ROBO BUILDER

Intelligent Modular Robot

wCK series

User's Manual Ver 1.07

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1 INTRODUCTION

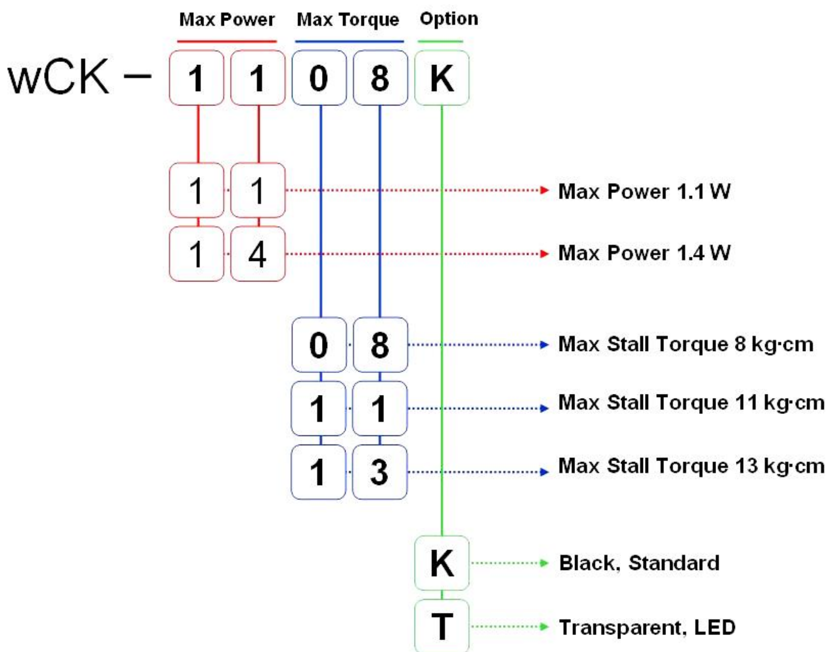
1-1 Introduction

RoboBuilder's wCK module is an intelligent robotic module with which users can build creative robots of various shapes and easily operate and control robots. It is the first block type robotic module in the world that has a joint insertion assembly structure. This quick and simple joint assembly scheme enables users to simply plug a plastic joint part into wCK modules to mechanically link two different wCK modules, which dramatically helps reduce building time. Internally a control board and a servo actuator mechanism are integrated together within the small plastic enclosure. The wCK module itself can operate as a small independent robot system because it is equipped with external I/O ports and can run a self-running motion program. The wCK module adopt a PID motion control technology and realized motion control characteristics as precise and accurate as industrial servo motors. Users can design and build robotic systems with multi-axis articulated mechanism much more easily and efficiently by adopting wCK robotic modules. This is because the wCK module is designed for users to easily extend functionality and to fast track troubleshooting and maintenance.

[Figure 1-1a] Picture of wCK module(packaged)

[Figure 1-1b] Picture of wCK module

1-2 Model Listing



[Figure 1-2a] Model Name Scheme

• The series name "wCK" comes from the sound "Wingchick" that the actuator module makes when in motion.

Model Listing	0 8 Torque 8kg·cm	1 1 Torque 11kg·cm	1 3 Torque 13kg·cm	
1 1 Power 1.1 W	wCK-1108K	wCK-1111K	wCK-1113K	K Black
	wCK-1108T	wCK-1111T	wCK-1113T	T Trans parent
1 4 Power 1.4 W	wCK-1408K	wCK-1411K	wCK-1413K	K Black
	wCK-1408T	wCK-1411T	wCK-1413T	T Trans Parent

(Available Model Listings may change without notice)

[Figure 1-2b] Model Listings

1-3 Main Specifications

• Communication	Multi drop Full Duplex UART serial communication
• Baud Rate	4,800bps ~ 921,600bps(8 levels)
• Extension	Max 254 modules per channel(ID 0~253)
• Operating Voltage	6VDC ~ 10VDC(7.4VDC~8.4VDC recommended)
• Speed	Max No Load Speed 0.15 sec/60˚(wCK-1108 under recommended voltage)
• Stall Torque	Max 13kg·cm(wCK-1413 under recommended voltage)
• Max Power	1.1W(wCK-1108, 1111), 1.4W(wCK-1413)
• Gear Ratio	1/173(wCK-1108), 1/241(wCK-1111, 1413)
• Control Mode	Position Control, Speed Control, Torque Control
• Control Angle	0~254(Standard Resolution), 0~1,022(High Resolution)
• Operating Angle	0˚~269˚(Standard Resolution), 0˚~333˚(High Resolution)
• Resolution	8 bit/1.055˚(Standard Rosolution), 10 bit/0.325˚(High Resolution)
• Error Range	±0.8˚(Standard Resolution)
• Speed Level	30 levels(Position Control Mode), 16 levels(Wheel Mode)
• Case Material	Engineering Plastic
• Gear Material	POM(wCK-1108), POM+Metal(wCK-1111,1413)
• Size	51.6 mm×27.1 mm×36.4 mm
• Weight	45g(wCK-1108), 49g(wCK-1111,1413)

1-4 Main Features

• All-in-One Integrated Robot Module

All components such as the controller, the sensor, the actuator, and the I/O port are integrated in a small plastic enclosure.

• Compact Design

Compact and elegant exterior design with smooth curved lines enhances its functionality as well as helps efficient mechanical system designing.

• 2 Way Mechanical Power Transmission

2 way mechanical power transmission structure enables users to build various structures of mechanical systems.

• Quick & Simple Joint Assembly

Quick and simple joint assembly scheme enables users to simply plug a plastic joint into wCK modules to connect wCK modules, which helps to generate creative robots and dramatically reduce building time.

• Presice PID Control

Position control error of ±0.8˚ realized through precise PID control(in Standard Resolution)
High resolution Mode 10 bit 1,024 steps(unit control angle 0.325˚),
Standard Resolution Mode 8 bit 256steps(unit control angle 1.055˚)

• Error Compensation Algorithm

Special algorithm for position error compensation realized ±0.8˚ level of error with low resolution potentiometer feedback.

• Position Control, Speed Control, Torque Control

Three different control modes help users apply wCK module to systems with various control requirements.

• Various Operation Mode

Position control mode, Synchronized position control mode, Wheel mode, Passive mode, Break mode, Self-running mode, etc

• Various Parameters

Various parameters configurable such as wCK ID, Baud rate, Position control resolution, PID gains, Movement speed, Acceleration range, Motion Boundary, Max operation current, etc

• Multi Drop Full Duplex UART serial communication

The Full Duplex UART two-way serial communication enables to connect to wCK directly without using separate communication device from external controller.

• Control Optimized Protocol

Minimized communication time delay by adopting optimized protocol structure and real-time response method for all commands.

• External I/O Port

1channel A/D input(0V~5V), 2channels Digital Output(TTLlevel)

• Self-running Motion

wCK can run a motion and sensor interaction by itself without being controlled by external controller

• Various Speed Levels

30 levels in position control mode, 16 levels in 360˚ wheel mode

• Voltage-adaptive Automatic Adjustment of Control Angle

wCK module can implement automatic compensation for control output according to real-time input voltage

• Windows based Programming Software

Windows-based software such as wCK programmer, Motion Builder, Action Builder

• Wide range of Input Voltage

Wide range of input voltage (6VDC~10VDC)

• Wide range of Control Angle

0˚~269˚ in standard resolution, 0˚~333˚ in high resolution

• Power-saving Break Mode

Break mode stops the motion of a wCK module and thus help hold still system's mechanical structure without consuming electric power by using dynamic break effect.

• Passive Sensor Mode

In passive mode, wCK releases torque and acts as a sensor

• Reverse-voltage Protection, Over-current Protection

Protection circuits built-in for reverse-voltage and over-current

• Initialization of ID and Baud Rate

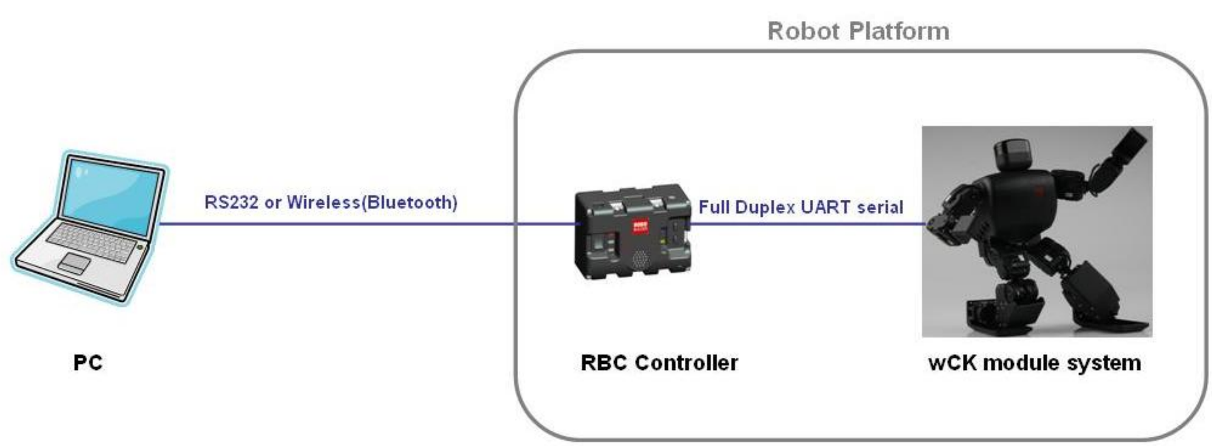
wCK ID and baud rate can be initialized for debugging or troubleshooting purpose

• Two Metal Bearings for Mechanical Durability

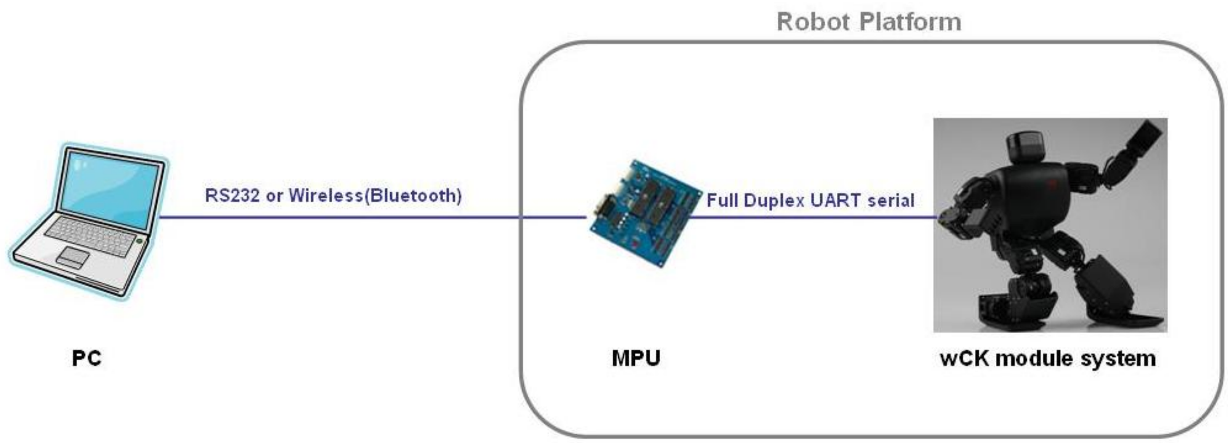
Mechanical durability is ensured with two metal bearings applied on the rotation axis

1-5 Control Scheme

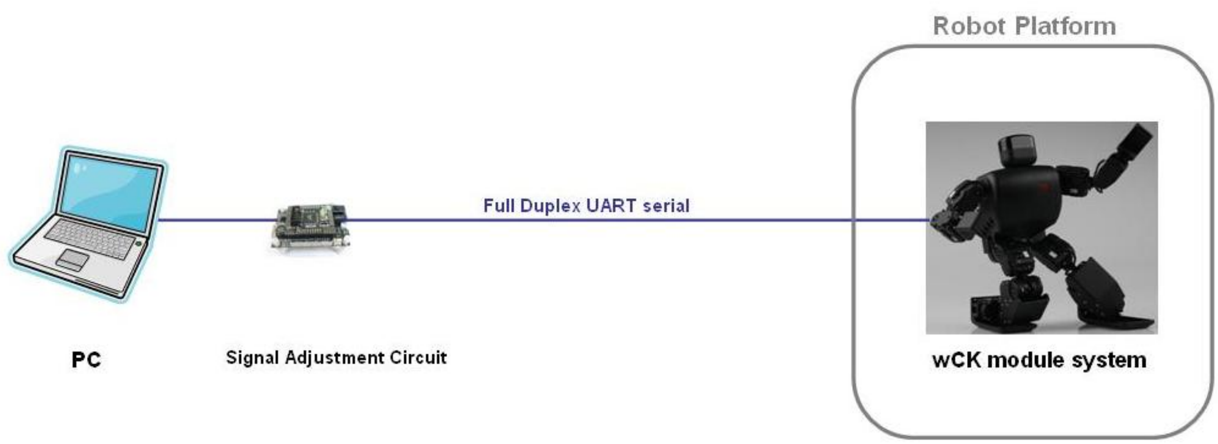
wCK module can be controlled by RoboBuilder's RBC controller, general puupose MCUs, as well as directly by a PC. The RBC controller can be used to connect the PC to the wCK modules as the RBC controller has circuitry to convert the RS232 signals to voltage levels used on the wCK's communication network. A separate voltage translation circuit may be required when using a MCU or a PC to control a wCK module. RoboBuilder provides this separately as a voltage translator circuit board (refer to Appendix A-2 for detail).



