x18	REG_TURN_COUNT	2	R (R/W)	-	-32760	32760	Accumulated Turn Count. (R/W is only available : F/W >= v1.4)	1 = 360°
	0x1A	REG_32BITS_POSITION_L	2	R	-	0	65535	Read the Accumulated Turn Position High 2 Bytes.	4096=90°
	0x1C	REG_32BITS_POSITION_H	2	R	-	0	65535	Read the Accumulated Turn Position Low 2 Bytes.	1=4 x 360°
	0xC8	REG_TIME_L	2	R	-	0	65535	Read the Servo operation time Low 2 Bytes.	sec
	0xCA	REG_TIME_H	2	R	-	0	65535	Read the Servo operation time High 2 Bytes.	1=65536 sec
	0x74	REG_PRODUCT_NO	2	R	-	0	65535	Read the Servo product number.	-
	0xFC	REG_VERSION	2	R	-	0	65535	Read the Servo version.	-
	0xFE	REG_VERSION	2	R	-	0	65535	Read the Servo version. (Bit Inverse)	-
Status 2	0x16	REG_CURRENT	2	R	-	0	65535	Read the generated Current.	mA
	0xD0	REG_MOTOR_TEMP	2	R	-	-32767	32767	Read the Motor temperature.	Computational reference
	0xD2	REG_TEMP	2	R	-	-32767	32767	Read the internal temperature of the Servo.	Computational reference
	0xD4	REG_HUM	2	R	-	0	32767	Read the internal relative humidity of the servo.	Computational reference
Action	0x1E	REG_POSITION_NEW	2	R/W	-	0	16383	Set New Position.	4096=90°
	0x24	REG_TURN_NEW	2	R/W	-	-32760	32760	Set New Turn (TURN mode only)	1=360°
Comm	0x32	REG_ID [In case of DroneCAN]	2	R/W	0	1	254 [127]	Set the SERVO ID.	'0' need Broadcast.
	0x38	REG_CAN_BAUDRATE	2	R/W	0	0	8	Set the baud rate.	0 = 1000 kbps
									1 = 800 kbps
									2 = 750 kbps
									3 = 500 kbps
									4 = 400 kbps
									5 = 250 kbps
									6 = 200 kbps

								7 = 150 kbps
								8 = 125 kbps
	0x3C	REG_CAN_BUS_ID_H [In case of DroneCAN]	2	R/W	0	0	65535 [0]	Set the CAN ID High 2 Bytes. (2.0A: 0~2047, 2.0B: 0~536870911) [Not used on DroneCAN.]	- [Keep 0]
	0x3E	REG_CAN_BUS_ID_L [In case of DroneCAN]	2	R/W	0	0	65535 [128]	Set the CAN ID Low 2 Bytes. (2.0A: 0~2047, 2.0B :0~536870911) [Set the Node ID.] [Add 0x100, if v1.4(2) <= F/W < v1.5(1)]	'0' need Broadcast.
	0x40	REG_SAMPLE_POINT	2	R/W	1	0	1	Set the CAN Sample Point.	0 = 50%,
									1 = 87.5%
	0x6A	REG_CAN_MODE	2	R/W	-	0	2	Select Protocol Type.	0 = 2.0A If F/W Type = A or C
									1 = 2.0B If F/W Type = A or C
									2 = DroneCAN, if F/W Type = A
Mode	0x44	REG_RUN_MODE [In case of DroneCAN]	2	R/W	0	0	3	Set run mode. [SERVO MODE is fixed before F/W 1.6(2)]	0: Multi-Turn mode
									1: Servo mode
									2: CR (F/W >= v2.0)
									3: Speed (F/W>=v2.0)
	0x9A	REG_POS_LOCK_TIME	2	R/W	3	0	5000	Set the time for OLP to operate. (Only SERVO Mode)	sec
	0x9C	REG_POS_LOCK_TORQUE_ RATIO	2	R/W	-	0	100	Set torque ratio when OLP operates. (Only SERVO Mode)	%
	0xB0	REG_POSITION_MAX_LIMIT	2	R/W	-	0	16383	Set the position max limits. (Only SERVO Mode)	4096=90°
	0xB2	REG_POSITION_MIN_LIMIT	2	R/W	-	0	16383	Set the position min limits. (Only SERVO Mode)	4096=90°
Option	0x2E	REG_STREAM_TIME	2	R/W	1000	0	11000	Set the Stream Period. (Range: 1000 ~10000) (Must F/W Ver >= 1.4) Set the Stream Freq. (Range: 10001 ~ 11000)	Period: (ms) Freq : Value - 10000 Hz
	0x30	REG_STREAM_MODE	2	R/W	0	0	1	Set the Stream Mode.	0 = Off, 1 = On
	0xE2	REG_STREAM ADDR_0	2	R/W	0	0	65535	Bit 0~7 :Stream Custom 1 Adder	-
								Bit 8~15 :Stream Custom 2 Adder	
	0xE4	REG_STREAM ADDR_1	2	R/W	0	0	65535	Bit 0~7 :Stream Custom 3 Adder	-
								Bit 8~15 :Stream Custom 4 Adder	
	0xE6	REG_STREAM ADDR_2	2	R/W	0	0	65535	Bit 0~7 :Stream Custom 5 Adder	-
								Bit 8~15 :Stream Custom 6 Adder	
	0xE8	REG_STREAM ADDR_3	2	R/W	0	0	65535	Bit 0~7 :Stream Custom 7 Adder	-
								Bit 8~15 :Stream Custom 8 Adder	
	0x46	REG_POWER_CONFIG	2	R/W	0	0	1536	Bit 10-9 : Forced Emergency Stop	0 = Off
									1= Motor_Free
									2= Speed_Down
									3=Motor_Hold
								Bit 0: S/W Reset	0 = Off, 1 = Reset
	0x4E	REG_DEADBAND	2	R/W	-	0	4095	Set the Position Dead band.	step
	0x50	REG_POS_MAX	2	R/W	0	0	16383	Set the maximum position. (0 is inactive)	4096=90°

