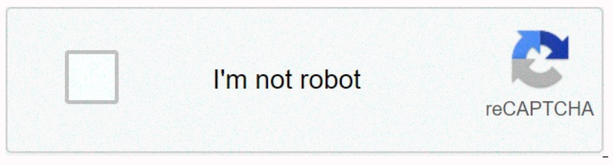

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Dynamixel servomotor robotics DYNAMIXEL is an exclusive actuator of intelligent robots with fully integrated DC motors + gearbox reduction + controller + pilot + network in the DC servo module. The DYNAMIXEL XH/ XM series offers a wide range of control techniques based on current high-performance detection algorithms. It adopts aluminum housings and adopts new technologies such as hollow cable repair structures for user convenience. Select on this product sheet before you order the dynamixel XM430-W210-T or XM430-W210-R. Page 2 Dynamixel Robotics servomotor DYNAMIXEL is an exclusive actuator of intelligent robots with fully integrated DC motors + gearbox reduction + controller + pilot + network in the DC servo module. The DYNAMIXEL XH/ XM series offers a wide range of control techniques based on current high-performance detection algorithms. It adopts aluminum housings and adopts new technologies such as hollow cable repair structures for user convenience. Select this product sheet before your order is dinamixel XM430-W350-T or XM430-W350-R. Page 3 Dynamixel Robotics servomotor DYNAMIXEL is an exclusive actuator of intelligent robots with fully integrated DC motors + gearbox reduction + controller + pilot network + in servo DC modules. The DYNAMIXEL XH/ XM series offers a wide range of control techniques based on current high-performance detection algorithms. It adopts aluminum housings and adopts new technologies such as hollow cable repair structures for user convenience. Select on this product sheet before your Order is dinamixel XM540-W150-T or XM540-W150-R. Page 4 Dynamixel Robotics servomotor The DYNAMIXEL XM540-W270 servo motor is an exclusive actuator of intelligent robots with fully integrated DC motors + gearbox reduction + controller + pilot + network in servo DC modules. The DYNAMIXEL XH/XM Robotics Series offers a variety of control techniques based on current high-performance detection algorithms. It adopts aluminum housings and adopts new technologies such as hollow cable repair structures for user convenience. Select this product sheet before your order is dinamixel XM540-W270-T or XM540-W270-R. Page 5 Dynamixel servo motor Motor servo Robotis AX-12W is a wheeled version of the popular AX-12A. The AX-12W servo motor has the ability to monitor its speed, temperature, voltage and load. Edit on GitHub XM430-W210 Item Specifications ARM CORTEX-M3 MCU Specifications (72 [MHz], 32Bit) Absolute Keyless Sensor Position encoder (12Bit, 360 [°])Maker : ams(www.ams.com), Part No: AS5045 Motor Coreless Baud Rate 9600 [bps] ~ 4.5 [Mbps] PID Control Algorithm Control Resolution 4096 [pulse/rev] Backlash 15 [arcmin] (0.25 [°]) Current Control Mode Operating Mode This Control Mode Control Mode Control Mode Mode Mode (0 ~ 360 [°])Extended Position Control Mode (Multi-turn)Current Position Control ModePWM Control Mode (Voltage Control Mode) Weight 82 [g] Dimensions (W x H x D) 28.5 x 46.5 x 34 [mm] Gear Ratio 212.6 : 1 Torque 2,7 [N.m] (falling 11,1 [V], [V], [A]) 3.0 [N.m] (at 12.0 [V], 2.3 [A])3.7 [N.m] (at 14.8 [V], 2.7 [A]) No Load Speed 70 [rev/min] (at 11.1 [V])77 [rev/min] (at 12.0 [V])95 [rev/min] (at 14.8 [V]) Radial Load 40 [N] (10 [mm] away from the horn) Axial Load 20 [N] Operating Temperature -5 ~ +80 [°C] Input Voltage 10.0 ~ 14.8 [V] (Recommended : 12.0 [V]) Command Signal Digital Packet Protocol Type TTL Half Duplex Asynchronous Serial Communication with 8bit, 1stop, No ParityRS485 Asynchronous Serial Communication with 8bit, 1stop, No Parity Physical Connection RS485 / TTL Multidrop Bus ID 253 ID (0 ~ 252) Feedback Position, Velocity, Current, Realtime tick, Trajectory, Temperature, Input Voltage, etc Part Material Full Metal GearMetal (Front, Middle), Engineering Plastic (Back) Standby Current 40 [mA] DANGER (May cause serious injury or death) Never place items containing water , flammable, and solvent near the product. Never place fingers, arms, toes, and other body parts near the product during surgery. Turn off the power if the product emits a strange smell or smoke. Keep the product out of reach of children. Check the power polarity before the cable. CAUTION (May cause injury or damage to the product) Do not operate the product at temperatures exceeding the range of -5 ~ +80 [°C]. Do not insert sharp bars or pins during product operation. CAUTION (May cause injury or damage to the product) Do not disassemble or modify the product. Do not drop or apply a strong shock to the product. NOTE: Max Torque and Stall Torque Performance Graphs differ in measurement methods. Kiosk torque is the value measured by the instantaneous torque it can reach. This is generally how rc servos are measured. The Performance Graph is also referred to as the N-T curve, which is measured by gradually increasing loads. The actual motor operating environment is closer to the performance chart, not the stall torque method. For this reason, performance charts are widely used in the industry. Generally, Max Torque of the Performance Graph is less than Kiosk Torque. CAUTION: When supplying power It is recommended to use a ROBOTIS controller or SMPS2DYNAMIXEL. Do not connect or disconnect DYNAMIXEL while power is provided. The Table of Control Tables is a data structure that is applied in the device. Users can read certain Data to gain device status with the Read Instructions Package, and modify the Data also to control the device with the WRITE Instruction Pack. The Control Table, data, address table control is a structure consisting of several Data fields to save status or to control the device. Users can check the current status of the device by reading Specific Data from the Control Table with the Read Instructions Package. The WRITE Instruction Pack allows users to control the device by changing specific Data in the Control Table. Address is a unique value when accessing specific Data in a Plan Control Table To read or write data, the user must point to a specific Address in the Package. Please refer to Protocol 2.0 for more details on the Instruction Pack. NOTE: Appendages two are applied to negative values. For more information, please refer to wikipedia's complement Two. The Area (EEPROM, RAM) Control Table is divided into 2 Areas. Data in the RAM Area is reset to the initial value when power is reset (Volatile). On the other hand, data in the EEPROM Area is retained even when the device is turned off (Non-Volatile). Data in the EEPROM Area can only be written if Torque Enable(64) is cleared to '0'. The size of the data size varies from 1 ~ 4 bytes depending on its use. Please check the data size when updating the data with the Instruction Pack. For data greater than 2 bytes will be stored according to Little Endian. Access Table Control has two different access properties. The property 'RW' stands for read and write access permissions while 'R' stands for read access only. Data with read-only properties cannot be changed by the WRITE Instruction. Read only the properties('R') are commonly used to measure and monitor objectives, and reading write properties ('RW') is used to control the device. Initial Value Each data in the Control Table is restored to the original value when the device is activated. The default value in the EEPROM area is the initial device value (factory default setting). If there is a value in the EEPROM area modified by the user, the modified value is restored as the starting value when the device is turned on. The Initial value in the RAM area is restored when the device is turned on. EEPROM Area Address Control Table (Byte) Access Access DefaultValue Range Units 0 2 Model Number R 1,030 -- 2 4 R Information Models - - - 6 1 Firmware Version R -- - 7 1 RW ID 1 0~252 -8 1 Baud Rw 1 0~7 - 9 1 RW Return Delay Time 250 0~0~1 254 2 [µsec] 10 1 Mode Drive RW 0 0 ~ 5 - 11 1 Mode of Operation RW 3 0 ~ 16 - 12 1 Secondary(Shadow) ID RW 255 0 ~ 252 - 13 1 Protocol Type RW 2 1 ~ 2 - 20 4 Homing Offset RW 0 -1.044 .479 ~ 1,044,479 1 [pulse] 24 4 Moving Threshold RW 10 0 ~ 1,023 0.229 [rev/min] 31 1 Temperature limit RW 80 0 ~ 100 1 [°C] 32 2 Max Voltage Limit RW 160 95 ~ 16 0.1 [V] 34 2 Minute Voltage Limit RW 95 95 ~160 0.1 [V] 36 2 Limit PWM RW 885 0 ~ 885 0.113 [%] 38 2 Current Limit RW 1,193 0 ~ 1,193 2.69 [mA] 44 4 Speed Limit RW 330 0 ~ 1,023 0.229 [rev/min] 48 4 Max Position Limit RW 4095 0 ~ 4095 1 [pulse] 52 4 Min Position Limit RW 0 0 0 ~4.095 1 [pulse] 63 1 Shutdown RW 52 - - Table Size Control Address Area RAM (Byte) Access Range DefaultValue Unit 64 1 Torque Enable RW 0 0 ~1 - 65 1 LED RW 0 0 ~1 - 68 1 Return Rate status RW 2 0 ~2 - 69 1 Registered Instruction R 0 0 ~ 1 - 70 1 Hardware Error Status R 0 - - 76 2 Speed I Get RW 1920 0 ~ 16383 - 78 2 Speed P Gain RW 100 0 ~ 16383 - 80 2 Position D Gain RW 0 0 ~ 16383 - 82 2 Position I Gain RW 0 0 ~ 16383 - 84 2 Position P Gain RW 800 0 ~ 16383 - 88 2 Feedforward 2nd Gain - 90 2 Feedforward 1st Gain RW 0 0 ~ 16,383 - 98 1 Bus Watchdog RW 0 1 ~ 127 20 [msec] 100 2 Goal PWM RW - -PWM Limit(36) ~ PWM Limit(36) - 102 2 Goal Current RW - -Current Limit(38) ~ Current Limit(38) 2.69 [mA] 104 4 Goal Velocity RW - -Velocity Limit(44) ~ Velocity Limit(44) 0.229 [rev/min] 108 4 Profile Acceleration RW 0 0 ~ 32,767 0 ~ 32,737 214.577 [rev/min2] 1 [ms] 112 4 Profile Velocity RW 0 0 ~ 32,767 0.229 [rev/min] 116 4 Goal Position RW - Min Position Limit(52) ~ Max Position Limit(48) 1 [pulse] 120 2 Realtime Tick R - 0 ~ 32,767 1 [msec] 122 1 Moving R 0 0 ~ 1 - 123 1 Moving Status R 0 - - 124 2 Present PWM R - - - 126 2 Present Current R - - 2.69 [mA] 128 4 Present Velocity R - - 0.229 [rev/min] 132 4 Present Position R - - 1 [pulse] 136 4 Velocity Trajectory R - - 0.229 [rev/min] 140 4 Position Trajectory R - - 1 [pulse] 144 2 Present Input Voltage R - - 0.1 [V] 146 1 Present Temperature R - - 1 [°C] 168 2 Indirect Address 1 RW 224 64 ~ 661 - 170 2 Indirect Address 2 RW 225 64 ~ 661 - 172 2 Indirect Address 3 RW 226 64 ~ 661 - ... ... - - 218 2 Indirect Address 26 RW 249 64 ~ 661 - 220 2 Indirect Address 27 RW 250 64 ~ 661 - 222 2 Indirect Address 28 RW 251 64 ~ 661 - 224 1 Indirect Data 1 RW 0 0 ~ 255 - 225 1 Indirect Data 2 RW 0 0 ~ 255 - 226 1 Indirect Data 3 RW 0 0 ~ 255 - ... ... - - 249 1 Indirect Data 26 RW 0 0 ~ 255 - 250 1 Indirect Data 27 RW 0 0 ~ 255 - 251 1 Indirect Data 28 RW 0 0 ~ 255 - 578 2 Indirect Address 29 RW 634 64 ~ 661 - 580 2 Indirect Address 30 RW 635 64 ~ 661 - 582 2 Indirect Address 31 RW 636 64 ~ 661 - ... ... - - 628 2 Indirect Address 54 RW 659 64 ~ 661 - 630 2 Indirect Address 55 RW 660 64 ~ 661 - 632 2 Indirect Address 56 RW 661 64 ~ 661 - 634 1 Indirect Data 29 RW 0 0 ~ 255 - 635 1 Indirect Data 30 RW 0 0 ~ 255 - 6363 1 RW 0 0 ~ 255 - ... - - 659 1 Indirect Data 54 RW 0 0 ~ 255 - 660 1 Indirect Data 55 RW 0 0 ~ 255 - 661 1 Indirect Data 56 RW 0 0 ~ 255 - CAUTION : Protocol 1.0 does not support addresses greater than 255. Therefore, Indirect Addresses 29~56 and Indirect Data 29~56 can only be accessed with Protocol 2.0. Description of WARNING Control Table : Data in the EEPROM Area can only be written when the Enable Torque value(64) is cleared to '0'. Model Number(0) This address stores the DYNAMIXEL model number. Firmware Version(6) This address stores the dynamixel firmware version. ID(7) ID is a unique value in the network to identify each DYNAMIXEL with the Instruction Pack. A value of 0 ~ 252 (0xFC) can be used as id, and 254(0xFE) is occupied as broadcast ID. Broadcast ID (254, 0xFE) can send instruction packs to all connected DYNAMIXEL simultaneously. NOTE: Please avoid using identical IDs for some DYNAMIXEL. You may encounter communication failures or may not be able to detect DYNAMIXEL with identical IDs. NOTE: If the Instruction Package ID is set to ID (0xFE), the Status Package will not be returned for READ and WRITE Instructions. For To details, please refer to the Status Package section for Protocol 1.0 or Protocol 2.0. Baud Rate(8) The Baud Rate(8) determines the speed of serial communication between the controller and DYNAMIXEL. Baud Rate Margin of Error 7 4.5M [bps] 0.000 [%] 6 4M [bps] 0.000 [%] 5 3M [bps] 0 ,000 [%] 4 2M [bps] 0.000 [%] 3 1M [bps] 0.000 [bps] 0.000 [bps] 0.000 [bps] 0.00%] 2 115,200 [bps] 0.000 [%] 1 (Default) 57,600 [bps] 0.000 [%] 0 9600 [bps] 0.000 [%] NOTE: Less than 3% of baud interest rate error margin will not affect UART communication. NOTE: For stable communication with higher Baudrate, configure the USB Latency value down. Delay Time for Return of USB Latency Settings(9) After DYNAMIXEL receives the Instruction Package, the Status Package transmission delay for The Return Delay Time(9). For example, if the Return Delay Time(9) is set to '10', the Status Package will be returned after 20[µsec] when the Instruction Pack is received. Description of Unit Value Range 2[µsec] 0 ~ 254 Default value '250'(500[µsec]), Maximum 508[µsec] Drive Mode (10) This address configures dynamixel drive mode. Drive Mode is available from the V38 firmware. Bit Item Description Bit 7(0x80) - Not used, always '0' Bit 6(0x40) - Not used, always '0' Bit 5(0x20) - Not used, always '0' Bit 4(0x10) - Not used, always '0' Bit 3(0x08) - Not used, always '0' Bit 2(0x04) Profile Configuration [0] Speed-Based Profile: Create Profile by Speed[1] Time-Based Profile: Create Profile by time ※ See What is Bit Profile 1(0x02) - Not used, always '0' Bit0(0x01) Normal/Inverted Mode [0] Normal Mode: CCW(Positive), CW (Negative)[1] Reverse Mode: CCW(Negative), CW (Positive) NOTE : Time-based profiles are available from the V42 firmware. NOTE: If the Bit 0 value (Normal/Inverted Mode) of Drive Mode(10) is set to 1, the rotation direction is reversed. As such, Golput's position, the current position will have an inverted direction. This feature can be very useful when configuring symmetric joint or wheel systems. Operation Mode(11) Description Operation Mode Value 0 Current Control Mode DYNAMIXEL only controls current(torque) regardless of speed and position. This mode is ideal for griprs or systems that use only current(torque) controls or systems that have additional speed/position controllers. 