[Figure 1-5a] Using RBC controller



[Figure 1-5b] Using general-purpose MCU



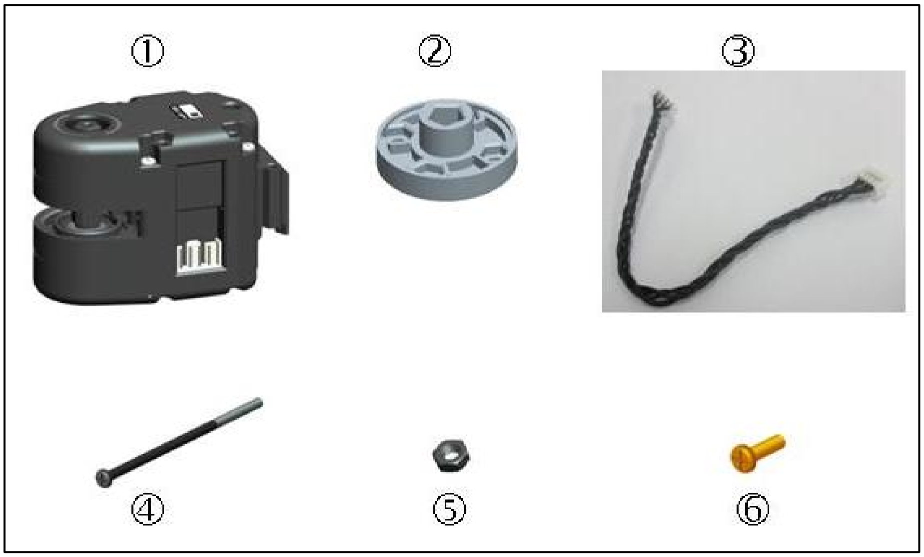
[Figure 1-5c] Direct PC Control without external controller

1-6 Application

The wCK module can be applied to various types of articulated robot platforms for purposes such as R&D, toys and entertainment, game and amusement, commercial, and educational purposes. It can also be used for systems that require multi-axis movement such as medical devices, tool sets for science and education etc. The self-running motion of the wCK module helps to build a simple and compact stand alone system too.

[Figure 1-6a] Application(Various Articulated Robots)

1-7 Part List



[Figure 1-7a] Part List

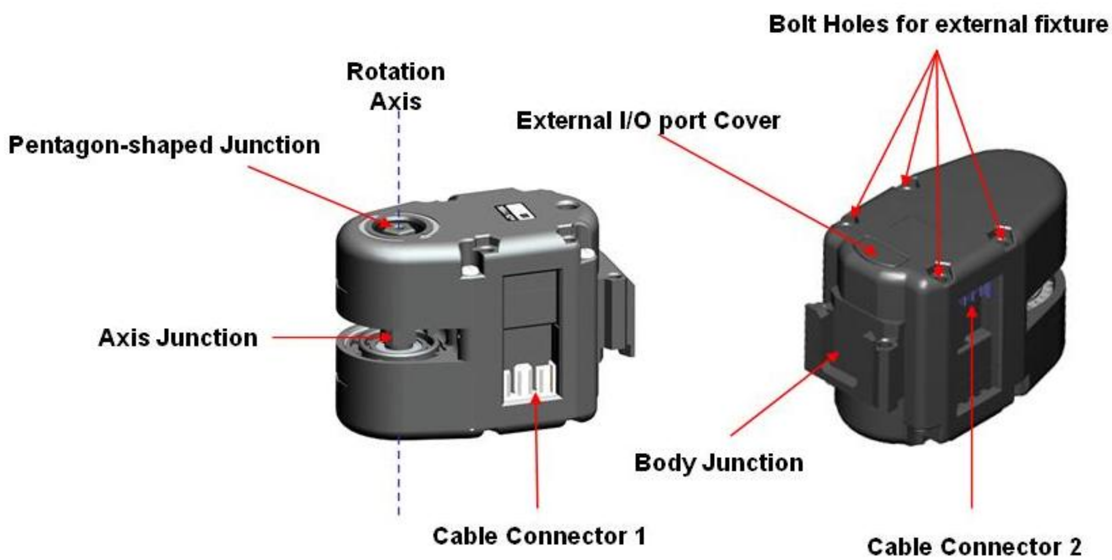
Part List

No	Qty		Part Name	Use
①	1 EA	×	wCK module	Intelligent wCK robot module
②	1 EA	×	Round Joint	Transmit force of wCK module to external object
③	1 EA	×	wCK Cable (4wire twisted)	Wiring cable for wCK module
④	4 EA	×	Bolt 1 (M2×40mm)	Fix wCK module onto external object
⑤	4 EA	×	Nut (M2)	Fix wCK module onto external object
⑥	1 EA	×	Bolt 2 (M2×8mm)	Fix round joint to the axis of wCK module

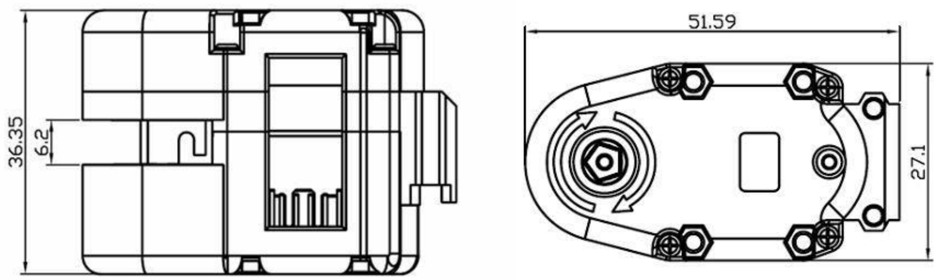
1-8 Mechanical Specifications

• Size	51.6 mm×27.1 mm×36.4 mm
• Weight	45g(wCK-1108), 49g(wCK-1111,1413)
• Stall Torque	Max 13kg·cm(wCK-1413 under recommended input voltage)
• Mechanical Connection Method	Quick & Simple Joint Insert Assembly
• Mechanical Connection Point	3 Junction Points(pentagon-shaped Junction, Axis Junction, Body Junction)
• Joint	Various Robot Structure can be created using 12 types connection Joints
• Gear Ratio	1/173(wCK-1108), 1/241(wCK-1111, 1413)
• Gear Material	POM(wCK-1108), POM+Metal(wCK-1111,1413)
• Case Material	Engineering Plastic
• Case Color	Black(wCK-1108K, 1111K, 1413K), Transparent(wCK-1108T)

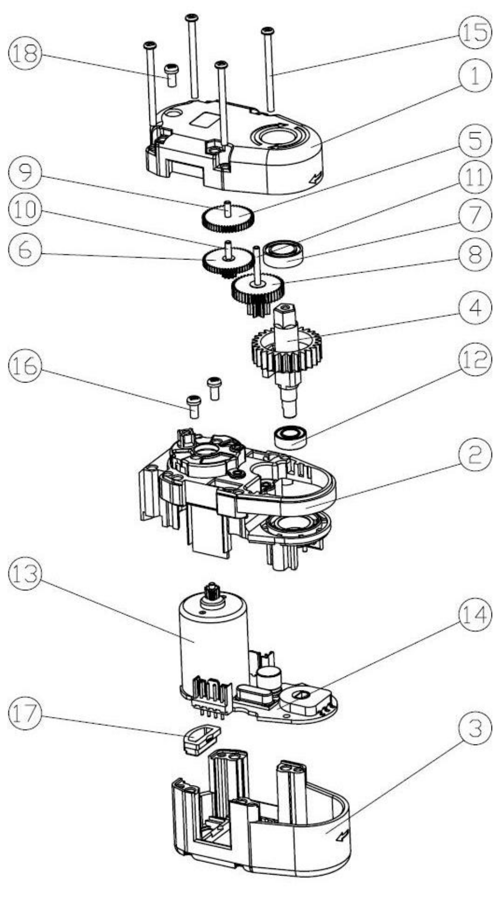
►cf. Max Stall Torque = Stall Torque of built-in DC motor × Gear Ratio × 80%



[Figure 1-8a] Names of External Parts



[Figure 1-8b] Dimension



1 Cover Top
2 Housing
3 Cover Bottom
4 Gear4
5 Gear1
6 Gear2
7 Bearing1
8 Gear3
9 Gear1 Shaft
10 Gear2 Shaft
11 Gear3 Shaft
12 Bearing2
13 DC Motor
14 PCB Ass'y
15 Screw1
16 Screw2
17 Ext I/O Cover
18 Screw3

[Figure1-8c] Blow Up Picture

1-9 Electrical & Control Specifications

• Communication	Multi drop Full Duplex UART serial communication
• Baud Rate	4,800bps ~ 921,600bps(8 levels)
• Extension	Max 254 modules per channel(ID 0~253)
• DC motor type	Precious metal brush DC motor
• Operation Voltage	6VDC ~ 10VDC(7.4VDC~8.4VDC recommended)
• Max Current	400mA ~ 1,800mA (Over-current Protection)
• Reverse-voltage Protection	0 ~ -28V
• Max Power	1.4W(wCK-1413), 1.1W(wCK-1108, 1111)
• Speed Level	30 levels(Position Control Mode), 16 levels(Wheel Mode)
• Speed	Max No Load Speed0.19sec/60˚(wCK-1413), 0.21sec/60˚(wCK-1111), 0.15sec/60˚(wCK-1108)
• Acceleration Range	range from 20 to 100
• Max Stall Torque	13kg·cm(wCK-1413), 11kg·cm(wCK-1111), 8kg·cm(wCK-1108) under recommended input voltage
• Control Mode	Position Control, Speed Control, Torque Control
• Control Angle	0~254(Standard Resolution), 0~1,022(High Resolution)
• Operation Angle	0˚~269˚(Standard Resolution), 0˚~333˚(High Resolution)
• Resolution	8 bit/1.055˚(Standard Resolution), 10 bit/0.325˚(High Resolution)
• Unit Control Angle	269˚/255=1.055˚ (Standard Resolution), 333˚/1023=0.325˚ (High Resolution)
• Control Error	±0.8˚(8 bit Standard Resolution)
• P gain	1~120 recommended
• D gain	0~254 recommended
• I gain	0~10 recommended

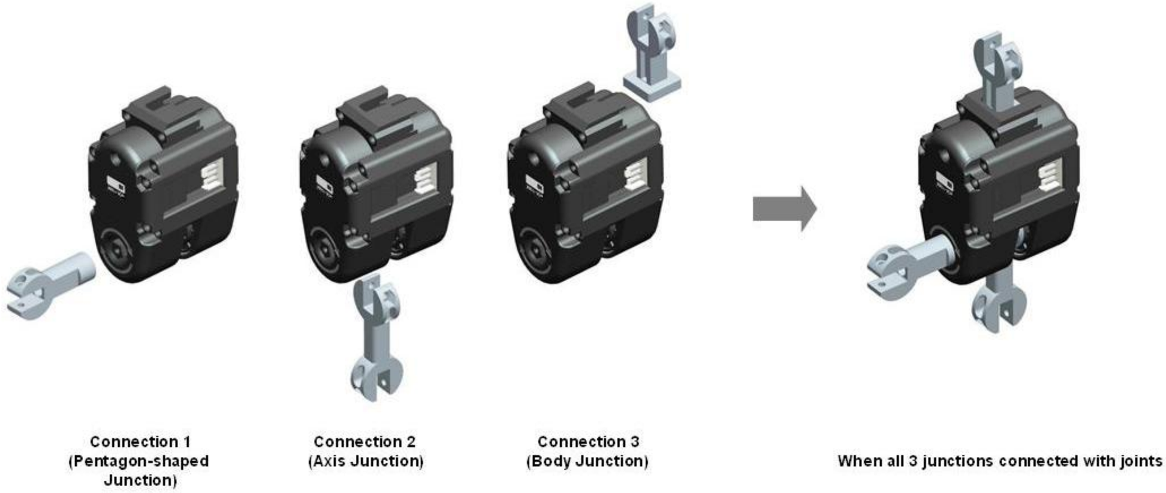
►cf. Max Power = Max Power of built-in DC motor × Gear Ratio × 66%(the average efficiency of 4-step mechanical gear)

►cf. Max No Load Speed = Max No Load Speed of built-in DC motor × 1 / Gear Ratio

2 USING wCK MODULE

2-1 Mechanical Connection

The wCK modules can be easily connected and extended by plugging various joint parts into the junction points of wCK module. This Quick & Simple assembly scheme enables users to design and build robot systems with various and complex articulated structures quickly and efficiently.



[Figure 2-1a] Joint Connection Scheme

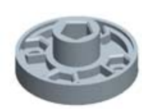
A variety of mechanical structures are available using the joints shown below in [Figure 2-1b]. When connecting a joint with the wCK module the junction is held tight even without screwing bolts, which is very effective and helpful for users to invent creative structures in designing a new robotic system.

				
JOINT 1	JOINT 2	JOINT 3	JOINT 4	JOINT 5
				
JOINT 6	JOINT 7	JOINT 8	JOINT 9	JOINT 10
				
JOINT 11	JOINT 12			

(Joint sold separately as option)

[Figure 2-1b] Joint Type

Joints are grouped as below according to different points of connecting junction.

