proMotion CDS55xx
User Manual

<table>
<thead>
<tr>
<th>Doc. Ver.</th>
<th>Update</th>
<th>Rev.</th>
<th>Authorized by</th>
<th>Remarks</th>
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<td>2010-3-22</td>
<td></td>
<td>何裕德</td>
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</tr>
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<td>1.1</td>
<td>2010-3-27</td>
<td></td>
<td>计海锋</td>
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<td>1.3</td>
<td>2010-8-17</td>
<td>Cid</td>
<td>徐俊辉</td>
<td>Revise</td>
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</tbody>
</table>
Thanks for purchasing ProMotion CDS55xx series robot servo. This document is currently a trial version. If you have any errors or suggestion, please send Email to us or post at our web forum:

http://robot.up-tech.com/bbs/index.asp?boardid=1

Service dept. : 86-10-82114870/4887/4890

Service Email : robot_service@up-tech.com
1 General Introduction

1.1 Features and profile

ProMOTION CDS series robot servo is a robot actuator which integrated motor, sensor, servo algorithm and serial bus port. It's an ideal actuator for small robots and other simple position control equipment.

- **High torque:**
  - 16Kgf.cm (CDS5516/5500)
  - 6Kgf.cm (CDS5506)
- **High speed:**
  - 0.18s/60°(CDS5516/5500)
  - 0.16s/60°(CDS5506)
- DC 6.0V~16V power supply
- 0.32° position resolution
- Double-side output shaft
- Alloy gearbox, dual ball-bearing (CDS5516/5500)
- Resin gearbox, dual ball-bearing (CDS5516/5500)
- Rubber O-ring at output shaft
- Position control range: 0-300°
- 1023 step speed control, continuous rotation
- Up to 30-50 servos serial bus link
- 1Mbps High baud rate
- 250Hz servo refresh rate
- Position/Temperature/Voltage/Speed feedback
- Interface and protocol mostly compatible to Robotis Dynamixel AX12+

CDS55xx robot servo uses advanced control algorithm and high-speed microcontroller, with fast response and high position accuracy.

The CDS55xx robot servo integrated a continuous rotation position sensor with 330° measure range for position control, and it enables the continuous rotation.

The CDS55xx use a half-duplex UART as communication bus port. User can assign a address for each servo, and control single servo or broadcast instruction to each servo.

The communication protocol of CDS55xx is opened to users; please refer to this document. The bus port is compatible to Robotis' Dynamixel AX12+, and the protocol is mostly compatible to it.

There are two work modes of CDS55xx: Position mode and gear motor mode. User can change mode with instructions.

The profile and mount flange is compatible to most off-the-shelf standard R/C servos. Please refer to the “CDS55xx robot servo Datasheet” for more Details.
1.2 Electrical Connection

1.2.1 Bus port

The bus port and typical connection diagram of proMOTION CDS55xx series robot servo is as shown below:

![Bus port and connection diagram]

1.2.2 Serial connection

CDS55xx robot servo uses a half-duplex UART bus for serial communication. There are two main methods to connect a CDS55xx servo:

**Method One: Control CDS55xx via a UP-debugger (or Robotis’ USB2Dynamixel)**

The UP-debugger will be recognized as a virtual RS-232 serial port device. User can send instruction packet with RS-232 communication software (such as Hyper Terminal or UPTECH Robotics’ RobotServoTerminal), the instruction packet will be send to the UP-debugger and transferred to the CDS55xx robot servo. The servo will execute the instruction packet and return a response packet.

The RobotServoTerminal software is designed for tuning or setting up CDS55xx robot servos. This method is a convenient method to set up and tune your servos. If you use a PC as the robot’s main controller, this method enables you to control servos with only a UP-debugger board.
Method Two : Control CDS55xx via Microcontroller

Method One needs a PC running Windows XP or Windows Vista system. If you do not want to use PC, you can design a microcontroller to interface the CDS55xx servos. You only need a UART port on the MCU, and make little interface circuit. the sub paragraph 1.2.3 gives a sample interface schematic using a AVR MCU’s UART port. Chapter 5 of this document gives a sample controller, including schematic and some sample C code.

1.2.3 Interface schematic

The serial bus interface of CDS55xx servo is a half-duplex UART, with 3 wires. To control the CDS55xx servos, the main controller needs to convert its UART signals to the half duplex type.

The schematic of a CDS55xx servo interface is shown below.

The power is supplied to the CDS55xx servo from the main controller through Pin 1 and Pin 2 of the Molex3P connector.

The direction of data signals on the TTL level MCU_TXD and MCU_RXD depends on the MCU_TXEN and MCU_RXEN level as the following.

<table>
<thead>
<tr>
<th>MCU_TXEN</th>
<th>MCU_RXEN</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>the signal from MCU_TXD is output as SIG</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>the signal from SIG is input as MCU_RXD</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>high-impedance</td>
</tr>
</tbody>
</table>
2 Communication protocol

2.1 Summary

The CDS55xx serial bus has a master device and multiple slave devices. The controller (or the PC) acts as master device, the CDS55xx servos act as slave devices. The communication sequence is:

- The master sends an instruction packet;
- The slave receive the instruction packet, execute it, and then send an answer packet to the master.