1 Speed Control Mode This mode controls speed. This mode is identical to dynamixel's wheel mode. This mode is ideal for wheel type robots. 3(Default) Position Control Mode This mode controls position. This mode is identical to dynamixel's existing Shared Mode. The operating position range is limited by Max Position Limit(48) and Min(52) Position Limit. This mode is ideal for articulated robots whose each joint rotates less than 360 degrees. 4 Extended Position Control Mode (Multi-turn) The control position of this mode. This mode is identical to dynamixel's Multi-Turn Mode which 512 rounds supported(-256[rev] ~ 256[rev]). This mode is ideal for multi-turn wrists or conveyor systems or systems that require additional reducing gears. 5 Current Position Based Control Mode This mode controls the current position and (torque). Up to 512 rounds are supported(-256[rev] ~ 256[rev]). This mode is ideal for systems that require current positioning and control such as articulation robots or gripkers. 16 CONTROL Mode PWM (Voltage Control Mode) This mode directly controls the PWM output. (Voltage Control Mode) NOTE: When Operation Mode(11) switches to another mode, the Gain value, such as Velocity PI(76, 78); PID positions(80, 82, 84); Feedforward(88, 90), will be reset to the selected Operation Mode(11). In addition, the profile generator and boundary value determination data will be reset as well. See the next description for more details. Note that the modified Position PiD values(80, 82, 84) and PWM(36) Limit can be read through the Control Table. NOTE: PWM stands for Pulse Width Modulation which modulates PWM's task to control the motor. It changes the width of the pulse to control the average supply voltage to the motor, and this technique is widely used in the field of motor control. PWM Control Mode is similar to AX and RX series Wheel Modes. Input the PWM(100) value to control the supply voltage for DYNAMIXEL in PWM Control Mode. NOTE: Current Position(132) represents 4 continuous byte ranges from -2,147,483,648 to 2,147,483,647 when Torque is turned off regardless of Operation Mode(11). However, The Current Position(132) will be reset to the absolute position value in one full rotation in the following case: When Operation Mode(11) switches to Position Control Mode, the Current Position(132) is reset to the absolute position value in full rotation. When torque is turned on in Position Control Mode, the Current Position(132) is reset to the absolute position value in one full rotation. Activate the power supply or use the Reboot Instructions. Note that the Current Position value (132) may be affected by the Homing Offset(20). The Secondary ID(Shadow) (12) assigns the secondary ID to DYNAMIXEL. Secondary IDs(12) can be shared to group between DYNAMIXELs and to synchronize their movements, unlike ID(7) which should not overlap. Be aware of the difference between Secondary ID(12) and ID(7) by reading the following. Under the same Secondary ID(12), multiple DYNAMIXELs can be grouped. ID(7) has a greater priority than the Secondary ID(12). If two items (Secondary ID(12) and ID(7)) are with each other, ID(7) must be applied first. The EEPROM area of the Control Table cannot be modified using Secondary ID(12). The RAM area can be modified using secondary ID(12). If Instruction Packet ID is the same as Secondary ID(12), Status Package will not be returned. If the value of Secondary ID(12) is 253 or higher, the Secondary ID function is disabled. Description Value 0 ~ 252 Enable secondary ID function 253 ~ 255 Disable secondary ID function, Default value '255' See the following Secondary ID(12) to understand correctly. Note that the DYNAMAIXELs example in the following example uses a different ID (1 to 5). Set the Secondary ID of all DYNAMIXELs to '5'. Send Write Instruction Pack (ID(7) = 1, LED(65) = 1). DYNAMIXEL with ID '1' turns on its LED by the Instruction Package, and the Status Package will be returned. Send Write Instruction Pack (ID(7) = 5, LED(65) = 1). All DYNAMIXELs turn on their LEDs, but The Status ID Package '5' will only be returned. Set the Secondary ID of all DYNAMIXELs to '100'. Send Write Instruction Pack (ID(7) = 100, LED(65) = 0). All DYNAMIXELs turn off their LEDs. Because no DYNAMIXEL uses ID 100, but uses the same Secondary ID, the Status Package will not be returned. Protocol Type(13) Users can choose dynamixel protocol type (1.0 and 2.0). Even if Protocol 1.0 is selected, Protocol Control Table 2.0 will be used. It is recommended to use identical protocol types for some DYNAMIXEL. DYNAMIXEL 1 Series 1.0 AX Compatible Value Protocol Type, DX Series, RX Series, EX Series, MX Series with Firmware under v39 2(default) 2.0 MX-28/64/106 with Firmware v39 or higher, X Series, PRO Series WARNING : To change Protocol 2.0 to Protocol 1.0, use Dynamixel Wizard 2.0 as R+ Manager 2.0 is not compatible with Protocol 1.0 products. NOTE: Protocol 2.0 is greatly improved from protocol 1.0. Accessing some areas of the Control Table may be denied if protocol 1.0 is selected. This manual complies with protocol 2.0. Please see Protocol 1.0 and Protocol 2.0 from the e-Manual for more details on the protocol. NOTE: Please refer to the Protocol Compatibility table for the product. Homing Offset(20) Home Offset(20) adjusts the position of the cage. The offest value is added to Current Position(132). Current Position(132) = Actual Position + Offset Homing(20) Description Of Unit Value Range about 0.088 [°] -1,044,479 ~ 1,044,479(-255 ~ 255[rev]) 4,096 resolution records: In the case of Position Control Mode (Shared Mode) rotating less than 36 invalid Homing Offset(20) values are ignored (valid range: -1,024 ~ 1,024). NOTE: In case the Reverse Mode Bit is set in Drive Mode(10), the Homing Offset(20) value mark will not be reversed. Moving Threshold(24) Moving Threshold(24) determines whether DYNAMIXEL is moving or not. When the absolute value of Current Speed(128) is greater than the Moving Threshold(24), Move(122) is set to '1'. Otherwise, it's cleared to '0'. Unit Description Value is about 0.229 rpm All associated speeds Data using the same unit range 0 ~ 1023 - Temperature Limit(31) Temperature Limit (31) limits dynamixel operating temperature. When the Current Temperature (146) is greater than the Temperature Limit(31), the Upper Heating Error Bit (0x04) and the Hardware Error Bit (0x80) in the Hardware Error State(70) are set. If Hot Bit Error (0x04) is configured at Shutdown(63), Enable Torque(64) is cleared to '0' and DYNAMIXEL torque is Disabled. View View for more detailed information. Description Of Unit Value Range About 1° 0 ~ 100 0 ~ 100° ATTENTION : Do not set this value higher than the default. If DYNAMIXEL experiences a temperature warning alarm (Overheating Error Bit(0x04)), leave it to cool for 20 minutes or more. Otherwise, it can cause severe damage in the operation. Min/Max Voltage Limit (32, 34) Min Voltage Limit (32) and Max Voltage Limit(34) determine the maximum and minimum operating voltage. When the current input voltage obtained from current input voltage(144) exceeds the range of Max Voltage Limit(32) and Min Voltage Limit(34), Voltage Range Error Bit(0x01) and Hardware Error Bit(0x80) in hardware error status (70) is set. If Bit Input Voltage Error (0x10) is configured at Shutdown(63), Enable Torque(64) is cleared to '0' and Torque is disabled. For more details, please refer to the Shutdown(63) section. Description Unit Value Range About 0.1 [V] 95 ~ 160 9.5 ~ 16.0 [V] PWM Limit(36) PWM Limit(36) indicates the maximum PWM output. The destination PwM(100) cannot be configured with any value that exceeds the PWM(36) Limit. The PWM(36) limit is commonly used in all operating modes as an output limit, therefore a decrease in PWM output will result in a decrease in torque and speed. For more details, please refer to the Gain section of each mode of operation. Description Value 0(0 [%]) ~ 885(100 [%]) 885 = 100 [%] output Current Limit(38) Current Limit(38) indicates the maximum current output limit(torque). Destination Flow(102) cannot be configured with any value that exceeds the Current Limit(38). The Current Limit(38) is used in torque control mode and the current position control mode, reducing the Current Limit(38) will result in a decrease in DYNAMIXEL torque. For more details, please refer to PID Position Gain(80~84). The Unit Value Range is about 2.69[mA] 0 ~ 1,193 NOTE: The Current Limit(38) may vary by each DYNAMIXEL so please check the Control Table. Speed Limit (44) Speed Limit(44) represents the maximum score of Goal Speed(104). For more details, see Goal Speed(104). Unit Value Range 0.229rpm 0 ~ 1.023 NOTE: The default value of Velocity Limit(44) has decreased since the V42 Firmware. Min/Max Position Limits(48, 52) Min and Max Position Limits(48, 52) limit the desired maximum and minimum positions for Position Control Mode (Shared Mode) in the range of 1 rotation(0 ~ 4095). Therefore, the Destination Position(116) must be configured within the position limit range. This value is not used in Extended Position Control Mode and current position control mode. Unit Value Range 0.088 [°] 0 ~ 4.095(1 rotation) NOTE: Max Position Limit(48) and Min Position Limit(52) are used only in Position Control Mode with one turn. DYNAMIXEL Shutdown(63) can protect itself by detecting dangerous situations that may occur during operation. Every Bit processed inclusive with the 'OR' logic, therefore, several options can be generated. For example, when '0x05' (binary : : defined in Shutdown(63), DYNAMIXEL can detect Input Voltage Errors (binary : 00000001) and Overheating Error(binary : 00000100). If the error is detected, Enable Torque(64) is cleared to '0' and the motor output becomes 0 [%]. REBOOT is the only method to reset Torque Enable(64) to '1' (Torque ON) after shutdown. Check the Hardware Error Bit(0x80) in the Package Status error field or the current state via Hardware Error State (70). The following are detectable situations. Bit Item Description Bit 7 - Not Used, Always '0' Bit 6 - Not used, Always '0' Bit 5 Overload Error(default) Detects persistent load exceeding maximum output Bit 4 Electrical Shock Error(default) Detects electric shock on circuits or insufficient power to operate Bit 3 Motor Encoder Error motor corruption Detects bit 2 Overheating Error(default) Internal temperature control exceeds configurable operating temperature Bit 1 - Not used, Always '0' Bit 0 Input Voltage Fault Detection input voltage exceeds the configured operating voltage record: If Shutdown occurs, the LED will flash every second. (Firmware v41 or higher) If Shutdown occurs, reboot the device. H/W REBOOT : Turn S/W REBOOT power off and on : Send REBOOT Instructions (For more details, see reboot section of e-Manual.) Enable Torque(64) Enable Torque(64) specifies Torque ON/OFF. Writing '1' to the Toque Enable address will enable Torque and all Data in the EEPROM area will be locked. Description Value 0(Default) Turn off torque 1 Enable torque and lock EEPROM area NOTE : Current Position(132) can be reset when Operation Mode(11) and Torque Enabled(64) are updated. For more details, please refer to Homing Offset(20) and Current Position(132). The LED(65) LED(65) specifies the ON or Off LED. Bit Description 0(Default) Turn off LED 1 Turn on LED NOTE: Check dynamixel status with flashing