	0xC2	REG_POS_MID	2	R/W	8192	0	16383	Set Mid position.	4096=90°
	0x52	REG_POS_MIN	2	R/W	0	0	16383	Set the minimum position. (0 is inactive)	4096=90°
	0xDA	REG_SPEED_VOLTAGE	2	R/W	-	0	65535	Set the reference voltage for the speed.	100mV (120 = 12.0V)
	0xDC	REG_SPEED_UP	2	R/W	-	0	65535	Set the acceleration time.	ms
	0xDE	REG_SPEED_DN	2	R/W	-	0	65535	Set the deceleration time.	ms
	0xE0	REG_SPEED_ES	2	R/W	-	0	65535	Set the deceleration time in case of an emergency stop. (It cannot be lower than the deceleration time.)	ms
	0x64	REG_INERTIA_RANGE	2	R/W	1	0	4095	Set the Inertia gain range.	0 = smart sense disable 1 = smart sense auto Gain Range 2~4095 (4095=100%)
	0x54	REG_VELOCITY_MAX (SPEED)	2	R/W	-	0	4095	Set the maximum velocity.	pos/100msec
	0x56	REG_TORQUE_MAX	2	R/W	4095	0	4095	Set the maximum torque.	4095=100%
	0x58	REG_VOLTAGE_MAX	2	R/W	-	0	65535	Set the maximum Voltage	10mV (100 = 1.00V)
	0x5A	REG_VOLTAGE_MIN	2	R/W	-	0	65535	Set the minimum Voltage	10mV (100 = 1.00V)
	0x5C	REG_TEMPER_MAX	2	R/W	-	-32767	32767	Set the maximum Temperature.	℃
	0x6C	REG_TEMPER_MIN	2	R/W	-	-32767	32767	Set the minimum Temperature.	℃
	0xC6	REG_ECHO	2	R/W	0	0	65535	User define Volatile memory. (It becomes '0' when power is reset.)	-
	0xCC	REG_USER_1	2	R/W	0	0	65535	User define Non-volatile memory.	-
	0xCE	REG_USER_2	2	R/W	0	0	65535	User define Non-volatile memory.	-
Current Circuit Model Only	0x26	REG_SPEC_TORQUE	2	R/W	-	0	65535	Set the torque output by measuring the current.	1 = 10mW (9000=90.00W)
	0xD8	REG_CURRENT_MAX	2	R/W	-	0	65535	Set the Max Current.	mA
Drone CAN Only	0x2C	REG_UNITLESS_RAD_MODE	2	R/W	0	0	1	Set the unit of angle for stream mode.	0=unitless 1=radian
Config	0x6E	REG_FACTORY_DEFAULT	2	W	0	0	65535	Set data to previous or factory default.	3855 = factory default 65535 = Load User Page
	0x70	REG_CONFIG_SAVE	2	W	0	0	65535	Save changed data in memory.	65535 = Save User Page
NOTE) Yellow Values need SAVE and RESET									

2-2　Additional Address Table

This is the Address list of the registered added due to F/W version update.

Address		Name	len	R/W	Range			Feature	Unit
					Default	min	max		
Added in F/W v1.4	0x06	REG_STATUS	2	R	-	0	3	Bit 0 : Read the E_STATUS.	0 = Enabled 1 = Disabled
								Bit 1: Read the Over Current state.	0 = Over Current status 1 = Normal status
	0xA6	REG_REF_1	2	R/W	-	0	65535	Referenceable flags Bit 0 = Reg 0xA8	Bit 0=1 (Referenceable)
	0xA8	REG_PAD_VOLT	2	R/W	-	0	65535	PAD voltages	Byte0=PAD volt1 Byte1=PAD volt2
	0xA2	REG_SETUP	2	R/W	-	0	65535	Bit 0 : PAD Control Bit 1 : Start Position Bit 2 : Brake instead of Free (BLDC) Bit 3 : Over Volt Brake Bit 7 : Stream CAN ID: F/W>= v1.5(1) Bit 10 : Fail Safe :F/W>= v1.5(2) Bit 12 : Realtime ID1, ID2 :F/W>= v2.0 Bit 15 = Motor Diretion: F/W >= v2.1	Keep bits
	0x7A	REG_START_POSITION	2	R/W	0	0	16383	Start Position. Reg 0xA2: bit 1 = needed.	
	0x80	REG_OVERVOLT_BRAKE_VOLTAGE	2	R/W	0	0	65535	Brake Voltage Reg 0xA2: bit 3 = 1 needed.	1000 = 10.00V
Added in F/W v1.5	0x20	REG_TMP_CONFIG	2	R/W	0	0	65535	Bit 0 = Pause Stream Must F/W >= v1.5	Bit 0 = 1(Paused)
	0x3A	REG_STREAM_CAN_ID_H	2	R/W	0	0	65535	Custom Stream CAN ID, Reg 0xA2: bit 7 = 1 needed. Must F/W Ver >= v1.5(1)	Bit 31 = 1 (CAN 2.0B) Bit 31 = 0 (CAN 2.0A)
	0x42	REG_STREAM_CAN_ID_L	2	R/W	0	0	65535		
	0x94	REG_FAIL_SAFE_POSITION	2	R/W	0	0	16383	Fail Safe Position. Reg 0xA2: bit 10 = 1 needed. Must F/W Ver >= v1.5(2)	4096=90°
	0xB4	REG_FAIL_SAFE_TIME	2	R/W	0	0	65535	Set the time period for the condition where Fail Safe activates. Reg 0xA2: bit 10 = 1 needed. Must F/W Ver >= v1.5(2)	ms
FW >= 1.6(3)	0xAC	TURN_MULIPLIER	2	R/W	1	-32760	32760	DorneCAN, Multi-Turn: +/-1.0 x MULTIPLIER	
F/W >= v2.1	0xA0	REG_SETUP_2	2	R/W	-	0	65535	Bit 0 ~ 14: System Reserved Bit 15 = Enable Setup_EX_X Regs (Keep bit 1 if bit = 1 aleady)	You must keep reserved bits
	0x41	REG_SETUP_EX_3	2	R/W	-	0	65535	Bit 0 = Reserved Bit 1 = Enable TURN_MULTIPLIER Bit 2 ~ 15 = Reserved	You must keep reserved bits
	0xAC	TURN_MULIPLIER	2	R/W	1	-32760	32760	DorneCAN, Multi-Turn: +/-1.0 x MULTIPLIER	
NOTE) Yellow Values need SAVE and RESET									

2-3   Status

The registers to check the status of the SERVO.

2-3.1   REG_EMERGENCY_STOP

The current error states. Items that do not meet the set criteria can be checked with Flag.

15	14	13	12	11	10	9	8
Reserved	Volt Over Error	Volt Under Error	Reserved	MCU TEMP Over Error	MCU TEMP Under Error	POS Max Error	POS Min Error

7	6	5	4	3	2	1	0
Reserved							
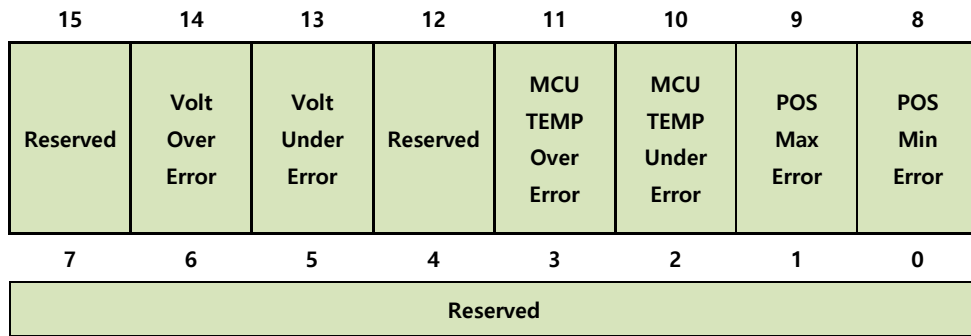
Address	length	R/W	Default	Min	Max
0x48	2	R	0	0	65535

- Bit 15,12, 7~0: Reserved – Do not use.
- Bit 14: Volt over error – Set to 1, if the current voltage is higher than the standard voltage.
- Bit 13: Volt under error – Set to 1, if the current voltage is lower than the standard voltage.
- Bit 11: MCU Temp over error – Set to 1, if the current MCU temperature is higher than the standard temperature.
- Bit 10: MCU Temp under error – Set to 1, if the current MCU temperature is lower than the standard temperature.
- Bit 9: POS max error – Set to 1, if the current position is higher than the maximum position.
- Bit 8: POS min error – Set to 1, if the current position is lower than the minimum position.

