

XGO-Mini通信协议

XGO-Mini Communication Protocol

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前言

Preface

本文档适用于 XGO产品上位机与机器狗之间命令/数据交互的通信协议,采用标准TTL串行通讯，XH2.54 4PIN接口连接。

This document applies to the communication protocol for command/data integration between XGO upper host and the robot dog. The communication protocol is based on standard TTL serial communication and features XH2.54 4PIN interface connection.

背景知识

Background

XGO-Mini是一款12自由度桌面级机器狗，可以实现全向移动，六维姿态控制，姿态稳定，多种运动步态，内部搭载了9轴的IMU，关节位置传感和电流传感器反馈自身姿态和关节转角与力矩，用于内部算法和二次开发。

XGO-Mini is a desktop-sized AI quadruped robot with 12 DOFs which can achieve omnidirectional movement, 6D posture control, stable posture, and a variety of motions. Equipped with a 9-axis IMU, its joint position sensor and electric current sensor is able to reflect to its own posture and joint rotation angle and torque, which are used for algorithms verification and exploitation.

用六角螺丝到拧下背部两颗螺丝，左右两侧螺丝，尾部两颗螺丝后，拆除机器狗后背板，注意小心拔掉电源线。

Unscrew 2 screws on the back, 2 screws on the left and right, and 2 screws at the tail with a hex screwdriver, detach the back panel of the robot dog, unplug the power cord with caution.

如下图所示主板一侧有两个串口通信接口，按主板丝印线序和上位机线序对接即可以开始调试。两个端子对外供电电压分别是5V和3.3V，但不可同时使用。

As shown below, there are 2 serial communication interfaces at one side of the motherboard, connect interfaces by the line sequence printed on the motherboard and the host computer, then start the testing procedure. External supply voltage at two terminals is 5V and 3.3V respectively, but both are not allowed to use simultaneously.

默认情况下3.3V端子被AI模块占用，如果想用其他设备进通讯，请将AI模组端子拔下。

In default mode, 3.3V terminal is occupied by the AI module. Unplug the AI module terminal if you intend to use other device for communication.



软件接口

Software interface

通讯采用固定格式：字头+信息+字尾。

The fixed format applicable to communication: prefix+message+suffix.

标准TTL串行通讯：

Standard TTL serial communication:

波特率 Baud rate	115200
数据位 Data bit	8
停止位 Stop bit	1
奇偶校验位 Parity bit	无 NA

1. 通讯格式

1. Communication format

字头 Prefix	长度 (Length)	Message	校验和 (CheckSum)	字尾 Suffix
0x55	0x00			0x00 0xAA

		整个数据包所占字节数 Bytes occupied by the data packet	具体数据 Data	判断数据是否正确 Check if data is correct		
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字头：固定格式

Prefix: in fixed format

长度：数据包长度=字头占位[2]+长度占位[1]+Data占位[x]+校验和占位[1]+字尾占用[2]=6+x

Length: length of data packet = space occupied by prefix [2] + space occupied by length [1] + space occupied by Data [x] + space occupied by CheckSum [1] + space occupied by suffix [2]=6+x

Message: 详见2.指令

Message: See 2. Command

校验和：CheckSum = ~(Length+Message)若括号内的计算和超过255，则取最低一个字节，然后取反

Checksum: CheckSum= ~(Length+Message) If the sum of bytes in the bracket is greater than 255, the byte with the lowest value is taken, vice versa.

字尾:固定格式

Suffix: in fixed format

TIPS:本机接收指令时，如果长度或校验和出错，则认为数据出错，会自动丢弃该数据包。

TIPS: When the local appliance receives a command, if the length or CheckSum goes wrong, then the data is considered to be wrong and the data packet will be automatically discarded.

