



CAN(2.0A, 2.0B)/UAVCAN Servo Control Protocol Manual

Revision 2.00_EN

HITEC RCD, INC.

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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 Normal Packet Format

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 | ID | Address | REG Length | Check Sum |
| 0x96 | 0xXX | 0xXX | 0x00 | 0xXX |

- Response from SERVO

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

1-4.1 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 |
|---------------|----|---------|---------------|-------------|--------------|--------------|

1-4.2 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.

1-4.3 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 |
|--------|----|----------------|---------------|-------------|--------------|--------------|

1-4.4 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.

1-4.5 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 |
|--------|----|---------|---------------|---------------------|----------------------|--------------|

1-4.6 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

$$\text{Check Sum} = (\text{ID} + \text{Address} + \text{Length}) \& 0\text{xFF}$$

- Write Mode Check Sum Calculation

$$\text{Check Sum} = (\text{ID} + \text{Address} + \text{Length} + \text{Data [0]} + \text{Data [1]}) \& 0\text{xFF}$$

1-5 Custom Packet Format

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

It is recommended to use Custom Packet protocol in TURN MODE situation.

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

Read 2 Address Data (Position Now, Turn Count)

Read Long DATA (32bit position)

Custom Packet 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 | Address | Data | Data |
|---------|------|---------|------|------|
| ID | | | Low | High |
| 'w' | 0xXX | 0xXX | 0xXX | 0xXX |

- Lowercase 'w'

- Data write to SERVO (2 Address Data)

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

- Response from SERVO

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

- Request 2 data to SERVO (2 Address Data)

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

- Response from SERVO (2 Address Data)

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

1-5.1 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 | Address | Data | Data | Address | Data | Data |
| ID | | A | Low A | High A | B | Low B | High B |

1-5.2 ID

A 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.

| | | | | | | | |
|---------|----|---------|-------|--------|---------|-------|--------|
| Message | ID | Address | Data | Data | Address | Data | Data |
| ID | | A | Low A | High A | B | Low B | 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.

1-5.3 Address

Register Address Byte.

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

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

1-5.4 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 |
|---------------|----|--------------|---------------|----------------|--------------|---------------|----------------|

1-6. UAVCAN Protocol

Supported UAVCAN Data Type is as follows.

Actuator.ArrayCommand

Actuator.Status

GetNodeInfo

NodeStatus

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

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.

2 CAN SERVO Register

2-1Address Table

| Address | Name | len | R/W | Range | | | Feature | Unit | |
|------------------|------------|-----------------------|-----|-------|-----|--------|---|---|-------------------------|
| | | | | reset | 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. | °C |
| | 0x18 | REG_TURN_COUNT | 2 | R/W | - | -32760 | 32760 | Read the Accumulated Turn Count. | 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 | |
| Status (SG Only) | 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 | 2 | R/W | 0 | 0 | 254 | Set the SERVO ID. | '0' is Broadcast. |
| | | REG_ID (UAVCAN Only) | 2 | R/W | 0 | 0 | 127 | Set the SERVO ID. | '0' is 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 | 2 | R/W | 0 | 0 | 65535 | Set the CAN ID High 2 Bytes. (2.0A: 0~2047, 2.0B: 0~536870911) | '0' is Broadcast. |
| | | REG_CAN_BUS_ID_H (UAVCAN Only) | 2 | R/W | 0 | 0 | 0 | Not used on UAVCAN. | Fixed value to '0' |
| | 0x3E | REG_CAN_BUS_ID_L | 2 | R/W | 0 | 0 | 65535 | Set the CAN ID Low 2 Bytes. (2.0A: 0~2047, 2.0B :0~536870911) | '0' is Broadcast. |
| | | REG_CAN_NODE ID (UAVCAN Only) | 2 | R/W | 0 | 0 | 128 | Set the Node ID. | '0' is Broadcast. '128' is Setting value. |
| 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 | 0 | 1 | Set the CAN Specification. | 0 = 2.0A 1 = 2.0B | |
| Mode | 0x44 | REG_RUN_MODE | 2 | R/W | 0 | 0 | 1 | Set the run mode. | 0: Multi-Turn mode 1: Servo mode |
| | | REG_RUN_MODE (UAVCAN Only) | 2 | R/W | 1 | 1 | 1 | Set the run mode. | Set servo mode only |
| | 0x9A | REG_POS_LOCK_TIME | 2 | R/W | 3 | 0 | 5000 | Set the time for OLP to operate. (Only Use SERVO Mode) | sec |
| | 0x9C | REG_POS_LOCK_TORQUE_RATIO | 2 | R/W | - | 0 | 100 | Set torque ratio when OLP operates. (Only Use SERVO Mode) | % |
| | 0xB0 | REG_POSITION_MAX_LIMIT | 2 | R/W | - | 0 | 16383 | Set the position max limits. (Only Use SERVO Mode) | 4096=90° |
| | 0xB2 | REG_POSITION_MIN_LIMIT | 2 | R/W | - | 0 | 16383 | Set the position min limits. (Only Use SERVO Mode) | 4096=90° |
| Option | 0x2E | REG_STREAM_TIME | 2 | R/W | 1000 | 0 | 10000 | Set the Stream Period. | ms |
| | 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 |