There are two types of packets; the “Instruction Packet” (sent from the main controller to the servos) and the “Status Packet” (sent from the servos to the main controller.)

There can be multiple CDS55xx servos on the bus; each servo should be assigned an unique ID. The instruction packet contains the ID info, only the corresponding servos will response the instruction packet when other servos will ignore them.

2.2 Instruction packet

Instruction packet format:

<table>
<thead>
<tr>
<th>HEADER</th>
<th>ID</th>
<th>LENGTH</th>
<th>INSTRUCTION</th>
<th>PARAMETER0…N</th>
<th>CHECK SUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>0xFF</td>
<td>0xFF</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The meanings of each packet byte definition are as the following.

**Header:**
two 0xFF in sequence indicates the start of a incoming instruction packet.

**ID:**
The unique ID of a CDS55xx unit. There are 254 available ID values, ranging from 0X00 to 0XFD. Broadcasting ID 0XFE is the Broadcasting ID which indicates all of the connected CDS55xx units. Packets sent with this ID apply to all CDS55xx units on the network. Thus packets sent with a broadcasting ID will not return any status packets.

**LENGTH:**
The length of the packet where its value is “Number of parameters (N) + 2”

**INSTRUCTION:**
The instruction for the CDS55xx servo to perform.

**PARAMETER0…N**
Used if there is additional information needed to be sent other than the instruction itself.

**CHECK SUM**
The computation method for the ‘Check Sum’ is as the following.

Check Sum = ~ (ID + Length + Instruction + Parameter1 + ... Parameter N).If the calculated value is larger than 255, the lower byte is defined as the checksum value.

~ represents the NOT logic operation.
2.3 Status packet

The Status Packet is the response packet from the CDS55xx servos to the Main Controller after receiving an instruction packet. The structure of the status packet is as the following:

<table>
<thead>
<tr>
<th>HEADER</th>
<th>ID</th>
<th>LENGTH</th>
<th>ERROR</th>
<th>PARAMETER</th>
<th>CHECK SUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>0xFF</td>
<td>0xFF</td>
<td>Length</td>
<td>Status</td>
<td>Parameter1 ... Parameter N</td>
<td>Check Sum</td>
</tr>
</tbody>
</table>

The meanings of each packet byte definition are as the following.

**HEADER**  
The two 0xFF bytes indicate the start of the packet.

**ID**  
The unique ID of the CDS55xx unit returning the packet. The initial value is set to 1.

**LENGTH**  
The length of the packet where its value is “Number of parameters (N) + 2”

**ERROR**  
The byte representing errors sent from the CDS55xx unit. The meaning of each bit is as the following.

<table>
<thead>
<tr>
<th>BIT</th>
<th>Name</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIT 7</td>
<td>0</td>
<td>---</td>
</tr>
<tr>
<td>BIT 6</td>
<td>Instruction Error</td>
<td>Set to 1 if an undefined instruction is sent or an action instruction is sent without a Reg_Write instruction.</td>
</tr>
<tr>
<td>BIT 5</td>
<td>Overload Error</td>
<td>Set to 1 if the specified maximum torque can't control the applied load.</td>
</tr>
<tr>
<td>BIT 4</td>
<td>Checksum Error</td>
<td>Set to 1 if the checksum of the instruction packet is incorrect.</td>
</tr>
<tr>
<td>BIT 3</td>
<td>Range Error</td>
<td>Set to 1 if the instruction sent is out of the defined range.</td>
</tr>
<tr>
<td>BIT 2</td>
<td>Overheating Error</td>
<td>Set to 1 if the internal temperature of the CDS55xx unit is above the operating temperature range as defined in the control table.</td>
</tr>
<tr>
<td>BIT 1</td>
<td>Position Limit Error</td>
<td>Set as 1 if the Goal Position is set outside of the range between CW Angle Limit and CCW Angle Limit.</td>
</tr>
<tr>
<td>BIT 0</td>
<td>Input Voltage Error</td>
<td>Set to 1 if the voltage is out of the operating voltage range as defined in the control table.</td>
</tr>
</tbody>
</table>

**PARAMETER0...N**  
Used if additional information is needed.

**CHECK SUM**  
The computation method for the ‘Check Sum’ is as the following.

Check Sum = ~ (ID + Length + Instruction + Parameter1 + ... Parameter N)

If the calculated value is larger than 255, the lower byte is defined as the checksum value.

~ represents the NOT logic operation.

2.4 Instruction Set

The following Instructions are available.

