**Purpose of Documentation:**

Direct comparison of the servo motors to find out its suitability for the project.

General Servo specifications:

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| --- | --- | --- | --- |
| Item | AX-12A(OLD) CORED | XM540-W150-T/R (NEW) COREDLESS | MX-64T (IN LAB) COREDLESS  (IN LAB) |
| Baud Rate | 7,843 [bps] ~ 1 [Mbps] | 9,600 [bps] ~ 4.5 [Mbps] | 8,000 [bps] ~ 4.5 [Mbps] |
| Resolution | 0.29 [°] | 4096 [pulse/rev] | 4096 [pulse/rev] |
| Motor | Cored | Coreless | Coreless |
| Operating Modes | 0 ~ 300 [°]  Endless Turn | Current Control Mode  Velocity Control Mode  Position Control Mode (0 ~ 360 [°])  Extended Position Control Mode (Multi-turn)  Current-based Position Control Mode  PWM Control Mode (Voltage Control Mode) | Wheel Mode (Endless Turn)  Joint Mode (0 ~ 360 [°])  Multi-turn Mode |
| Gear Ratio | 254 : 1 | 152.3 : 1 | 200 : 1 |
| Stall Torque | 1.5 [N.m] (at 12 [V], 1.5 [A]) | 6.9 [N.m] (at 11.1 [V] 4.2 [A])  7.3 [N.m] (at 12.0 [V], 4.4 [A])  8.9 [N.m] (at 14.8 [V], 5.5 [A]) | 5.5 [N.m] (at 11.1 [V], 3.9 [A])  6.0 [N.m] (at 12 [V], 4.1 [A)]  7.3 [N.m] (at 14.8 [V], 5.2 [A]) |
| No Load Speed | 59 [rev/min] (at 12V) | 50 [rev/min] (at 11.1 [V])  53 [rev/min] (at 12.0 [V])  66 [rev/min] (at 14.8) | 58 [rev/min] (at 11.1 [V])  63 [rev/min] (at 12 [V])  78 [rev/min] (at 14.8 [V]) |
| Input Voltage | 9.0 ~ 12.0 [V] (**Recommended : 11.1V**) | 10.0 ~ 14.8 [V] (**Recommended : 12.0 [V]**) | 10.0 ~ 14.8 [V] (Recommended : 12.0 [V]) |
| Physical Connection | TTL Level Multi Drop Bus  Half Duplex Asynchronous Serial Communication  (8bit, 1stop, No Parity) | RS485 / TTL Multidrop Bus  TTL Half Duplex Asynchronous Serial Communication with 8bit, 1stop, No Parity  RS485 Asynchronous Serial Communication with 8bit, 1stop, No Parity | RS485 / TTL Multidrop Bus  TTL Half Duplex Asynchronous Serial Communication with 8bit, 1stop, No Parity  RS485 Asynchronous Serial Communication with 8bit, 1stop, No Parity |
| Feedback | Position, Temperature, Load, Input Voltage, etc | Position, Velocity, Current, Realtime tick, Trajectory, Temperature, Input Voltage, etc | Position, Temperature, Load, Input Voltage, etc |

Relevant Servo specifications:

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|  | AX-12A(OLD) | XM540-W150-T/R (NEW) | MX-64T (IN LAB) |
| Weight | 54.6 [g] | 165 [g] | MX-64AR/AT: 135 [g]  MX-64R/T: 126 [g] |
| RPM | 0 ~ 1,023(0x3FF)  1,023 X 0.111 = 113.553 (Join Mode) | 0 ~ 1,023(0x3FF)  1,023 X 0.229 = 234.267 (Velocity Limit) | 0~1023 (0X3FF)  1023 x 0.114 = 116.62 (Join Mode) |
| Operating Voltage | (**Recommended : 11.1V**) max is 12v | (**Recommended : 12.0 [V]**) | (**Recommended : 12.0 [V]**) |
| Torque | 1.5 [N.m] / 9.81 = 0.15 kgf | 6.9[N.m] / 9.81 = 0.703kgf    7.3 [N.m] / 9.81 = 0.744kgf    8.9 [N.m] 8.9 / 9.81 = 0.907kgf | 5.5 [N.m] /9.81 = 0.5606kgf    6.0 [N.m] /9.81 = 0.6116kgf    7.3 [N.m] /9.81 = 0.7441kgf |
| No-load | 59 [rev/min] (at 12V) | 50 [rev/min] (at 11.1 [V])  53 [rev/min] (at 12.0 [V])  66 [rev/min] (at 14.8) | 58 [rev/min] (at 11.1 [V])  63 [rev/min] (at 12 [V])  78 [rev/min] (at 14.8 [V]) |
| Total Torque(Max Torque) | There are 4 legs with 3 motors each, totaling to 12 motors    0.15kgf x 12= 1.8kgf max for stall Torque | There are 4 legs with 3 motors each, totaling to 12 motors  0.703kgf x 12 = 8.436 kgf max for stall Torque    0.744kgf x 12 = 8.928kgf max for stall Torque    0.907kgf x 12 = 10.884kgf max for stall Torque | There are 4 legs with 3 motors each, totaling to 12 motors    0.5606kgf x 12 =6.072kgf max for stall Torque    0.6116kgf x 12 =7.3392kgf max for stall Torque    0.7441kgf x12 = 8.9292kgf max for stall Torque |

References from :

Calculation of torque and max load:

<https://robotics.stackexchange.com/questions/14943/how-much-weight-can-dc-motor-carry>

Unit of calculated load:

<https://en.wikipedia.org/wiki/Kilogram-force>