2-3.2   REG_POSITION

The current position value of CAN Servo and the range is 0 to +16383.
Based on the position '0', it can be operated 360° in clockwise direction.

Address	Length	R/W	Default	Min	Max
0x0C	2	R/O	-	0	16383

- The resolution is 4096 = 90˚

2-3.3 **REG_VELOCITY**

The current speed (VEL) of the SERVO and the unit is pos/100msec.

It is shown through the following equation.

PT (PID SAMPLE TIME) = Register 0x3A

V = speed: unit sec / 60°

VEL = speed conf. value: Register 0x0E

RPM = VEL * 10 * 90 / 4096 / 360 * 60 / PT * 10

VEL = (1 / (V / 60)) x PT / 10 * 4096 / 90 / 10

If PT = 10

  VEL = (about)27.33 * RPM

  V =(about)273.06 / VEL

Address	Length	R/W	Default	Min	Max
0x0E	2	R/O	-	0	65535

● Please note that the calculation formula and unit differ depending on the version of SERVO.

Firmware	RPM Calculation	Reg 0x0E's Unit
FW Ver < 1.3	RPM = VEL*1000*90/4096/360*60/PT*10	Pos/1msec
FW Ver >= 1.3	RPM = VEL*10*90/4096/360*60/PT*10	Pos/100msec

The unit's Pos is the value of REG_POSITION, which is 4096=90°

2-3.4 **REG_TORQUE**

The Duty of current Motor's PWM. It affects the torque.

Address	Length	R/W	Default	Min	Max
0x10	2	R/O	0	0	4095

● It outputs 100% Duty at 4095

2-3.5 **REG_VOLTAGE**

The value of current supply voltage.

It represents 0.01 V per 1 register value. If the value is 1200, the actual supply voltage is 12V.

Address	Length	R/W	Default	Min	Max
0x12	2	R/O	-	0	65535

2-3.6 **REG_MCU_TEMPER**

The internal temperature of MCU.

It can be set to 1 ℃ per data value and the actual temperature is 20°C when the value of Register is 20.

Address	Length	R/W	Default	Min	Max
0x14	2	R/O	0	-57	196

2-3.7 **REG_TURN_COUNT**

The current number of rotations.

In case of + 360˚ position, it is +1. In case of -360˚ position, Register value is -1.

Address	Length	R/W	Default	Min	Max
0x18	2	R (R/W)	0	-32760	+32760

- R/W Type = R/W, if F/W Ver >= v1.4

2-3.8 **REG_32BITS_POSITION_L**

The low value of current position (angle).

Address	length	R/W	Default	Min	Max
0x1A	2	R/O	-	0	65535

- REG_POSITION + (REG_TURN_COUNT *16384)의 Low Word

2-3.9 **REG_32BIT_POSITION_H**

The high value of current position (angle).

Address	length	R/W	Default	Min	Max
0x1C	2	R/O	-	65535	2^31

- REG_POSITION + (REG_TURN_COUNT *16384)의 High Word

2-3.10 **REG _TIME_L**

The operating time after SERVO power is turned on.

It is the low value and the total running time can be checked by adding up the high value with low value.

1sec per value. If Register value is 20, run time is 20 seconds.

Address	Length	R/W	Default	Min	Max
0xC8	2	R/O	0	-32760	32760

2-3.11 REG _TIME_H

The operating time after SERVO power is turned off.

It is the high value and the total running time can be checked by adding up the high value with low value.

65535sec per value. If Register value is 10, run time is 655350 seconds.

Address	Length	R/W	Default	Min	Max
0xCA	2	R/O	0	-32760	32760

2-3.12 REG_PRODUCT_NO

Read the production number of SERVO

Address	Length	R/W	Default	Min	Max
0x74	2	R/O	-	0	65535

2-3.13 REG_VERSION

Read the version of SERVO

Address	Length	R/W	Default	Min	Max
0xFC	2	R/O	-	0	65535

2-3.14 REG_VERSION(BIT_INVERSE)

Read the version of SERVO (BIT INVERSE)

Address	Length	R/W	Default	Min	Max
0xFE	2	R/O	-	0	65535

2-4   Status 2

The registers to check the status of the motor current or temperature.

2-4.1   REG_CURRENT

The current value used. It can be set to 1mA per data value and the actual current is 10A when the value of Register is 10000.

Address	Length	R/W	Default	Min	Max
0x16	2	R/O	0	0	65535

● This function works only for current circuit model only (ex: SG series, MDB950SW)

2-4.2   REG _MOTOR_TEMP

The temperature of the current Motor.

The temperature value of the motor can be calculated by the following equation.

T0 = 298.15, VT = 3.3 / 4096 * data

Rt = (10 * VT) / (3.3 - VT)

Temperature(℃) = 1007747 / (log(Rt) * T0 - log(10) * T0 + 3380) - 273.15

Address	Length	R/W	Default	Min	Max
0xD0	2	R/O	0	-32760	32760

● This function works only for motor temper sensor equipped model only (ex: SG series, MDB950SW)

2-4.3   REG_TEMP

The internal temperature of the current SERVO.

The temperature value of the SERVO can be calculated by the following equation.

Temperature(℃) = 175.72 * data / 65536 - 46.85;

Address	Length	R/W	Default	Min	Max
0xD2	2	R/O	0	-32760	32760

● This function works only for humidity sensor model only (ex: SG series)

2-4.4   REG_HUM

The relative humidity inside the SERVO.

The humidity value of the SERVO can be calculated by the following equation.

Humidity(%RH) = 125 * data / 65536 - 6;

Address	Length	R/W	Default	Min	Max
0x4D	2	R/O	0	0	65535

● This function works only for humidity sensor model only (ex: SG series)

2-5   Action

It is the Register to operate CAN SERVO.

2-5.1   REG_POSITION_NEW

Specify a new position for SERVO with a resolution of 4096 = 90°

Address	length	R/W	Default	Min	Max
0x1E	2	R/W	-	0	16383

- In SERVO Mode, it only can move from the range of POSITION_MIN_LIMIT to POSITION_MAX_LIMIT.

2-5.2   REG_TURN_NEW

Set the number of rotations. The initial value is 0.

If set +1, the servo rotates 360° in the + direction relative to 0.

Address	length	R/W	Default	Min	Max
0x24	2	R/W	0	-32760	32760

- It only operates in TURN Mode.

2-6 Communication

Register that set the communication environment of the servo. Communication Data can be saved and initialized.

2-6.1 REG_ID

Set the ID.