TEL : +86-010-8211-4870, +86-010-8211-4887 FAX : Ext.828  
http://robot.up-tech.com
### 2.4.1 WRITE DATA

**Function:**
To write data into the control table of the CDS55xx servo.

**Length:**
N+3 (N is the number of data to be written).

**Instruction:**
0X03

**Parameter 1:**
Starting address of the location where the data is to be written.

**Parameter 2:**
1st data to be written.

**Parameter 3:**
2nd data to be written.

**Parameter N+1:**
Nth data to be written.

**Example 1**
Setting the ID of a connected CDS55xx servo to 1.
Write 1 to address 3 of the control table. The ID is transmitted using the Broadcasting ID (0xFE).

**Instruction Packet:**
0XFF 0XFF 0XFE 0X04 0X03 0X01 0XF6

<table>
<thead>
<tr>
<th>HEADER</th>
<th>ID</th>
<th>LENGTH</th>
<th>INSTRUCTION</th>
<th>PARAMETERS</th>
<th>CHECKSUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>0XFF</td>
<td>0FF</td>
<td>0XFE</td>
<td>0X04</td>
<td>0X03</td>
<td>0X01</td>
</tr>
</tbody>
</table>

Because it was transmitted with a Broadcast ID (0XFE), no status packets are returned.

### 2.4.2 READ DATA

**Function:**
Read data from the control table of a CDS55xx servo.

**Length:**
0X04

**Instruction:**
0X02

**Parameter 1:**
Starting address of the location where the data is to be read.

**Parameter 2:**
Length of the data to be read.

**Example 2**
Reading the internal temperature of the CDS55xx servo with an ID of 1.
Read 1 byte from address 0x2B of the control table.

**Instruction Packet:**
0XFF 0XFF 0X01 0X04 0X02 0X2B 0X01 0XCC

<table>
<thead>
<tr>
<th>HEADER</th>
<th>ID</th>
<th>LENGTH</th>
<th>INSTRUCTION</th>
<th>PARAMETERS</th>
<th>CHECKSUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>0XFF</td>
<td>0FF</td>
<td>0X01</td>
<td>0X04</td>
<td>0X02</td>
<td>0X2B</td>
</tr>
</tbody>
</table>

The returned Status Packet will be as the following.

**Status Packet:**
0XFF 0XFF 0X01 0X03 0X00 0X20 0XDB
The data read is 0x20. Thus the current internal temperature of the CDS55xx servo is approximately 32°C (0x20).

### 2.4.3 REG WRITE

**Function**
The REG_WRITE instruction is similar to the WRITE_DATA instruction, but the execution timing is different. When the Instruction Packet is received the values are stored in the Buffer and the Write instruction is under a standby status. At this time, the Registered Instruction register (Address 0x2C) is set to 1. After the Action Instruction Packet is received, the registered Write instruction is finally executed.

**Length**
N+3 (N is the number of data to be written)

**Instruction**
0X04

**Parameter 1**
Starting address of the location where the data is to be written

**Parameter 2**
1st data to be written

**Parameter 3**
2nd data to be written

**Parameter N+1**
Nth data to be written

### 2.4.4 ACTION

**Function**
Triggers the action registered by the REG_WRITE instruction

**Length**
0X02

**Instruction**
0X05

**Parameter**
NONE

The ACTION instruction is useful when multiple CDS55xx servos need to move simultaneously. When controlling multiple CDS55xx servo units, slight time delays can occur between the 1st and last units to receive an instruction. The CDS55xx servo handles this problem by using the ACTION instruction.

**Broadcasting**
The Broadcast ID (0xFE) is used when sending ACTION instructions to more than two CDS55xx servos. Note that no packets are returned by this operation.

### 2.4.5 PING

**Function**
Does not command any operations. Used for requesting a status packet or to check the existence of a CDS55xx servo with a specific ID.

**Length**
0X02

**Instruction**
0X01

**Parameter**
NONE

**Example 3**
Obtaining the status packet of the CDS55xx servo with an ID of 1

**Instruction Packet**: 0xFF 0xFF 0X01 0X02 0X01 0xFB
The returned Status Packet is as the following
Status Packet : 0XFF 0XFF 0X01 0X02 0X00 0XFC

Regardless of whether the Broadcasting ID is used or the Status Return Level (Address 16) is 0, a Status Packet is always returned by the PING instruction.

### 2.4.6 RESET

**Function**
Changes the control table values of the CDS55xx servo to the Factory Default Value settings

**Length**
0X02

**Instruction**
0X06

**Parameter**
NONE

**Example 4**
Resetting the CDS55xx servo with an ID of 0

Instruction Packet : 0XFF 0XFF 0X00 0X02 0X06 0XF7

The returned Status Packet is as the following
Status Packet : 0XFF 0XFF 0X00 0X02 0X00 0XFD

Note the ID of this CDS55xx servo is now changed to 1 after the RESET instruction.

### 2.4.7 SYNC WRITE

**Function**
Used for controlling many CDS55xx servos at the same time. The communication time decreases by the Synch Write instruction since many instructions can be transmitted by a single instruction.

However, you can use this instruction only when the lengths and addresses of the control table to be written to are the same. Also, the broadcasting ID needs to be used for transmitting.