Junction Point	JOINT
Pentagon-shaped Junction + Axis Junction	 JOINT 2
Pentagon-shaped Junction + Body Junction	 JOINT 3
Axis Junction + Body Junction	 JOINT 1  JOINT 6
Body Junction + Body Junction	 JOINT 4  JOINT 8
Axis Junction + Axis Junction	 JOINT 10
Others	 JOINT 5  JOINT 7  JOINT 9  JOINT 11  JOINT 12

[Figure 2-1c] Joint Type for Different Connection

[Figure 2-1d] Joint Type for Connection Styles

<table>
<tr><td rowspan="2">
JOINT 1</td><td></td></tr>
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JOINT 2</td><td></td></tr>
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JOINT 3</td><td></td></tr>
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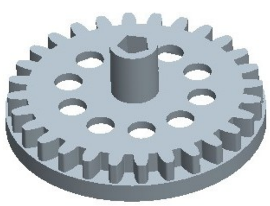
 JOINT 4	
	
 JOINT 5	
 JOINT 6	
	

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JOINT 7</td><td></td></tr>
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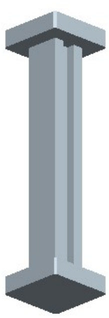
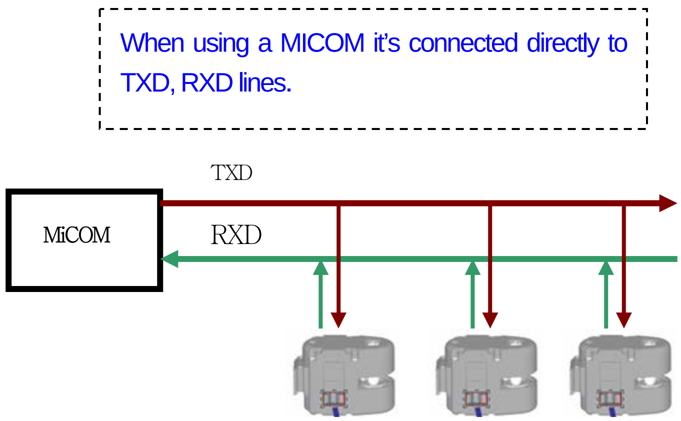
<tr><td rowspan="2">
JOINT 8</td><td></td></tr>
<tr><td></td></tr>
<tr><td>
JOINT 9</td><td></td></tr>
</table>

 JOINT 10	
	
 JOINT 11	 
 JOINT 12	 

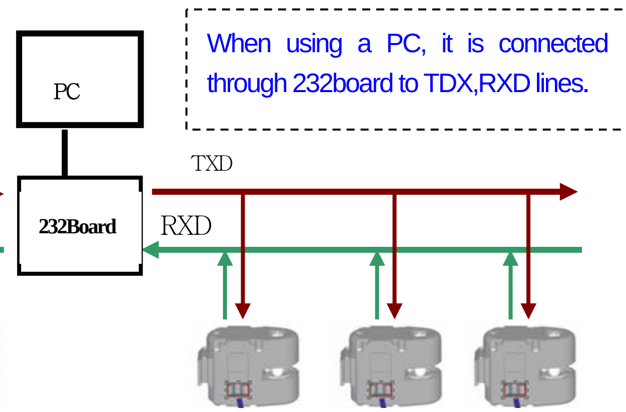
2-2 Electrical Connection

Wiring

Depending on the controller type, the electrical wiring structure is different as shown in below [Figure 2-1a] and [Figure 2-2b].



[Figure 2-2a] Using a MICOM



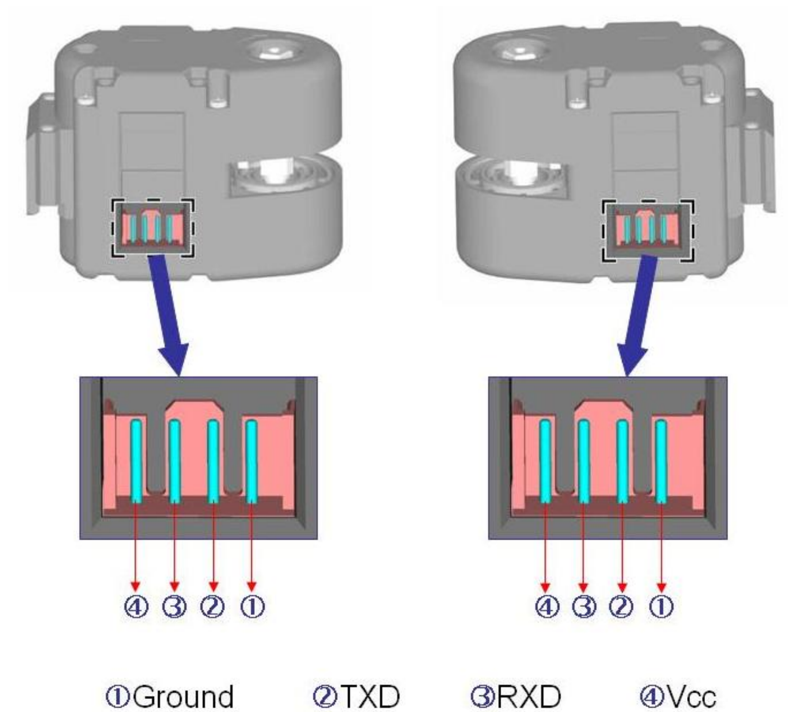
[Figure 2-2b] Using a PC

[Figure 2-2c] wCK module cable

[Figure 2-2d] PC Connection Cable

Connectors

The wCK module has two built-in connectors on both sides of the body. The two connectors are electrically connected in parallel so the module is ready to communicate if either one of the two connectors are plugged. The other one is used to extend to another wCK module. The connectors at both ends of a wCK module cable are polarized, which eliminates the risk of making a wiring mistake.

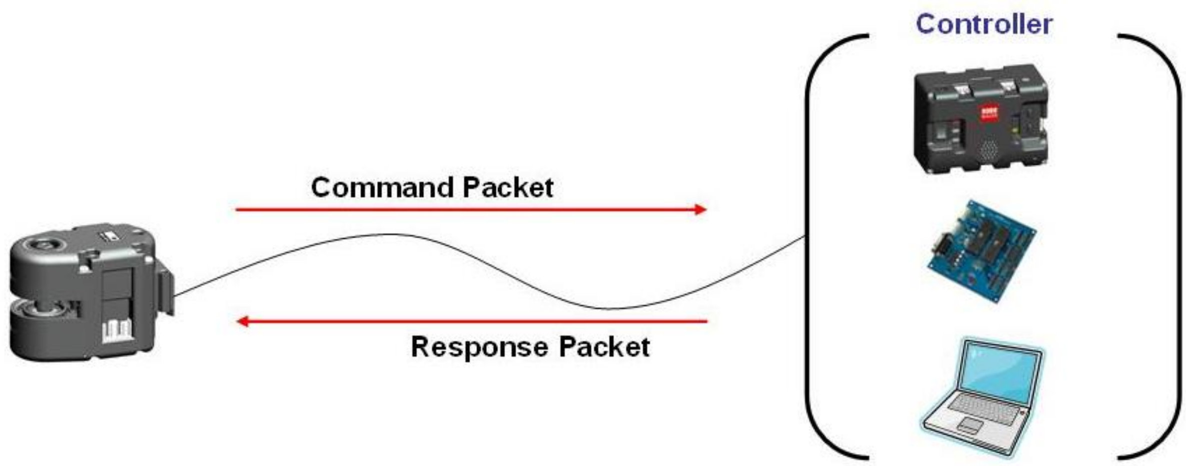


[Figure 2-2e] wCK module Cable Connector & Pin Arrangement

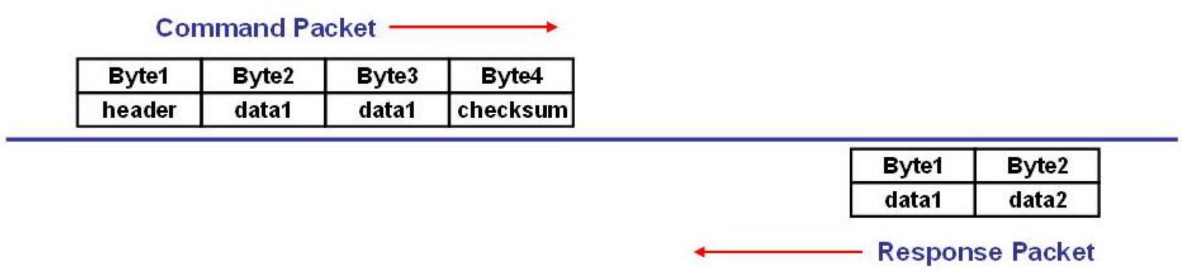
2-3 Communication

Protocol

The wCK module adopted a dedicated communication protocol named "Multi drop Full Duplex UART two-way serial communication protocol". Basically the communication is carried out in a repeated cycle of that Controller sends a Command Packet to the wCK module and then the wCK module sends back a Response Packet in return.



[Figure 2-3a] Communication



[Figure 2-3b] Protocol Structure

Summary of Protocol Commands

Below is the summary of protocol commands required to control a wCK module.

For detailed explanation of protocol commands, please refer to appendix [A-1Communication Protocol].

8 bit Command	(1) Position Move	Move Position Command
	(2) Synchronized Position Move	Synchronized Move Position Command(used to control multiple wCK modules)
	(3) Status Read	Read Torque and Position
	(4) Passive wCK	Passive Mode(Sensor Mode) Command
	(5) Wheel wCK	360˚ Wheel Mode Command
	(6) Break wCK	Break Mode(Power-saving) Command
Set Command	(7) Baud rate Set	Baud rate Setting Command
	(8) P,D gain Set	P gain, D gain Setting Command
	(9) P,D gain Read	Read P gain and D gain
	(10) I gain Set	I gain Setting Command
	(11) I gain Read	Read I gain
	(12) Runtime P,D gain Set	Runtime P gain, D gain Setting Command
	(13) Runtime I gain Set	Runtime I gain Setting Command
	(14) ID Set	wCK ID Setting Command
	(15) Speed Set	Speed/Acceleration range Setting Command
	(16) Speed Read	Read Speed/Acceleration range
	(17) Runtime Speed Set	Runtime Speed/Acceleration range Setting Command
	(18) Over Load Set	Over Load Setting Command
	(19) Over Load Read	Read Over Load
	(20) Boundary Set	Movement Boundary Setting Command
	(21) Boundary Read	Read Movement Boundary Setting Command
Extended Command	(22) I/O Write	Write to External I/O port
	(23) I/O Read	Read External I/O port
	(24) Motion Data Write	Write Self-running motion program
	(25) Motion Data Read	Read Self-running motion program
10 bit Command	(26) Position Move	10 bit Move Position Command
	(27) Position Read	10 bit Read Position Command

Reset Time after Power Supply

wCK module turns into "Stand By" status after 65msec during which no command is recognized.

Power Supply → Reset Delay: 65msec → Stand-by(passive mode)

Communication Time Delay

Command transmission through RS-232 inevitably generates a time delay if multiple wCK modules are connected together. So each wCK module receives commands at different time. Usually this time delay is negligible but for a system that requires precise control characteristics please refer to below table and use it to design the system accordingly.

Baud Rate [bps]	1 Byte Transmission Time [μs]	1 Command(4 byte) Transmission Time [μs]	1 Command Delay Time at 30 rpm [°]
4,800	2.083	8.333	1.5
9,600	1.042	4.167	0.75
38,400	0.260	1.042	0.1875
57,600	0.174	0.692	0.0125
115,200	0.087	0.347	0.0625
230,400	0.043	0.174	0.03125
460,800	0.022	0.087	0.015625
921,600	0.011	0.043	0.0078125

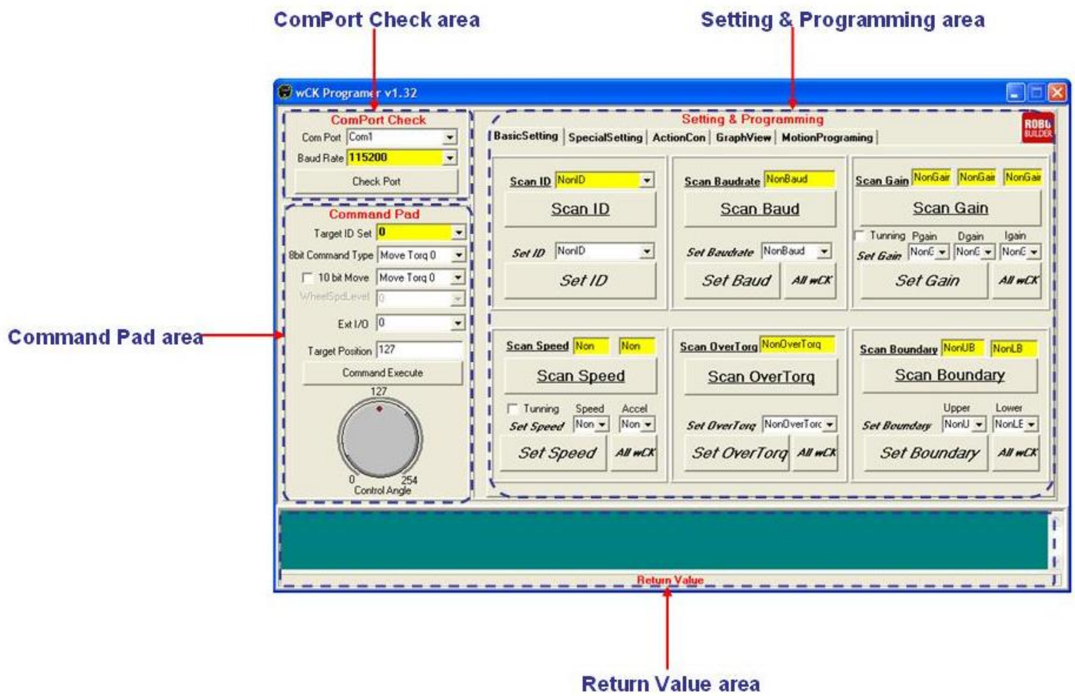
Command Response Time

The table below shows the Command Response Time at different baud rates. Command Response Time is the amount of time it takes for a wCK module from sending a Command Packet to receiving its Response Packet.