Set the ID. If multiple CAN SERVOs are connected by the same signal line, the ID must be assigned a unique value. Only the CAN SERVOs that matches the ID of the packet will recognize the corresponding packet. Unmatched CAN SERVOs will not respond.

Each device(Node) of DroneCAN network has a Unique Node ID.

Set the servo Node ID value. It can be set from 1 to 127.

However, please set REG_CAN_BUS_ID_H = 0, REG_CAN_BUS_ID_L = 128

Mode	Address	length	R/W	Default	Min	Max
CAN 2.0A, B	0x32	2	R/W	0	0	255
DroneCAN				0	0	127

- If REG_ID is changed and saved, it operates with changed ID from the next power reset.

2-6.2 REG_BAUDRATE

Set the Baud Rate.

It can support communication speeds from at least 125 Kbps up to 1000 Kbps.

Address	length	R/W	Default	Min	Max
0x38	2	R/W	5	0	8

REG_BAUDRATE	Baud Rate
0	1000 Kbps
1	800 Kbps
2	750 Kbps
3	500 Kbps
4	400 Kbps
5	250 Kbps
6	200 Kbps
7	150 Kbps
8	125 Kbps

- If you save after changing BAUDRATE, it operates at changed baud rate after power reset.

2-6.3 REG_CAN_BUS_ID_H

Set the CAN BUS ID.

CAN BUS ID can be set by adding high value and low value.

In DroneCAN, set the value to 0.

Mode	Address	Length	R/W	Default	Min	Max
CAN 2.0A, B	0x3C	2	R/W	0	0	8191
DroneCAN				0	0	0

2-6.4 REG_CAN_BUS_ID_L

Set CAN BUS ID.

CAN BUS ID can be set by adding low value and high value.

Mode	Address	Length	R/W	Default	Min	Max
CAN 2.0A, B	0x3E	2	R/W	0	0	65535
DroneCAN				0	0	128

- In CAN 2.0A, it can be specified from 0 to 2047.
- In case of CAN 2.0B, it is available to designate 0 ~ 536870911 as low and high data.
- To change this item, save and power reset are required.
- Recommended in DroneCAN status: Set this value to 128 and set the node ID (actuator) value of the servo in REG_ID[0x32].
- In DroneCAN state, if this value is between 1 and 127, the servo compares whether it matches the Src Node ID value of ArrayCommand.
- In DroneCAN state, if this value is 128, the servo ignores the Src Node ID value of ArrayCommand. (However, F/W Ver 1.3 or higher is required)

2-6.5 REG_ SAMPLE_POINT

Selects the sampling point ratio of the CAN communication signal.

Address	length	R/W	Default	Min	Max
0x40	2	R/W	0	0	1

- 0 = 50% and 1 = 87.5%
- To change it, save and power reset are required.

2-6.6 **REG_CAN_MODE**

Set CAN MODE.

Address	length	R/W	Default	Min	Max
0x6A	2	R/W	-	0	2

- 0 = CAN 2.0, 1 = CAN 2.0B, 2 = DroneCAN
- To change it, save and power reset are required.
- If the F/W type is C, it cannot be changed to DroneCAN.
- If the F/W type is U, it cannot be changed to CAN 2.0A, 2.0B.

2-7   MODE

This Register is used to set RUN MODE of Servo. MODE Data can be saved and initialized.

2-7.1   REG_RUN_MODE

Select SERVO MODE or Multi-Turn MODE of CAN SERVO.

In case of DroneCAN, only SERVO MODE is available before F/W v1.6(2) version.

Address	length	R/W	Default	Min	Max
0x44	2	R/W	1	0	1

- 0= Multi-Turn MODE, 1= SERVO MODE, 2= CR, 3 = Speed
- To change it, save and power reset are required.

- **SERVO MODE**

  SERVO MODE is the mode to control within 0~360 degree.

  By using REG_POSITION_MIN_LIMIT and REG_POSITION_MAX_LIMIT, you can adjust the angle of CAN SERVO.

- **Multi-Turn MODE**

  Multi-Turn MODE is the mode to control until ±32760 turns.

  By using REG_TURN_NEW, you can adjust the number of turns. And also, by using REG_POSITION_NEW, you can adjust the position.

- **CR MODE – F/W Ver >= v2.0**

  This is continuous rotation mode. It specifies only the motor direction and output. Actual rotation speed may vary depending on external load.

  POS_MIN, POS_MAX values become -100%, +100%.

- **Speed MODE – F/W Ver >= v2.0**

  This is continuous rotation mode. Adjusts the output to the specified speed. The motor output varies according to the load to keep the rotational speed constant.

  POS_MIN, POS_MAX values become -100%, +100%.

  The speed set in Reg 0x54 VELOCITY MAX becomes 100%. Set the speed at which the motor can actually operate. Think of 32767 as infinity.

2-7.2   REG_POS_LOCK_TIME

Set the operation time, when CAN SERVO is in OLP condition. 1 = 1 second. If you set 3, OLP will be activate when CAN SERVO is being in OLP condition over 3 seconds.

Address	length	R/W	Default	Min	Max
0x9A	2	R/W	3	0	5000

- At 0, OLP is activate all the time.
- Only activate in SERVO MODE (Not applicable in Multi-turn MODE

2-7.3 REG_POS_LOCK_TORQUE_RATIO

Set the Torque when OLP is activate.

The torque is output as much as the percentage of the currently set torque.

1= 1% and 100 = 100%.

Address	length	R/W	Default	Min	Max
0x9C	2	R/W	100	0	100

- Only activate in SERVO MODE (Not applicable in Multi-turn MODE)

2-7.4 REG_POSITION_MAX_LIMIT

Set the maximum position that can be operated.

Data = 0~ +16383 and the resolution of data = 4096 = 90°.

Address	length	R/W	Default	Min	Max
0xB0	2	R/W	15018	0	16383

- If the value of REG_POSITION_NEW is set higher than REG_POSITION_MAX_LIMIT, it does not move.
- REG_POSITION_MAX_LIMIT should be set higher than REG_POSITION_MIN_LIMIT value.

2-7.5 REG_POSITION_MID

Set the center value of the position that can be operated.

Data = 0~ +16383 and the resolution of data = 4096 = 90°

Address	length	R/W	Default	Min	Max
0xC2	2	R/W	8192	0	16383

- It should be set to the center value between REG_POSITION_MAX_LIMIT and REG_POSITION_MIN_LIMIT.

2-7.6 REG_POSITION_MIN_LIMIT

Set the minimum position that can be operated.

Data = 0~ +16383 and the resolution of data = 4096 = 90°.

Address	length	R/W	Default	Min	Max
0xB2	2	R/W	1366	0	16383

- If the value of REG_POSITION_NEW is set lower than REG_POSITION_MIN_LIMIT, it does not move.
- REG_POSITION_MIN_LIMIT should be set lower than REG_POSITION_MAX_LIMIT value.

2-8 Option

Register to set Servo function. Option data can be saved and initialized.

2-8.1 REG_STREAM_TIME

Set the time of the stream period.