**ID**
0XFE

**Length**
(L + 1) * N + 4 (L: Data length for each CDS55xx servo, N: The number of CDS55xx servos)

**Instruction**
0X83

**Parameter1**
Starting address of the location where the data is to be written

**Parameter2**
The length of the data to be written (L)

**Parameter3**
The ID of the 1st CDS55xx servo

**Parameter4**
The 1st data for the 1st CDS55xx servo

**Parameter5**
The 2nd data for the 1st CDS55xx servo Data for the 1st CDS55xx servo

... **Parameter L+3**
The Lth data for the 1st CDS55xx servo

**Parameter L+4**
The ID of the 2nd CDS55xx servo
### Example 5

Setting the following positions and velocities for 4 CDS55xx servos:

- CDS55xx servo with an ID of 0: to position 0X010 with a speed of 0X150
- CDS55xx servo with an ID of 1: to position 0X220 with a speed of 0X360
- CDS55xx servo with an ID of 2: to position 0X030 with a speed of 0X170
- CDS55xx servo with an ID of 0: to position 0X220 with a speed of 0X380

Instruction Packet: `0XFF 0XFF 0XFE 0X18 0X83 0X1E 0X04 0X00 0X10 0X00 0X50 0X01 0X01 0X20 0X02 0X60 0X03 0X02 0X30 0X00 0X70 0X01 0X03 0X20 0X02 0X80 0X03 0X12`

<table>
<thead>
<tr>
<th>HEADER</th>
<th>ID</th>
<th>LENGTH</th>
<th>NSTRUCTION</th>
<th>PARAMETERS</th>
<th>HEADER</th>
</tr>
</thead>
<tbody>
<tr>
<td>0XFF</td>
<td>0XF</td>
<td>0XFE</td>
<td>0X18</td>
<td>0X83</td>
<td>0X1E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0X04</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0X00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0X10</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>0X00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0X50</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0X01</td>
</tr>
<tr>
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<td>0X01</td>
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<tr>
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<td></td>
<td></td>
<td></td>
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<td>0X20</td>
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<td>0X02</td>
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<td>0X60</td>
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<td>0X03</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>0X20</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0X02</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0X80</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0X03</td>
</tr>
</tbody>
</table>

No status packets are returned since the Broadcasting ID was used.
## 3 Memory contents