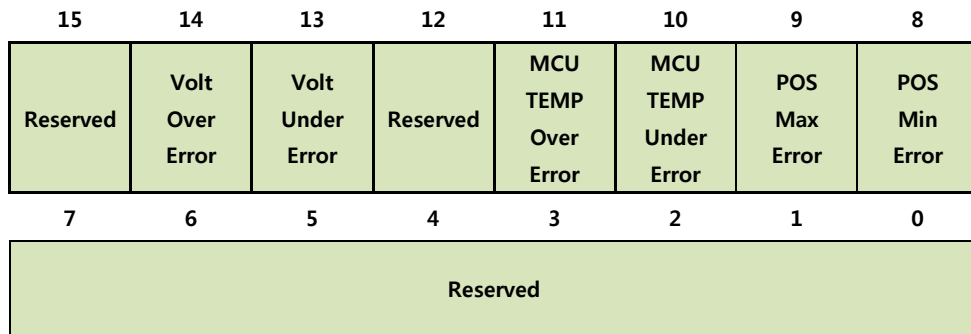
| | | | | | | | | | |
|--|------|--------------------------|---|-----|------|--------|-------|--|--|
| | | | | | | | | Bit 0: S/W Reset | 0 = Off, 1 = Reset |
| | 0x4E | REG_DEADBAND | 2 | R/W | - | 0 | 4095 | Set the Position Dead band. | step |
| | 0x50 | REG_POS_MAX | 2 | R/W | 0 | 0 | 16383 | Set 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. | °C |
| | 0x6C | REG_TEMPER_MIN | 2 | R/W | - | -32767 | 32767 | Set the minimum Temperature. | °C |
| | 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. | - |
| Option (SG 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 |
| Option (UAVCAN Only) | 0x2C | REG_UNITLESS_RAD_MODE | 2 | R/W | 0 | 0 | 1 | Set the unit of angle for stream mode. | 0=unitless 1=radian |
| Option (Ver1.4 Only) | 0x06 | REG_E_STATUS | 2 | R | - | 0 | 3 | Bit 0 : Read the E_STATUS. Bit 1: Read the Over Current state. | 0 = enabled 1 = disabled 0 = Over Current status 1 = Normal status |
| | 0xA6 | REG_E_REF_1 | 2 | R/W | - | 0 | 65535 | PAD voltages | - |
| | 0xA8 | REG_E_PAD_VOLT | 2 | R/W | - | 0 | 1 | Select the PAD voltage mode. | 0 = PAD voltage1 1 = PAD voltage2 |
| | 0xA2 | REG_E_SETUP | 2 | R/W | - | 0 | 1 | Select whether to use PAD voltage. | 0= unuse 1= use |
| 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 Status

It is a Register that store status information.