Units can be set to either Period or Frequency.

Address	length	R/W	Default	Min	Max
0x2E	2	R/W	1000	0	11000

- Period : 0 ~ 10000 ms
- Frequency : 10001 ~ 11000 = (Value-10000) Hz (F/W Ver >= v1.4(2))

2-8.2 REG_STREAM_MODE

Set STREAM MODE ON / OFF.

Address	length	R/W	Default	Min	Max
0x30	2	R/W	0	0	1

- 0: STREAM_MODE_OFF, 1: STREAM_MODE_ON

- **STREAM_MODE**
- CAN SERVO returns REG_POSITION and REG_TURN_COUNT values automatically at specified time intervals without the need for manual read by HOST.
  (Return REG_TURN_COUNT only when using TURN MODE.)

2-8.3 REG_STREAM_ADDR_0

Set the desired data Adder when outputting in Stream Mode.

15	14	13	12	11	10	9	8
Stream Custom 2 Adder							

7	6	5	4	3	2	1	0
Stream Custom 1 Adder							
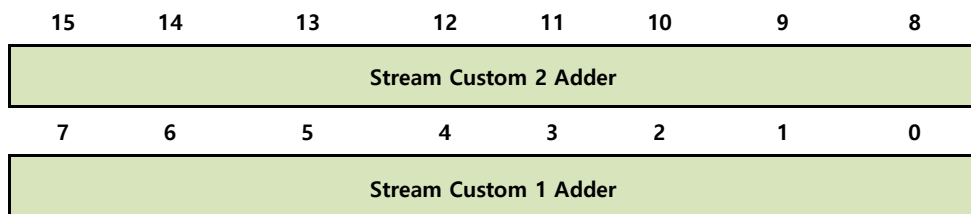
Address	length	R/W	Default	Min	Max
0xE2	2	R/W	0	0	65535

- Bit 7~0: Adder of Stream Custom 1
- Bit 15~8: Adder of Stream Custom 2
- If the setting values of REG_STREAM_ADDR_0 ~ 4 are all 0, REG_POSITION and REG_TURN_COUNT values are returned.
- Applicable only when the servo is CAN2.0A or CAN2.0B

2-8.4 **REG_STREAM_ADDR_1**

Set the desired data Adder when outputting in Stream Mode.

15	14	13	12	11	10	9	8
Stream Custom 4 Adder							

7	6	5	4	3	2	1	0
Stream Custom 3 Adder							
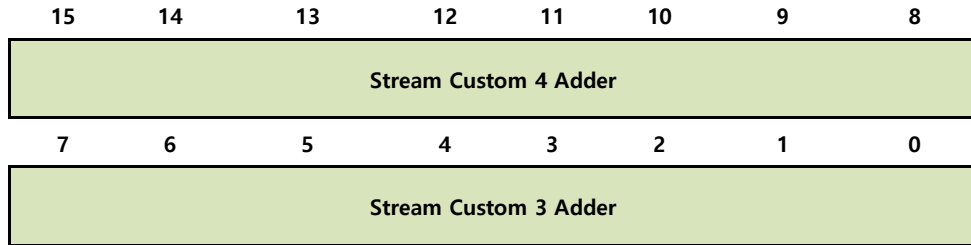
Address	length	R/W	Default	Min	Max
0xE4	2	R/W	0	0	65535

- Bit 7~0: Adder of Stream Custom 3
- Bit 15~8: Adder of Stream Custom 4
- If the setting values of REG_STREAM_ADDR_0 ~ 4 are all 0, REG_POSITION, REG_TURN_COUNT values are returned.
- Applicable only when the servo is CAN2.0A or CAN2.0B

2-8.5 **REG_STREAM_ADDR_2**

Set the desired data Adder when outputting in Stream Mode.

15	14	13	12	11	10	9	8
		Stream Custom 6 Adder					

7	6	5	4	3	2	1	0
		Stream Custom 5 Adder					

Address	length	R/W	Default	Min	Max
0xE6	2	R/W	0	0	65535

- Bit 7~0: Adder of Stream Custom 5
- Bit 15~8: Adder of Stream Custom 6
- If the setting values of REG_STREAM_ADDR_0 ~ 4 are all 0, REG_POSITION, REG_TURN_COUNT values are returned.
- Applicable only when the servo is CAN2.0A or CAN2.0B

2-8.6 **REG_STREAM_ADDR_3**
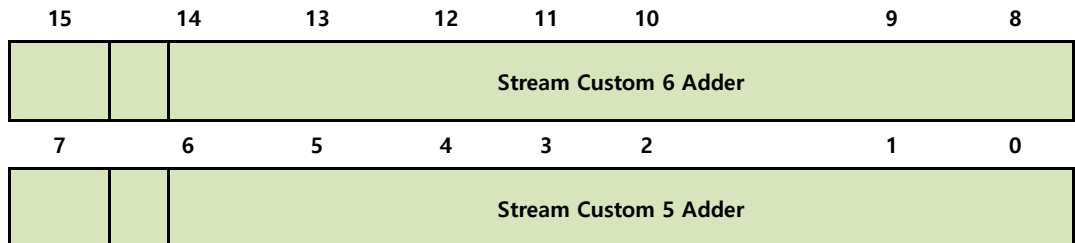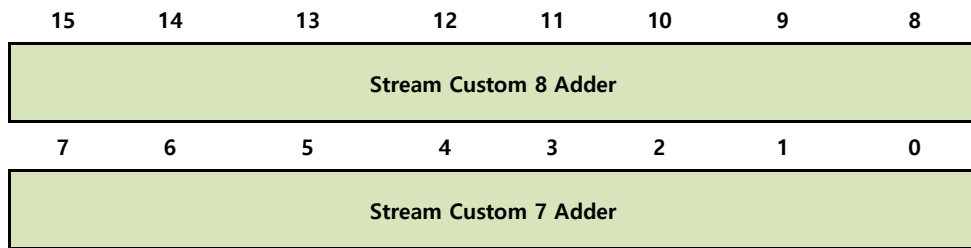
Set the desired data Adder when outputting in Stream Mode.

15	14	13	12	11	10	9	8
Stream Custom 8 Adder							

7	6	5	4	3	2	1	0
Stream Custom 7 Adder							

Address	length	R/W	Default	Min	Max
0xE8	2	R/W	0	0	65535

- Bit 7~0: Adder of Stream Custom 7
- Bit 15~8: Adder of Stream Custom 8
- If the setting values of REG_STREAM_ADDR_0 ~ 4 are all 0, REG_POSITION, REG_TURN_COUNT values are returned.
- Applicable only when the servo is CAN2.0A or CAN2.0B

2-8.7 **REG_POWER_CONFIG**

Set the power management method.