### 3.1 Control Table

<table>
<thead>
<tr>
<th>Address</th>
<th>Item</th>
<th>Access</th>
<th>Initial</th>
<th>Memory</th>
</tr>
</thead>
<tbody>
<tr>
<td>0(0X00)</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>EEPROM</td>
</tr>
<tr>
<td>1(0X01)</td>
<td>Model Number</td>
<td>RD</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>2(0X02)</td>
<td>Version of Firmware</td>
<td>RD</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>3(0X03)</td>
<td>ID</td>
<td>RD,WR</td>
<td>1(0x01)</td>
<td></td>
</tr>
<tr>
<td>4(0X04)</td>
<td>Baud Rate</td>
<td>RD,WR</td>
<td>1(0x01)</td>
<td></td>
</tr>
<tr>
<td>5(0X05)</td>
<td>Return Delay Time</td>
<td>RD,WR</td>
<td>0(0x01)</td>
<td></td>
</tr>
<tr>
<td>6(0X06)</td>
<td>CW Angle Limit(L)</td>
<td>RD,WR</td>
<td>0(0x00)</td>
<td></td>
</tr>
<tr>
<td>7(0X07)</td>
<td>CW Angle Limit(H)</td>
<td>RD,WR</td>
<td>0(0x00)</td>
<td></td>
</tr>
<tr>
<td>8(0X08)</td>
<td>CCW Angle Limit(L)</td>
<td>RD,WR</td>
<td>255(0xFF)</td>
<td></td>
</tr>
<tr>
<td>9(0X09)</td>
<td>CCW Angle Limit(H)</td>
<td>RD,WR</td>
<td>3(0x03)</td>
<td></td>
</tr>
<tr>
<td>10(0x0A)</td>
<td>(Reserved)</td>
<td>-</td>
<td>0(0x00)</td>
<td></td>
</tr>
<tr>
<td>11(0X0B)</td>
<td>The Highest Limit Temperature</td>
<td>RD, WR</td>
<td>80(0x50)</td>
<td></td>
</tr>
<tr>
<td>12(0X0C)</td>
<td>the Lowest Limit Voltage</td>
<td>RD,WR</td>
<td>60(0X3C)</td>
<td></td>
</tr>
<tr>
<td>13(0XD)</td>
<td>the Highest Limit Voltage</td>
<td>RD, WR</td>
<td>160(0x50)</td>
<td></td>
</tr>
<tr>
<td>14(0X0E)</td>
<td>Max Torque(L)</td>
<td>RD,WR</td>
<td>255(0xFF)</td>
<td></td>
</tr>
<tr>
<td>15(0X0F)</td>
<td>Max Torque(H)</td>
<td>RD,WR</td>
<td>3(0x03)</td>
<td></td>
</tr>
<tr>
<td>16(0X10)</td>
<td>Status Return Level</td>
<td>RD,WR</td>
<td>2(0x02)</td>
<td></td>
</tr>
<tr>
<td>17(0X11)</td>
<td>Alarm LED</td>
<td>RD,WR</td>
<td>5(0x25)</td>
<td></td>
</tr>
<tr>
<td>18(0X12)</td>
<td>Alarm Shutdown</td>
<td>RD,WR</td>
<td>5(0x04)</td>
<td></td>
</tr>
<tr>
<td>19(0X13)</td>
<td>(Reserved)</td>
<td>-</td>
<td>0(0x00)</td>
<td></td>
</tr>
<tr>
<td>20(0X14)</td>
<td>Down Calibration(L)</td>
<td>RD</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>21(0X15)</td>
<td>Down Calibration(H)</td>
<td>RD</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>22(0X16)</td>
<td>Up Calibration(L)</td>
<td>RD</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>23(0X17)</td>
<td>Up Calibration(H)</td>
<td>RD</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>24(0X18)</td>
<td>Torque Enable</td>
<td>RD,WR</td>
<td>0(0x00)</td>
<td>RAM</td>
</tr>
<tr>
<td>25(0X19)</td>
<td>LED</td>
<td>RD,WR</td>
<td>0(0x00)</td>
<td></td>
</tr>
<tr>
<td>26(0X1A)</td>
<td>CW Compliance Margin</td>
<td>RD,WR</td>
<td>2(0X02)</td>
<td></td>
</tr>
<tr>
<td>27(0X1B)</td>
<td>CCW Compliance Margin</td>
<td>RD,WR</td>
<td>2(0X02)</td>
<td></td>
</tr>
<tr>
<td>28(0X1C)</td>
<td>CW proportion</td>
<td>RD,WR</td>
<td>32(0x20)</td>
<td></td>
</tr>
<tr>
<td>29(0X1D)</td>
<td>CCW proportion</td>
<td>RD,WR</td>
<td>32(0x20)</td>
<td></td>
</tr>
<tr>
<td>30(0X1E)</td>
<td>Goal Position(L)</td>
<td>RD,WR</td>
<td>[Addr36]value</td>
<td></td>
</tr>
<tr>
<td>31(0X1F)</td>
<td>Goal Position(H)</td>
<td>RD,WR</td>
<td>[Addr37]value</td>
<td></td>
</tr>
<tr>
<td>32(0X20)</td>
<td>Moving Speed(L)</td>
<td>RD,WR</td>
<td>0(0x00)</td>
<td></td>
</tr>
<tr>
<td>33(0X21)</td>
<td>Moving Speed(H)</td>
<td>RD,WR</td>
<td>0(0x00)</td>
<td></td>
</tr>
<tr>
<td>34(0X22)</td>
<td>Acc</td>
<td>RD,WR</td>
<td>32(0x20)</td>
<td></td>
</tr>
<tr>
<td>35(0X23)</td>
<td>Dcc</td>
<td>RD,WR</td>
<td>32(0x20)</td>
<td></td>
</tr>
<tr>
<td>36(0X24)</td>
<td>Present Position(L)</td>
<td>RD</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>37(0X25)</td>
<td>Present Position(H)</td>
<td>RD</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>38(0X26)</td>
<td>Present Speed(L)</td>
<td>RD</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>39(0X27)</td>
<td>Present Speed(H)</td>
<td>RD</td>
<td>?</td>
<td></td>
</tr>
</tbody>
</table>
Control Table

The Control Table contains information on the status and operation of the CDS55xx servo. The CDS55xx servo is operated by writing values to its control table and its status is checked by reading values off its control table.

RAM and EEPROM

The data values for the RAM area will be set to the default initial values whenever the power is turned on. However, the data values for the EEPROM area are non-volatile and will still remain even after the power is turned off.

Initial Value

The Initial Value column on the right side of the control table shows the Factory Default Values for the case of EEPROM area data, and shows the initial value when the power is turned on for the case of RAM area data.

The following explains the meaning of data stored in each of the addresses in the control table.

Address 0x01  Model Number. For CDS5516 this value is 0X01 (1).
Address 0x02  Firmware Version.
Address 0x03  ID. The unique ID number assigned to each CDS55xx servos for identifying them. Different IDs are required for each CDS55xx servos that are on the same network.
Address 0x04  Baud Rate. Determines the communication speed. The computation is done by the following formula.

\[
\text{Speed (BPS)} = \frac{2000000}{(\text{Address4} + 1)}
\]

Data Value for each Major Baud Rate

<table>
<thead>
<tr>
<th>Address4 Hex</th>
<th>Set</th>
<th>BPS</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0X01</td>
<td>1000000.0</td>
<td>1000000.0</td>
</tr>
<tr>
<td>3</td>
<td>0X03</td>
<td>500000.0</td>
<td>500000.0</td>
</tr>
<tr>
<td>7</td>
<td>0X07</td>
<td>250000.0</td>
<td>250000.0</td>
</tr>
<tr>
<td>16</td>
<td>0X10</td>
<td>117647.1</td>
<td>115200.0</td>
</tr>
<tr>
<td>34</td>
<td>0X22</td>
<td>57142.9</td>
<td>57600.0</td>
</tr>
<tr>
<td>103</td>
<td>0X67</td>
<td>19230.8</td>
<td>19200.0</td>
</tr>
</tbody>
</table>

Other baud rate is still available, but not saved after power off.