2-2.1 REG_EMERGENCY_STOP

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



| Address | length | R/W | Reset | 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.

2-2.2 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 | Reset | Min | Max |
|---------|--------|-----|-------|-----|-------|
| 0x0C | 2 | R/O | - | 0 | 16383 |

- The resolution is $4096 = 90^\circ$

2-2.3 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

$$\text{RPM} = \text{VEL} * 10 * 90 / 4096 / 360 * 60 / \text{PT} * 10$$

$$\text{VEL} = (1 / (\text{V} / 60)) * \text{PT} / 10 * 4096 / 90 / 10$$

If PT = 10

$$\text{VEL} = (\text{about})27.33 * \text{RPM}$$

$$\text{V} = (\text{about})273.06 / \text{VEL}$$

| Address | Length | R/W | Reset | 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 |
|------------------|--|-----------------|
| Previous version | $\text{RPM} = \text{VEL} * 1000 * 90 / 4096 / 360 * 60 / \text{PT} * 10$ | Pos/1msec |
| X.3 | $\text{RPM} = \text{VEL} * 10 * 90 / 4096 / 360 * 60 / \text{PT} * 10$ | Pos/100msec |

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

2-2.4 REG_TORQUE

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

| Address | Length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|------|
| 0x10 | 2 | R/O | 0 | 0 | 4095 |

- It outputs 100% Duty at 4095

2-2.5 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 | Reset | Min | Max |
|---------|--------|-----|-------|-----|-------|
| 0x12 | 2 | R/O | - | 0 | 65535 |

2-2.6 REG_MCU_TEMPER

The internal temperature of MCU.

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

of Register is 20.

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

2-2.7 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 | Reset | Min | Max |
|---------|--------|-----|-------|--------|--------|
| 0x18 | 2 | R/O | 0 | -32760 | +32760 |

2-2.8 REG_32BITS_POSITION_L

The low value of current position (angle).

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

- REG_POSITION+ (REG_TURN_COUNT *16384)의 Low Word

2-2.9 REG_32BIT_POSITION_H

The high value of current position (angle).

| Address | length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-------|-------------------|
| 0x1C | 2 | R/O | - | 65535 | 2 [^] 31 |

- REG_POSITION+ (REG_TURN_COUNT *16384)의 High Word

2-2.10 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 | Reset | Min | Max |
|---------|--------|-----|-------|--------|-------|
| 0xC8 | 2 | R/O | 0 | -32760 | 32760 |

2-2.11 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 | Reset | Min | Max |
|---------|--------|-----|-------|--------|-------|
| 0xCA | 2 | R/O | 0 | -32760 | 32760 |

2-2.12 REG_PRODUCT_NO

Read the production number of SERVO

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

2-2.13 REG_VERSION

Read the version of SERVO

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

2-2.14 REG_VERSION(BIT_INVERSE)

Read the version of SERVO (BIT INVERSE)

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

2-3 Status (SG Series Only)

It is the register that stores the status information added only to SG Series SERVO.

2-3.1 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 | Reset | Min | Max |
|---------|--------|-----|-------|-----|-------|
| 0x16 | 2 | R/O | 0 | 0 | 65535 |

- This function works only for SG series SERVO.

2-3.2 REG_MOTOR_TEMP

The temperature of the current Motor.

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

$$T_0 = 298.15$$

$$V_T = 3.3 / 4096 * \text{data}$$

$$R_t = (10 * V_T) / (3.3 - V_T)$$

$$\text{Temperature}(\text{°C}) = 1007747 / (\log(R_t) * T_0 - \log(10) * T_0 + 3380) - 273.15$$

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

- This function works only for SG series SERVO.

2-3.3 REG_TEMP

The internal temperature of the current SERVO.

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

$$\text{Temperature}(\text{°C}) = 175.72 * \text{data} / 65536 - 46.85;$$

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

- This function works only for SG series SERVO.

2-3.4 REG_HUM

The relative humidity inside the SERVO.