LED count. The Boot Representation LED status flickered after the Factory Reset LED flashed 4 times the Alarm LED flashed the Boot Mode LED At Status Return Level(68) The Status Return Rate(68) decided how to return the Status Package when DYNAMIXEL received the Instruction Package. Description Of Instructional Instruction Value 0 PING Instruction Returns PING Instuksi only 1 INSTRUCTIONREAD PING Instruction Return PING and Read Instuksi only 2 All Instructions Return all Instruction NOTES: If the Instruction Package ID is set to Broadcast ID (0xFE), the Status Package will not be returned for READ and WRITE Instructions regardless of status return rate. For more details, please refer to the Status Packages for Protocol 1.0 or Protocol 2.0 section. 1 Package ID is a field that indicates the ID of the device that must receive the Instruction Pack and process it. Registered Instruction(69) Description Value 0 REG_WRITE instruction not 1 REG_WRITE note: If action instructions are executed, the value will be changed to 0. 0. The Hardware Error Status(70) indicates the hardware error status. DYNAMIXEL can protect itself by detecting dangerous situations that can occur during operation. Each Bit is processed inclusively with the 'OR' logic, therefore, several options can be generated. For example, when '0x05' (binary : 00000101) is defined in Shutdown(63), DYNAMIXEL can detect Input Voltage Errors (binary : 00000001) and Overheating Errors (binary : 00000100). If the error is detected, Enable Torque(64) is cleared to '0' and the motor output becomes 0 [%]. REBOOT is the only method to reset Torque Enable(64) to '1' (Torque ON) after shutdown. Check the Hardware Error Bit(0x80) in the Package Status error field or the current state via Hardware Error State (70). The following are detectable situations. Bit Item Description Bit 7 - Not Used, Always '0' Bit 6 - Not used, Always '0' Bit 5 Overload Error(default) Detects persistent load exceeding maximum output Bit 4 Electrical Shock Error(default) Detects electric shock on circuits or insufficient power to operate Bit 3 Motor Encoder Error motor corruption Detects bit 2 Overheating Error(default) Internal temperature control exceeds configurable operating temperature Bit 1 - Not used, Always '0' Bit 0 Input Voltage Fault Detection input voltage exceeds the configured operating voltage record: If Shutdown occurs, the LED will flash every second. (Firmware v41 or higher) If Shutdown occurs, reboot the device. H/W REBOOT : Turn S/W REBOOT power off and on : Send REBOOT Instructions (For more details, see reboot section of e-Manual.) Speed PI Gain(76, 78) Speed PI Gain(76, 78) indicates gain of Speed Control Mode. The advantages of the INTERNAL CONTROLLER DYNAMIXEL can be calculated from the Gain of the Control Table as shown below. Constants in each equation include sampling time. The Velocity P Gain of the INTERNAL DYNAMIXEL controller is abbreviated KVP and the control table is abbreviated KVP (TBL). Gain Conversion Equations Controller Speed Description Range I Gain(76) KVI KVI =KVI(TBL) / 65536 0 ~ 16383 I Get Speed P Gain(65.65 536 0~16,383 I Gain Velocity P Gain(65,536 0~16,383 I Gain Velocity P Gain(65.5 36 0~16,383 I Gain Velocity P Gain(65,536 0~16,383 I Gain Velocity P Gain(65,536 0~178)KVP KVP=KVP(TBL)/128 0~16.383 P Gain Below the number is a block chart explaining the speed controller in Speed Control Mode. When the instructions transmitted from the user are received by DYNAMIXEL, the following steps are required to drive the horn. NOTE: Ka stands for Anti-windup Gain and β is a coefficient of position conversion and speed that cannot be modified by the user. For more details on PID controllers, please refer to the PID Controller in wikipedia. Position PID Gain(80, 82, 84), Feedforward 1/2nd Gain(88, 90) This gain is used in Position Control Mode and Extended Position Control Mode. The advantages of the INTERNAL CONTROLLER DYNAMIXEL can be calculated from the Gain of the Control Table as shown below. The constants in each equation include sampling time. P P Position Acquisition abbreviated internal KPP and control table abbreviated KPP (TBL). Gain Controller Conversion Equation Position Description Range D Gain(80) KPD KPD = KPD(TBL) / 16 0 ~ 16,383 D Gain Position I Gain (82) KPI KPI = KPI(TBL) / 65,536 0 ~ 16,383 I Position Acquisition P (84) KPP KPP = KPP (TBL) / 128 0 ~ 16383 P Gain Feedforward 2nd Gain(88) KFF2nd KFF2nd(TBL) / 4 0 ~ 16,383 Feedforward Acceleration Gain Feedforward 1st Gain(90) KFF1st KFF1st(TBL) / 4 0 ~ 16,383 Feedforward Velocity Gain Below the number is a block diagram that describes the position controller in Position Control Mode and Extended Position Control Mode. When instructions from the user are received by DYNAMIXEL, the following steps are required to drive the horn. NOTE: In the case of PWM Control Mode, the PID controller and Feedforward controller are disabled while the Goal PWM(100) value directly controls the motor via inverter. In this way, the user can directly control the voltage supply to the motor. Ka is an Anti-windup Reinforcement that cannot be modified by the user. For more details on PID controllers and Feedforward controllers, please refer to PID Controllers and Feed Forwarding. Below the image is a block diagram describing the current position-based controller in current Position Control Mode. Since Position Control Mode is currently very similar to Position Control Mode, the differences will be focused in the following steps. The difference is also highlighted with a green marker in the block chart. Feedforward and PID controllers calculate the desired current based on the desired trajectory. Goal Current(102) decides the desired end current by setting a limit on the desired calculated current. The controller currently calculates the PWM output for the motor based on the desired end current. The objective of PWM(100) sets a limit on calculated PWM output and decides the final PWM value. The final PWM value is applied to the motor via Inverter, and the DYNAMIXEL horn is driven. Results are saved at Current Position(132), Current Speed(128), Current PWM(124) and Current(126). NOTE: Ka is an Anti-windup Reinforcement that cannot be modified by the user. Bus Watchdog(98) Bus Supervisor (98) is a Fail-safe device to terminate DYNAMIXEL if communication between the controller and DYNAMIXEL communication (RS485, TTL) is interrupted due to an un specified error. Communication is defined as all Instruction Packs in the DYNAMIXEL Protocol. Description Unit Value 20[ms] - Range 0 Disable Bus Supervisory Function, Clear Bus Supervisor Error Range 1 ~127 Enable Bus Supervisor Range -1 Bus Supervisor Error Status Bus Watchdog Function monitors communication interval (time) between controller and DYNAMIXEL when Torque Enable(64) is '1'. If the metered communication interval (time) is greater than Bus Watchdog(98), DYNAMIXEL stops. Bus Watchdog (98) to be changed to '-1' Bus Supervisor). If Bus Supervisor Error appears, The Value of Goals (PWM Goals(100), Goal Flows(102), Goal Speed(104), Goal Position(116)) will be converted into read-only access. Therefore, when the new value is written to the Destination Value, the Range Error will be returned through the Status package. If the Value of Bus Watchdog(98) is changed to '0', the Bus Supervision Error will be cleared. NOTE: For details of Range Error, please see Protocol 2.0 NOTE: Bus Watchdog (98) is available from the v38 firmware. Bus Watchdog (98) The following example is an example of the operation of the Bus Watchdog function. After setting operation mode(11) to speed control mode, change Torque Enable(64) to '1'. If '50' is written in Goal Velocity(104), DYNAMIXEL will rotate towards CCW. Change the value of Bus Watchdog(98) to '100' (2,000 [ms]). (Enable Bus Surveillance Function) If no instruction pack is received for 2,000 [ms], DYNAMIXEL will stop. When stopped, Profile Acceleration (108) and Profile Speed(112) are applied as '0'. The value of Bus Watchdog(98) changes to '-1' (Bus Supervisor Error). At this time, access to the Destination Value will be converted to read-only. If '150' is written to Target Speed(104), the Error Range will be returned via the Status Package. If the Value of Bus Watchdog(98) is changed to '0', the Bus Supervision Error will be cleared. If 150 is written in Destination Speed(104), DYNAMIXEL will rotate towards CCW. The purpose of PWM(100) When Operation Mode(11) is PWM Control Mode, both PID and Feedforward controllers will be disabled because the Goal PWM(100) value directly controls the motor via inverter. However, in other Operating Modes(11), destination PWM(100) only limits the PWM value. Read PID Position Gain(80, 82, 84), Feedforward 1st/2nd Gains(88, 90) or Velocity PI Gain(76, 78) for how Goal PWM (100) works with profit. NOTE: The purpose of PWM(100) must not exceed the PWM(36) Limit. Current Target(102) Use Current Target(102) to set the desired current when Operation Mode(11) is Torque Control Mode. Additionally, Destination Flow(102) may be used to set limits to the current in the current position-based Control Mode. The Range of Unit Values is approximately 2.69[mA] -Current Limit(38) ~ Current Limit(38) NOTE: The Current Goal(102) cannot exceed the Current Limit(38). NOTE: Applying high current on the motor for a long period of time can damage the motor. Target Speed(104) Use Destination Speed(104) to set the desired speed when Operation Mode(11) is Speed Control Mode. Know that Goal Speed (104) does not limit the speed of movement. Unit Value Range 0.229 rpm -Speed Limit(44) ~ Speed Limit(44) NOTE: This value must not exceed the Speed Limit(44). NOTE: DYNAMIXEL's maximum speed and maximum torque are affected by the voltage supply. Therefore, if supplying voltage changes, so does the maximum speed. This manual complies with the recommended supply voltage (12[V]). : If Profile Acceleration (108) and Target Speed(104) are modified simultaneously, the modified Profile Acceleration(108) is modified(108) used to process Goal Velocity(104). Profile Acceleration(108) When Drive Mode(10) is a Speed-based Profile, Profile Acceleration(108) specifies Profile acceleration. When Drive Mode(10) is a Time-Based Profile, Profile Acceleration(108) sets the Profile acceleration time. Be aware that Profile Acceleration(108) will be applied in all control modes except Current Control Mode or PWM Control Mode in Operation Mode(11). For more detailed information, see What is The Profile Value Description Unit Speed Based Profile 214577 [rev/min2] Setting the Profile Range acceleration 0 ~ 32767 '0' stands for acceleration Unit Description Value Of Unlimited Time-Based Profiles 1 [msec] Set the Profile Range acceleration time 0 ~ 32737 '0' stands for unlimited acceleration time ('msec]msec'). Profile Acceleration (108) will not exceed 50% of the Profile Speed value (112). NOTE: Time-based profiles are available from firmware version 42. Profile Speed(112) When Drive Mode(10) is a Velocity-based Profile, Profile Speed(112) sets the Profile's maximum speed. When Drive Mode(10) is Time-Based Profile, Profile Speed(112) sets a time range for the Profile. Be aware that Profile Speed(112) will only be applied to Position Control Mode or Extended Position Control Mode in Operation Mode(11). For more information, see What is a Profile. NOTE: Speed Control Mode uses only Profile Acceleration (108) without Profile Speed (112). Unit Description Value Profile Based Speed 0.229 [rev/min] Set the speed of Profile Range 0 ~ 32767 '0' stands for Unit Description Value Time-Based Profile infinite speed of 1 [msec] Set the time range to Profile Range 0 ~ 32737 '0' stands for unlimited speed. Profile Acceleration (108) will not exceed 50% of the Profile Speed value (112). NOTE: Time-based profiles are available from the V42 firmware. Goal position(116) Goal Position(116) determines the desired position. From dynamixel's front view, CCW is in an increasing direction, while CW is in a descending direction. How to reach the Destination Position(116) is different from the 4 Profiles provided by DYNAMIXEL. See What profiles to guess for more details. Value Mode Description Position Control Mode Min(52) ~ Max Position Limit(48) Starting Value : 0 ~ 4095 Extended Position Control Mode -1,048,575 ~ 1,048,575 -256[rev] ~ 256[rev] Current Position Control Mode -1,048,575 -256[rev] ~ 256[rev] Current Position Control Mode -1,048,575 -256[rev] ~ 256[rev] Current Position Control Mode this is -1,048,575 -256[rev] ~ 256[rev] Current Position Control Mode -1,048,575 -256[rev] Current Position Based Control Mode -2561,048,575 ~ 1,048,575 -256[rev] ~ 256[rev] Description Constant Conversion Degrees 0.088°/Value 1[rev] : 0 ~ 4.095 NOTE : When turning off the power supply or changing the Operation Mode in Extended Position Control Mode, The Current Position is reset to the absolute position value of a single turn. NOTE: Current Position(132) represents 4 continuous byte ranges from -2,147,483,648 to 2,147,483,647 when Torque is