Note

A maximum Baud Rate error of 3% is within the tolerance of UART communication.

Caution

The initial value of Baudrate is set to 1(1000000bps).

Address 0x05  Return Delay Time. The time it takes for the Status Packet to return
after the Instruction Packet is sent. The delay time is given by 2uSec
* Address5 value.

Address 0x06,0x07,0x08,0x09

**Operating Angle Limit.** Sets the CDS55xx servo’s operating angle range. The Goal Position needs to be within the range of: CW Angle Limit <= Goal Position <= CCW Angle Limit. An Angle Limit Error will occur if the Goal Position is set outside this range set by the operating angle limits.

Address 0x0B

**the Highest Limit Temperature.** This value is fixed. The upper limit of the CDS55xx servo’s operating temperature. If the internal temperature of the CDS55xx servo gets higher than this value, the Over Heating Error Bit (Bit 2 of the Status Packet) will return the value 1, and an alarm will be set by Address 17, 18. The values are in Degrees Celsius.

Address 0x0C,0x0D

**the Lowest (Highest) Limit Voltage.** The upper and lower limits of the CDS55xx servo’s operating voltage. If the present voltage (Address 42) is out of the specified range, a Voltage Range Error Bit (Bit 0 of the Status Packet) will return the value 1, and an alarm will be set by Address 17, 18. The values are 10 times the actual voltage value. For example, if the Address 12 value is 80, then the lower voltage limit is set to 8V.

Address 0x0E,0x0F, 0x22,0x23

**Max Torque.** The maximum torque output for the CDS55xx servo. When this value is set to 0, the CDS55xx servo enters the Free Run mode. There are two locations where this maximum torque limit is defined; in the EEPROM (Address 0X0E, 0x0F) and in the RAM (Address 0x22, 0x23). When the power is turned on, the maximum torque limit value defined in the EEPROM is copied to the location in the RAM. The torque of the CDS55xx servo is limited by the values located in the RAM (Address 0x22,0x23).

Address 0X10

**Status Return Level.** Determines whether the CDS55xx servo will return a Status Packet after receiving an Instruction Packet.

<table>
<thead>
<tr>
<th>Address16</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Do not respond to any instructions</td>
</tr>
<tr>
<td>1</td>
<td>Respond only to READ_DATA instructions</td>
</tr>
<tr>
<td>2</td>
<td>Respond to all instructions</td>
</tr>
</tbody>
</table>

In the case of an instruction which uses the Broadcast ID (0xFE) the Status Packet will not be returned regardless of the Address 0x10 value.

Address 0X11

**Alarm LED.** If the corresponding Bit is set to 1, the LED blinks when an Error occurs.

<table>
<thead>
<tr>
<th>Bit</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit7</td>
<td>0</td>
</tr>
<tr>
<td>Bit</td>
<td>Function</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------------------------------</td>
</tr>
<tr>
<td>Bit7</td>
<td>0</td>
</tr>
<tr>
<td>Bit6</td>
<td>If set to 1, torque off when an Instruction Error occurs</td>
</tr>
<tr>
<td>Bit5</td>
<td>--</td>
</tr>
<tr>
<td>Bit4</td>
<td>If set to 1, torque off when a Checksum Error occurs</td>
</tr>
<tr>
<td>Bit3</td>
<td>If set to 1, torque off when a Range Error occurs</td>
</tr>
<tr>
<td>Bit2</td>
<td>If set to 1, torque off when an Overheating Error occurs</td>
</tr>
<tr>
<td>Bit1</td>
<td>If set to 1, torque off when an Angle Limit Error occurs</td>
</tr>
<tr>
<td>Bit0</td>
<td>If set to 1, torque off when an Input Voltage Error occurs</td>
</tr>
</tbody>
</table>

This function operates following the “OR” logical operation of all bits. For example, if the value is set to 0x05, the LED will blink when an Input Voltage Error occurs or when an Overheating Error occurs.

**Address 0x12**

**Alarm Shutdwon.** If the corresponding Bit is set to 1, the CDS55xx servo’s torque will be turned off when an Error occurs.