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

$$\text{Humidity}(\%RH) = 125 * \text{data} / 65536 - 6;$$

| Address | Length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|-------|
| 0x4D | 2 | R/O | 0 | 0 | 65535 |

- This function works only for SG series SERVO.

2-4 Action

It is the Register to operate CAN SERVO.

2-4.1 REG_POSITION_NEW

Specify a new position for SERVO with a resolution of $4096 = 90^\circ$

| Address | length | R/W | Reset | 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.

2-4.2 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 | Reset | Min | Max |
|---------|--------|-----|-------|--------|-------|
| 0x24 | 2 | R/W | 0 | -32760 | 32760 |

- It only operates in TURN Mode.

2-5 Communication

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

2-5.1 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. ID can be specified from 0 to 255.

| Address | length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|-----|
| 0x32 | 2 | R/W | 0 | 0 | 255 |

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

2-5.2 REG_ID (if UAVCAN)

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. ID can be specified from 0 to 127.

Each device(Node) of UAVCAN 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

| Address | length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|-----|
| 0x32 | 2 | R/W | 0 | 0 | 127 |

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

2-5.3 REG_BAUDRATE

Set the Baud Rate.

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

| Address | length | R/W | Reset | 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.

2-5.4 REG_CAN_BUS_ID_H (if protocol = CAN 2.0A, CAN 2.0B)

Set the CAN BUS ID.

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

| Address | Length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|------|
| 0x3C | 2 | R/W | 0 | 0 | 8191 |

2-5.1 REG_CAN_BUS_ID_H (if protocol = UAVCAN)

Set this value 0.

| Address | Length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|-----|
| 0x3C | 2 | R/W | 0 | 0 | 0 |

2-5.2 REG_CAN_BUS_ID_L (if protocol = CAN 2.0A, CAN 2.0B)

Set CAN BUS ID.

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

| Address | Length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|-------|
| 0x3E | 2 | R/W | 0 | 0 | 65535 |

- 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.

2-5.3 REG_CAN_BUS_ID_L (if protocol = UAVCAN)

| Address | Length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|-----|
| 0x3E | 2 | R/W | 0 | 0 | 128 |

- Recommendation: Set 128 for this value, and set the servo's Node ID (Actuator) value in REG_ID[0x32]
- If this value is between 1 and 127, the servo compares whether it matches the Src Node ID value of ArrayCommand.
- If this value is 128, the servo ignores the Src Node ID value of ArrayCommand. (However, FW Ver 1.3 or higher is required)

2-5.4 REG_SAMPLE_POINT

Selects the sampling point ratio of the CAN communication signal.

| Address | length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|-----|
| 0x40 | 2 | R/W | 0 | 0 | 1 |

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

2-5.5 REG_CAN_MODE

Set CAN MODE.

| Address | length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|-----|
| 0x6A | 2 | R/W | 0 | 0 | 1 |

- 0 = CAN 2.0 and 1 = CAN 2.0B
- To change it, save and power reset are required.

2-6 MODE

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

2-6.1 REG_RUN_MODE

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

| Address | length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|-----|
| 0x44 | 2 | R/W | 1 | 0 | 1 |

- 0= Multi-Turn MODE, 1= SERVO MODE
- 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_MAX_LIMIT and REG_POSITION_MIN_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.

2-6.2 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 | Reset | 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)

2-6.3 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 | Reset | Min | Max |
|---------|--------|-----|-------|-----|-----|
| 0x9C | 2 | R/W | 100 | 0 | 100 |

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

2-6.4 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 | Reset | 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.

2-6.5 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 | Reset | 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.

2-6.6 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 | Reset | 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.