turned off regardless of Operation Mode(11). However, the Current Position(132) will be reset to value in one full rotation in the following case: When Operation Mode(11) switches to Position Control Mode, the Current Position(132) is reset to the absolute position value in full rotation. When torque is turned on in Position Control Mode, the Current Position(132) is reset to the absolute position value in one full rotation. Activate the power supply or use the Reboot Instructions. Note that the Current Position value (132) may be affected by the Homing Offset(20). Velocity Trajectory(136) The Velocity Trajectory(136) is the desired speed trajectory created by the Profile. Operating methods can be changed based on Operation Mode(11). For more details, see What Profile is it. Speed Control Mode : When the Profile reaches the end point, the Speed Trajectory(136) becomes equal to the Destination Speed(104). Position Control Mode, Extended Position Control Mode, Current Based Position Control Mode : Speed Trajectory is used to create position trajectory(140). When the Profile reaches its endpoint, velocity trajectory(136) is cleared to '0'. Position Trajectory (140) Position Trajectory(140) is the desired position trajectory created by the Profile. Position Path(140) is only used when Operation Mode(11) is Position Control Mode, Extended Position Control Mode, or Current position control mode. For more details, see What is a Profile. The Current Input Voltage (144) of the Current Input Voltage (144) indicates the current voltage being supplied. For more details, see Max/Min Voltage Limit(32, 34). Current Temperature (146) Current Temperature (146) indicates the internal temperature of DYNAMIXEL. For more details, see Temperature Limit(31). Indirect Addresses, Indirect Addresses indirect Data, and Indirect Data are useful when accessing two remote addresses in the Control Table as sequential addresses. - Sequential address improves the efficiency of the Instruction Pack. Addresses that can be defined as Indirect Addresses are limited to the RAM area(Address 64 ~ 661). If a specific address is allocated to An Indirect Address, Indirect Address inherits the Data features and properties of a specific Address. Properties include size(byte length), value range, and Access property(Read Only, Read/Write). For example, allocating 65(LED Address) to Indirect Address 1(168), Indirect Data 1(224) could perform exactly the same as the LED(65). Description Of Indirect Address Range 64 ~ 661 EEPROM address cannot be assigned to Indirect Address indirect address and Indirect Data Sample Example 1 Allocate Size 1 byte LED(65) to Indirect Data 1(224). Indirect Address 1(168) : change the value to '65' which is the LED address. Set Indirect Data 1(224) to '1' : LED(65) also becomes '1' and LEDs are turned on. Set Indirect Data 1(224) to '0' : LED(65) also becomes '0' and LEDs are turned off. Example 2 Allocating a Size of 4 bytes of Destination Position(116) to Indirect Data 4 consecutive bytes must be allocated. Indirect Address : change the value to '116' which is the first address of the Destination Position. Indirect Address 3(172) : change the value to '117' which is the second address of the Destination Position. Indirect Address 4(174) : change the value to '118' which is the third address of the Destination Position. Indirect Address 5(176) : change the value to '119' which is the fourth address of the Destination Position. Assign 4 byte values '1,024' to Indirect Data 2 : Destination Position(116) is also the '1024' and DYNAMIXEL movements. NOTE: To allocate Data in a Control Table of more than 2[bytes] to Indirect Addresses, all addresses must be allocated to Indirect Addresses such as Example 2 above. NOTE: Indirect Addresses 29~56 and Indirect Data 29~56 can only be accessed with Protocol 2.0. How to Assemble CAUTION: DYNAMIXEL-X series cable assemblies through perforated cases Set the entangled cable before assembling the rear box. Do not assemble the case of the back with entangled wires. Entangled cables can be pinched by this case and cause communication errors. Maintenance Of Horn Selection Frame Assembly is mounted on dynamixel front wheel gears while the bearing set is mounted on the rear. Mount the Horn When mounting the horn, match the parallel markings on the horn and fit the gears. Once the alignment is done correctly, gently push the center of the horn towards the actuator. Gear Replacement You may need to replace the internal gear set when the gear is worn out or damaged. Please follow the video of dental replacement instructions. Reference NOTE Compatibility Guide Harness Compatibility What profile profile is an acceleration/deceleration control method to reduce vibration, noise and motor load by controlling dramatically changing speed and acceleration. It's also called Profile Velocity because it controls acceleration and deceleration based on speed. DYNAMIXEL provides 3 different profile types. The following describes 3 Profiles. Profiles are usually selected by a combination of Profile Speed(112) and Profile Acceleration (108). When assigned a Destination Position (116), the DYNAMIXEL profile creates the desired speed trajectory based on the current speed (initial speed of the Profile). When DYNAMIXEL receives the desired position updated from the new Destination Position (116) as it moves towards the previous Destination Position(116), the speed smoothly varies for the desired new speed trajectory. Maintaining speed continuity while updating the desired speed trajectory is called Velocity Override. For simple calculations, let's assume that the initial speed of the Profile is '0'. The following describes how the Profile processes Destination Position(116) instructions in Position Control mode, Extended Position Control Mode, Current position control mode. VPRFL Profile Condition Type(112) = 0 Profile not used(Step Instructions) (VPRFL(112) ≠ 0) & (APRF(108) = Rectangular Profile (VPRFL(112) ≠ 0) & (APRF(108) ≠ 0) Trapezoid Profile Certification Please at information about unregistered certifications. FCC note: This equipment has been tested and found to comply with limits for Class A digital devices, in accordance with section 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when equipment is operated in a commercial environment. This equipment generates, uses, and can emit radio frequency energy and, if not installed and used according to the instruction manual, can cause harmful interference to radio communication. The operation of this equipment in residential areas is likely to cause dangerous disruption in which case users will be required to repair the disruption at their own expense. WARNING Any changes or modifications not expressly approved by the manufacturer may invalidate the user's authority to operate the equipment. Quick Start Prerequisite Warning: USB2Dynamixel has been discontinued. Some software may not support the OS you are using. Be sure to read the e-Manual of the software you are using to check the supported OS for proper use of the software. NOTE: U2D2 is a small size USB communication converter that allows to control and operate DYNAMIXEL with a PC. The U2D2 Power Hub combined with the U2D2 supplies a wide range of external resources with a stable power supply to DYNAMIXEL. DYNAMIXEL Compatible Software You can use software exclusive to DYNAMIXEL. Look at the software compatibility in the next table and select the software you want for your project. Model AX Series DX Series RX SERIES EX Series MX X-Series PRO Series P Series R + Manager 2.0 X O DYNAMIXEL Wizard O X X O O X (XL320 usable) O X DYNAMIXEL Wizard 2.0 O DYNAMIXEL SDK O DYNAMIXEL Workbench O R+ Manager R+ Manager is used to handle devices used by robots. The main functions of the program are as follows. Manage controller firmware. (Update and Restore) Check the status of controllers and peripheral devices. (Test) Set the necessary mode. (Settings) NOTE: R+ Manager 2.0 or DYNAMIXEL Wizard 2.0 provides a variety of features compared to R+ Manager. R+ Manager 2.0 The R+ Manager 2.0 manages DYNAMIXEL controllers and devices consisting of robots. By connecting products, you can update your product to the latest version and test The Table of Control. The functions previously provided in RoboPlus Manager 1.0 and Wizard 1.0 have been combined in RoboPlus Manager 2.0. WARNING: R+ Manager 2.0 is not compatible with DYNAMIXEL using protocol 1.0. DYNAMIXEL Wizard 2.0 supports all DYNAMIXEL for Firmware Recovery, Firmware Update, and changing DYNAMIXEL Control Table data. DYNAMIXEL Wizard 2.0 DYNAMIXEL Wizard 2.0 is a tool optimized for managing DYNAMIXEL from various operating systems. The following features are provided with Wizard 2.0. DYNAMIXEL Dynamixel Firmware Update Dynamixel Diagnosis Dynamixel Configuration and DYNAMIXEL Data Plotting Test in Real-Time Generate & Monitor DYNAMIXEL DYNAMIXEL Package The DYNAMIXEL SDK is a software development kit that provides DYNAMIXEL control functions using package communication. The DYNAMIXEL SDK API is designed for DYNAMIXEL actuators and DYNAMIXEL-based platforms. You should be familiar with the C/C++ programming language for proper software use. This e-Manual provides comprehensive information about ROBOTIS products and applications. Supported Songang and Programming Features: C, C++, C#, Python, Java, MATLAB, LabVIEW Windows, Mac, Linux. ROS Arduino DYNAMIXEL Workbench DYNAMIXEL Workbench, based on the DYNAMIXEL SDK, is a library that provides a simpler and easier method to use DYNAMIXEL. Laguang and Supported Programming Features: C++ Linux, MacOS ROS Arduino NOTE: DYNAMIXEL Workbench may provide a lack of content or features compared to the DYNAMIXEL SDK. To use DYNAMIXEL with enough content, use the DYNAMIXEL SDK. Communication Circuits To control the DYNAMIXEL actuator, the main controller needs to convert its UART signal to a duplex half type. A diagram of the circuits recommended for this is shown below. TTL Communication RS-485 Communication RS-485 Dynamixel Power Circuit is supplied via Pin1(-), Pin2(+). (The above circuits are built into the DYNAMIXEL controller only) In the circuit diagram above, the direction of TxD and RxD data signals at the TTL Level is determined according to the 485 DIRECTION level as follows: In the case of DIRECTION485 LEVEL = High: TxD signal is output to D + and D- In case Direction485 Level = Low: Signal D + and D- is the output for RxD Image Please also checkout ROBOTIS Download Center for software applications, CAD 3D / 2D, and other useful resources! Page 2 Edit on GitHub 2XL430-W250 Specification 2XL430-W250 is a ground breaking DYNAMIXEL that makes it possible to control 2 axes (2 DOFs) with a single module. To control 2 axes simultaneously, each axle must be assigned a different ID when sharing identical Baud rates(8). Because the Control Table for each axle is separated except Baudrate, the 2XL430-W250 can be applied in a variety of applications. Its use is identical to other DYNAMIXEL's, but be aware that Firmware Recovery resets both axes to factory settings. ARM CORTEX-M3 MCU Item Specifications (72 [MHz], 32Bit) Absolute Encoder Nirsentut Position Sensor (12Bit, 360 [°])Maker : ams(www.ams.com), Part No : AS5601 Motor Cored Baud Rate 9,600 [bps] ~ 4.5 [Mbps] Control Algorithm Resolution control PID 4096 [pulse/rev] Operation Mode Control Mode Velocity Mode Mode (0 ~ 360 [°])))) Extended Position Control Mode (Multi-turn)PWM Control Mode (Voltage Control Mode) Weight 98.2 [g] Dimensions (W x H x D) 36 x 46.5 x 36 [mm] Gear Ratio 257.4 : 1 Kiosk Torque 1.0 [N.m] (at 9.0 [V], 1.0 [A])1.4 [N.m] (at 11.1 [V], 1.3 [A])1.5 [N.m] (at 12:00 p.m.0 [V], 1.4 [A]) No Load Speed 47 [rev/min] (at 9.0 [V])57 [rev/min] (at 11:1 [V])61 (at 12:0 [V]) Operating Temperature -5 ~ +72 [°C] Input Voltage 6.5 ~ 12.0 [V] (Recommended : 11.1 11.1 TTL Half Duplex Digital Packet Protocol Signal Command Serial Communication Asynchronous (8bit, 1stop, No Parity) Physical Connection ID 253 ID (0~252) Position Feedback, Speed, Load, Realtime Tick, Trajectory, Temperature, Input Voltage, material etc. Full Metal Gear Engineering Plastic Parts (Front, Center, Rear) Standby Current 49 [mA] HAZARD (May cause serious injury or death) Never place items containing water , flammable, and solvent near the product. Never place fingers, arms, toes, and other body parts near the product during surgery. Turn off the power if the product emits a strange smell or smoke. Keep the product out of reach of children. Check the power polarity before the cable. CAUTION (May cause injury or damage to the product) Do not operate the product at temperatures exceeding the range of -5 ~ +72 [°C]. Do not insert sharp bars or pins during product operation. CAUTION (May cause injury or damage to the product) Do not disassemble or modify the product. Do