2. 指令

2. Commands

2.1写指令, 无应答 (0x00)

2.1 Write command, no response (0x00)

字头 Prefix		Length	指令类型 Command Type	首地址 First Address	数据 Data	Checksum	字尾 Suffix	
0x55	0x00						0x00	0xAA
			0x00		data1,data2			

指令:0x00, 向内存表连续写入一定字节的数据，不会产生应答

Command: 0x00, write data of some bytes to MemTable consecutively, no response will be generated

首地址:数据包写入的首地址(详见协议内存表)

First address: the first address written in the data packet (more details are available in the protocol MemTable)

数据:连续写入的数据

Data: data that are written consecutively

例: 设置机器人最大速度向前运动

Example: set the max. forward movement speed of the robot

0x55 0x00 0x09 0x00 0x30 0xFF 0xC7 0x00 0xAA

字头 : 0x55 0x00

Prefix: 0x55 0x00

Length: 0x09, 数据包共9个字节

Length: 0x09, there are 9 bytes contained in the data packet

Message: 0x00无应答写指令, 0x30前后移动速度寄存器地址, 0xff设置最大速度

Message: 0x00 write command with no response, 0x30 register address of forward, backward movement speed, 0xff set the max. speed

Checksum: 0x09+0x00+0x30+0xFF=0x138, 取最低字节0x38, 取反得0xC7

Checksum: 0x09+0x00+0x30+0xFF=0x138, take the lowest byte 0x38, take the inverse to get 0xC7

字尾: 0x00 0xAA

Suffix: 0x00 0xAA

2.2读指令 (0x02)

2.2 Read command (0x02)

字头 Prefix		Length	指令 类型 Command Type	首地址 First Address	字节数 Bytes	Checksum	字尾 Suffix	
0x55	0x00						0x00	0xAA
		0x09	0x02					

指令: 0x02, 读取内存表中一段连续的字节

Command: 0x02, a length of consecutive bytes in the read MemTable

首地址: 数据包读取的首地址 (详见协议内存表)

First address: the first address of the data packet that has been read (more details are available in the protocol MemTable)

字节数: 连续读取的字节长度

Bytes: the length of bytes that are read consecutively

返回数据包格式:

Format of the data packet returned:

字头 Prefix		Length	应答符 Response character	首地址 First Address	数据 Data	Checksum	字尾 Suffix	
0x55	0x00						0x00	0xAA
			0x12					

应答符: 0x12, 表明该数据包为读取指令的应答包

Response character: 0x12, it means this packet is response packet of the read command

首地址: 读取指令数据包中的首地址

First address: the first address in the read command packet

数据: 读取到的数据, 长度为相应读取指令要求字节长度

Data: the data that has been read, with the same length as the length of bytes requested by the read command

例: 读取12个舵机的位置

Example: read the respective position of 12 steering gears

0x55 0x00 0x09 0x02 0x50 0x0C 0x98 0x00 0xAA

字头: 0x55 0x00

Prefix: 0x55 0x00

Length: 0x09, 数据包共9个字节

Length: 0x09, there are 9 bytes contained in the data packet

Message: 0x02读指令, 0x50舵机ID为11位置寄存器地址, 0x0C, 连续读取12个字节

Message: 0x02 read command, 0x50 gear ID is the register address at the position "11", read 12 bytes consecutively

Checksum: $0x09+0x02+0x50+0x0C=0x67$, 取反得0x98

Checksum: $0x09+0x02+0x50+0x0C=0x67$, reverse to obtain 0x98

字尾: 0x00 0xAA

Suffix: 0x00 0xAA

读取返回数据包:

Read the packet returned:

0x55 0x00 0x14 0x12 0x50 0x80 0x80 0x80 0x80 0x80 0x80 0x80 0x80
0x80 0x80 0x80 0x80 0x89 0x00 0xAA

字头: 0x55 0x00

Prefix: 0x55 0x00

Length: 0x14, 数据包共20个字节

Length: 0x14, there are 20 bytes contained in the packet

Message: 0x12应答符, 0x50首地址与相应读取指令一致, 0x80共12个, 对应12个连续寄存器地址

Message: 0x12 response character, the first address of 0x50 is the same as the corresponding read command, there are 12 "0x80" that correspond to the respective address of 12 consecutive registers