2-7 Option

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

2-7.1 REG_STREAM_TIME

The cycle of STREAM function. The unit is 1ms.

| Address | length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|-------|
| 0x2E | 2 | R/W | 1000 | 0 | 10000 |

2-7.2 REG_STREAM_MODE

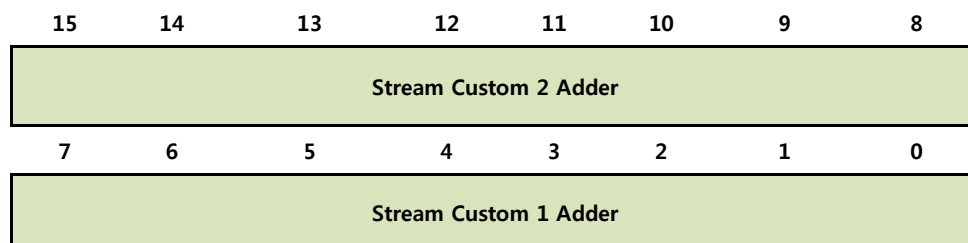
Set STREAM MODE ON / OFF.

| Address | length | R/W | Reset | 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.)

2-7.3 REG_STREAM_ADDR_0

Set the desired data Adder when outputting in Stream Mode.

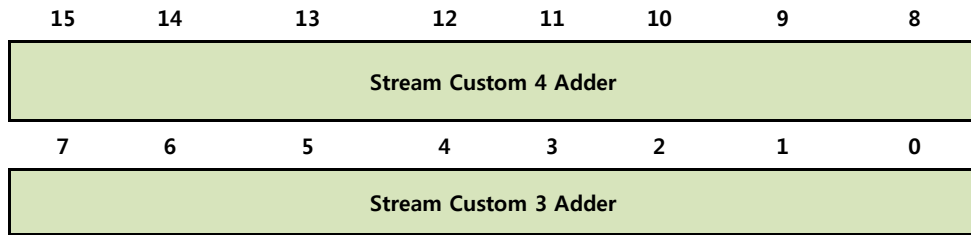


| Address | length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|-------|
| 0xE2 | 2 | R/W | 0 | 0 | 65535 |

- 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

2-7.4 REG_STREAM_ADDR_1

Set the desired data Adder when outputting in Stream Mode.

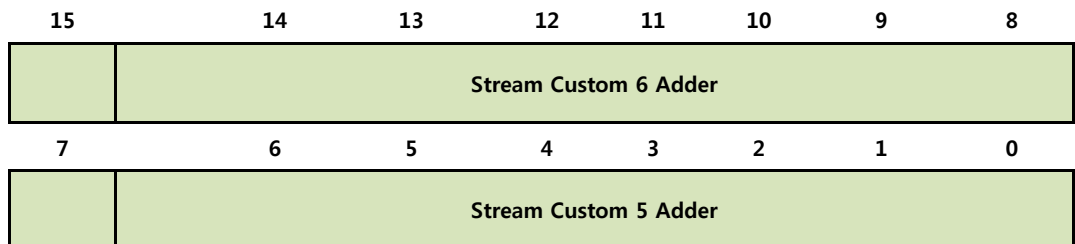


| Address | length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|-------|
| 0xE4 | 2 | R/W | 0 | 0 | 65535 |

- 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

2-7.5 REG_STREAM_ADDR_2

Set the desired data Adder when outputting in Stream Mode.

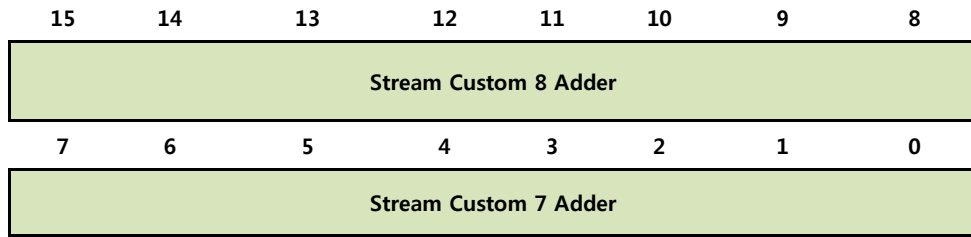


| Address | length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|-------|
| 0xE6 | 2 | R/W | 0 | 0 | 65535 |

- 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

2-7.6 REG_STREAM_ADDR_3

Set the desired data Adder when outputting in Stream Mode.