not drop or apply a strong shock to the product. NOTE Performance Graph : Max Torque and Stall Torque Performance Graphs differ in measurement methods. Kiosk torque is the value measured by the instantaneous torque it can reach. This is generally how rc servos are measured. The Performance Graph is also referred to as the N-T curve, which is measured by gradually increasing loads. The actual motor operating environment is closer to the performance chart, not the stall torque method. For this reason, performance charts are widely used in the industry. Generally, Max Torque of the Performance Graph is less than Kiosk Torque. CAUTION: When supplying power It is recommended to use a ROBOTIS controller or SMPS2DYNAMIXEL. Do not connect or disconnect DYNAMIXEL while power is provided. The Table of Control Tables is a data structure that is applied in the device. Users can read certain Data to gain device status with the Read Instructions Package, and modify the Data also to control the device with the WRITE Instruction Pack. The Control Table, data, address table control is a structure consisting of several Data fields to save status or to control the device. Users can check the current status of the device by reading Specific Data from the Control Table with the Read Instructions Package. The WRITE Instruction Pack allows users to control the device by changing specific Data in the Control Table. An address is a unique value when accessing specific Data in a Control Table with an Instruction Pack. To read or write data, the user must designate a specific Address in the Instruction Pack. Please refer to Protocol 2.0 for more details on the Instruction Pack. NOTE: Appendages two are applied to negative values. For more information, please refer to wikipedia's complement Two. Area (EEPROM, RAM) Control Table divided into 2 Data in the RAM Area is reset to the initial value when power is reset (Volatile). On the other hand, data in the EEPROM EEPROM Area even when the device is turned off (Non-Volatile). EEPROM Area data can only be written when the Torque Enable(64) value of the control table for each axle is all set as '0'. The size of the data size varies from 1 ~ 4 bytes depending on its use. Please check the data size when updating the data with the Instruction Pack. For data greater than 2 bytes will be stored according to Little Endian. Access Table Control has two different access properties. The property 'RW' stands for read and write access permissions while 'R' stands for read access only. Data with read-only properties cannot be changed by the WRITE Instruction. Read only the properties('R') are commonly used to measure and monitor objectives, and reading write properties ('RW') is used to control the device. Initial Value Each data in the Control Table is restored to the original value when the device is activated. The default value in the EEPROM area is the initial device value (factory default setting). If there is a value in the EEPROM area modified by the user, the modified value is restored as the starting value when the device is turned on. The Initial value in the RAM area is restored when the device is turned on. EEPROM Area Address Control Table (Byte) Access Range DefaultValue Unit 0 2 Model Number R 1,090 - - 2 4 R Model Information - - - 6 1 Firmware Version R - - - 7 1 RW ID 1, 2 0~252 – 8 1 Baud Rate RW 1 0~7 - 9 1 Delay Return RW 250 0~254 2 [μsec] 10 1 Mode Drive RW 0 0 0~5-11 1 Mode of Operation RW 3 0~1 16 - 12 1 Secondary(Shadow) RW ID 255 0 ~ 252 - 13 1 Protocol Type RW 2 1 ~ 2 - 20 4 Homing Offset RW 0 -1,044,479 ~ 1,044,479 1 [1]. Pulse] 24 4 Moving Threshold RW 10 0 ~ 1,023 0.229 [rev/min] 31 1 Temperature Limit RW 72 0 ~ 100 1 [°C] 32 2 Max Voltage Limit RW 140 60 ~ 140 0.1 [V] 34 2 Voltage Limit Min RW 60 60 ~ 140 0.1 [V] 36 2 Limit PWM RW 885 0 ~ 885 0.113 [%] 44 4 Speed Limit RW 250 0 ~ 1,023 0.229 [rev/min] 48 4 Max Position Limit RW 4,095 0 ~ 4,095 1 [pulse] 52 4 Min Position Limit RW 0 0 ~ 4095 1 [pulse] 63 1 Shutdown RW 52 - - RAM Area Address Size Control Table (Byte) Data Name Access DefaultValue Range Unit 5264 1 Torque Enable RW 0 0 ~1 - 65 1 LED RW 0 0 ~ 1 - 68 1 Status Back Level RW 2 0 ~ 2 - 69 1 Registered Instruction R 0 0 ~ 1 - 70 1 Hardware Error Status R 0 - - 76 2 Speed I Get RW 1 ,800 16,383 - 78 2 Velocity P Gain RW 100 0 ~ 16,383 - 80 2 Position D Gain RW 2,000 0 ~ 16,383 - 82 2 Position I Gain RW 0 0 ~ 16383 - 84 2 Position P Gain RW 640 0~16383 –88 2 Feedforward 2nd Gain RW 0 0~16,383 – 90 2 Feedforward 1st Gain RW 0 0~16,383 – 98 1 Bus Watchdog RW 0 1~127 20[msec] 100 2 Objectives PWM RW - -Limit PWM(36) ~ Limit PWM(36) - 104 4 Speed Destination RW - -Speed Limit(44) ~ Speed Limit(44) 0.229 [rev/min] 108 4 Profile Acceleration RW 0 0~ 32.7670 ~ 32.737 214.577 [rev/min2] 1 [ms] 112 4 Profile Velocity RW 0 0 ~ 32,767 0229 116 4 Destination Position RW - Min Position Limit (52) ~ Max Max Limit(48) 1 [pulse] 120 2 Realtime Tick R - 0 ~ 32,767 1 [msec] 122 1 Moving R 0 0 ~ 1 - 123 1 Moving Status R 0 - - 124 2 Present PWM R - - - 126 2 Present Load R - -1,000 ~ 1,000 0.1 [%] 128 4 Present Velocity R - - 0.229 [rev/min] 132 4 Present Position R - - 1 [pulse] 136 4 Velocity Trajectory R - - 0.229 [rev/min] 140 4 Position Trajectory R - - 1 [pulse] 144 2 Present Input Voltage R - - 0.1 [V] 146 1 Present Temperature R - - 1 [°C] 168 2 Indirect Address 1 RW 224 64 ~ 661 - 170 2 Indirect Address 2 RW 225 64 ~ 661 - 172 2 Indirect Address 3 RW 226 64 ~ 661 - ... ... - - 218 2 Indirect Address 26 RW 249 64 ~ 661 - 220 2 Indirect Address 27 RW 250 64 ~ 661 - 222 2 Indirect Address 28 RW 251 64 ~ 661 - 224 1 Indirect Data 1 RW 0 0 ~ 255 - 225 1 Indirect Data 2 RW 0 0 ~ 255 - 226 1 Indirect Data 3 RW 0 0 ~ 255 - ... - - 249 1 Indirect Data 26 RW 0 0 ~ 255 - 250 1 Indirect Data 27 RW 0 0 ~ 255 - 251 1 Indirect Data 28 RW 0 0 ~ 255 - 578 2 Indirect Address 29 RW 6 34 64 ~ 661 - 580 2 Indirect Address 30 RW 635 64 ~ 661 - 582 2 Indirect Address 31 RW 636 64 ~ 661 - ... ... - 628 2 Indirect Address 54 RW 659 64 ~ 661 - 630 2 Indirect Address 55 RW 660 64 ~ 661 - 632 2 Indirect Address 56 RW 661 64 ~ 661 - 634 1 Indirect Data 29 RW 0 0 ~ 255 - 635 1 Indirect Data 30 RW 0 0 ~ 255 - 255636 1 Indirect Data 31 RW 0 0 0 ~ 255 - ... - - 659 1 Indirect Data 54 RW 0 0 ~ 255 - 660 1 Indirect Data 55 RW 0 0 ~ 255 - 661 1 Indirect Data 56 RW 0 0 0 ~ 255 - BE CAREFUL : Protocol 1.0 does not support addresses greater than 256. Therefore, Indirect Addresses 29~56 and Indirect Data 29~56 can only be accessed with Protocol 2.0. Warning Description Table Control : Be sure to read the following for right use of 2XL430-W250 with Table of Controls. EEPROM Area data can only be written when the Torque Enable(64) value of the control table for each axle is all set as '0'. Each 2XL430 axle has its own control table. However, baud rate(8) and Protocol Type(13) values are synchronized at all times because there is only one communication module in the 2XL430-W250 actuator. Additionally, Torque Enable(64) must be set as 0 when modifying this address. Model Number(0) This address stores the DYNAMIXEL model number. Firmware Version(6) This address stores the dynamixel firmware version. ID(7) ID is a unique value in the network to identify each DYNAMIXEL with the Instruction Pack. A value of 0 ~ 252 (0xFC) can be used as id, and 254(0xFE) is occupied as broadcast ID. Broadcast ID (254, 0xFE) can send instruction packs to all connected DYNAMIXEL simultaneously. NOTE: Please avoid using identical IDs for some DYNAMIXEL. You may encounter communication failures or may not be able to detect DYNAMIXEL with identical IDs. NOTE: If the Instruction Package ID is set to Broadcast ID (0xFE), Status will not be returned for READ and WRITE Instructions. For more details, please refer to the Status Packages for Protocol 1.0 or Protocol 2.0 section. BE CAREFUL : Please two different 2Ds for the 2XL430. Attempting to assign an identical ID to each joint will result in a Data Limit Error(0x06) of the status package. Baud Rate(8) The Baud Rate(8) determines the speed of serial communication between the controller and DYNAMIXEL. Baud Rate Margin of Error 7 4.5M [bps] 0.000 [%] 6 4M [bps] 0.000 [%] 5 3M [bps] 0 ,000 [%] 4 2M [bps] 0.000 [%] 3 1M [bps] 0.000 [bps] 0.000 [bps] 0.000 [bps] 0.00%] 2 115,200 [bps] 0.000 [%] 1 (Default) 57,600 [bps] 0.000 [%] 0 9600 [bps] 0.000 [%] NOTE: Less than 3% of baud interest rate error margin will not affect UART communication. NOTE: For stable communication with higher Baudrate, configure the USB Latency value down. USB Latency Setting CAUTION : Only one Baud Rate can be used for 2XL430. Trying to change the Baud Rate from one joint will also affect it to the other joint. Late Return Time(9) After DYNAMIXEL receives the Instruction Package, it delays the delivery of the Status Package for The Late Return Time(9). For example, if the Return Delay Time(9) is set to '10', the Status Package will be returned after 20[μsec] when the Instruction Pack is received. Description of Unit Value Range 2[μsec] 0 ~ 254 Default value '250'(500[μsec]), Maximum 508[μsec] Drive Mode (10) Drive Mode(10) configures DYNAMIXEL Drive Mode. Bit Item Description Bit 7(0x80) - Not used, always '0' Bit 6(0x40) - Not used, always '0' Bit 5(0x20) - Not used, always '0' Bit 4(0x10) - Not used, always '0' Bit 3(0x08) - Not used, always '0' Bit 2(0x04) Profile Configuration [0] Speed-Based Profile: Create Profile by Speed[1] Time-Based Profile: Create Profile by time ※ See What is Bit Profile 1(0x02) - Not used, always '0' Bit0(0x01) Normal/Inverted Mode [0] Normal Mode: CCW(Positive), CW (Negative)[1] Reverse Mode: CCW(Negative), CW (Positive) NOTE : Time-based profiles are available from the V42 firmware. NOTE: If the Bit 0 value (Normal/Inverted Mode) of Drive Mode(10) is set to 1, the rotation direction is reversed. As such, Golput's position, the current position will have an inverted direction. This feature can be very useful when configuring symmetric joint or wheel systems. Operation Mode(11) Description Of Operation Mode Value 1 Speed Control Mode(0° ~ 360°) This mode controls speed and is ideal for wheel operation. This mode is identical to dynamixel's wheel mode. 3(Default) Position Control Mode This mode controls position and is identical to Shared Mode.The operating position range is limited by the Max Position Limit(48) and the Min(52) Position Limit. This mode is ideal for articulated robots whose each joint rotates less than 360°. 4 Extended Position Control Mode (Multi-turn) This mode controls position and is identical to the supported Multi-turn Mode.512 rotation (-256[rev] ~ 256[rev]) and is ideal for multi-turn wrists or conveyor systems or systems that require gear Additional. 16 CONTROL Mode PWM (Voltage Control Mode) This mode directly controls the output of PWM (Voltage Control Mode) NOTE: PWM is for Wide Pulse Modulation that modulates PWM Tasks to control the motor. It changes the width of the pulse to control the average supply voltage to the motor and this technique is widely used in the field of motor control. PwM Control Mode is similar to DYNAMIXEL AX Wheel Mode and RX series. Use Destination PWM(100) in PWM Control Mode to control supply voltage for DYNAMIXEL. NOTE: Current Position(132) represents 4 continuous byte ranges from -2,147,483,648 to 2,147,483,647 when Torque is turned off regardless of Operation Mode(11). However, The Current Position(132) will be reset to the absolute position value in one full rotation in the following case: When Operation Mode(11) switches to Position Control Mode, the Current Position(132) is reset to the absolute position value in full rotation. When torque is turned on in Position Control Mode, the Current Position(132) is reset to the absolute position value in one full rotation. Activate the power supply or use the Reboot Instructions. Note that the Current Position value (132) may be affected by the Homing Offset(20). The Secondary ID(Shadow) (12) assigns the secondary ID to DYNAMIXEL. Secondary IDs(12) can be shared to group between DYNAMIXELs and to synchronize their movements, unlike ID(7) which should not overlap. Be aware of the difference between Secondary ID(12) and ID(7) by reading the following. Under the same Secondary ID(12), multiple DYNAMIXELs can be grouped. ID(7) has a greater priority than the Secondary ID(12). If two items (Secondary ID(12) and ID(7)) are with each other, ID(7) must be applied first. The EEPROM area of the Control Table cannot be modified using Secondary ID(12). The RAM area can be modified using secondary ID(12). If Instruction Packet ID is the same as Secondary ID(12), Status Package will not be returned. If the value of Secondary ID(12) is 253 or higher, the Secondary ID function is disabled. Description Value 0 ~ 252 Enable the Secondary ID function 253 ~ 255 Disable the Secondary ID function, Default value '255' See the following instance of Secondary ID(12) to understand correctly. Note that the DYNAMAIXELs example in the following example uses a different ID (1 to 5). Set the Secondary ID of all DYNAMIXELs to '5'. Send Write Instruction Pack (ID(7) = 1, LED(65) = 1). DYNAMIXEL with ID '1