15	14	13	12	11	10	9	8
Reserved					Forced Emergency Stop		Reserved

7	6	5	4	3	2	1	0
Reserved							S/W RESET
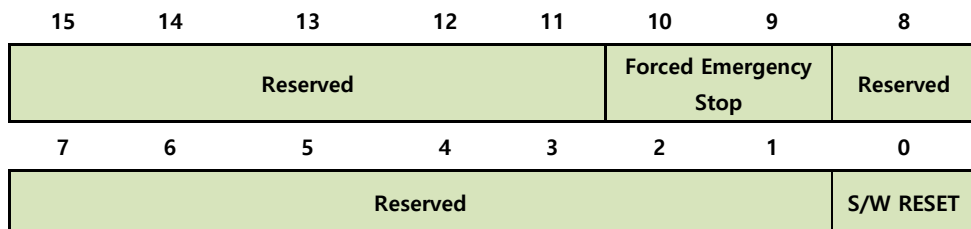
Address	length	R/W	Default	Min	Max
0x46	2	W	-	0	65535

- Bit 15~11, 7~1: Reserved – Do not use.
- Bit 10~9: Forced Emergency Stop – Use Forced Emergency Stop function

    0: OFF

    1: Motor_Free

    (Forced Emergency Stop is turned ON when the motor power is off.)

    2: Speed_Down

    (After Motor Speed decreases (REG_SPEED_ES setting) and stops, the motor goes into the HOLD state and Forced Emergency Stop is turned ON.)

    3: Motor_Hold

    (The motor goes into the Hold state and Forced Emergency Stop is turned ON.)

- Bit 0: Reset – Software Reset of SERVO

    1: Reset On (Reset to 0)

2-8.8 **REG_DEADBAND**

Set Dead Band area of SERVO.

Address	length	R/W	Default	Min	Max
0x4E	2	R/W	0	0	4095

- If the value is high, Jitter may occur during operation. (20 or less recommended)

2-8.9 **REG_POS_MAX**

Set the maximum position value that operates in the normal state.

Data = 0~ +16383 and the resolution of data = 4096 = 90°.

Address	length	R/W	Default	Min	Max
0x50	2	R/W	16383	0	16383

- 0 = Off
- REG_EMERGENCY_STOP condition is met, if the REG_POSITION value is higher than REG_POS_MAX.

2-8.10 **REG_POS_MIN**

Set the minimum position value that operates in the normal state.

Data = 0~ +16383 and the resolution of data = 4096 = 90°.

Address	length	R/W	Default	Min	Max
0x52	2	R/W	0	0	16383

- 0 = Off
- REG_EMERGENCY_STOP condition is met, if the REG_POSITION value is lower than REG_POS_MIN.

2-8.11 **REG_SPEED_VOLTAGE**

Set the reference voltage for the maximum speed of SERVO.

It compares with the input voltage of SERVO and adjusts the ratio of the maximum speed value.

EX) REG_VELOCITY_MAX(SPEED) = 2000, REG_SPEED_VOLTAGE = 120,

If REG_VOLTAGE value is 60, the actual maximum speed is applied as 60/120*2000=1000 in voltage proportion and operates.

Address	length	R/W	Default	Min	Max
0xDA	2	R/W	0	0	65535

Even if the REG_VOLTAGE value is higher than the REG_SPEED_VOLTAGE value, the REG_VELOCITY value is not set higher than REG_VELOCITY_MAX(SPEED).

2-8.12 **REG_SPEED_UP**

Set the acceleration time of SERVO. The unit is ms and it accelerates at maximum speed for 10 ms.

Address	length	R/W	Default	Min	Max
0xDC	2	R/W	0	0	65535

- If the data value is 0, it moves at constant speed at the maximum speed.

2-8.13 **REG_SPEED_DN**

Set the deceleration time of SERVO. The unit is ms and it decelerates for 10ms and stops at the stop position.

Address	Length	R/W	Default	Min	Max
0xDE	2	R/W	0	0	65535

- If the data value is 0, it moves at constant speed at the maximum speed.

2-8.14 **REG_SPEED_ES**

Set the deceleration time when Forced Emergency Stop occurs. The unit is ms. If the value is 10, when Forced Emergency Stop occurs, it decelerates and stops for 10 ms.

Address	length	R/W	Default	Min	Max
0xE0	2	R/W	0	0	65535

- If the data value is 0, it stops immediately when Forced Emergency Stop occurs.
- It cannot be set higher than REG_SPEED_DN

2-8.15 **REG_INERTIA_RANGE**

Set the rate when INERTIA occurs in SERVO. In the range of 2~4095, the ratio of the Gain Range value can be set to 0 to 100%, and the Smart Sense that automatically adjusts the ratio can be turned On/Off.

Address	length	R/W	Default	Min	Max
0x64	2	R/W	0	0	4095

- When the data value is 0, the Smart Sens is turned OFF, and the Gain Range value is 100%.
- When the data value is 1, the Smart Sense is turned ON to automatically adjust the Gain Range value.
- **Smart Sense**
  When SERVO generates continuous INERTIA due to the load, it reads the average value of the INERTIA and adjust the Gain Range value to prevent INERTIA.

2-8.16 **REG_VELOCITY_MAX(SPEED)**

Set the maximum speed value that operates in a normal state and its unit is pos/100msec. It is shown through the following equation.

RPM = SPEED * 10 * 90 / 4096 / 360 * 60 → SPEED =(about)27.33 * RPM

SPEED= (1 / (V / 60)) * 4096 / 90 / 10   → V(sec/60°) =(about)273.06 / SPEED

The unit of V is sec/60°

Address	length	R/W	Default	Min	Max
0x54	2	R/W	-	0	4095

- Please note that the calculation formula and unit differ depending on the version of SERVO.

Firmware	Calculation	Unit
Previous version	SPEED = V*1000*90/4096/360*60	Pos/1msec
X.3	SPEED= V*10*90/4096/360*60	Pos/100msec

The unit's Pos is the value of REG_POSITION, which is 4096=90°

2-8.17 **REG_TORQUE_MAX**

Set the maximum width of the motor PWM duty. 4095 = 100%

Address	length	R/W	Default	Min	Max
0x56	2	R/W	4095	0	4095

2-8.18 **REG_VOLTAGE_MAX**

Set the highest voltage that operates in the normal state.

1 = 0.01V. 1200 = 12V.

Address	length	R/W	Default	Min	Max
0x58	2	R/W	0	0	65535

- 0 = Off
- REG_EMERGENCY_STOP condition is met, if the REG_VOLTAGE value is higher than REG_VOLTAGE_MAX.

2-8.19 REG_VOLTAGE_MIN

Set the lowest voltage that operates in the normal state.

1 = 0.01V. 1200 = 12V.

Address	length	R/W	Default	Min	Max
0x5A	2	R/W	-	0	65535

- 0 = Off.
- REG_EMERGENCY_STOP condition is met, if the REG_VOLTAGE value is lower than REG_VOLTAGE_MIN.

2-8.20 REG_TEMPER_MAX

Set the maximum temperature value at which MCU TEMPER operates in a normal state.

1 = 1˚C, 20 = 20˚C.

Address	length	R/W	Default	Min	Max
0x5C	2	R/W	0	-32767	32767

- 0 = Off.
- REG_EMERGENCY_STOP condition is met, if REG_MCU_TEMPER value is higher than REG_TEMPER_MAX.