Checksum: $0x14+0x12+0x50+0x80*12(d)=0x676$, 取最低字节0x76, 取反得0x89

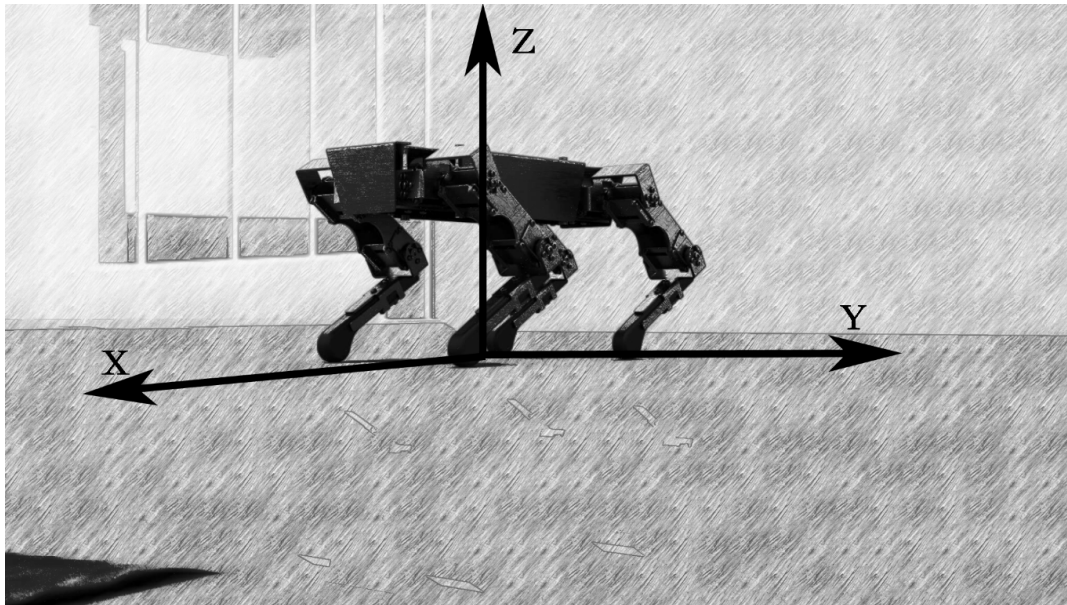
Checksum: $0x14+0x12+0x50+0x80*12(d)=0x676$, take the byte with the lowest value 0x76, reverse to obtain 0x89

