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Annexos

Especificacions càmera Grasshopper Grass-03K2C-C

Resolution	640 x 480
Frame Rate	200 FPS
Megapixels	0.3 MP
Chroma	Color
Sensor Name	Kodak KAI0340
Sensor Type	CCD
Readout Method	Global shutter
Sensor Format	1/3"
Pixel Size	7.4 μm
Lens Mount	C-mount
ADC	14-bit
Gain Range	0 dB to 24 dB
Exposure Range	0.02 ms to >10 seconds
Trigger Modes	Standard, bulb, skip frames, overlapped, multi-shot
Partial Image Modes	Pixel binning, ROI
Image Processing	Gamma, lookup table, white balance
Image Buffer	32 MB
User Sets	2 memory channels for custom camera settings
Flash Memory	512 KB non-volatile memory
Non-isolated I/O Ports	2 bi-directional
Serial Port	1 (over non-isolated I/O)
Auxiliary Output	3.3 V, 150 mA maximum
Interface	FireWire 1394b
Power Requirements	8 to 30 V
Power Consumption (Maximum)	3.5 W at 12 V
Dimensions	44 mm x 29 mm x 58 mm
Mass	104 g
Machine Vision Standard	IIDC v1.31
Compliance	CE, FCC, KCC, RoHS
Temperature (Operating)	0° to 40°C
Temperature (Storage)	-30° to 60°C
Humidity (Operating)	20 to 80% (no condensation)
Humidity (Storage)	20 to 95% (no condensation)
Warranty	3 years

Especificacions actuadors Dynamixel™ AX-12+



[AX-12/12+]

[AX-12A]

※ AX-12+ is the improved version of existing AX-12: the design of circuit, material, and wheel gear are specially improved.

※ AX-12A is a new version of the AX-12+ with the same performance but more advanced external design. Only the AX-12A is now being sold.

H/W Specification

- Weight : 53.5g (AX-12/AX-12+), 54.6g (AX-12A)
- Dimension : 32mm * 50mm * 40mm
- Resolution : 0.29°
- Gear Reduction Ratio : 254 : 1
- Stall Torque : 1.5N.m (at 12.0V, 1.5A)
- No load speed : 59rpm (at 12V)
- Running Degree
 - 0° ~ 300°
 - Endless Turn
- Running Temperature : -5°C ~ +70°C
- Voltage : 9 ~ 12V (Recommended Voltage 11.1V)
- Command Signal : Digital Packet
- Protocol Type : Half duplex Asynchronous Serial Communication (8bit,1stop,No Parity)
- Link (Physical) : TTL Level Multi Drop (daisy chain type Connector)
- ID : 254 ID (0~253)
- Communication Speed : 7343bps ~ 1 Mbps
- Feedback : Position, Temperature, Load, Input Voltage, etc.
- Material : Engineering Plastic

Stall torque is the maximum instantaneous and static torque

Stable motions are possible with robots designed for loads with 1/5 or less of the stall torque

Control Table

Control Table consists of data regarding the current status and operation, which exists inside of Dynamixel. The user can control Dynamixel by changing data of Control Table via Instruction Packet.

EEPROM and RAM

Data in RAM area is reset to the initial value whenever the power is turned on while data in EEPROM area is kept once the value is set even if the power is turned off.

Address

It represents the location of data. To read from or write data to Control Table, the user should assign the correct address in the Instruction Packet.

Access

Dynamixel has two kinds of data: Read-only data, which is mainly used for sensing, and Read-and-Write data, which is used for driving.

Initial Value

In case of data in the EEPROM Area, the initial values on the right side of the below Control Table are the factory default settings. In case of data in the RAM Area, the initial values on the right side of the above Control Tables are the ones when the power is turned on.

Highest/Lowest Byte

In the Control table, some data share the same name, but they are attached with (L) or (H) at the end of each name to distinguish the address. This data requires 16bit, but it is divided into 8bit each for the addresses (low) and (high). These two addresses should be written with one Instruction Packet at the same time.