DYNAMIXEL-X series cable assemblies through perforated cases Set the entangled cable before assembling the rear box. Do not assemble the case of the back with entangled wires. Entangled cables can be pinched by this case and cause communication errors. Do not assemble both cables through a hollow box. Reference NOTE Compatibility Guide Harness Compatibility What profile profile is an acceleration/deceleration control method to reduce vibration, noise and motor load by controlling dramatically changing speed and acceleration. It's also called Profile Velocity because it controls acceleration and deceleration based on speed. DYNAMIXEL provides 3 different profile types. The following describes 3 Profiles. Profiles are usually selected by a combination of Profile Speed(112) and Profile Acceleration (108). When assigned a Destination Position (116), the DYNAMIXEL profile creates the desired speed trajectory based on the current speed (initial speed of the Profile). When DYNAMIXEL receives the desired position updated from the new Destination Position (116) as it moves towards the previous Destination Position(116), the speed smoothly varies for the desired new speed trajectory. Maintaining speed continuity while updating the desired speed trajectory is called Velocity Override. For simple calculations, let's assume that the initial speed of the Profile is '0'. The following describes how the Profile processes the Destination Position(116) instruction in Position Control mode, Extended Position Control Mode. VPRFL(112) Profile Condition Type = 0 Not used Profile(Step Instruction) (VPRFL(112) ≠ 0) & (APRF(108) = 0) Rectangular Profile (VPRFL(112) ≠ 0) & (APRF(108) ≠ 0) Certification Trapezoid Please check with us for information on unregistered certifications. FCC notes: This equipment has been tested and found with restrictions for Class B digital devices, in accordance with section 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful disturbances in residential installations. This equipment generates, uses, and can emit radio frequency energy and, if not installed and used according to the instructions, can cause harmful interference to radio communication. However, there is no guarantee that interference will not occur in certain installations. If this equipment causes harmful interference to radio or television reception, which can be determined by turning the equipment off and on, users are encouraged to try to fix the interference with one more of the following steps: Reorientation or relocation of the receiver antenna. Increase separation between equipment and receivers. Connect the equipment to a power outlet in a circuit different from the one connected to the receiver. Consult an experienced radio/TV dealer or technician for assistance. WARNING Any changes or modifications not expressly approved by the manufacturer may invalidate the user's authority to operate the equipment. Quick Start Prerequisite Warning: USB2Dynamixel has been discontinued. Some software may not support the OS you are using. Be sure to read the e-Manual of the software you are using to check the supported OS for proper use of the software. NOTE: U2D2 is a small size USB communication converter that allows to control and operate DYNAMIXEL with a PC. The U2D2 Power Hub combined with the U2D2 supplies a wide range of external resources with a stable power supply to DYNAMIXEL. DYNAMIXEL Compatible Software You can use software exclusive to DYNAMIXEL. Look at the software compatibility in the next table and select the software you want for your project. Model AX Series DX Series RX Series EX Series MX X-Series PRO Series P R+ Manager 2.0 X X DYNAMIXEL Wizard O X X O O X (XL320 usable) O X DYNAMIXEL Wizard 2.0 O DYNAMIXEL SDK O DYNAMIXEL Workbench O R+ Manager R+ Manager R+ Manager is used to handle devices used by robots. The main functions of the program are as follows. Manage controller firmware. (Update and Restore) Check the status of controllers and peripheral devices. (Test) Set the necessary mode. (Settings) NOTE: R+ Manager 2.0 or DYNAMIXEL Wizard 2.0 provides a variety of features compared to R+ Manager. R+ Manager 2.0 The R+ Manager 2.0 manages DYNAMIXEL controllers and devices consisting of robots. By connecting products, you can update your product to the latest version and test The Table of Control. The functions previously provided in RoboPlus Manager 1.0 and Wizard 1.0 have been combined in RoboPlus Manager 2.0. WARNING: R+ Manager 2.0 is not compatible with DYNAMIXEL using protocol 1.0. Wizard 2.0 supports all DYNAMIXEL for Firmware Recovery, Firmware Update, and changing DYNAMIXEL Control Table data. DYNAMIXEL Wizard 2.0 DYNAMIXEL Wizard 2.0 is a tools to manage DYNAMIXEL from various operating systems. The following features are provided with DYNAMIXEL Wizard 2.0. DYNAMIXEL Dynamixel Firmware Update Dynamixel Diagnosis Configuration and Dynamixel Data Plotting Test in Real-Time Generate & DYNAMIXEL Monitor DYNAMIXEL SDK Dynamixel SDK package is a software development kit that provides DYNAMIXEL control functions using package communication. The DYNAMIXEL SDK API is designed for DYNAMIXEL actuators and DYNAMIXEL-based platforms. You should be familiar with the C/C++ programming language for proper software use. This e-Manual provides comprehensive information about ROBOTIS products and applications. Supported Songang and Programming Features: C, C++, C#, Python, Java, MATLAB, LabVIEW Windows, Mac, Linux. ROS Arduino DYNAMIXEL Workbench DYNAMIXEL Workbench, based on the DYNAMIXEL SDK, is a library that provides a simpler and easier method to use DYNAMIXEL. Laguang and Supported Programming Features: C++ Linux, MacOS ROS Arduino NOTE: DYNAMIXEL Workbench may provide a lack of content or features compared to the DYNAMIXEL SDK. To use DYNAMIXEL with enough content, use the DYNAMIXEL SDK. Communication Circuits To control the DYNAMIXEL actuator, the main controller needs to convert its UART signal to a duplex half type. A diagram of the circuits recommended for this is shown below. TTL Communication Images Please also checkout the ROBOTIS Download Center for software applications, 3D/2D CAD, and other useful resources! Page 3 Edit on GitHub 2XC430-W250 Specification 2XC430-W250 is a ground breaking DYNAMIXEL that makes it possible to control 2 axes (2 DOFs) with a single module. To control 2 axes simultaneously, each axle must be assigned a different ID when sharing identical Baud rates(8). Since the Control Table for each axle is separated except Baudrate, the 2XC430-W250 can be applied in a variety of applications. Its use is identical to other DYNAMIXEL's, but be aware that Firmware Recovery resets both axes to factory settings. ARM CORTEX-M3 MCU Item Specifications (72 [MHz], 32Bit) Absolute Encoder Nirsentut Position Sensor (12Bit, 360 [°])Maker : ams(www.ams.com), Part No : AS5601 Motor Coreless Baud Rate 9600 [bps] ~ 4.5 [Mbps] Control Algorithm Resolution control PID 4096 [pulse/rev] Mode Operation Mode Control Mode Velcoity Mode Mode (0 ~ 360 [0 ~ 360°])Extended Position Control Mode (Multi-turn)PWM Control Mode (Voltage Control Mode) Weight 102 [g] Dimensions (W x H x D) 36 x 46.5 x 36 [mm] Gear Ratio 257.4 : 1 Kiosk Torque 1.3 [N.m] (at 9.0 [V], 1.1 [A])1.6 [N.m] (at 11.1 [V], 1.3 [A])1.8 [N.m] (at 12:0 [V], 1.4 [A]) No Load Speed 48 [rev/min] (rev /min] (at 9.0 [V])59 [rev/min] (at 11.1 [V])64 [rev/min] (at 12.0 [V]) Operating Temperature -5 ~ +72 [°C] Input Voltage 6.5 ~ 14.8 [V] (Recommended : 12.0 [V]) Command Signal Digital Packet Type TTL Half Duplex Asynchronous Serial Communication(8bit, 1stop, No Parity) Physical Connection TTL Multidrop Bus (5V Logic) ID 253 ID ID ~ 252) Position Feedback, Speed, Load, Realtime Ticks, Trajectory, Temperature, Input Voltage, material etc. Full Metal Gear Engineering Plastic Parts (Front, Center, Rear) Current Standby 49 [mA] HAZARD (May cause serious injury or death) Never place items containing water, flammable, and solvent near the product. Never place fingers, arms, toes, and other body parts near the product during surgery. Turn off the power if the product emits a strange smell or smoke. Keep the product out of reach of children. Check the power polarity before the cable. CAUTION (May cause injury or damage to the product) Do not operate the product at temperatures exceeding the range of -5 ~ +72 [°C]. Do not insert sharp bars or pins during product operation. CAUTION (May cause injury or damage to the product) Do not disassemble or modify the product. Do not drop or apply a strong shock to the product. NOTE Performance Graph : Max Torque and Stall Torque Performance Graphs differ in measurement methods. Kiosk torque is the value measured by the instantaneous torque it can reach. This is generally how rc servos are measured. The Performance Graph is also referred to as the N-T curve, which is measured by gradually increasing loads. The actual motor operating environment is closer to the performance chart, not the stall torque method. For this reason, performance charts are widely used in the industry. Generally, Max Torque of the Performance Graph is less than Kiosk Torque. CAUTION: When supplying power It is recommended to use a ROBOTIS controller or SMPS2DYNAMIXEL. Do not connect or disconnect DYNAMIXEL while power is provided. The Table of Control Tables is a data structure that is applied in the device. Users can read certain Data to gain device status with the Read Instructions Package, and modify the Data also to control the device with the WRITE Instruction Pack. The Control Table, data, address table control is a structure consisting of several Data fields to save status or to control the device. Users can check the current status of the device by reading Specific Data from the Control Table with the Read Instructions Package. The WRITE Instruction Pack allows users to control the device by changing specific Data in the Control Table. An address is a unique value when accessing specific Data in a Control Table with an Instruction Pack. To read or write data, the user must designate a specific Address in the Instruction Pack. Please refer to Protocol 2.0 for more details on the Instruction Pack. NOTE: Appendages two are applied to negative values. For more information, please refer to wikipedia's complement Two. The Area (EEPROM, RAM) Control Table is divided into 2 Areas. Data in the RAM Area is reset to the initial value when power is reset (Volatile). On the other hand, data in the EEPROM Area is retained even when the device is (Non-Volatile). EEPROM Area Data can only be written when the Torque Value Enable(64) control controls for each a gandar is set as '0'. The size of the data size varies from 1 ~ 4 bytes depending on its use. Please check the data size when updating the data with the Instruction Pack. For data greater than 2 bytes will be stored according to Little Endian. Access Table Control has two different access properties. The property 'RW' stands for read and write access permissions while 'R' stands for read access only. Data with read-only properties cannot be changed by the WRITE Instruction. Read only the properties('R') are commonly used to measure and monitor objectives, and reading write properties ('RW') is used to control the device. Initial Value Each data in the Control Table is restored to the original value when the device is activated. The default value in the EEPROM area is the initial device value (factory default setting). If there is a value in the EEPROM area modified by the user, the modified value is restored as the starting value when the device is turned on. The Initial value in the RAM area is restored when the device is turned on. EEPROM Area Address Control Table (Byte) Access Access DefaultValue Range Unit 0 2 Model Number R 1160 -- 2 4 Model R Information -- - - 6 1 Firmware Version R -- - 7 1 RW ID 1, 2 0~252 – 8 1 Baud Rate RW 1 0~7 - 9 1 Delay Return RW 250 0~254 2 [μsec] 10 1 Mode Drive RW 0 0 0~5-11 1 Mode of Operation RW 3 0~1 16 - 12 1 Secondary(Shadow) RW ID 255 0 ~ 252 - 13 1 Protocol Type RW 2 1 ~ 2 - 20 4 Homing Offset RW 0 -1,044,479 ~ 1,044,479 1 [1]. Pulse] 24 4 Moving Threshold RW 10 0 ~ 1,023 0.229 [rev/min] 31 1 Temperature Limit RW 80 0 ~ 100 1 [°C] 32 2 Max Voltage Limit RW 160 60 ~ 16 0.1 [V] 34 2 Voltage Limit Min RW 60 60 ~ 160 0.1 [V] 36 2 Limit PWM RW 885 0 ~ 885 0.113 [%] 4 4 Speed Limit RW 275 0 ~ 1.023 0.229 [rev/min] 48 4 Max Position Limit RW 4.095 0 ~ 4.095 1 [pulse] 52 4 Min Position Limit RW 0 0 ~ 4095 1 [pulse] 63 1 Shutdown