<table>
<thead>
<tr>
<th>Bit</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit7</td>
<td>0</td>
</tr>
<tr>
<td>Bit6</td>
<td>If set to 1, torque off when an Instruction Error occurs</td>
</tr>
<tr>
<td>Bit5</td>
<td>--</td>
</tr>
<tr>
<td>Bit4</td>
<td>If set to 1, torque off when a Checksum Error occurs</td>
</tr>
<tr>
<td>Bit3</td>
<td>If set to 1, torque off when a Range Error occurs</td>
</tr>
<tr>
<td>Bit2</td>
<td>If set to 1, torque off when an Overheating Error occurs</td>
</tr>
<tr>
<td>Bit1</td>
<td>If set to 1, torque off when an Angle Limit Error occurs</td>
</tr>
<tr>
<td>Bit0</td>
<td>If set to 1, torque off when an Input Voltage Error occurs</td>
</tr>
</tbody>
</table>

This function operates following the “OR” logical operation of all bits. However, unlike the Alarm LED, after returning to a normal condition, it maintains the torque off status. To recover, the Torque Enable (Address 0x18) needs to be reset to 1.

**BIT5 overload signs is invalid, when CDS55XX overload, the torque is automatically reduced to a security value, but not completely torque of.**

The following (from Address 0x18) is in the RAM area.

**Address 0x18**

**Torque Enable.** When the power is first turned on, the CDS55xx servo enters the Torque Free Run condition (zero torque). Setting the value in Address 0x18 to 1 enables the torque.

**Address 0x19 LED.** The LED turns on when set to 1 and turns off if set to 0.

**Address 0x1A~0x1B**

**compliance Margin.** If difference of the target location and the physical location is smaller than compliance Margin, the position control will be insensitive.

**Address 0x1C~0x1D**

**CW/CCW proportion.** Adjust the position Position loop

**Address 0x1E,0x1F**

**GoalPosition.** Requested angular position for the CDS55xx servo output to move to. Setting this value to 0x3ff moves the output shaft to the position at 300°.

**Address 0x20,0x21**
Moving Speed. Sets the angular velocity of the output moving to the Goal Position. Setting this value to its maximum value of 0x3ff moves the output with an angular velocity of 62 RPM, provided that there is enough power supplied (The lowest velocity is when this value is set to 1. When set to 0, the velocity is the largest possible for the supplied voltage, e.g. no velocity control is applied.)

Address 0x20, 0x21

Acc, Dcc. Those are the Acceleration and Deceleration of the CDS55xx servo move to GoalPosition

Address 0x24, 0x25


Address 0x26, 0x27

Present Speed. Current angular velocity of the CDS55xx servo output.

Address 0x28, 0x29

Present Load. The magnitude of the load on the operatin CDS55xx servo. Bit 10 is the direction of the load.

Address 0x2A

Present Voltage. The voltage currently applied to the CDS55xx servo. The value is 10 times the actual voltage. For example, 10V is represented as 100 (0x64).

Address 0x2B

Present Temperature. The internal temperature of the CDS55xx servo in Degrees Celsius.

Address 0x2C

Registered Instruction. Set to 1 when an instruction is assigned by the REG_WRITE command. Set to 0 after it completes the assigned instruction by the Action command.

Address 0x2E

Moving. Set to 1 when the CDS55xx servo is moving by its own power.

Address 0x2F

Lock. If set to 1, only Address 0x18 to 0x23 can be written to and other areas cannot. Once locked, it can only be unlocked by turning the power off.

Address 0x30, 0x31

Punch. The minimum current supplied to the motor during operation. The initial value is set to 0x20 and its maximum value is 0x3ff.

3.2 Endless Turn

If both values for the CW Angle Limit and the CCW Angle Limit are set to 0, an Endless Turn mode can be implemented by setting the
Goal Speed. This feature can be used for implementing a continuously rotating wheel.

<table>
<thead>
<tr>
<th>BIT</th>
<th>Value</th>
<th>Turn Direction</th>
<th>Speed Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>15~11</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Turn Direction = 0 : CCW Direction Turn, Load Direction = 1: CW Direction Turn

### 4 Example

**Example 6**

**Changing the ID to 0 for a CDS55xx servo with an ID of 1**

**Instruction Packet**

Instruction = WRITE_DATA, Address = 0x03, DATA = 0x00

**Communication**

->in: FF FF 01 04 03 03 00 F4 (LEN:008)

<out: FF FF 01 02 00 FC (LEN:006)

**Status Packet Result** NO ERROR

**Example 7**

**Changing the Baud Rate of a CDS55xx servo to 1M bps**

**Instruction Packet**

Instruction = WRITE_DATA, Address = 0x04, DATA = 0x01

**Communication**

->in: FF FF 00 04 03 04 01 F3 (LEN:008)

<-out: FF FF 00 02 00 FD (LEN:006)

**Status Packet Result** NO ERROR

**Example 8**

**Resetting the Return Delay Time to 4 uSec for a CDS55xx servo with an ID of 0**

A Return Delay Time Value of 1 corresponds to 2uSec.

**Instruction Packet**

Instruction = WRITE_DATA, Address = 0x05, DATA = 0x02

**Communication**

->in: FF FF 00 04 03 05 02 F1 (LEN:008)

<-out: FF FF 00 02 00 FD (LEN:006)

**Status Packet Result** NO ERROR

It is recommended to set the Return Delay Time to the minimum value allowed by the Main Controller.