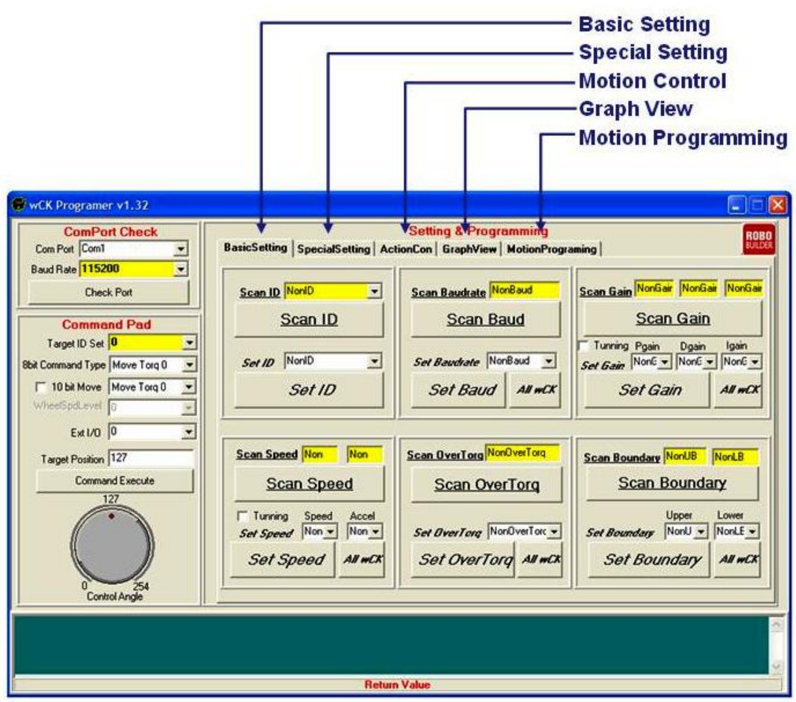
Command \ Baud Rate	4800 bps	9600 bps	38400 bps	57600 bps	115200 bps
Position Move	13159	7083	2517	1354	1180
Position Read	13159	7083	2517	1354	1180
Passive wCK	13159	7083	2517	1354	1180
Break wCK	13159	7083	2517	1354	1180
Wheel wCK	13159	7083	2517	1354	1180
Read Gain	17326	9166	3038	1701	1354
Read Resolution	17326	9166	3038	1701	1354
Read Load Range	17326	9166	3038	1701	1354
Read Boundary	17326	9166	3038	1701	1354
Baud Rate Set	136144	127950	122829	121492	121145
Gain Set	136144	127950	122829	121492	121145
ID Set	136144	127950	122829	121492	121145
Resolution Set	136144	127950	122829	121492	121145
Load Range Set	136144	127950	122829	121492	121145
Boundary Set	136144	127950	122829	121492	121145

2-4 Software

Users need to use "wCK programmer" the developer's software tool in order to use and control a wCK module. Windows-based wCK programmer is used to configure all settings and parameters, execute and simulate commands, create and edit self-running motion program. Refer to separate user's guide to understand the details about wCK programmer.



[Figure 2-4a] wCK Programmer Screen Layout

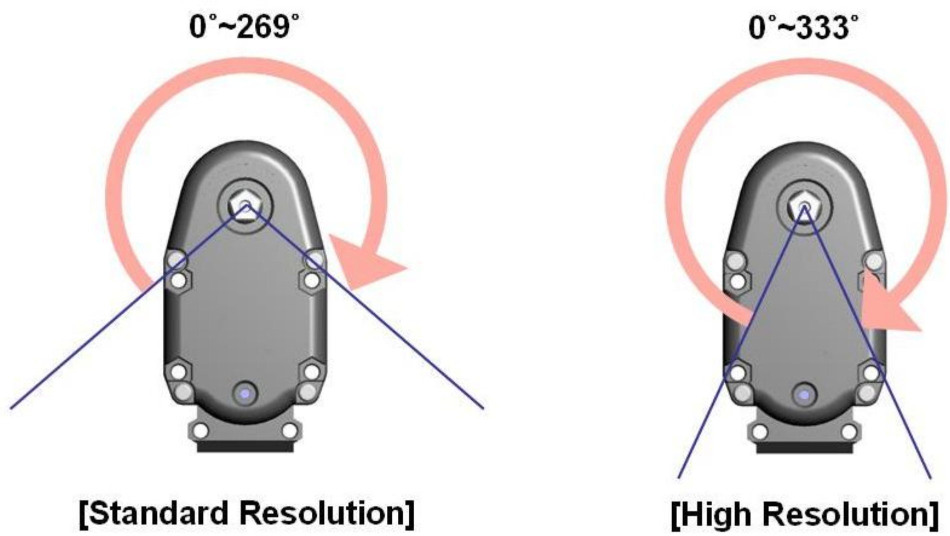


[Figure 2-4b] Setting & Programming Area

3 CONTROL FUNCTIONS

3-1 Position Control

The Position Control of wCK module is achieved by users commanding a wCK module to go to a specific position(target position in the unit of control angle) then the wCK module moves to that specific position in response to that command. The actual physical displacement is different from the control angle depending on the control resolution in which wCK is operating.

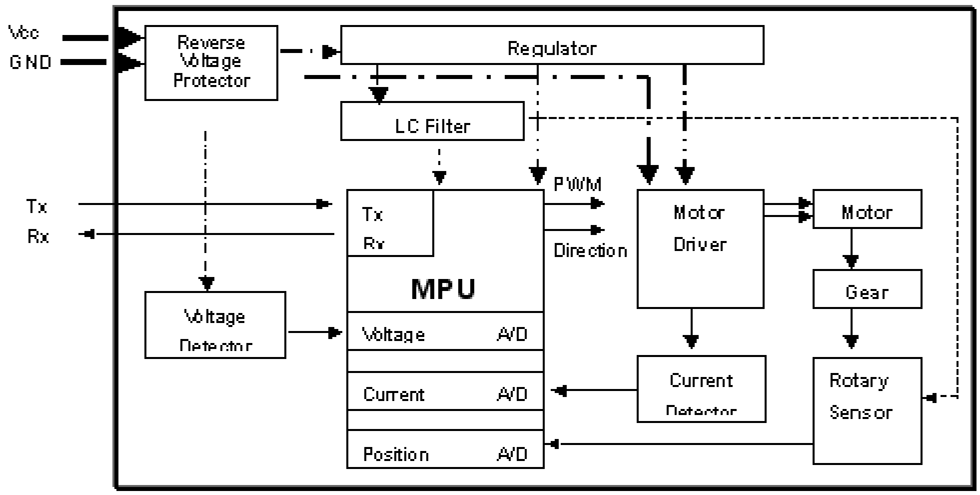


The Control Angle is a conceptual angle that controller uses to calculate and control internally, while Movement Angle means the actual displacement of angle that a wCK module makes to move to a target position angle. The Unit Angle is the physical displacement of rotation angle caused by executing a single unit of Control Angle.

Control Angle	0~254(Standard Resolution), 0~1,022(High Resolution)
Movement Angle	0˚~269˚(Standard Resolution), 0˚~333˚(High Resolution)
Unit Angle	269˚/255=1.055˚ (Standard Resolution), 333˚/1023=0.325˚ (High Resolution)
Control Error	±0.8˚(Standard Resolution)

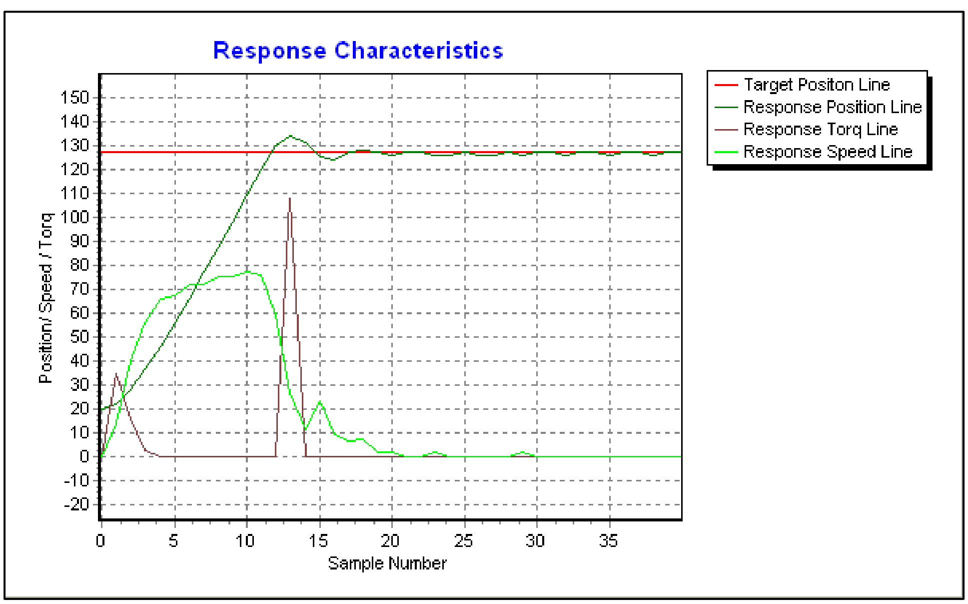
The full Movement Angle, illustrated above, can be used when a Joint such as Joint 2, Joint 3, Joint 5, Joint 9, Joint 12 is connected to the Pentagon-shaped Junction, while a smaller range of Movement Angle is available when a Joint such as Joint 1, Joint 2, Joint 6, Joint 10 is connected to the Axis Junction.

The wCK module realizes precise motion control by adopting a PID control technology. The following is the block diagram that shows the simplified control scheme of the built-in motion control system.

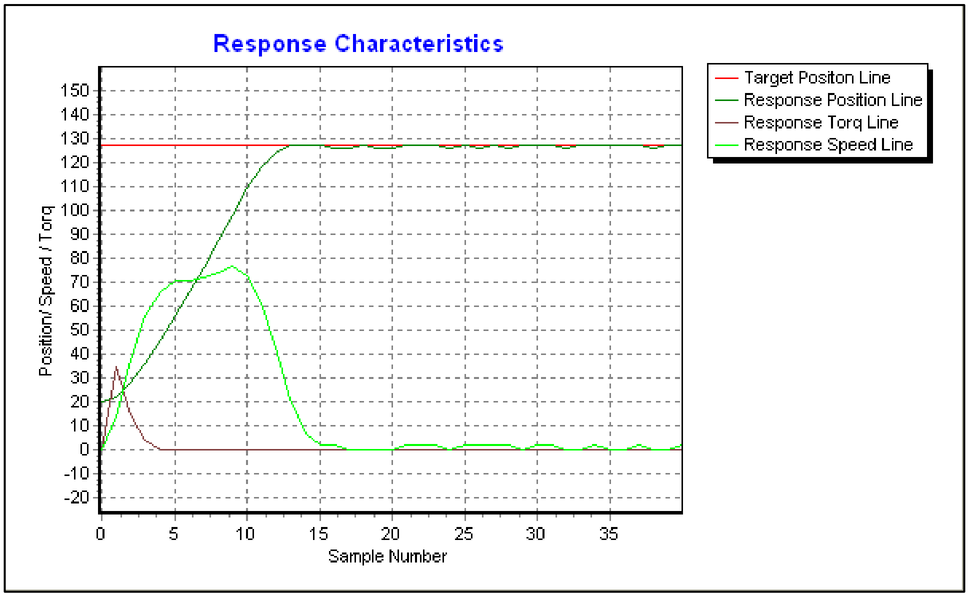


Below are the response characteristics graphs that show the different response characteristics of wCK module when each method of P gain Control, PD gain Control, and PID gain Control is applied.

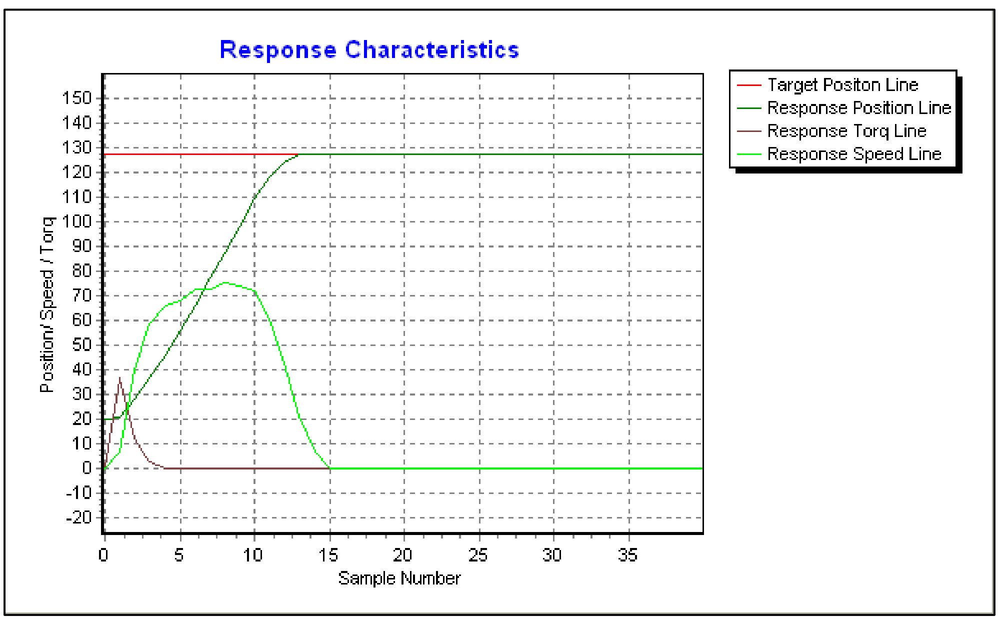
- P gain Control



- PD gain Control



- PID gain Control



3-2 Synchronized Position Control

Synchronized Position Control function is used to synchronize and control multiple wCK modules that are connected electrically on a same channel. A maximum of 31 wCK modules can be connected and controlled simultaneously so this function is very useful in motion controlling a multi-axis robotic systems.