字尾: 0x00 0xAA

Suffix: 0x00 0xAA

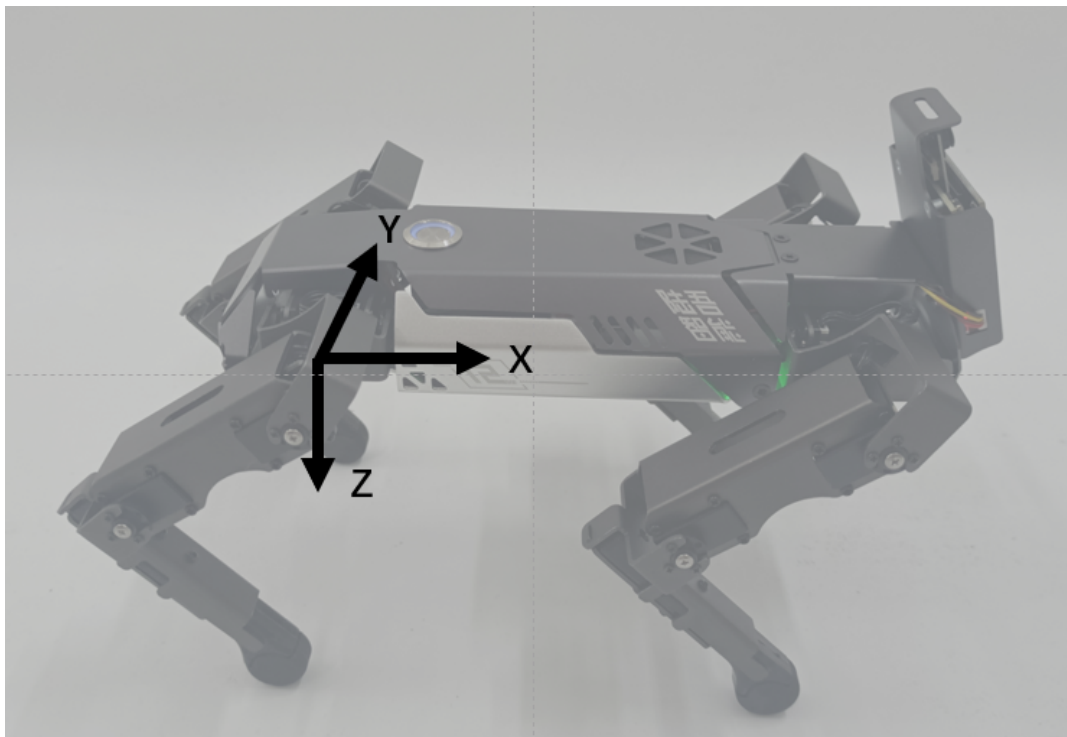
3. 机器人坐标系

3. Robot coordinate system



整机坐标系

Whole unit coordinate system



单腿坐标系

Single leg coordinate system

下面为XGO内存表

The MemTable of XGO is given below

备注：调试模式、整机模式、单腿模式、舵机模式（优先级递减）：当尝试写入这四种模式下的任一寄存器以改变其中数据时，机器人将会默认进入该模式，而另三种模式下的寄存器数据不起作用。默认整机模式。

Remark: test mode, whole unit mode, single leg mode, steering gear mode (priority level in a descending order): when you try to write any register under the four modes to change data, the robot will enter the mode by default while the register data under other three modes cannot work. The robot is default in whole unit mode.

地址 Address	功能 Function	读写 Read-write	初始值 Initial Value	备注 Note	模式 Mode
0x00	工作状态 Mode of operation	读 Read	0x00		状态信息 State information
0x01	电池电量 Battery level	读 Read	0xff	范围为0-100，线性对应电量最低值-最高值 Range: 0-100, linearly corresponding to the lowest-highest battery level	
0x02	XGO版本 XGO version	读 Read		0x00 MINI 0x01 Lite 0x02 PRO	
0x03	表演模式 Performance mode	写 Write	0x00	0x00正常控制模式 0x01循环做动作 0x00 normal control mode 0x01 cyclic action	
0x04	标定模式 Calibration mode	写 Write	0x00	0x01进入标定模式 0x00退出标定模式完成标定 0x01 Enter the calibration mode 0x00 Exit the calibration mode and complete the calibration process	
0x10	蓝牙连接状态 Status of Bluetooth connection	读 Read	0x00	0x00本机无蓝牙设备或蓝牙模块故障 0x01支持蓝牙设备但未连接手机终端 0x02已连接手机终端 0x00 The appliance has no Bluetooth device or the Bluetooth module malfunctions 0x01 Bluetooth device is supported but the mobile terminal is not connected 0x02 The mobile terminal is connected	蓝牙信息 暂不支持 Bluetooth information Currently not supported
0x11	蓝牙串口波特率 Baud rate of Bluetooth serial port	读 Read	0x00		
0x12	蓝牙密码 Bluetooth password	读写 Read-write	1234	该寄存器为字符串类型，典型值占位可能超过一个字节，读取命令时将忽略指令中的字节数，返回数据包中按真实字节数，写入时数据包中请按真实字节数	

				This register is a string type and the space occupied by typical value may be more than one byte. Bytes in the instruction will be ignored when reading command, take actual bytes in the packet returned; when writing take actual bytes in the packet	
0x13	蓝牙名称 Bluetooth name	读写 Read-write	HC-05	该寄存器为字符串类型，典型值占位可能超过一个字节，读取命令时将忽略指令中的字节数，返回数据包中按真实字节数，写入时数据包中请按真实字节数 This register is a string type and the space occupied by typical value may be more than one byte. Bytes in the instruction will be ignored when reading command, take actual bytes in the packet returned; when writing take actual bytes in the packet	
0x20	卸载舵机 Unmount steering gear	读写 Read-write	0x00	0x00舵机处于正常工作状态，0x01卸载所有舵机，0x11-0x14依次卸载1-4号腿，0x21-0x24依次恢复1-4号腿 0x00 The steering gear is in normal operation, 0x01 Unmount all gears, 0x11-0x14 Unmount #1-4 leg in order, 0x21-0x24 Remount #1-4 leg in order	调试模式 Test mode
0x21	重置舵机零位 Reset the zero position of steering gear	写 Write	0x00	0x00舵机处于正常工作状态0x01所有舵机记录当前位置为零位 该寄存器设定为0x01后，会自动跳变为0x00 0x00 The steering gear is in normal operation, 0x01 All gears record the current position as the zero position. Once set as 0x01, the register will automatically jump to 0x00	
0x30	前后移动速度 Forward/backward movement speed	读写 Read-write	0x80	范围为0x00-0xff，线性对应反向最大值-正向最大值，正方向按机器人坐标系，下同 Range: 0x00-0xff, linearly corresponding to the revers max. value-forward max. value. The forward direction is the same as the robot coordinate system, the same below	整机模式 Whole unit mode
0x31	左右移动速度 Left/right movement speed	读写 Read-write	0x80		
0x32	顺时针/逆时针旋转速度 Clockwise/counterclockwise rotation speed	读写 Read-write	0x80	迎着z轴射来方向顺时针对应最大值方向 The incidence direction along the z axis corresponds to the max. value direction clockwise	
0x33	身体沿x方向平移距离	读写	0x80	足端与地面接触点不变而身体扭动，下同	