**Example 9**

**Limiting the operating angle range to 0°~150° for a CDS55xx servo with an ID of 0**

Since the CCW Angle Limit of 0x3ff corresponds to 300°, the angle 150° is represented by the value 0x1ff

**Instruction Packet**

Instruction = WRITE_DATA, Address = 0x08, DATA = 0xff, 0x01

**Communication**

->in: FF FF 00 05 03 08 FF 01 EF (LEN:009)

<-out: FF FF 00 02 00 FD (LEN:006)

**Status Packet Result** NO ERROR

**Example 10**

**Resetting the upper limit for the operating temperature to 80°C for a CDS55xx servo with an ID of 0**

**Instruction Packet**

Instruction = WRITE_DATA, Address = 0x0B, DATA = 0x50

**Communication**

->in: FF FF 00 04 03 0B 50 9D (LEN:008)

<-out: FF FF 00 02 00 FD (LEN:006)

**Status Packet Result** NO ERROR

**Example 11**

**Setting the operating voltage to 10V ~ 17V for a CDS55xx servo with an**
Example 12: Setting the maximum torque to 50% of its maximum possible value for a CDS55xx servo with an ID of 0

Set the MAX Torque value located in the ROM area to 0x1ff which is 50% of the maximum value 0x3ff.

Instruction Packet
- Instruction = WRITE_DATA, Address = 0x0E, DATA = 0xff, 0x01

Communication
- ->in: FF FF 00 04 03 10 00 E8 (LEN:008)
- <-out: FF FF 00 02 00 FD (LEN:006)

Status Packet Result: NO ERROR

Example 13: Set the CDS55xx servo with an ID of 0 to never return a Status Packet

Instruction Packet
- Instruction = WRITE_DATA, Address = 0x10, DATA = 0x00

Communication
- ->in: FF FF 00 04 03 10 00 E8 (LEN:008)
- <-out: FF FF 00 02 00 FD (LEN:006)

Status Packet Result: NO ERROR

The Status Packet is not returned starting with the following instruction.

Example 15: Set the Alarm to blink the LED and Shutdown (Torque off) the actuator when the operating temperature goes over the set limit

Since the Overheating Error is Bit 2, set the Alarm value to 0x04.

Instruction Packet
- Instruction = WRITE_DATA, Address = 0x11, DATA = 0x04, 0x04

Communication
- ->in: FF FF 00 05 03 11 04 04 DE (LEN:011)
- <-out: FF FF 00 02 00 FD (LEN:006)

Status Packet Result: NO ERROR

Example 16: Turn on the LED and Enable Torque for a CDS55xx servo with an ID of 0

Instruction Packet
- Instruction = WRITE_DATA, Address = 0x18, DATA = 0x01, 0x01

Communication
- ->in: FF FF 00 05 03 18 01 01 DD (LEN:011)
- <-out: FF FF 00 02 00 FD (LEN:006)

Status Packet Result: NO ERROR

You can verify the Torque Enabled status by trying to move the output of the actuator by hand.

Example 18: Position the output of a CDS55xx servo with an ID of 0 to 180° with an angular velocity of 31RPM

Set Address 0x1E (Goal Position) to 0x200 and Address 0x20 (Moving Speed) to 0x200.

Instruction Packet
- Instruction = WRITE_DATA, Address = 0x1E, DATA = 0x00, 0x02, 0x00, 0x02

Communication
- ->in: FF FF 00 07 03 1E 00 02 00 02 D3 (LEN:011)
Position the output of a CDS55xx servo with an ID of 0 to 0° and Position
the output of a CDS55xx servo with an ID of 1 to 300°, and initiate the
movement at the same time.

If the WRITE_DATA is used, the movement of the two actuators
cannot be initiate at the same time, thus the REG_WRITE and
ACTION instructions should be used instead.

Instruction Packet
ID=0, Instruction = REG_WRITE, Address = 0x1E, DATA = 0x00,
0x00
ID=1, Instruction = REG_WRITE, Address = 0x1E, DATA = 0xff, 0x03
ID=0xFE (Broadcasting ID), Instruction = ACTION,

Communication
-> in: FF FF 00 05 04 1E 00 00 D8 (LEN:009)
<- out: FF FF 00 02 00 FD (LEN:006)
-> in: FF FF 01 05 04 1E FF 03 D5 (LEN:009)
<- out: FF FF 01 02 00 FC (LEN:006)
-> in: FF FF FE 02 05 FA (LEN:006)
<- out: //No return packet against broadcasting ID

Once locked, the only way to unlock it is to remove the power.
If an attempt is made to access any locked data, an error is
returned. Range Error:0x08.

Instruction Packet
Instruction = WRITE_DATA, Address = 0x30, DATA = 0x40, 0x00

Communication
-> in: FF FF 00 05 03 30 40 00 87 (LEN:009)
<- out: FF FF 00 02 00 FD (LEN:006)
Appendix

CDS55xx Electrical Block Diagram
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