3-3 Passive Mode

Passive wCK Mode is used to release the torque from the axis of the wCK module so that the rotation axis may be moved smoothly by external force, which means the wCK module acts as a sensor.

3-4 Speed/Acceleration Setting

The user can select and change the levels of speed(from 0 to 30) and acceleration range(from 20 to 100) of a wCK module.

3-5 Movement Boundary Setting

The user can set the movement boundary range of a wCK so that the wCK can only move within a specified range of rotation angles. This function is useful for applications that requires a motion in a narrow range of movement angle is critical.

3-6 Reverse-voltage Protection

The wCK module has built-in reverse-voltage protection to protect from user's wiring mistake.

3-7 Over-current Protection

The wCK module has built-in over-current(over-torque) protection to protect the product from excessive external forces and protect user from injury. A range of from 33 to 199 is selectable for an actual scale of current from 400 mA to 1,800 mA.

3-8 Wheel Mode

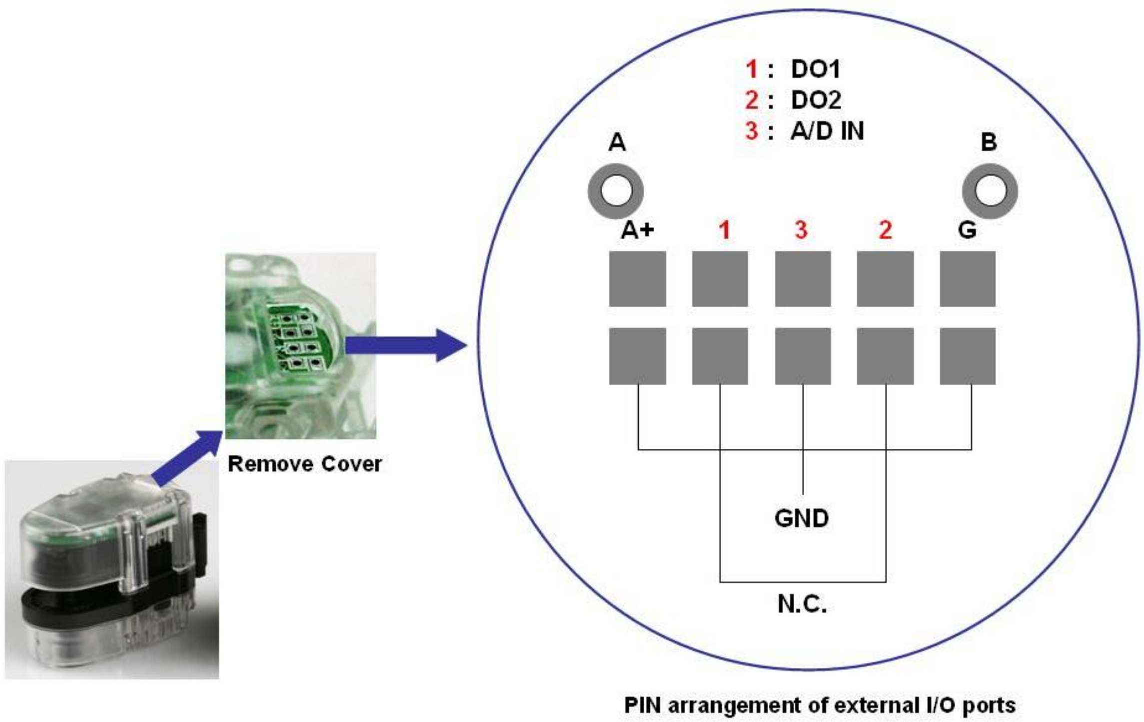
Using wCK module's 360˚ Wheel Mode a user can build a system that requires a spinning motion at a specified rotational speed. Clock-wise and counter clock-wise rotation is selectable and 16 levels of speed can be selected.

3-9 Break Mode

Break Mode stops the motion of a wCK module and thus helps hold a system's mechanical structure still without consuming electrical power by using dynamic break effect. Once break mode applied, all wCK modules connected on a single channel turn into Break Mode.

3-10 External I/O Port

wCK module has 1 channel of A/D input(0V~5V) and 2 channels of Digital Output(TTL level).



[Figure 3-10] External I/O Port & Pin Arrangement

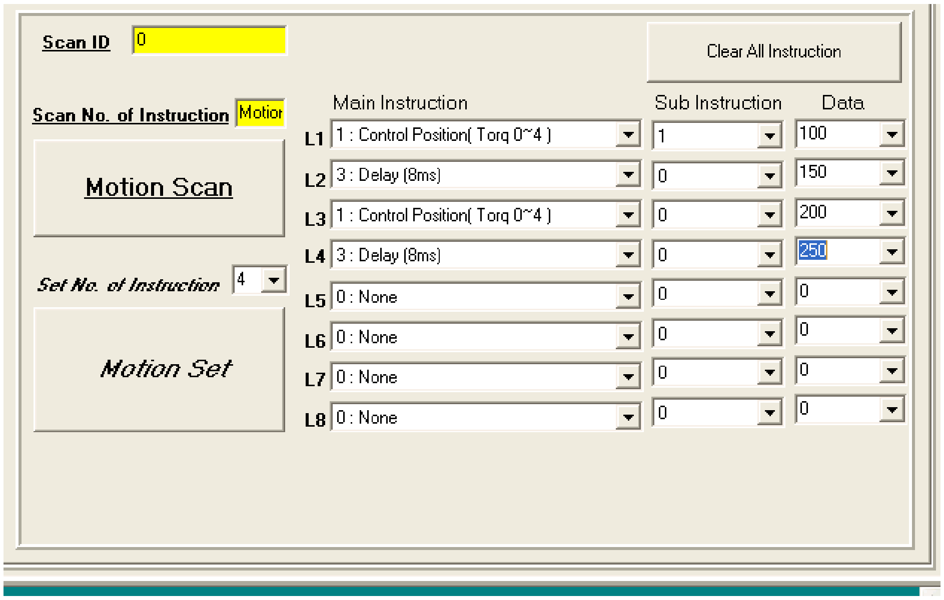
3-11 Self-running Motion

wCK module's self-running motion enables users to build a simple and compact stand alone system without using a separate external controller. The programming logics used in the "wCK programmer" when creating a self-running motion is shown in the table below. Self-running motion is activated only when the number of instructions is more than 0. Please refer to appendix [A-1-3 extended command (24) Motion Data Write] for its relationship with the structure of Command Packet.

Motion Command(1 Byte)		**Motion Data(1 Byte)**
Main Instruction	**Sub Instruction**	**Data**
0: None	0	X
1: Position Control	Speed(0~4)	8 bit Position Value
2: Motion Type	1(Passive), 2(Power Down), 3(Wheel CCW), 4(Wheel CW)	The Speed value in Wheel Mode(0~15)
3: Delay Time(Max 4,095 ms)	Upper 4 bit delay value	Lower 8 bit delay value(in ms)
4: DIO	X	2 bit external port output value
5: Position Conditional Decision	1("==") 2(">") 3("<") 4(">=") 5("<=")	8 bit Position Value
6: A/D Conditional Decision	1("==") 2(">") 3("<") 4(">=") 5("<=")	8 bit external port A/D input value
7: No of Repetition	X	0 : Infinity, 1 to 254(No of repetition)
8: End of Program	X	X

[Example Program]

The rotation axis of a wCK module moves to position 100 at torque 1, then moves to position 200 at torque 0 after delay 150, then repeat this motion after delay 250.



3-12 Initialization of wCK ID and Baud rate

While configuring or controlling a wCK module, the user may encounter a problem or a situation when they have to initialize the ID and baud rate of the wCK module, either by mistake or because of a product fault. Remove the cover of external I/O port first and use tweezers to apply electric current between point A and point B for more than 10 seconds, then the ID and baud rate will be initialized.(default initial values, ID=0, Baud rate=115,200)

A. APPENDIX

A-1 Communication Protocol

A-1-1 8 bit Command

(1) Position Move

"Position Move" command makes wCK module return the values of current load and current position to controller and then move to a specified target position.

▶ Command Packet

1byte	1byte	1byte	1byte
Header	Data1	Target position	Checksum

Header = 0xFF

Data1

Torque			ID				
7	6	5	4	3	2	1	0

※ Torq : 0(Max)~4(Min), ID : 0~30

Target position = 0~254

Checksum = (Data1 X OR Target position) AND 0x7F

▶ Response Packet

1byte	1byte
Load	Position

※ Load : 0~254, Position : 0~254

e.g.) Command a wCK module with ID 0 to move to target position 0x7F(127) at torque 0

• Command Packet

1byte	1byte	1byte	1byte
0xFF	0x00	0x7F	0x7F

• Response Packet

1byte	1byte
Load	Position

(2) Synchronized Position Move

"Synchronized Position Move" command makes multiple wCK modules move to a specified target position. Five torque levels are selectable for the movement.

▶ Command Packet

1byte	1byte	1byte	1byte		1byte	1byte
Header	Data1	Data2	ID0 target	···	lastID target	Checksum

Header = 0xFF

Data1

Torque			31				
7	6	5	4	3	2	1	0

※ Torque : 0(Max)~4(Min)

Data2

Arbitrary Value			lastID+1				
7	6	5	4	3	2	1	0

※ Last ID + 1 : 1~31(last wCK module's ID+1)

※ ID[x] target : 0~254(target position of wCK module with ID x)

※ Last ID target : 0~254(target position of wCK module with Last ID)

Checksum = (ID0 target XOR …(byte(LAST ID +3)) AND 0x7F

▶ Response Packet None

e.g.) Command wCK modules with ID 0 and ID 1 to move simultaneously to target position 0x7F(127) at torque 0(Max)

• Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
0xFF	0x1F	0x02	0x7F	0x7F	0x00

• Response Packet None

(3) Status Read

"Status Read" command makes wCK module read its current load and current position.

▶ Command Packet

1byte	1byte	1byte	1byte
Header	Data1	Data2	Checksum

Header = 0xFF

Data1

Mode(=5)			ID				
7	6	5	4	3	2	1	0

※ Mode: 5, ID : 0~30

Data2 = Arbitrary Value

Checksum = (Data1 XOR Data2) AND 0x7F

▶ Response Packet

1byte	1byte
Load	Position

※ Load : 0~254, Position : 0~254

e.g.)Command a wCK module with ID 0 to read its status.

- Command Packet

1byte	1byte	1byte	1byte
0xFF	0xA0	0x00	0x20

- Response Packet

1byte	1byte
Load	Position

(4) Passive wCK

"Passive wCK" command makes a wCK module return the value of current position and release torque from the rotation axis so that it can be moved freely by external force.

▶ Command Packet

1byte	1byte	1byte	1byte
Header	Data1	Data2	Checksum

Header = 0xFF

Data1

Mode(=6)			ID				
7	6	5	4	3	2	1	0

※ Mode : 6, ID : 0~30

Data2

Mode(=1)				Arbitrary Value			
7	6	5	4	3	2	1	0

※ Mode : 1

Checksum = (Data1 XOR Data2) AND 0x7F

▶ Response Packet

1byte	1byte
Data2	Position

※ Position : 0~254

e.g.)Command a wCK module with ID 0 to turn into Passive wCK mode

- Command Packet

1byte	1byte	1byte	1byte
0xFF	0xC0	0x10	0x50

- Response Packet

1byte	1byte
0x10	Position

(5) Wheel wCK

"Wheel wCK" command makes a wCK module carry out 360° revolving motion. 16 different speed levels are selectable.

▶ Command Packet

1byte	1byte	1byte	1byte
Header	Data1	Data2	Checksum

Header = 0xFF

Data1

Mode(=6)			ID				
7	6	5	4	3	2	1	0

※ Mode: 6, ID : 0~30

Data2

회전방향				속도			
7	6	5	4	3	2	1	0

※ Direction : 3(CCW), 4(CW)

※ Speed : 0(stop), 1(min)~15(max)

Checksum = (Data1 XOR Data2) AND 0x7F

▶ Response Packet

1byte	1byte
No of Rotation	Position

※ No of Rotation : 0~255(No of Rotation after power supplied, :CCW, :CW)

※ Position = 0~254

e.g.) Command a wCK module with ID0 to revolve to CCW direction at speed level 15.

- Command Packet

1byte	1byte	1byte	1byte
0xFF	0xC0	0x3F	0x7F

- Response Packet

1byte	1byte
회전수	Position

(6) Break wCK

"Break wCK" command make all wCK modules connected on one channel to turn into Break Mode. Break Mode stops the motion of a wCK module and thus help hold still a system's mechanical structure without consuming electric power by using dynamic break. In this mode, the rotation axis become stiff and hard to move with a hand.

▶ Command Packet

1byte	1byte	1byte	1byte
Header	Data1	Data2	Checksum

Header = 0xFF

Data1

Mode(=6)			31				
7	6	5	4	3	2	1	0

※ Mode : 6

Data2

Mode(=2)				Arbitrary Value			
7	6	5	4	3	2	1	0

※ Mode : 2

Checksum = (Data1 XOR Data2) AND 0x7F

▶ Response Packet

1byte	1byte
ID	Position

※ ID : 0~30, Position : 0~254

e.g.) Command a wCK module with ID 0 to turn into Break mode

- Command Packet

1byte	1byte	1byte	1byte
0xFF	0xDF	0x20	0x7F

- Response Packet

1byte	1byte
0x00	Position

A-1-2 Set Command

(7) Baud rate Set

"Baud rate Set" command sets the communication baud rate of a wCK module. Supported baud rates are 4800 bps, 9600 bps, 38400 bps, 57600 bps, 115200 bps, 230400 bps, 460800 bps, 921600 bps.