2-8.21 REG_TEMPER_MIN

Set the maximum temperature value at which MCU TEMPER operates in a normal state.

1 = 1˚C, 20 = 20˚C.

Address	length	R/W	Default	Min	Max
0x6C	2	R/W	0	-32767	32767

- 0 = Off.
- REG_EMERGENCY_STOP condition is met, if REG_MCU_TEMPER value is lower than REG_TEMPER_MIN.

2-8.22 REG_ECHO

This value can be set by the user. It will be 0 when the SERVO is reset.

Address	length	R/W	Default	Min	Max
0xC6	2	R/W	0	0	65535

2-8.23 **REG_USER_1**

It is a data address that users can save randomly.

Address	length	R/W	Default	Min	Max
0xCC	2	R/W	0	0	65535

- Only after SAVE after changing REG_ECHO, it can be saved after power reset.

2-8.24 **REG_USER_2**

It is a data address that users can save randomly.

Address	length	R/W	Default	Min	Max
0xCE	2	R/W	0	0	16383

- Only after SAVE after changing REG_ECHO, it can be saved after power reset.

2-9   Option (Current Circuit Model Only)

2-9.1   REG_SPEC_TORQUE

Set the maximum power of the torque output.

1 = 10mW. 9000 = 90W.

Address	length	R/W	Default	Min	Max
0x26	2	R/W	0	0	65535

2-9.2   REG_CURRENT_MAX

Set the maximum current to limit for products with a current measurement circuit.

1 = 1mA, 10000 = 10A.

Address	length	R/W	Default	Min	Max
0xD8	2	R/W	65535	0	65535

- 0 = Off.

2-10 Option (DroneCAN Only)

2-10.1 REG_UNITLESS_RAD_MODE

Sets the unit of angle for stream mode.

Address	length	R/W	Default	Min	Max
0x2C	2	R/W	0	0	1

- 0 = Unitless, 1 = Radian

2-11 Configuration

The Register to configure CAN SERVO.

2-11.1 REG_DEFAULT

Restore all register values to factory default or recently saved.

Writing 3855 to this register will return all register values to their factory defaults. If you write 0xFFFF, it will return to the last saved state.

If you want to maintain this state after power reset, you should save all the register values using REG_CONFIG_SAVE register.

Address	length	R/W	Default	Min	Max
0x6E	2	W	-	-	-

- When returning to the factory defaults, all register values you have changed will be erased. Please be careful to use.

2-11.2 REG_CONFIG_SAVE

Save all register change values.

Even if the register value is changed, it will return to the last saved setting after the power is reset. If you write 0xFFFF to DATA, all current register values are saved and you can maintain the current state even after power reset.

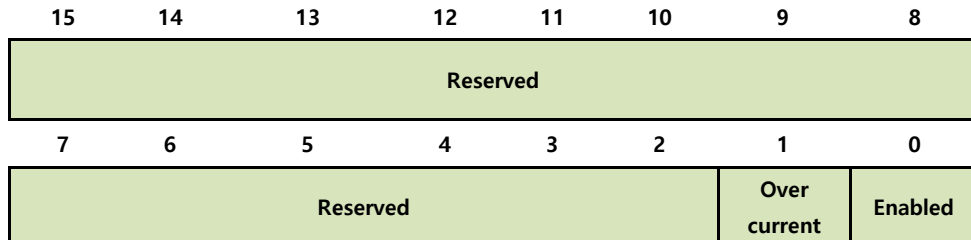| Address	length	R/W	Default	Min	Max
0x70	2	R/W	0	0	65535

- After saved, previous Configuration Register values cannot be recalled. Please be careful to use.

2-12 Additional Function (F/W Ver >= v1.4)

Functions added by F/W update and is applied from F/W v1.4 onwards.

2-12.1 REG_STATUS

Check the status of E_STATUS.

15	14	13	12	11	10	9	8
Reserved							

7	6	5	4	3	2	1	0
Reserved						Over current	Enabled

Address	length	R/W	Default	Min	Max
0x06	2	R	-	0	3

- Bit 0: Flag that becomes 1 if possible to refer to REG_STATUS

  0 = disabled, 1= enabled(referenceable)
- Bit 1: Over Current status. (SG50 only)

  0 = Normal status, 1 = Over Current status

2-12.2 REG_REF_1

Address	length	R/W	Default	Min	Max
0xA6	2	R	-	0	1

- If Bit 0 = 1, e_PAD_VOLT [0xA8] can be referenced.

2-12.3 REG_PAD_VOLT

The operating voltage of the installed PAD

Address	length	R/W	Default	Min	Max
0xA8	2	R	-	0	65535

- Low Byte = Voltage 1 [V]
- High Byte = Voltage 2 [V]

2-12.4 REG_SETUP

Set functions such as PAD's operating voltage.

Address	length	R/W	Default	Min	Max
0xA2	2	R/W	-	0	65535

- Bit 0 = PAD Set the operating voltage, 0 = Voltage 1, 1 = Voltage 2
- Bit 1 = Use Start Position
- Bit 2 = Use Brake Instead Free (BLDC Servo Only)
- Bit 3 = Use Over Volt Brake
- Bit 7 = Use Custom Stream CAN ID (F/W Ver >= v1.5(1))
- Bit 10 = Use Fail Safe (F/W Ver >= v1.5(2))
- Bit 12 = Use Realtime ID1, ID2 (F/W Ver >= v2.0 (exactly 1.11))
  If enabled, ID1(Servo ID) and ID2(Node ID) are applied immediately without Servo Reset.
- Bit 15 = Motor Direction = 0(normal), 1(reverse) (F/W Ver >= v2.1)

2-12.5 REG_START_POSITION

This is Power On Start Position (Not Fail Safe Position)

Address	length	R/W	Default	Min	Max
0x7A	2	R/W	0	0	16383

- You must set e_SETUP (0xA2) bit 1 = 1, if you want use start position function.

2-12.6 REG_OVERVOLT_BRAKE_VOLTAGE

When a voltage higher than the set voltage is generated, the electromagnetic brake is applied to lower the voltage generation.

Address	length	R/W	Default	Min	Max
0x80	2	R/W	0	0	65535

- This is Over Voltage Brake Function's Voltage Value. Ex) 1000 = 10.00V
- You must set e_SETUP (0xA2) bit 3 = 1

2-13 Additional Function (F/W Ver >= v1.5)

Functions added by F/W update and is applied from F/W v1.5 onwards.
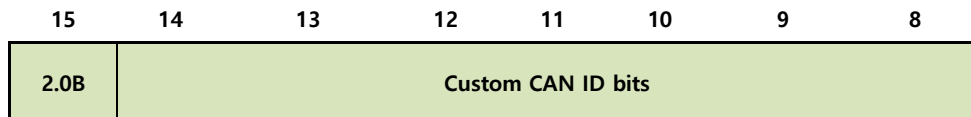
2-13.1 REG_TMP_CONFIG

The initial value is 0.