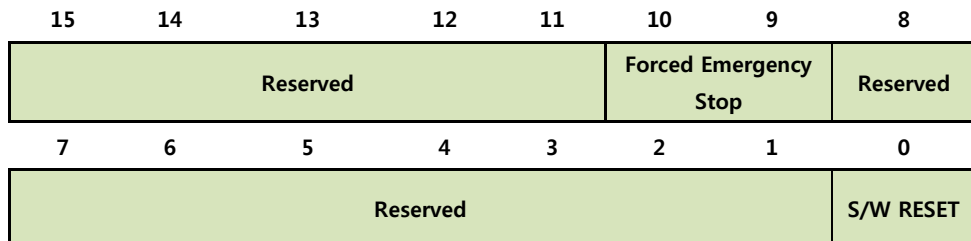


| Address | length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|-------|
| 0xE8 | 2 | R/W | 0 | 0 | 65535 |

- 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

2-7.7 REG_POWER_CONFIG

Set the power management method.



| Address | length | R/W | Reset | 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)

2-7.8 REG_DEADBAND

Set Dead Band area of SERVO.

| Address | length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|------|
| 0x4E | 2 | R/W | 0 | 0 | 4095 |

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

2-7.9 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 | Reset | 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.

2-7.10 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 | Reset | 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.

2-7.11 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 $60/120 \times 2000 = 1000$ in voltage proportion and operates.

| Address | length | R/W | Reset | 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).

2-7.12 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 | Reset | Min | Max |
|---------|--------|-----|-------|-----|-------|
| 0xDC | 2 | R/W | 0 | 0 | 65535 |

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

2-7.13 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 | Reset | Min | Max |
|---------|--------|-----|-------|-----|-------|
| 0xDE | 2 | R/W | 0 | 0 | 65535 |

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

2-7.14 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 | Reset | 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

2-7.15 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 | Reset | 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.

2-7.16 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.

$$\text{RPM} = \text{SPEED} * 10 * 90 / 4096 / 360 * 60 \rightarrow \text{SPEED} = (\text{about})27.33 * \text{RPM}$$

$$\text{SPEED} = (1 / (V / 60)) * 4096 / 90 / 10 \rightarrow V(\text{sec}/60^\circ) = (\text{about})273.06 / \text{SPEED}$$

The unit of V is sec/60°

| Address | length | R/W | Reset | 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 | $\text{SPEED} = V * 1000 * 90 / 4096 / 360 * 60$ | Pos/1msec |
| X.3 | $\text{SPEED} = V * 10 * 90 / 4096 / 360 * 60$ | Pos/100msec |

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

2-7.17 REG_TORQUE_MAX

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

| Address | length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|------|
| 0x56 | 2 | R/W | 4095 | 0 | 4095 |

2-7.18 REG_VOLTAGE_MAX

Set the highest voltage that operates in the normal state.

1 = 0.01V. 1200 = 12V.

| Address | length | R/W | Reset | 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.

2-7.19 REG_VOLTAGE_MIN

Set the lowest voltage that operates in the normal state.

1 = 0.01V. 1200 = 12V.

| Address | length | R/W | Reset | 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.

2-7.20 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 | Reset | 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.

2-7.21 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 | Reset | 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.

2-7.22 REG_ECHO

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

| Address | length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|-------|
| 0xC6 | 2 | R/W | 0 | 0 | 65535 |

2-7.23 REG_USER_1

It is a data address that users can save randomly.

| Address | length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|-------|
| 0xCC | 2 | R/W | 0 | 0 | 65535 |

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

2-7.24 REG_USER_2

It is a data address that users can save randomly.

| Address | length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|-------|
| 0xCE | 2 | R/W | 0 | 0 | 16383 |

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

2-8 Option (SG Series Only)

2-8.1 REG_SPEC_TORQUE

Set the maximum power of the torque output.