▶ Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
Header	Data1	Data2	Data3	Data4	Checksum

Header = 0xFF

Data1

Mode(=7)			ID				
7	6	5	4	3	2	1	0

※ Mode : 7, ID : 0~30

Data2 = 0x08

Data3 = 0(921600bps), 1(460800bps), 3(230400bps), 7(115200bps),
15(57600bps), 23(38400bps), 95(9600bps), 191(4800bps),

Data4 = Data3

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

1byte	1byte
new Baud rate	new Baud rate

※ new Baud rate : 0~191

e.g.) Set the baud rate of a wCK module with ID 0 to 115200bps.

- Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
0xFF	0xE0	0x08	0x07	0x07	0x68

- Response Packet

1byte	1byte
0x03	0x03

(8) P, D gain Set

"P,D gain Set" command sets the P gain and D gain of a wCK module. It's recommended that user set P gain and D gain according to the formula of P gain = 1.5 × D gain.

▶ Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
Header	Data1	Data2	Data3	Data4	Checksum

Header = 0xFF

Data1

Mode(=7)			ID				
7	6	5	4	3	2	1	0

※ Mode : 7, ID : 0~30

Data2 = 0x09

Data3 = new P-gain (1~254 recommended)

Data4 = new D-gain (0~254 recommended)

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

1byte	1byte
new P gain	new D gain

※ new P gain : 1~254, new D gain : 0~254

e.g.) Set the P gain and D gain of a wCK module with ID 0 (P gain = 100, D gain = 100).

- Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
0xFF	0xE0	0x09	0x64	0x64	0x69

- Response Packet

1byte	1byte
0x64	0x64

(9) P, D gain Read

"P, D gain Read" command makes a wCK module read the values of P gain and D gain.

▶ Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
Header	Data1	Data2	Data3	Data4	Checksum

Header = 0xFF

Data1

Mode(=7)			ID				
7	6	5	4	3	2	1	0

※ Mode : 7, ID : 0~30

Data2 = 0x0A

Data3 = Arbitrary Value

Data4 = Data3

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

1byte	1byte
P gain	D gain

※ P gain : 1~254, D gain : 0~254

e.g.) Command a wCK module with ID 0 to read its P gain and D gain.

- Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
0xFF	0xE0	0x0A	0x00	0x00	0x6A

- Response Packet

1byte	1byte
P-gain	D-gain

(10) I gain Set

"I gain Set" command sets the I gain of a wCK module.

▶ Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
Header	Data1	Data2	Data3	Data4	Checksum

Header = 0xFF

Data1

Mode(=7)			ID				
7	6	5	4	3	2	1	0

※ Mode : 7, ID : 0~30

Data2 = 0x15

Data3 = new I gain(0~10 recommended)

Data4 = Data3

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

1byte	1byte
new I gain	new I gain

※ new I gain : 0~10

e.g.) Set the I gain of a wCK module with ID 0 to 100.

• Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
0xFF	0xE0	0x15	0x64	0x64	0x75

• Response Packet

1byte	1byte
0x64	0x64

(11) I gain Read

"I gain Read" command makes a wCK module read the value of I gain.

▶ Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
Header	Data1	Data2	Data3	Data4	Checksum

Header = 0xFF

Data1

Mode(=7)			ID				
7	6	5	4	3	2	1	0

※ Mode : 7, ID : 0~30

Data2 = 0x16

Data3 = Arbitrary Value

Data4 = Data3

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

1byte	1byte
I-gain	I-gain

※ I gain : 0~10

e.g.) Command a wCK module with ID 0 to read its I gain

• Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
0xFF	0xE0	0x16	0x00	0x00	0x76

• Response Packet

1byte	1byte
I-gain	I-gain

(12) Runtime P, D gain Set

"Runtime P, D gain Set" command set the runtime P gain and D gain of a wCK module. When power cycled, the gains return to their original values.

▶ Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
Header	Data1	Data2	Data3	Data4	Checksum

Header = 0xFF

Data1

Mode(=7)			ID				
7	6	5	4	3	2	1	0

※ Mode : 7, ID : 0~30

Data2 = 0x0B

Data3 = 1~254 recommended (P-gain)

Data4 = 0~254 recommended (D-gain)

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

1byte	1byte
P gain	D gain

※ P gain : 1~254, D gain : 0~254

e.g.) Set the runtime P gain and D gain of a wCK module with ID 0 (P gain = 100, D gain = 100).

• Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
0xFF	0xE0	0x0B	0x64	0x64	0x69

• Response Packet

1byte	1byte
0x64	0x64

(13) Runtime I gain Set

"Runtime I gain Set" command set the runtime I gain of a wCK module. When power cycled, the gain returns to its original value.

▶ Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
Header	Data1	Data2	Data3	Data4	Checksum

Header = 0xFF

Data1

Mode(=7)			ID				
7	6	5	4	3	2	1	0

※ Mode : 7, ID : 0~30

Data2 = 0x18

Data3 = I-gain (0~10 recommended)

Data4 = Data3

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

1byte	1byte
I gain	I gain

※ I gain : 0~10

e.g.) Set the runtime I gain of a wCK module with ID to 4.

• Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
0xFF	0xE0	0x18	0x04	0x04	0x78

• Response Packet

1byte	1byte
0x04	0x04

(14) ID Set

"ID Set" command sets the ID number of a wCK module.

▶ Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
Header	Data1	Data2	Data3	Data4	Checksum

Header = 0xFF

Data1

Mode(=7)			ID				
7	6	5	4	3	2	1	0

※ Mode : 7, ID : 0~30

Data2 = 0x0C

Data3 = new ID(0~254)

Data4 = Data3

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

1byte	1byte
new ID	new ID

※ new ID : 0~254

e.g.) Set the ID of a wCK module with ID 0 to 30.

- Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
0xFF	0xE0	0x0C	0x1E	0x1E	0x6C

- Response Packet

1byte	1byte
0x1E	0x1E

(15) Speed Set

"Speed Set" command sets the speed and acceleration range of a wCK module.

▶ Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
Header	Data1	Data2	Data3	Data4	Checksum

Header = 0xFF

Data1

Mode(=7)			ID				
7	6	5	4	3	2	1	0

※ Mode : 7, ID : 0~30

Data2 = 0x0D

Data3 = Speed(0~30)

Data4 = Accel(20~100), Accel = acceleration range

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

1byte	1byte
new speed	new accel

※ new speed : 0~30, new accel : 20 ~ 100

e.g.) Set the speed and acceleration range of a wCK module with ID 0 (Speed = 30, Accel = 100).

- Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
0xFF	0xE0	0x0D	0x1E	0x64	0x1D

- Response Packet

1byte	1byte
0x1E	0x64

(16) Speed Read

"Speed Read" command makes a wCK module to read values of its speed and acceleration range.

▶ Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
Header	Data1	Data2	Data3	Data4	Checksum

Header = 0xFF

Data1

Mode(=7)			ID				
7	6	5	4	3	2	1	0

※ Mode : 7, ID : 0~30

Data2 = 0x0E

Data3 = Arbitrary Value

Data4 = Arbitrary Value

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

1byte	1byte
Speed	Accel

※ speed : 0~30, accel : 20 ~ 100

e.g.) Command a wCK module with ID 0 to read its speed and acceleration range.

• Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
0xFF	0xE0	0x0E	0x00	0x00	0x6E

• Response Packet

1byte	1byte
Speed	Accel

(17) Runtime Speed Set

"Runtime Speed Set" command sets the runtime speed and acceleration range of a wCK module.

▶ Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
Header	Data1	Data2	Data3	Data4	Checksum

Header = 0xFF

Data1

Mode(=7)			ID				
7	6	5	4	3	2	1	0

※ Mode : 7, ID : 0~30

Data2 = 0x17

Data3 = Speed(0~30)

Data4 = Accel(20~100)

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet None

e.g.) Set the runtime speed and acceleration range of a wCK module with ID 0 (Speed = 30, Accel = 100).

- Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
0xFF	0xE0	0x17	0x1E	0x64	0x0D

- Response Packet None

(18) Over Load Set

"Over Load Set" command sets the over load boundary of a wCK module.

(※ caution : If a wCK module detect over load status, it automatically turns into Passive wCK mode.)

▶ Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
Header	Data1	Data2	Data3	Data4	Checksum

Header = 0xFF

Data1

Mode(=7)			ID				
7	6	5	4	3	2	1	0

※ Mode : 7, ID : 0~30

Data2 = 0x0F

Data3 = 33~199

No	Data3	Current(mA)
1	33	400
2	44	500
3	56	600

4	68	700
5	80	800
6	92	900
7	104	1000
8	116	1100
9	128	1200
10	199	1800

Data4 = Data3

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

1byte	1byte
new overload	new overload

※ new overload : 33~199

e.g.) Set the over load of a wCK module with ID 0 to 104(actual current is 1000mA).

- Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
0xFF	0xE0	0x0F	0x68	0x68	0x6F

- Response Packet

1byte	1byte
0x68	0x68

(19) Over Load Read

"Over Load Read" command makes a wCK module to read the value of its over load boundary.

▶ Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
Header	Data1	Data2	Data3	Data4	Checksum

Header = 0xFF

Data1

Mode(=7)			ID				
7	6	5	4	3	2	1	0

※ Mode : 7, ID : 0~30

Data2 = 0x10

Data3 = Arbitrary Value

Data4 = Data3

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

1byte	1byte
overload	overload

※ overload : 33~199

e.g.) Command a wCK module with ID 0 to read its over load.

- Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
0xFF	0xE0	0x10	0x00	0x00	0x70

- Response Packet

1byte	1byte
Over Load	Over Load

(20) Boundary Set

"Boundary Set" command sets the rotation movement boundary of a wCK module.

▶ Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
Header	Data1	Data2	Data3	Data4	Checksum

Header = 0xFF

Data1

Mode(=7)			ID				
7	6	5	4	3	2	1	0

※ Mode : 7, ID : 0~30

Data2 = 0x11

Data3 = new Lower Boundary(0~254)

Data4 = new Upper Boundary(0~254)

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

1byte	1byte
New Lower Boundary	New Upper Boundary

※ new Upper Boundary : 0~254, new Lower Boundary : 0~254

e.g.) Set the movement boundary of a wCK module with ID 0 (Lower Boundary = 100, Upper Boundary = 50).

• Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
0xFF	0xE0	0x11	0x64	0x32	0x20

• Response Packet

1byte	1byte
0x64	0x32

(21) Boundary Read

'Boundary Read" command make a wCK module to read the value of its movement boundary.

▶ Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
Header	Data1	Data2	Data3	Data4	Checksum

Header = 0xFF

Data1

Mode(=7)			ID				
7	6	5	4	3	2	1	0

※ Mode : 7, ID : 0~30

Data2 = 0x12

Data3 = Arbitrary Value

Data4 = Data3

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

1byte	1byte
Lower Bound	Upper Bound

※ new Upper Boundary : 0~254, new Lower Boundary : 0~254

e.g.) Comand a wCK module with ID 0 to read its boundary values.

- Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
0xFF	0xE0	0x12	0x00	0x00	0x72

- Response Packet

1byte	1byte
Lower Boundary	Upper Boundary

A-1-3 Extended Command

(22) I/O Write

"I/O Write" command makes a wCK module to write to the D/O(Digital Output) port.

▶ Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
Header	Data1	Data2	Data3	Data4	Checksum

Header = 0xFF

Data1

Mode(=7)			ID				
7	6	5	4	3	2	1	0

※ Mode : 7, ID : 0~30

Data2 = 0x64

Data3

Arbitrary Value						CH	
7	6	5	4	3	2	1	0

※ bit0 = D/O 1 output value, bit1 = D/O 2 output value

Data4 = Data3

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

1byte	1byte
D/O Value	D/O Value

※ D/O Value = Data3

e.g.) Command a wCK module with ID 0 to write the D/O values (CH1 = 1, CH2 = 1).

- Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
0xFF	0xE0	0x64	0x03	0x03	0x04

- Response Packet

1byte	1byte
0x03	0x03

(23) I/O Read

"I/O Read" command make a wCK module to read the I/O data from external port.

▶ Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
Header	Data1	Data2	Data3	Data4	Checksum

Header = 0xFF

Data1

Mode(=7)			ID				
7	6	5	4	3	2	1	0

※ Mode : 7, ID : 0~30

Data2 = 0x65

Data3 = Arbitrary Value

Data4 = Data3

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

1 byte	1 byte
D/O Value	8bit AD

※ D/O Value structure

Arbitrary Value						CH	
7	6	5	4	3	2	1	0

e.g.) Command a wCK module with ID 0 to read its I/O data.

- Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
0xFF	0xE0	0x65	0x00	0x00	0x04

- Response Packet

1byte	1byte
Output Value	8bit AD

(24) Motion Data Write

"Motion Data Write" command is used to set a self-running motion program to a wCK module. Refer to [3-11 Self-running Motion] for programming logics.

▶ Command Packet

1byte	1byte	1byte	1byte		1byte	1byte	1byte
Header	Data1	Data2	Motion Count	· · ·	Motion command X	Motion Data X	Checksum

Header = 0xFF

Data1

Mode(=7)			ID				
7	6	5	4	3	2	1	0

※ Mode : 7, ID : 0~30

Data2 = 0x 96

Motion Count = 0 ~ 8

Motion command X = 0 ~ 254

Motion data X = 0 ~ 254

Checksum = (byte2 XOR byte3 XOR · · · byten) AND 0x7f

▶ Response Packet

1byte	1byte
Motion Count	Motion Count

Motion Count : 0 ~ 8

e.g.) Set a self-running motion to a wCK module with ID 0 (shuttle between position 82 and position 172).