	Body shift distance along the x direction	Read-write		The body twists with the area where the foot contacts the floor remains unchanged, the same below
0x34	身体沿y方向平移距离 Body shift distance along the y direction	读写 Read-write	0x80	
0x35	身体高度 Body height	读写 Read-write	0x80	
0x36	身体绕x轴旋转角度 Angle at which the body rotates around the x axis	读写 Read-write	0x80	迎着坐标轴射来方向顺时针对应最大值方向 The incidence direction along the coordinate system corresponds to the max. value direction clockwise
0x37	身体绕y轴旋转角度 Angle at which the body rotates around the y axis	读写 Read-write	0x80	
0x38	身体绕z轴旋转角度 Angle at which the body rotates around the z axis	读写 Read-write	0x80	
0x39	以一定周期绕x轴旋转身体 A given period in which the body rotates around the x axis	读写 Read-write	0x00	0x00停止, 0x01-0xff线性对应最小-最大旋转速度, 该功能与直接设置位置寄存器不能同时起作用 0x00 stop, 0x01-0xff linearly corresponds to the min.-max. rotation speed, this function cannot work alongside with the direct setup of the position register
0x3A	以一定周期绕y轴旋转身体 A given period in which the body rotates around the y axis	读写 Read-write	0x00	
0x3B	以一定周期绕z轴旋转身体 A given period in which the body rotates around the z axis	读写 Read-write	0x00	
0x3C	原地踏步	读写	0x00	0x00停止, 0x01-0xff线性对应最小-最大踏步高度

	Stepping	Read-write		0x00 stop, 0x01-0xff linearly corresponds to the min.-max. stepping height	
0x3D	运动模式 Moving mode	读写 Read-write	0x00	0x00常速运动0x01慢速运动0x02高速运动 0x00 Move at normal speed 0x01 Move at slow speed 0x02 Move at high speed	
0x3E	动作指令 Action command	写 Write	0x00	动作指令表，0为默认站姿 1-N为各个动作(0-N为十进制)，1趴下，2站起，3匍匐前进，4转圈原地踏步，5蹲起，6转动Roll，7转动Pitch，8转动Yaw，9三轴转动，10撒尿，11坐下招鹅，12伸懒腰，13波浪，14左右摇摆，15求食，16找食物，17握手 List of action commands, 0 is the default stance 1-N means each action (0-N is decimal value), 1: lying down, 2: standing up, 3: creeping, 4: circling, 5: stepping, 6: squatting, 7: rolling, 8: pitching, 9: yawing, 10 three-axis rotation, 11 peeing, 12 sitting, 13 beckoning, 14: stretching, 15: waving, 16 swaying, 17 begging for food, 18 searching food, 19 shaking hands	
0x80	以一定周期沿X轴方向平移运动 A given period in which the body shifts along the X axis	读写 Read-write	0x00	0x00停止，0x01-0xff对应最小-最大旋转速度，移动幅度为位置限幅的一半 0x00 stop, 0x01-0xff corresponds to the min.-max. rotation speed, the extent of movement is a half of the position limit	
0x81	以一定周期沿Y轴方向平移运动 A given period in which the body shifts along the Y axis	读写 Read-write	0x00		
0x82	以一定周期沿Z轴方向平移运动 A given period in which the body shifts along the Z axis	读写 Read-write	0x00		
0x40	左前腿x方向足端位置 Foot position along the x direction of the left fore leg	读写 Read-write	0x80	范围为0x00-0xff，线性对应反向最大值-正向最大值，正方向按机器人坐标系 Range: 0x00-0xff, linearly corresponding to the reverse max. value-forward max. value, the forward direction is the same as the robot coordinate system	单腿模式 Single leg mode
0x41	左前腿y方向足端位置 Foot position along the y direction of the left fore leg	读写 Read-write	0x80		