1 = 10mW. 9000 = 90W.

| Address | length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|-------|
| 0x26 | 2 | R/W | 0 | 0 | 65535 |

2-8.2 REG_CURRENT_MAX

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

1 = 1mA, 10000 = 10A.

| Address | length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|-------|
| 0xD8 | 2 | R/W | 65535 | 0 | 65535 |

- 0 = Off.
- This function works only for SG series SERVO.

2-9 Option (UAVCAN Only)

2-9.1 REG_UNITLESS_RAD_MODE

Sets the unit of angle for stream mode.

| Address | length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|-----|
| 0x2C | 2 | R/W | 0 | 0 | 1 |

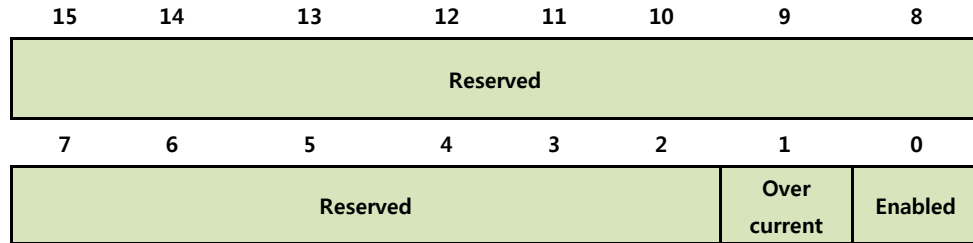
- 0 = Unitless, 1 = Radian

2-10 Option (Ver1.4 Only)

This feature applies only to version 1.4.

2-10.1 REG_E_STATUS

Check the status of E_STATUS.



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

- Bit 0: Flag that becomes 1 if possible to refer to e_Status
1 = enabled(referenceable), 0 = disabled
- Bit 1: Read the Over Current status.
1 = Normal status, 0 = Over Current status

2-10.2 REG_E_REF_1

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

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

2-10.3 REG_E_PAD_VOLT

The operating voltage of the installed PAD

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

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

2-10.4 REG_E_SETUP

Set functions such as PAD's operating voltage.

| Address | length | R/W | Reset | Min | Max |
|---------|--------|-----|-------|-----|-----|
| 0xA2 | 2 | R/W | 0 | 0 | 1 |

- Bit 0 = PAD Set the operating voltage, 0 = Voltage 1, 1 = Voltage 2

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 | Reset | Min | Max |
|---------|--------|-----|-------|-----|-------|
| 0x6E | 2 | W | - | - | 65535 |

- 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.

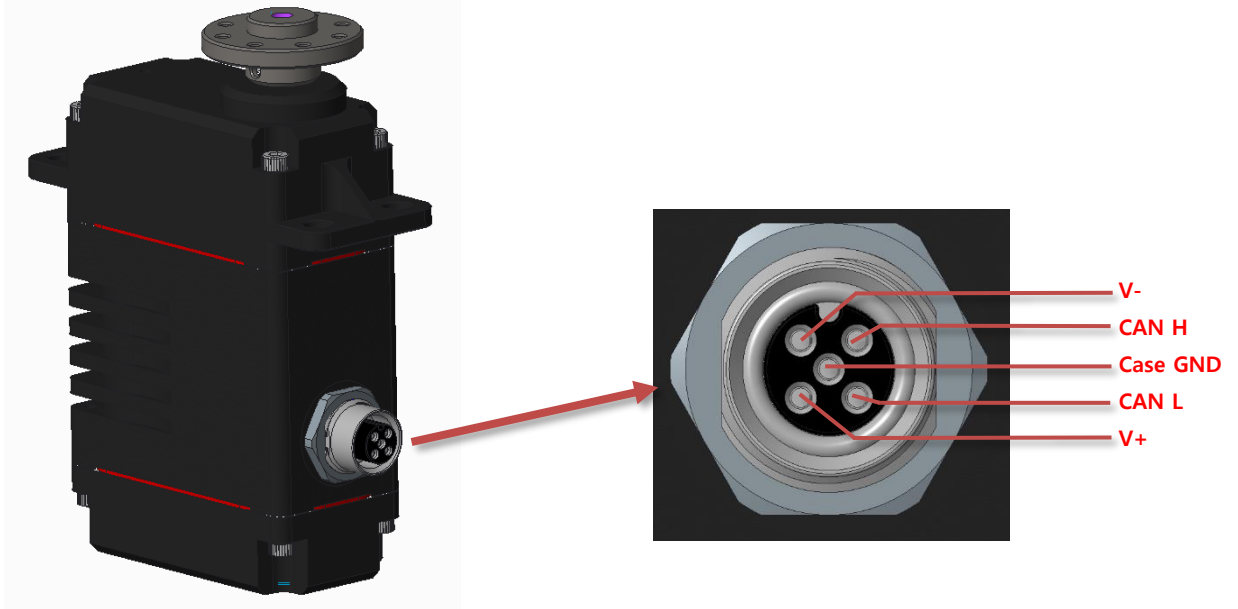
Even if the register value is changed, it will return to the last saved setting after the power is reset. If you write 0xFFFF to DATA, all current register values are saved and you can maintain the current state even after power reset.