- Command Packet

1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte
0xFF	0xE0	0x96	0x04	0x10	0x52	0x31	0x0A	0x10	0xAC	0x31	0x0a	0x0c

- Response Packet

1byte	1byte
0x04	0x04

(25) Motion Data Read

"Motion Data Read" command make a wCK module to read the number of instruction lines of a self-running motion program.

▶ Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
Header	Data1	Data2	Data3	Data4	Checksum

Header = 0xFF

Data1 =

Mode(=7)			ID				
7	6	5	4	3	2	1	0

※ Mode : 7, ID : 0~30

Data2 = 0x 97

Data3 = Arbitrary Value

Data4 = Data3

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

1 byte	1 byte
Motion Count	Motion Count

※ Motion Count : 0 ~ 8

e.g.) Command a wCK module with ID 0 to read the line number of instructions.

- Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
0xFF	0xE0	0x97	0x00	0x00	0x77

- Response Packet

1byte	1byte
Motion Count	Motion Count

A-1-4 10 bit Command

(26) Position Move

Under high resolution mode, "Position Move" command makes wCK module return the value of current position to controller and then move to a specified target position.

▶ Command Packet

1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte
Header	Data1	Data2	Data3	Data4	Data5	Data6	Checksum

Header = 0xFF

Data1

Mode(=7)			Arbitrary Value				
7	6	5	4	3	2	1	0

※ Mode : 7

Data2 = 0xc8

Data3 = ID(0~253)

Data4 = Torque(0~254)

Data5 = target position(Upper(H3) 3 bit)

X					Position(H3)		
7	6	5	4	3	2	1	0

Data6 = target position(Lower(L7) 7 bit)

Position(L7)							X
7	6	5	4	3	2	1	0

Check sum = (byte2 XOR byte3 XOR byte4XOR byte5 XOR byte6 XOR byte7) AND 0x7F

▶ Response Packet

1byte	1byte
Position(H3)	Position(L7)

※ Position(H3) + Position(L7) : 0~1023

e.g.) Command a wCK module with ID 0 to move to position 1000 at torque 0.

- Command Packet

1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte
0xFF	0xE0	0xC8	0x00	0x00	0x07	0xD0	0x7F

- Response Packet

1byte	1byte
0x07	0xD0

(27) Position Read

Under high resolution mode, "Position Read" command makes a wCK module to read the value of its current position.

▶ Command Packet

1byte	1byte	1byte	1byte	1byte	1byte
Header	Data1	Data2	Data3	Data4	Checksum

Header = 0xFF

Data1

Mode(=7)			Arbitrary Value				
7	6	5	4	3	2	1	0

※ Mode : 7

Data2 = 0xc9

Data3 = ID(0~253)

Data4 = Data3

Check sum = (byte2 XOR byte3 XOR byte5) AND 0x7F

▶ Response Packet

1byte	1byte
Position(H3)	Position(L7)

※ Position(H3) + Position(L7) : 0~1023

e.g.) Command a wCK module with ID 0 to read its position.

- Command Packet

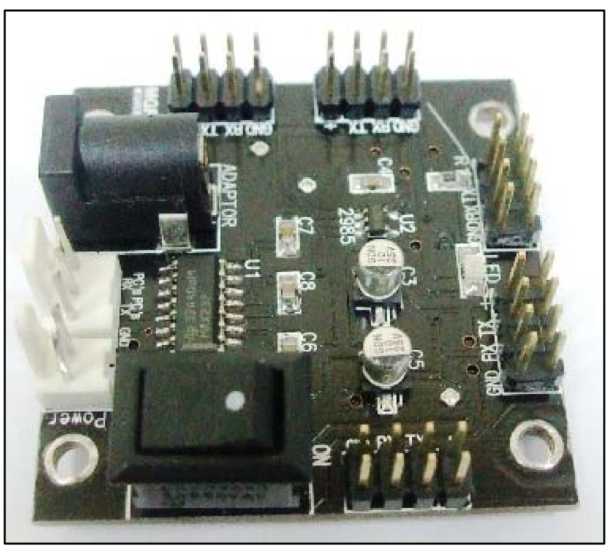
1byte	1byte	1byte	1byte	1byte	1byte
0xFF	0xE0	0xC9	0x00	0x00	0x29

- Response Packet

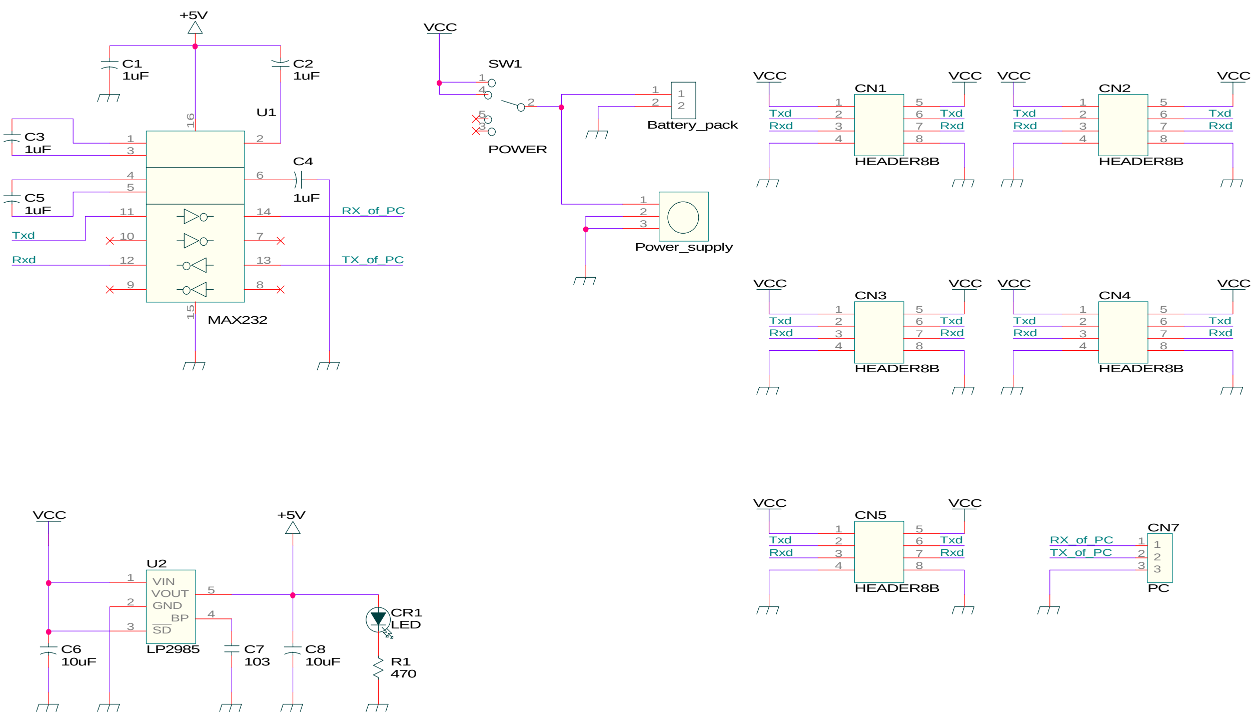
1byte	1byte
Position(H3)	Position(L7)

A-2 Communication Voltage Translation Circuit Board

An RS-232 communication voltage translation circuit board is used to adjust the signal level between wCK module and a controller. The following are the picture and circuit diagram of the signal board.



[Figure A-2a] RS-232 Communication Signal Adjustment Circuit Board



[Figure A-2b] Circuit Diagram of Communication Board

A-3 Baud rate setting for Independent Controller

In case of using a MCU to control a wCK module, it's recommended that a user refer to the following information in tables to minimize communication error.

●MCS51 family(using Timer 1 , Mode 1)

Clock[Mhz]	SMOD	TH1	Baud Rate[bps]	Error[%]
7.3728	0	252	4800	0
7.3728	1	248	4800	0
7.3728	0	254	9600	0
7.3728	1	252	9600	0
7.3728	1	255	38400	0
11.0592	0	250	4800	0
11.0592	1	244	4800	0
11.0592	0	253	9600	0
11.0592	1	250	9600	0
11.0592	1	255	57600	0
14.7456	0	248	4800	0
14.7456	1	240	4800	0
14.7456	0	252	9600	0
14.7456	1	248	9600	0
14.7456	0	255	38400	0
14.7456	1	254	38400	0
22.1184	0	244	4800	0
22.1184	1	232	4800	0
22.1184	0	250	9600	0
22.1184	1	244	9600	0
22.1184	1	253	38400	0
22.1184	0	255	57600	0
22.1184	1	254	57600	0
22.1184	1	255	115200	0

●80c196Kx(Mode1)

Clock[Mhz]	SP_BAUD	Baud Rate[bps]	Error[%]
7.3728	805F	4800	0
7.3728	802F	9600	0
7.3728	800B	38400	0
7.3728	8007	57600	0
7.3728	8003	115200	0
11.0592	808F	4800	0
11.0592	8047	9600	0
11.0592	8011	38400	0
11.0592	800B	57600	0
11.0592	8005	115200	0
14.7456	80BF	4800	0
14.7456	805F	9600	0
14.7456	8017	38400	0
14.7456	800F	57600	0

14.7456	8007	115200	0
14.7456	8003	230400	0

●PIC family

Clock[Mhz]	BRGH	SPBRG	Baud Rate[bps]	Error[%]
3.6864	0	11	4800	0
3.6864	0	5	9600	0
3.6864	0	0	57600	0
7.3728	0	23	4800	0
7.3728	0	11	9600	0
7.3728	0	2	38400	0
7.3728	0	1	57600	0
7.3728	0	0	115200	0
11.0592	0	35	4800	0
11.0592	0	17	9600	0
11.0592	0	2	57600	0
14.7456	0	47	4800	0
14.7456	0	5	38400	0
14.7456	0	3	57600	0
14.7456	0	1	115200	0

●AVR family

Clock[Mhz]	UBRRH	UBRRL	Baud Rate[bps]	Error[%]
7.3728	0	95	4800	0
7.3728	0	47	9600	0
7.3728	0	11	38400	0
7.3728	0	7	57600	0
7.3728	0	3	115200	0
7.3728	0	0	460800	0
14.7456	0	383	2400	0
14.7456	0	191	4800	0
14.7456	0	95	9600	0
14.7456	0	23	38400	0
14.7456	0	15	57600	0
14.7456	0	7	115200	0
14.7456	0	2	230400	0
14.7456	0	1	460800	0
14.7456	0	0	921600	0