RW 52 - - Ram Area Address Size Control Table (Byte) Data Name Access DefaultValue Range Unit Unit 64 1 Torque Enable RW 0 0 ~1 - 65 1 LED RW 0 0 ~ 1 - 68 1 Return Status Level RW 2 0 ~ 2 - 69 1 Registered Instruction R 0 0 ~ 1 - 70 1 Hardware Error Status R 0 - - 76 2 Speed I Get RW 1.1 920 0 ~16383 – 78 2 Velocity P Gain RW 100 0~16383 – 80 2 Position D Gain RW 0 0~16383 –82 2 Position I Gain RW 0 0~16383 – 84 2 P Gain Position RW 7 ~ 16383 ~ 88 2 Feedforward 2nd Gain RW 0 0 ~ 16,383 - 90 2 Feedforward 1st Gain RW 0 0 ~ 16,383 - 98 1 Bus Watchdog RW 0 1 ~ 127 20 [msec] 100 2 Goals PWM RW - -Limit PWM(36) ~ Limit PWM(36) - 104 4 Destination Speed RW - -Speed Limit(44) ~ Speed Limit(44) 0.229 [rev/min]108 4 Profile Acceleration RW 0 0 ~ 32,767 0 ~ 32,737 214,577 [rev/min2] 1 [ms] 112 4 Profile Velocity RW 0 0 ~ 32,767 0229 [rev/min] 116 4 Destination Position RW - Min Position Limit(52) ~ Max Position Limit(48) 1 [Pulse] 120 2 Tick R Realtime - 0 ~ 32767 1 [msec] 122 1 Move R 0 0 ~ 1 - 123 1 Moving R 0 - - 124 2 Present PWM R - - - 126 126 Present Load R - -1,000 ~ 1,000 0.1 [%] 128 4 Present Velocity R - - 0.229 [rev/min] 132 4 Present Position R - - 1 [pulse] 136 4 Velocity Trajectory R - - 0.229 [rev/min] 140 4 Position Trajectory R - - 1 [pulse] 144 2 Present Input Voltage R - - 0.1 [V] 146 1 Present Temperature R - - 1 [°C] 168 2 Indirect Address 1 RW 224 64 ~ 661 - 170 2 Indirect Address 2 RW 225 64 ~ 661 - 172 2 Indirect Address 3 RW 226 64 ~ 661 - ... ... - - 218 2 Indirect Address 26 RW 249 64 ~ 661 - 220 2 Indirect Address 27 RW 250 64 ~ 661 - 222 2 Indirect Address 28 RW 251 64 ~ 661 - 224 1 Indirect Data 1 RW 0 0 ~ 255 - 225 1 Indirect Data 2 RW 0 0 ~ 255 - 226 1 Indirect Data 3 RW 0 0 ~ 255 - ... ... - - 249 1 Indirect Data 26 RW 0 0 ~ 255 - 250 1 Indirect Data 27 RW 0 0 ~ 255 - 251 1 Indirect Data 28 RW 0 0 ~ 255 - 578 2 Indirect Address 29 RW 634 64 ~ 661 - 580 2 Indirect Address 30 RW 635 64 ~ 661 - 582 2 Indirect Address 31 RW 636 64 ~ 661 - - ... ... 628 2 Indirect Address 54 RW 659 64 ~ 661 - 630 2 Indirect Address 55 RW 660 64 ~ 661 - 632 2 Indirect Address 56 RW 661 64 ~ 661 - 634 1 Indirect Data 29 RW 0 0 ~ 255 - 635 1 Indirect Data 30 RW 0 0 ~ 2 55 - 636 1 Indirect Data 31 RW 0 0 ~ 255 - ... ... - - 659 1 Indirect Data54 RW 0 0 ~ 255 - 660 1 Data Indirect 55 RW 0 0 ~ 255 - 661 1 Indirect Data 56 RW 0 0 ~ 255 - CAUTION : Protocol 1.0 does not support addresses greater than 256. Therefore, Indirect Addresses 29~56 and Indirect Data 29~56 can only be accessed with Protocol 2.0. Warning Description Table Control : Be sure to read the following for right use of 2XC430-W250 with Table of Controls. EEPROM Area data can only be written when the Torque Enable(64) value of the control table for each axle is all set as '0'. Each 2XC430 axle has its own control table. However, the Baud Rate(8) and Protocol Type(13) values are synchronized at all times as there is only one communication module in the 2XC430-W250 actuator. Additionally, Torque Enable(64) must be set as 0 when modifying this address. Model Number(0) This address stores the DYNAMIXEL model number. Firmware Version(6) This address stores the dynamixel firmware version. ID(7) ID is a unique value in the network to identify each DYNAMIXEL with the Instruction Pack. A value of 0 ~ 252 (0xFC) can be used as id, and 254(0xFE) is occupied as broadcast ID. Broadcast ID (254, 0xFE) can send instruction packs to all connected DYNAMIXEL simultaneously. NOTE: Please avoid using identical IDs for some DYNAMIXEL. You may encounter communication failures or may not be able to detect DYNAMIXEL with identical IDs. NOTE: If the Instruction Pack ID is set to Broadcast ID (0xFE), the Status Package will not be returned for READ and WRITE Instructions. For more details, please refer to the Status Package section for Protocol 1.0 Protocol 2.0. CAUTION: Assign two different IDs to 2XC430-W250. Attempting to assign an identical ID to each joint will result in a Data Limit Error(0x06) of the status package. Status. The Rate(8) Baud Rate(8) determines the speed of serial communication between the controller and DYNAMIXEL. Baud Rate Margin of Error 7 4.5M [bps] 0.000 [%] 6 4M [bps] 0.000 [%] 5 3M [bps] 0 ,000 [%] 4 2M [bps] 0.000 [%] 3 1M [bps] 0.000 [bps] 0.000 [bps] 0.000 [bps] 0.00%] 2 115,200 [bps] 0.000 [%] 1 (Default) 57,600 [bps] 0.000 [%] 0 9600 [bps] 0.000 [%] NOTE: Less than 3% of baud interest rate error margin will not affect UART communication. NOTE: For stable communication with higher Baudrate, configure the USB Latency value down. USB Latency Setting CAUTION : Only one Baud Rate can be used for 2XC430-W250. Trying to change the Baud Rate from one joint will also affect it to the other joint. Late Return Time(9) After DYNAMIXEL receives the Instruction Package, it delays the delivery of the Status Package for The Late Return Time(9). For example, if the Return Delay Time(9) is set to '10', the Status Package will be returned after 20[μsec] when the Instruction Pack is received. Description of Unit Value Range 2[μsec] 0 ~ 254 Default value '250'(500[μsec]), Maximum 508[μsec] Drive Mode (10) Drive Mode(10) configures DYNAMIXEL Drive Mode. Bit Item Description Bit 7(0x80) - Not used, always '0' Bit 6(0x40) - Not used, always '0' Bit 5(0x20) - Not used, always '0' Bit 4(0x10) - Not used, always '0' Bit 3(0x08) - Not used, always '0' Bit 2(0x04) Profile Configuration [0] Speed-Based Profile: Create Profile by Speed[1] Time-Based Profile: Create Profile by time ※ See What is Bit Profile 1(0x02) - Not used, always '0' Bit0(0x01) Normal/Inverted Mode [0] Normal Mode: CCW(Positive), CW (Negative)[1] Reverse Mode: CCW(Negative), CW (Positive) NOTE : Time-based profiles are available from the V42 firmware. NOTE: If the Bit 0 value (Normal/Inverted Mode) of Drive Mode(10) is set to 1, the rotation direction is reversed. As such, Golput's position, the current position will have an inverted direction. This feature can be very useful when configuring symmetric joint or wheel systems. Operation Mode(11) Description Of Operation Mode Value 1 Speed Control Mode(0° ~ 360°) This mode controls speed and is ideal for wheel operation. This mode is identical to dynamixel's wheel mode. 3(Default) Position Control Mode This mode controls position and is identical to Shared Mode.The operating position range is limited by the Max Position Limit(48) and the Min(52) Position Limit. This mode is ideal for articulated robots whose each joint rotates less than 360°. 4 Multi-turn Mode This mode controls position and is identical to the supported Multi-turn Mode.512 rotation (-256[rev] ~ 256[rev]) and is ideal for multi-turn wrists or conveyor systems or systems that require additional reduction gear. 16 PWM Control Mode (Voltage Control Mode) This mode directly controls the output of PWM (Voltage Control Mode) NOTE: PWM stands for Pulse Width Modulation that modulates PWM Tasks to control the motor. It changes the width of the pulse to control the average supply voltage to the motor This technique is widely used in the field of motor control. PwM Control Mode is similar to DYNAMIXEL AX Wheel Mode and RX series. Use Destination PWM(100) in PWM Control Mode to control supply voltage for DYNAMIXEL. NOTE: Current Position(132) represents 4 continuous byte ranges from -2,147,483,648 to 2,147,483,647 when Torque is turned off regardless of Operation Mode(11). However, The Current Position(132) will be reset to the absolute position value in one full rotation in the following case: When Operation Mode(11) switches to Position Control Mode, the Current Position(132) is reset to the absolute position value in one full rotation. When torque is turned on in Position Control Mode, the Current Position(132) is reset to the absolute position value in one full rotation. Activate the power supply or use the Reboot Instructions. Note that the Current Position value (132) may be affected by the Homing Offset(20). The Secondary ID(Shadow) (12) assigns the secondary ID to DYNAMIXEL. Secondary IDs(12) can be shared to group between DYNAMIXELs and to synchronize their movements, unlike ID(7) which should not overlap. Be aware of the difference between Secondary ID(12) and ID(7) by reading the following. Under the same Secondary ID(12), multiple DYNAMIXELs can be grouped. ID(7) has a greater priority than the Secondary ID(12). If two items (Secondary ID(12) and ID(7)) are with each other, ID(7) must be applied first. The EEPROM area of the Control Table cannot be modified using Secondary ID(12). The RAM area can be modified using secondary ID(12). If Instruction Packet ID is the same as Secondary ID(12), Status Package will not be returned. If the value of Secondary ID(12) is 253 or higher, the Secondary ID function is disabled. Description Value 0 ~ 252 Enable the Secondary ID function 253 ~ 255 Disable the Secondary ID function, Default value '255' See the following instance of Secondary ID(12) to understand correctly. Note that the DYNAMAIXELs example in the following example uses a different ID (1 to 5). Set the Secondary ID of all DYNAMIXELs to '5'. Send Write Instruction Pack (ID(7) = 1, LED(65) = 1). DYNAMIXEL with ID '1' turns on its LED by the Instruction Package, and the Status Package will be returned. Send Write Instruction Pack (ID(7) = 5, LED(65) = 1). All DYNAMIXELs turn on their LEDs, but The Status ID Package '5' will only be returned. Set the Secondary ID of all DYNAMIXELs to '100'. Send Write Instruction Pack (ID(7) = 100, LED(65) = 0). All DYNAMIXELs turn off their LEDs. Because no DYNAMIXEL uses ID 100, but uses the same Secondary ID, the Status Package will not be returned. Protocol type(13) Users can choose dynamixel protocol type (1.0 and 2.0). Even if Protocol 1.0 is selected, Protocol Control Table 2.0 will be used. It is recommended to use identical protocol types for some DYNAMIXEL. DYNAMIXEL 1 Series 1.0 AX Compatible Value Protocol Type, DX, RX Series, EX Series, MX MX Series Firmware under v39 2(default) 2.0 MX-28/64/106 with Firmware v39 or higher, X Series, PRO Series WARNING : To change Protocol 2.0 to Protocol 1.0, use DYNAMIXEL 2.0 Guide as R+ Manager 2.0 is not compatible with Protocol 1.0 products. NOTE: Protocol 2.0 is greatly improved from protocol 1.0. Accessing some areas of the Control Table may be denied if protocol 1.0 is selected. This manual complies with protocol 2.0. Please see Protocol 1.0 and Protocol 2.0 from the e-Manual for more details on the protocol. NOTE: Please refer to the Protocol Compatibility table for the product. CAUTION: Only one Type of Protocol can be used for 2XC430-W250. Trying to change the Protocol Type from one joint will also affect to the other joint. Homing Offset(20) Home Offset(20) adjusts the position of the cage. The offest value is added to Current Position(132). Current Position(132) = Actual Position + Offset Homing(20) Description Of Unit Value Range about 0.088 [°] -1,044,479 ~ 1,044,479(-255 ~ 255[rev]) 4,096 resolution records: In the case of Position Control Mode (Shared Mode) rotating less than 36 invalid Homing Offset(20) values are ignored (valid range: -1,024 ~ 1,024). NOTE: In case the Reverse Mode Bit is set in Drive Mode(10), the Homing Offset(20) value mark will not be reversed. Moving Threshold(24) Moving Threshold(24) determines whether DYNAMIXEL is moving or not. When the absolute value of Current Speed(128) is greater than the Moving Threshold(24), Move(122) is set to '1'. Otherwise, it's cleared to '0'. Unit Description Value is about 0.229 rpm All associated speeds Data using the same unit range 0 ~ 1023 - Temperature Limit(31) Temperature Limit (31) limits dynamixel operating temperature. When the Current Temperature (146) is greater than the Temperature Limit(31), the Upper Heating Error Bit (0x04) and the Hardware Error Bit (0x80) in the Hardware Error State(70) are set. If Hot Bit Error (0x04) is configured at Shutdown(63), Enable Torque(64) is cleared to '0' and DYNAMIXEL torque will be disabled. See Shutdown(63) for more details. Description Of Unit Value Range About 1° 0 ~ 100 0 ~ 100° ATTENTION : Do not set this value higher than the default. If DYNAMIXEL experiences a temperature warning alarm (Overheating Error Bit(0x04)), leave it to cool for 20 minutes or more. Otherwise, it can cause severe damage in the operation. Min/Max Voltage Limit(32, 34) This value is the maximum and minimum operating voltage. When the current input voltage obtained from current input voltage(144) exceeds the range of Max Voltage Limit(32) and Min Voltage Limit(34), Voltage Range Error Bit(0x01) and Hardware Error Bit(0x80) in hardware error status (70) is set. If Bit Input Voltage Error (0x10) is configured at Shutdown(63), Enable Torque(64) is cleared to '0' and Torque is disabled. For more details, please refer to the Shutdown(63) section. Unit Value About 0.1V 60~140 6.0~14.0V