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

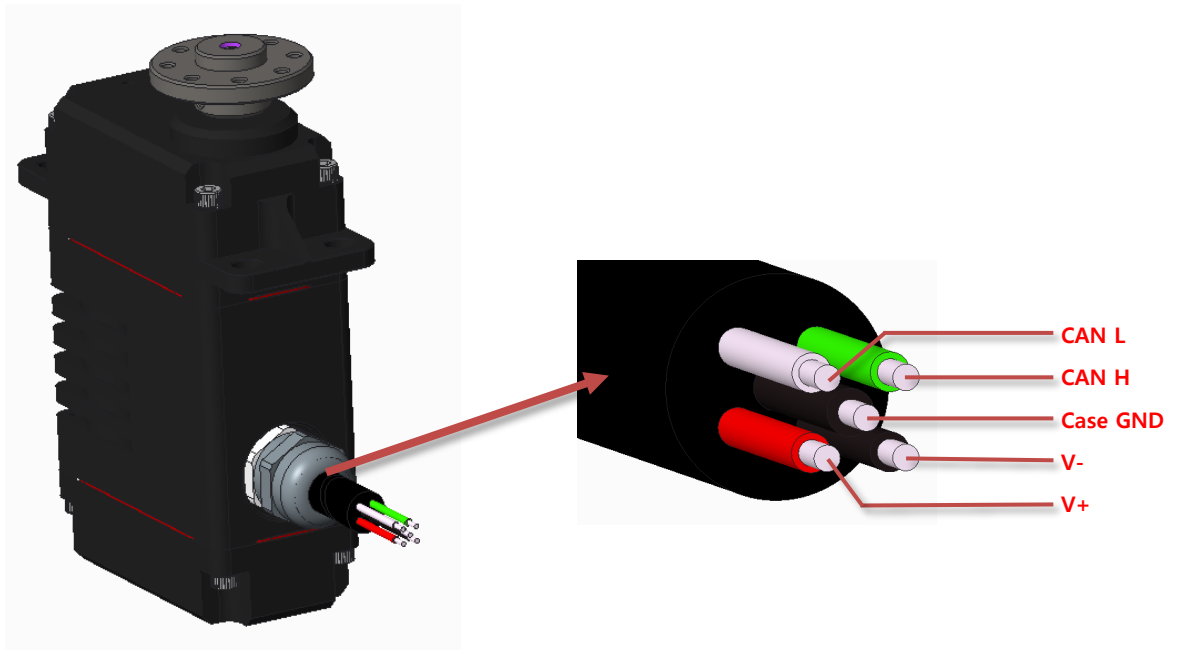
- After saved, previous Configuration Register values cannot be recalled. Please be careful to use.

3 Drawing

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



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



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