A-4 Application Example

The following is an example C programs required and helpful for controlling a wCK module. Functions relating to serial communication may vary depending upon the type of MPU so add accordingly required functions for your MPU.

```
/*=====================================================================================*/
/* Example Program                                                                      */
/* Motion Explanation : If given a force, wCK rotates to the direction of the force and stops */
/* Motion Logic : Read wCK's position feedback to decide rotation direction and start movement */
/*                    when there's any change in position                              */
/*=====================================================================================*/
#define HEADER    0xff
#define NULL      0
#define ROTATE_CCW  3
#define ROTATE_CW  4

/* Start of Function Prototype-------------------------------------------------*/
/*------------------ Function relating to serial communication ----------------*/
void SendByte(char data);   // Send 1 Byte to serial port
void GetByte(char timeout); // Receive 1 Byte from serial port
/*------------------Basic Functions relating to wCK module----------------------*/
void SendOperCommand(char Data1, char Data2);
void SendSetCommand(char Data1, char Data2, char Data3, char Data4);
char PosSend(char ServoID, char SpeedLevel, char Position);
char PosRead(char ServoID);
char ActDown(char ServoID);
char PowerDown(void);
char Rotation360(char ServoID, char SpeedLevel, char RotationDir);
void SyncPosSend(char LastID, char SpeedLevel, char *TargetArray, char Index);
char BaudrateSet(char ServoID, char NewBaud);
char GainSet(char ServoID, char *NewPgain, char *NewDgain);
char IdSet(char ServoID, char NewId);
char GainRead(char ServoID, char *Pgain, char *Dgain);
char ResolSet(char ServoID, char NewResol);
char ResolRead(char ServoID);
char OverCTSet(char ServoID, char NewOverCT);
char OverCTRead(char ServoID);
char BoundSet(char ServoID, char *NewLBound, char *NewUBound);
char BoundRead(char ServoID, char *LBound, char *UBound);
/*------------------------------------------------------- End of Function Prototype */
```

```
void main(void)
{
   char i, old_position;

   Initialize();   // Initialize peripheral devices(prepare for serial port)

   id = 0;
   old_position = ActDown(id);    // Read the initial position of a wCK with ID 0
   while(1) {
      now_position = ActDown(id);  // Read current position
      // If position value decreased, rotate to ccw direction for 1 second and turn to passive mode for 1 second
      if(now_position<old_position) {
         Rotation360(id, 10, ROTATE_CCW);
         delay_ms(1000);
         ActDown(id);
         delay_ms(1000);
      }
      // If position value increased, rotate to cw direction for 1 second and turn to passive mode for 1 second
      else if(now_position>old_position) {
         Rotation360(id, 10, ROTATE_CW);
         delay_ms(1000);
         ActDown(id);
         delay_ms(1000);
      }
      old_position = ActDown(id); // Read current position and save it
      delay_ms(300);
   }
}

///////////////////////////////// Definition of Basic Functions ///////////////////////////
/******************************************************************************/
/* Function that sends Operation Command Packet(4 Byte) to wCK module */
/* Input : Data1, Data2                                               */
/* Output : None                                                      */
/******************************************************************************/
void SendOperCommand(char Data1, char Data2)
{
   char CheckSum;
   CheckSum = (Data1^Data2)&0x7f;
   SendByte(HEADER);
   SendByte(Data1);
   SendByte(Data2);
   SendByte(CheckSum);
```

```
}

/******************************************************************************/
/* Function that sends Set Command Packet(6 Byte) to wCK module      */
/* Input : Data1, Data2, Data3, Data4                                */
/* Output : None                                                     */
/******************************************************************************/
void SendSetCommand(char Data1, char Data2, char Data3, char Data4)
{
  char CheckSum;
  CheckSum = (Data1^Data2^Data3^Data4)&0x7f;
  SendByte(HEADER);
  SendByte(Data1);
  SendByte(Data2);
  SendByte(Data3);
  SendByte(Data4);
  SendByte(CheckSum);
}

/**********************************************************************************************/
/* Function that sends Position Move Command to wCK module           */
/* Input : ServoID, SpeedLevel, Position                             */
/* Output : Current                                                  */
/**********************************************************************************************/
char PosSend(char ServoID, char SpeedLevel, char Position)
{
  char Current;
  SendOperCommand((SpeedLevel<<5)|ServoID, Position);
  GetByte(TIME_OUT1);
  Current = GetByte(TIME_OUT1);
  return Current;
}


/*********************************************************************************************/
/* Function that sends Position Read Command to wCK module           */
/* Input : ServoID                                                   */
/* Output : Position                                                 */
/*********************************************************************************************/
char PosRead(char ServoID)
{
  char Position;
  SendOperCommand(0xa0|ServoID, NULL);
```

```
   GetByte(TIME_OUT1);
   Position = GetByte(TIME_OUT1);
   return Position;
}

/******************************************************************************/
/* Function that sends Passive wCK Command to wCK module              */
/* Input : ServoID                                                    */
/* Output : Position                                                  */
/******************************************************************************/
char ActDown(char ServoID)
{
   char Position;
   SendOperCommand(0xc0|ServoID, 0x10);
   GetByte(TIME_OUT1);
   Position = GetByte(TIME_OUT1);
   return Position;
}

/***************************************************************************/
/* Function that sends Break  wCK Command to wCK module               */
/* Input : None                                                       */
/* Output : ServoID if succeed, 0xff if fail                          */
/***************************************************************************/
char PowerDown(void)
{
   char ServoID;
   SendOperCommand(0xdf, 0x20);
   ServoID = GetByte(TIME_OUT1);
   GetByte(TIME_OUT1);
   if(ServoID<31) return ServoID;
   return 0xff;     //Receive error
}

/*********************************************************************/
/* Function that sends 360 degree Wheel wCK Command        */
/* Input : ServoID, SpeedLevel, RotationDir                */
/* Return : Rotation Number                                */
/*********************************************************************/
char Rotation360(char ServoID, char SpeedLevel, char RotationDir)
{
   char ServoPos, RotNum;
   if(RotationDir==ROTATE_CCW) {
```

```
    SendOperCommand((6<<5)|ServoID, (ROTATE_CCW<<4)|SpeedLevel);
  }
  else if(RotationDir==ROTATE_CW) {
    SendOperCommand((6<<5)|ServoID, (ROTATE_CW<<4)|SpeedLevel);
  }
  RotNum = GetByte(TIME_OUT1);
  GetByte(TIME_OUT1);
  return RotNum;
}


/******************************************************************************/
/* Function that sends Synchronized Position Move Command to wCK module      */
/* Input : LastID, SpeedLevel, *TargetArray, Index                            */
/* Return : None                                                              */
/******************************************************************************/
void SyncPosSend(char LastID, char SpeedLevel, char *TargetArray, char Index)
{
  int i;
  char CheckSum;
  i = 0;
  CheckSum = 0;
  SendByte(HEADER);
  SendByte((SpeedLevel<<5)|0x1f);
  SendByte(LastID+1);
  while(1) {
    if(i>LastID) break;
    SendByte(TargetArray[Index*(LastID+1)+i]);
    CheckSum = CheckSum ^ TargetArray[Index*(LastID+1)+i];
    i++;
  }
  CheckSum = CheckSum & 0x7f;
  SendByte(CheckSum);
}

/************************************************************************/
/* Function that sends Baud rate Set Command to wCK module             */
/* Input : ServoID, NewBaud                                             */
/* Return : New Baudrate if succeed, 0xff if fail                       */
/************************************************************************/
char BaudrateSet(char ServoID, char NewBaud)
{
  SendSetCommand((7<<5)|ServoID, 0x08, NewBaud, NewBaud);
```

```
  GetByte(TIME_OUT2);
  if(GetByte(TIME_OUT2)==NewBaud) return NewBaud;
  return 0xff;
}

/******************************************************************/
/* Function that sends Gain Set Command to wCK module    */
/* Input : ServoID, *NewPgain, *NewDgain                 */
/* Return : 1 if succeed, 0 if fail                      */
/******************************************************************/
char GainSet(char ServoID, char *NewPgain, char *NewDgain)
{
  char Data1,Data2;
  SendSetCommand((7<<5)|ServoID, 0x09, *NewPgain, *NewDgain);
  Data1 = GetByte(TIME_OUT2);
  Data2 = GetByte(TIME_OUT2);
  if((Data1==*NewPgain) && (Data2==*NewDgain)) return 1;
  return 0;
}


/**************************************************************/
/* Function that sends ID Set Command to wCK module      */
/* Input : ServoID, NewId                                */
/* Return : New ID if succeed, 0xff if fail              */
/**************************************************************/
char IdSet(char ServoID, char NewId)
{
  SendSetCommand((7<<5)|ServoID, 0x0a, NewId, NewId);
  GetByte(TIME_OUT2);
  if(GetByte(TIME_OUT2)==NewId) return NewId;
  return 0xff;
}

/******************************************************************/
/* Function that sends Gain Read Command to wCK module  */
/* Input : ServoID, *NewPgain, *NewDgain                 */
/* Return : 1 if succeed,  0 if fail                     */
/******************************************************************/
char GainRead(char ServoID, char *Pgain, char *Dgain)
{
  SendSetCommand((7<<5)|ServoID, 0x0c, 0, 0);
  *Pgain = GetByte(TIME_OUT1);
```

```
  *Dgain = GetByte(TIME_OUT1);
  if((*Pgain>0) && (*Pgain<51) && (*Dgain<101)) return 1;
  return 0;
}

/******************************************************************************/
/* Function that sends Over Load Set Command to wCK module          */
/* Input : ServoID, NewOverCT                                        */
/* Return : New Overcurrent Threshold if succeed, 0xff if fail       */
/******************************************************************************/
char OverCTSet(char ServoID, char NewOverCT)
{
  char Data1;
  SendSetCommand((7<<5)|ServoID, 0x0f, NewOverCT, NewOverCT);
  sciRxReady(TIME_OUT2);
  Data1=sciRxReady(TIME_OUT2);
  if(Data1!=0xff) return Data1;
  return 0xff;
}

/***************************************************************************/
/* Function that sends Over Load Read Command to wCK module         */
/* Input : ServoID                                                   */
/* Return : Overcurrent Threshold if succeed, 0xff if fail           */
/***************************************************************************/
char OverCTRead(char ServoID)
{
  char Data1;
  SendSetCommand((7<<5)|ServoID, 0x10, 0, 0);
  sciRxReady(TIME_OUT1);
  Data1=sciRxReady(TIME_OUT1);
  if(Data1!=0xff) return Data1;
  return 0xff;
}

/**********************************************************************/
/* Function that sends Boundary Set Command to wCK module           */
/* Input : ServoID, *NewLBound, *NewUBound                           */
/* Return : 1 if succeed, 0 if fail                                  */
/*********************************************************************/
char BoundSet(char ServoID, char *NewLBound, char *NewUBound)
{
  char Data1,Data2;
```

```
  SendSetCommand((7<<5)|ServoID, 0x11, *NewLBound, *NewUBound);
  Data1 = GetByte(TIME_OUT2);
  Data2 = GetByte(TIME_OUT2);
  if((Data1==*NewLBound) && (Data2==*NewUBound)) return 1;
  return 0;
}

/******************************************************************************/
/* Function that sends Boundary Read Command to wCK module          */
/* Input : ServoID, *NewLBound, *NewUBound                          */
/* Return :  1 if succeed, 0 if fail                                */
/******************************************************************************/
char BoundRead(char ServoID, char *LBound, char *UBound)
{
  SendSetCommand((7<<5)|ServoID, 0x12, 0, 0);
  *LBound = GetByte(TIME_OUT1);
  *UBound = GetByte(TIME_OUT1);
  if(*LBound<*UBound) return 1;
  return 0;
}
//////////////////////////////// End of Basic Functions Definition /////////////////////////////
```

A-5 Default Parameter Settings

• Baud Rate	7 (115,200 bps)
• P gain	20
• D gain	30
• I gain	0
• wCK module ID	0
• Movement Speed	0 (No speed limit)
• Acceleration Range	60
• Over-current	33 (400mA)
• Control Angle Range	1, 254 (1~254)
• Motion Program Writing	0 (Self-running Motion inactivated)

■ wCK protocol definition

Group	Command	byte 1	byte 2 (bits 7 6 5)	byte 2 (bits 4 3 2 1 0)	byte 3	byte 4	byte 5	byte 6	byte 7	byte 8	byte 9	byte 10	…	byte	byte	byte	Response byte 1	Response byte 2
8bit Command	Position Move	header 0xFF	Torq 0~4	ID 0~30	target position 0~254	check sum (note1)											Load 0~254	position 0~254
	Syncronized Position Move		0~4	31	X, lastID+1 1~31	ID0 target 0~254	ID1 target 0~254	ID2 target 0~254	ID3 target 0~254	ID4 target 0~254	ID5 target 0~254	ID6 target 0~254	…	lastID-1 target 0~254	lastID target 0~254	check sum (note2)		
	Status Read		mode 5	ID 0~30	X	check sum (note1)											Load 0~254	position 0~254
	Passive wCK		6	ID 0~30	mode 1, X	(note1)											byte3	position 0~254
	Wheel wCK		6	0~30	3=CCW 4=CW, speed 0~15	(note1)											Rotation Count	position 0~254
	Break wCK		6	31	2, X	(note1)											ID	position 0~254
Configure Command	Baudrate Set		7	ID 0~30	mode 8	new baudrate 0~191	= byte4	check sum (note3)									new baudrate	new baudrate
	P,D gain Set		7	0~30	9	new P gain 1~254	new D gain 0~254										new P gain	new D gain
	P,D gain Read		7	0~30	10	X	= byte4										P gain	D gain
	Runtime P,D gain Set		7	0~30	11	P gain 1~254	D gain 0~254										P gain	D gain
	ID Set		7	0~30	12	new ID 0~254	= byte4										new ID	new ID
	SPEED Set		7	0~30	13	speed 0~30	accel 20~100										new Speed	new Accel
	SPEED Read		7	0~30	14	X	= byte4										Speed	Accel
	Over Load Set		7	0~30	15	new overcur T 33~199	= byte4										new Over Load	new Over Load
	Over Load Read		7	0~30	16	X	= byte4										Over Load	Over Load
	Boundary Set		7	0~30	17	new L bound 0~254	new U bound 0~254										new L bound	new U bound
	Boundary Read		7	0~30	18	X	= byte4										L bound	U bound
	I gain Set		7	0~30	21	new I gain 0~10	=byte4										new I gain	new I gain
	I gain Read		7	0~30	22	X	=byte4										I gain	I gain
	Runtime Speed Set		7	0~30	23	speed 0~30	accel 20~100											
	Runtime I gain Set		7	0~30	24	I gain 0~10	I gain 0~10										P gain	D gain
Extended Command	I/O Write		7	0~30	100	X, ch 1 0	=byte4	check sum									D/O Value	D/O Value
	I/O Read		7	0~30	101	X	=byte4	check sum									D/O Value	8bit AD
	Motion DATA Write		7	0~30	150	Motion Count 0~8	Motion Command 1 0~254	Motion DATA 1 0~254	Motion Command 2 0~254	Motion DATA 2 0~254	Motion Command 3 0~254	Motion DATA 3 0~254	…		check sum (note4)		Motion Count 0~8	Motion Count 0~8
	Motion DATA Read		7	0~30	151	X	=byte4	check sum (note3)									Motion Count 0~8	Motion Count 0~8
10bit Command	Position Move		7	x	200	ID 0~253	Torq 0~254	target(H3)	target(L7) 0~1023, X	check sum (note6)							position(H3)	position(L7) 0~1023, X
	Position Read		7	x	201	ID 0~253	=byte4	check sum (note5)									position(H3)	position(L7) 0~1023, X

※ X : don't care
※ note1 : CheckSum = (byte2 XOR byte3) AND 0x7F
※ note2 : CheckSum = (byte4 XOR … (byte(lastID+3)) AND 0x7F
※ note3 : CheckSum = (byte2 XOR byte3 XOR byte4 XOR byte5) AND 0x7F
※ note4 : CheckSum = (byte2 XOR byte3 XOR … byteN) AND 0x7F
※ note5 : CheckSum = (byte2 XOR byte3 XOR … byteN) AND 0x7F
※ note6 : CheckSum = (byte2 XOR byte3 XOR byte4 XOR byte5 XOR byte6 XOR byte7) AND 0x7F
※ Motion DATA commands: Self-running motion mode is activated only when the No of Instruction is more than 0 .