PWM Limit(36) Limit PWM(36) indicates maximum PWM output. The destination PwM(100) cannot be configured with any value that exceeds the PWM(36) Limit. The PWM(36) limit is commonly used in all operating modes as an output limit, therefore a decrease in PWM output will result in a decrease in torque and speed. For more details, please refer to the Gain section of each mode of operation. Description Value 0(0 [%]) ~ 885(100 [%]) 885 = 100 [%] Speed Limit output(44) Speed Limit(44) indicates the maximum value of Destination Speed(104). For more details, see Goal Speed(104). Unit Value Range 0.229rpm 0 ~ 1.023 NOTE: The default value of Velocity Limit(44) has decreased since the V42 Firmware. Min/Max Position Limits(48, 52) Min and Max Position Limits(48, 52) limit the desired maximum and minimum positions for Position Control Mode (Shared Mode) in the range of 1 rotation(0 ~ 4095). Therefore, the Destination Position(116) must be configured within the position limit range. This value is not used in Extended Position Control Mode. Unit Value Range 0.088 [°] 0 ~ 4.095(1 rotation) NOTE: Max Position Limit(48) and Min Position Limit(52) are used only in Position Control Mode with one turn. DYNAMIXEL Shutdown(63) can protect itself by detecting dangerous situations that may occur during operation. Each Bit is processed inclusively with the 'OR' logic, therefore, several options can be generated. For example, when '0x05' (binary : 00000101) is defined in Shutdown(63), DYNAMIXEL can detect Input Voltage Errors (binary : 00000001) and Overheating Errors (binary : 00000100). If the error is detected, Enable Torque(64) is cleared to '0' and the motor output becomes 0 [%]. REBOOT is the only method to reset Torque Enable(64) to '1' (Torque ON) after shutdown. Check the Hardware Error Bit(0x80) in the Package Status error field or the current state via Hardware Error State (70). The following are detectable situations. Bit Item Description Bit 7 - Not Used, Always '0' Bit 6 - Not used, Always '0' Bit 5 Overload Error(default) Detects persistent load exceeding maximum output Bit 4 Electrical Shock Error(default) Detects electric shock on circuits or insufficient power to operate Bit 3 Motor Encoder Error motor corruption Detects bit 2 Overheating Error(default) Internal temperature control exceeds configurable operating temperature Bit 1 - Not used, Always '0' Bit 0 Input Voltage Fault Detection input voltage exceeds the configured operating voltage record: If Shutdown occurs, the LED will flash every second. (Firmware v41 or higher) If Shutdown occurs, reboot the device. H/W REBOOT : Turn S/W REBOOT power off and on : Send REBOOT Instructions (For more details, see reboot section of e-Manual.) Torque Enable Torque(64) determines Torque ON/OFF. Writing '1' to the Toque Enable address will enable Torque and all Data in the EEPROM area will be locked. Value Description Turn torque off 1 Turn torque on and lock the EEPROM area NOTE: Current Position(132) can be reset while Operation Mode(11) and Enable Torque(64) are updated. For more details, please refer to Homing Offset(20) and Current Position(132). The LED(65) LED(65) specifies the ON or Off LED. Bit Description 0(Default) Turn off LED 1 Turn on LED NOTE: Check dynamixel status with flashing LED count. The Boot Representation LED status flickered after the Factory Reset LED flashed 4 times the Alarm LED flashed the Boot Mode LED At Status Return Level(68) The Status Return Rate(68) decided how to return the Status Package when DYNAMIXEL received the Instruction Package. Description Of Instructional Instruction Value 0 PING Instruction Returns PING Instuksi only 1 INSTRUCTIONREAD PING Instruction Return PING and Read Instuksi only 2 All Instructions Return all Instruction NOTES: If the Instruction Package ID is set to Broadcast ID (0xFE), the Status Package will not be returned for READ and WRITE Instructions regardless of status return rate. For more details, please refer to the Status Packages for Protocol 1.0 or Protocol 2.0 section. 1 Package ID is a field that indicates the ID of the device that must receive the Instruction Pack and process it. Instruction Registered(69) Description Value 0 REG_WRITE instruction not received 1 REG_WRITE received NOTE: If the ACTION instruction is executed, the value will be changed to 0. Hardware Error Status(70) Hardware Error Status(70) indicates the hardware error status. DYNAMIXEL can protect itself by detecting dangerous situations that can occur during operation. Each Bit is processed inclusively with the 'OR' logic, therefore, several options can be generated. For example, when '0x05' (binary : 00000101) is defined in Shutdown(63), DYNAMIXEL can detect Input Voltage Errors (binary : 00000001) and Overheating Errors (binary : 00000100). If the error is detected, Enable Torque(64) is cleared to '0' and the motor output becomes 0 [%]. REBOOT is the only method to reset Torque Enable(64) to '1' (Torque ON) after shutdown. Check the Hardware Error Bit(0x80) in the Package Status error field or the current state via Hardware Error State (70). The following are detectable situations. Bit Item Description Bit 7 - Not Used, Always '0' Bit 6 - Not used, Always '0' Bit 5 Overload Error(default) Detects persistent load exceeding maximum output Bit 4 Electrical Shock Error(default) Detects electric shock on circuits or insufficient power to operate Bit 3 Motor Encoder Error motor motor corruption Detects bit 2 OverHeating Error(default) Internal temperature control exceeds configurable operating temperature Bit 1 - Not used , Always '0' Bit 0 Input Voltage Fault Detection input voltage exceeds the operating voltage record If Shutdown occurs, the LED flashes every second. (Firmware v41 or higher) If Shutdown occurs, reboot the device. H/W REBOOT : Turn and turn on power again S/W REBOOT : Send REBOOT Instructions (For more details, see the Reboot section of the e-Manual.) Speed PI Gain(76, 78) Speed PI Gain(76, 78) indicates gain of Speed Control Mode. The advantages of the INTERNAL CONTROLLER DYNAMIXEL can be calculated from the Gain of the Control Table as shown below. Constants in each equation include sampling time. The Velocity P Gain of the INTERNAL DYNAMIXEL controller is abbreviated KVP and the control table is abbreviated KVP (TBL). Gain Conversion Equations Controller Speed Description Range I Gain(76) KVI KVI =KVI(TBL) / 65536 0 ~ 16383 I Get Speed P Gain(65.65 536 0~16,383 I Gain Velocity P Gain(65,536 0~16,383 I Gain Velocity P Gain(65.5 36 0~16,383 I Gain Velocity P Gain(65,536 0~16,383 I Gain Velocity P Gain(65,536 0~178)KVP KVP=KVP(TBL)/128 0~16.383 P Gain Below the number is a block chart explaining the speed controller in Speed Control Mode. When the instructions transmitted from the user are received by DYNAMIXEL, the following steps are required to drive the horn. NOTE: Ka stands for Anti-windup Gain and β is a coefficient of position conversion and speed that cannot be modified by the user. For more details on PID controllers, please refer to the PID Controller at wikipedia. Position PID Gain(80, 82, 84), Feedforward 1/2nd Gain(88, 90) This gain is used in Position Control Mode and Extended Position Control Mode. The advantages of the INTERNAL CONTROLLER DYNAMIXEL can be calculated from the Gain of the Control Table as shown below. The constants in each equation include sampling time. Position P acquisition from DYNAMIXEL internal controller is abbreviated as KPP and control table abbreviated as KPP (TBL). Gain Controller Conversion Equation Position Description Range D Gain(80) KPD KPD = KPD(TBL) / 16 0 ~ 16,383 D Gain Position I Gain (82) KPI KPI = KPI(TBL) / 65,536 0 ~ 16,383 I Position Acquisition P (84) KPP KPP = KPP (TBL) / 128 0 ~ 16383 P Gain Feedforward 2nd Gain(88) KFF2nd KFF2nd(TBL) / 4 0 ~ 16,383 Feedforward Acceleration Gain Feedforward 1st Gain(90) KFF1st KFF1st(TBL) / 4 0 ~ 16,383 Feedforward Velocity Gain Below the number is a block diagram that describes the position controller in Position Control Mode and Extended Position Control Mode. When instructions from the user are received by DYNAMIXEL, the following steps are required to drive the horn. NOTE: In the case of PWM Control Mode, the PID controller and Feedforward controller are disabled while the Goal PWM(100) value directly controls the motor via inverter. In this way, the user can directly control the voltage supply to the motor. Ka is an Anti-windup Reinforcement that cannot be modified by the user. For more details on PID controllers and Feedforward controllers, please refer to the PID Controller and Bait. Bus Watchdog(98) Bus Supervisor (98) is a Fail-safe device to terminate DYNAMIXEL if communication between the controller and DYNAMIXEL communication (RS485, TTL) is interrupted due to an un specified error. Communication is defined as all Instruction Packs in the DYNAMIXEL Protocol. Value Value Unit 20[ms] - Range 0 Disable Bus Supervisory Function, Clear Bus Supervisor Error Range 1 ~127 Enable Bus Supervisor Range -1 Bus Supervisor Error Status Bus Watchdog function monitors communication interval (time) between controller and DYNAMIXEL when Torque Enable(64) is '1'. If the metered communication interval (time) is greater than Bus Watchdog(98), DYNAMIXEL stops. Bus Watchdog (98) will be changed to '-1' (Bus Supervisor Error). If the Bus Supervisor Error screen appears, the Goal PWM (100), Goal Speed(104), Destination Position(116)) screen will be converted into read-only access. Therefore, when the new value is written to the Destination Value, the Range Error will be returned through the Status package. If the Value of Bus Watchdog(98) is changed to '0', the Bus Supervision Error will be cleared. NOTE: For details of Range Error, please see Protocol 2.0 NOTE: Bus Watchdog (98) is available from the v38 firmware. Bus Watchdog (98) The following example is an example of the operation of the Bus Watchdog function. After setting operation mode(11) to speed control mode, change Torque Enable(64) to '1'. If '50' is written in Goal Velocity(104), DYNAMIXEL will rotate towards CCW. Change the value of Bus Watchdog(98) to '100' (2,000 [ms]). (Enable Bus Surveillance Function) If no instruction pack is received for 2,000 [ms], DYNAMIXEL will stop. When stopped, Profile Acceleration (108) and Profile Speed(112) are applied as '0'. The value of Bus Watchdog(98) changes to '-1' (Bus Supervisor Error). At this time, access to the Destination Value will be converted to read-only. If '150' is written to Target Speed(104), the Error Range will be returned via the Status Package. If the Value of Bus Watchdog(98) is changed to '0', the Bus Supervision Error will be cleared. If 150 is written in Destination Speed(104), DYNAMIXEL will rotate towards CCW. The purpose of PWM(100) When Operation Mode(11) is PWM Control Mode, both PID and Feedforward controllers will be disabled because the Goal PWM(100) value directly controls the motor via inverter. However, in other Operating Modes(11), destination PWM(100) only limits the PWM value. Read PID Position Gain(80, 82, 84), Feedforward 1st/2nd Gains(88, 90) or Velocity PI Gain(76, 78) for how Goal PWM (100) works with profit. NOTE: The purpose of PWM(100) must not exceed the PWM(36) Limit. Target Speed(104) Use Destination Speed(104) to set the desired speed when Operation Mode(11) is Speed Control Mode. Know that Goal Speed (104) does not limit the speed of movement. Unit Value Range 0.229 rpm -Speed Limit(44) ~ Speed Limit(44) NOTE: This value must not exceed the Speed Limit(44). NOTE: DYNAMIXEL's maximum speed and maximum torque are affected by the voltage supply. Therefore, if supplying voltage changes, so does the maximum speed. This manual complies with the recommended supply voltage (12[V]). NOTE: If the Profile (108) and Target Speed(104) modified simultaneously, modified modified Acceleration(108) will be used to process the Target Speed(104). Profile Acceleration(108) When Drive Mode(10) is a Speed-based Profile, Profile Acceleration(108) specifies Profile acceleration. When Drive Mode(10) is a Time-Based Profile, Profile Acceleration(108) sets the Profile acceleration time. Be aware that Profile Acceleration(108) will be applied in all control modes except Current Control Mode or PWM Control Mode in Operation Mode(11). For more detailed information, see What is The Profile Value Description Unit Speed Based Profile 214577 [rev/min2] Setting the Profile Range acceleration 0 ~ 32767 '0' stands for acceleration Unit Description Value Of Unlimited Time-Based Profiles 1 [msec] Set the Profile Range acceleration time 0 ~ 32737 '0' stands for unlimited acceleration time ('msec]msec'). Profile Acceleration (108) will not exceed 50% of the Profile Speed value (112). NOTE: Time-based profiles are available from firmware version 42. Profile Speed(112) When Drive Mode(10) is