Address	length	R/W	Default	Min	Max
0x20	2	R/W	0	0	65535

- Bit 0 = 1(Pause Stream), 0(Active Stream) – F/W Ver >= v1.5

2-13.2 REG_CUSTOM_STREAM_CAN_ID_H

Set the value of Custom CAN ID High 2 bytes for Stream packet.

Only available from F/W Ver >= v1.5(1)

15	14	13	12	11	10	9	8
2.0B	**Custom CAN ID bits**						

Address	Length	R/W	Default	Min	Max
0x3A	2	R/W	-	0	65535

- Reg 0x3A – bit 15 = 1(CAN 2.0B), 0(CAN 2.0A)
- Reg 0x3A – bit 14:0 = High Word of CAN ID
- You must set e_SETUP(0xA2) bit 7 = 1

2-13.3 REG_CUSTOM_STREAM_CAN_ID_L

Set the value of Custom CAN ID Low 2 bytes for Stream packet.

Only available from F/W Ver >= v1.5(1)

Address	Length	R/W	Default	Min	Max
0x42	2	R/W	-	0	65535

- bit 15:0 = Low Word of CAN ID
- You must set e_SETUP(0xA2) bit 7 = 1

2-13.4 REG_FAIL_SAFE_POSITION - FW Ver >= 1.5(1)

Set the Failsafe Position.

Address	length	R/W	Default	Min	Max
0x94	2	R/W	0	0	16383

- You must set e_SETUP (0xA2) bit 10 = 1

2-13.5 REG_FAIL_SAFE_TIME

Set the time period for the condition where Fail Safe activates. Unit is ms.

Only available from F/W Ver >= v1.5(1)

Address	length	R/W	Default	Min	Max
0xB4	2	R/W	0	0	65535

- You must set e_SETUP (0xA2) bit 10 = 1

2-14 Additional Function (F/W Ver >= 1.6(3) and Ver < 1.7)

2-14.1 REG_TURN_MULTIPLIER

In DroneCAN, Multi-TURN state, magnify the target +/-1.0 by the specified magnification.

Address	Length	R/W	Default	Min	Max
0xAC	2	R/W	0	-32760	+32760

2-15 Additional Function (F/W Ver >= v2.1)

2-15.1 REG_SETUP_2

Address	length	R/W	Default	Min	Max
0xA0	2	R/W	-	0	65535

- Bit 0 ~ 14 : System Configuration Bits - You must keep these bits.
- Bit 15 = Enable SETUP_EX_X Registers (ex: SETUP_EX_3) – Keep bit 1 if already 1
  There are many hidden system settings in SETUP_EX registers,
  so if it is already ON, you should never change it to OFF.

2-15.2 REG_SETUP_EX_3

Address	Length	R/W	Default	Min	Max
0x41	2	R/W	-	0	65535

- Bit 0 = Reversed bit - You must keep this bit.
- Bit 1 = Enable TURN_MULTIPLIER function
- Bit 2 ~ 15 = Reversed bits - You must keep these bits.
- You must set REG_SETUP_2(0xA0) bit 15 = 1

2-15.3 REG_TURN_MULTIPLIER

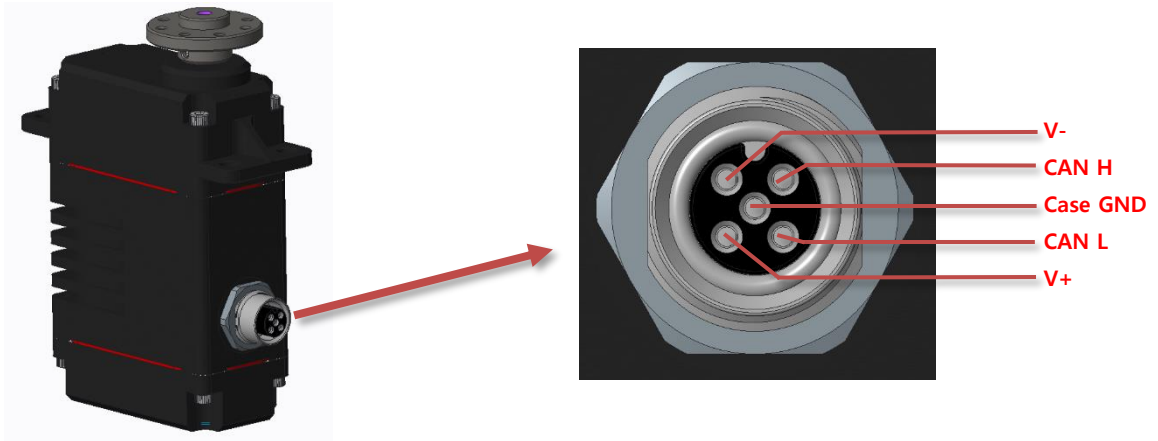In DroneCAN, Multi-TURN state, magnify the target +/-1.0 by the specified magnification.

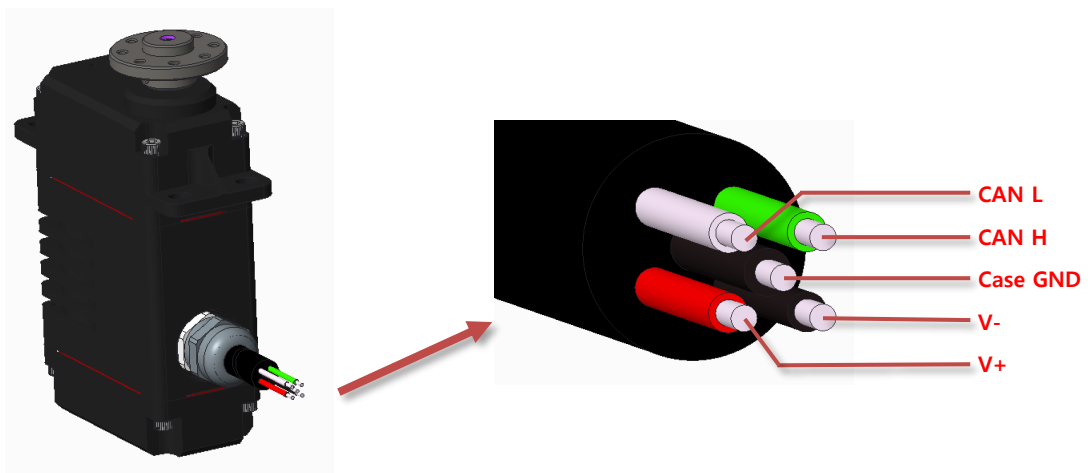| Address	Length	R/W	Default	Min	Max
0xAC	2	R/W	0	-32760	+32760

- You must set REG_SETUP_EX_3(0x41) bit 1 = 1 and REG_SETUP_2(0xA0) bit 15 = 1

3   Drawing

3-1   Connector and Pin Assign (SG Series CAN Circular Connector Type)

V-
CAN H
Case GND
CAN L
V+

3-2   Cable and Pin Assign (SG Series CAN Cable Type)

CAN L
CAN H
Case GND
V-
V+

3-3   Connector and Pin Assign (Standard CAN Servo Connector Type)

V-
V+
CAN L
CAN H