0x42	左前腿z方向足端位置 Foot position along the z direction of the left fore leg	读写 Read-w rite	0x80		
0x43	右前腿x方向足端位置 Foot position along the x direction of the right fore leg	读写 Read-w rite	0x80		
0x44	右前腿y方向足端位置 Foot position along the y direction of the right fore leg	读写 Read-w rite	0x80		
0x45	右前腿z方向足端位置 Foot position along the z direction of the right fore leg	读写 Read-w rite	0x80		
0x46	右后腿x方向足端位置 Foot position along the x direction of the right rear leg	读写 Read-w rite	0x80		
0x47	右后腿y方向足端位置 Foot position along the y direction of the right rear leg	读写 Read-w rite	0x80		
0x48	右后腿z方向足端位置 Foot position along the z direction of the right rear leg	读写 Read-w rite	0x80		
0x49	左后腿x方向足端位置 Foot position along the x direction of the left rear leg	读写 Read-w rite	0x80		
0x4A	左后腿y方向足端位置 Foot position along the y direction of the left rear leg	读写 Read-w rite	0x80		

0x4B	左后腿z方向足端位置 Foot position along the z direction of the left rear leg	读写 Read-w rite	0x80		
0x50	左前腿肘, ID为11舵机位置 Left fore leg elbow, ID is the position of #11 gear	读写 Read-w rite	0x80	<p>范围为0x00-0xff, 线性对应反向最大值-正向最大值 Range: 0x00-0xff, linearly corresponding to the reverse max. value-forward max. value</p>	舵机模式 Steering gear mode
0x51	左前腿臂, ID为12舵机位置 Left fore leg arm, ID is the position of #12 gear	读写 Read-w rite	0x80		
0x52	左前腿肩, ID为13舵机位置 Left fore leg shoulder, ID is the position of #13 gear	读写 Read-w rite	0x80		
0x53	右前腿肘, ID为21舵机位置 Right fore leg elbow, ID is the position of #21 gear	读写 Read-w rite	0x80		
0x54	右前腿臂, ID为22舵机位置 Right fore leg arm, ID is the position of #22 gear	读写 Read-w rite	0x80		
0x55	右前腿肩, ID为23舵机位置 Right fore leg shoulder, ID is the position of #23 gear	读写 Read-w rite	0x80		
0x56	右后腿肘, ID为31舵机位置 Right rear leg elbow, ID is the position of #31 gear	读写 Read-w rite	0x80		
0x57	右后腿臂, ID为32舵机位置 Right rear leg arm, ID is the position of #32 gear	读写 Read-w rite	0x80		

0x58	右后腿肩, ID为33舵机位置 Right rear leg shoulder, ID is the position of #33 gear	读写 Read-write	0x80	
0x59	左后腿肘, ID为41舵机位置 Left rear leg elbow, ID is the position of #41 gear	读写 Read-write	0x80	
0x5A	左后腿臂, ID为42舵机位置 Right rear leg arm, ID is the position of #42 gear	读写 Read-write	0x80	
0x5B	左后腿肩, ID为43舵机位置 Right rear leg shoulder, ID is the position of #43 gear	读写 Read-write	0x80	
0x5C	设置舵机速度 Set the speed of steering gear	读写 Read-write	0x80	范围为0x00-0xff, 线性对应最小值-最大值 (仅在该模式下有效) Range: 0x00-0xff, linearly corresponding to the min. - max. value (only applicable under this mode)
0x5D	舵机位置设置为站立姿态 The gear position is set as standing posture	写 Write	0x00	0x00不起作用0x01舵机位置恢复站立时位置 该寄存器设定为0x01后, 会自动跳变为0x00 0x00 inactive. 0x01 The gear position returns to the standing position. Once set as 0x01, the register will automatically jump to 0x00
0x61	IMU状态 IMU state	读写 Read-write	0x00	0x00关闭 0x01自稳定模式 0x00 close 0x01 self-stabilizing mode