Area	Address (Hexadecimal)	Name	Description	Access	Initial Value (Hexadecimal)
EEPROM	0 (0X00)	Model Number(L)	Lowest byte of model number	R	12 (0X0C)
	1 (0X01)	Model Number(H)	Highest byte of model number	R	0 (0X00)
	2 (0X02)	Version of Firmware	Information on the version of firmware	R	-
	3 (0X03)	ID	ID of Dynamixel	RW	1 (0X01)
	4 (0X04)	Baud Rate	Baud Rate of Dynamixel	RW	1 (0X01)
	5 (0X05)	Return Delay Time	Return Delay Time	RW	250 (0XFA)
	6 (0X06)	CW Angle Limit(L)	Lowest byte of clockwise Angle Limit	RW	0 (0X00)
	7 (0X07)	CW Angle Limit(H)	Highest byte of clockwise Angle Limit	RW	0 (0X00)
	8 (0X08)	CCW Angle Limit(L)	Lowest byte of counterclockwise Angle Limit	RW	255 (0XFF)
	9 (0X09)	CCW Angle Limit(H)	Highest byte of counterclockwise Angle Limit	RW	3 (0X03)
	11 (0X0B)	the Highest Limit Temperature	Internal Limit Temperature	RW	70 (0X46)
	12 (0X0C)	the Lowest Limit Voltage	Lowest Limit Voltage	RW	60 (0X3C)
	13 (0X0D)	the Highest Limit Voltage	Highest Limit Voltage	RW	140 (0X8E)
	14 (0X0E)	Max Torque(L)	Lowest byte of Max, Torque	RW	255 (0XFF)
	15 (0X0F)	Max Torque(H)	Highest byte of Max, Torque	RW	3 (0X03)
	16 (0X10)	Status Return Level	Status Return Level	RW	2 (0X02)
	17 (0X11)	Alarm LED	LED for Alarm	RW	36(0x24)
	18 (0X12)	Alarm Shutdown	Shutdown for Alarm	RW	36(0x24)
RAM	24 (0X18)	Torque Enable	Torque On/Off	RW	0 (0X00)
	25 (0X19)	LED	LED On/Off	RW	0 (0X00)
	26 (0X1A)	CW Compliance Margin	CW Compliance margin	RW	1 (0X01)
	27 (0X1B)	CCW Compliance Margin	CCW Compliance margin	RW	1 (0X01)
	28 (0X1C)	CW Compliance Slope	CW Compliance slope	RW	32 (0X20)
	29 (0X1D)	CCW Compliance Slope	CCW Compliance slope	RW	32 (0X20)
	30 (0X1E)	Goal Position(L)	Lowest byte of Goal Position	RW	-
	31 (0X1F)	Goal Position(H)	Highest byte of Goal Position	RW	-
	32 (0X20)	Moving Speed(L)	Lowest byte of Moving Speed (Moving Velocity)	RW	-
	33 (0X21)	Moving Speed(H)	Highest byte of Moving Speed (Moving Velocity)	RW	-
	34 (0X22)	Torque Limit(L)	Lowest byte of Torque Limit (Goal Torque)	RW	ADD14
	35 (0X23)	Torque Limit(H)	Highest byte of Torque Limit (Goal Torque)	RW	ADD15
	36 (0X24)	Present Position(L)	Lowest byte of Current Position (Present Velocity)	R	-
	37 (0X25)	Present Position(H)	Highest byte of Current Position (Present Velocity)	R	-
	38 (0X26)	Present Speed(L)	Lowest byte of Current Speed	R	-
	39 (0X27)	Present Speed(H)	Highest byte of Current Speed	R	-
	40 (0X28)	Present Load(L)	Lowest byte of Current Load	R	-
	41 (0X29)	Present Load(H)	Highest byte of Current Load	R	-
	42 (0X2A)	Present Voltage	Current Voltage	R	-
	43 (0X2B)	Present Temperature	Current Temperature	R	-
	44 (0X2C)	Registered	Means if Instruction is registered	R	0 (0X00)
	46 (0X2E)	Moving	Means if there is any movement	R	0 (0X00)
47 (0X2F)	Lock	Locking EEPROM	RW	0 (0X00)	
48 (0X30)	Punch(L)	Lowest byte of Punch	RW	32 (0X20)	
49 (0X31)	Punch(H)	Highest byte of Punch	RW	0 (0X00)	

Address Function

HelpEEPROM Area

Model Number

It represents the Model Number.

Firmware Version

It represents the firmware version.

ID

It is a unique number to identify Dynamixel.

The range from 0 to 252 (0xFC) can be used, and, especially, 254(0xFE) is used as the Broadcast ID.

If the Broadcast ID is used to transmit Instruction Packet, we can command to all Dynamixels.

Baud Rate

It represents the communication speed. 0 to 254 (0xFE) can be used for it.

This speed is calculated by using the below formula.

$$\text{Speed(BPS)} = 2000000/(\text{Data}+1)$$

Data	Set BPS	Target BPS	Tolerance
1	1000000.0	1000000.0	0.000 %
3	500000.0	500000.0	0.000 %
4	400000.0	400000.0	0.000 %
7	250000.0	250000.0	0.000 %
9	200000.0	200000.0	0.000 %
16	117647.1	115200.0	-2.124 %
34	57142.9	57600.0	0.794 %
103	19230.8	19200.0	-0.160 %
207	9615.4	9600.0	-0.160 %

Return Delay Time

It is the delay time per data value that takes from the transmission of Instruction Packet until the return of Status Packet.

0 to 254 (0xFE) can be used, and the delay time per data value is 2 usec.

That is to say, if the data value is 10, 20 usec is delayed. The initial value is 250 (0xFA) (i.e., 0.5 msec).

CW/CCW Angle Limit

The angle limit allows the motion to be restrained.

The range and the unit of the value is the same as Goal Position(Address 30, 31).

- CW Angle Limit: the minimum value of Goal Position(Address 30, 31)
- CCW Angle Limit: the maximum value of Goal Position(Address 30, 31)

The following two modes can be set pursuant to the value of CW and CCW.

Operation Type	CW / CCW
Wheel Mode	both are 0
Joint Mode	neither at 0

The wheel mode can be used to wheel-type operation robots since motors of the robots spin infinitely.

The joint mode can be used to multi-joints robot since the robots can be controlled with specific angles.

The Highest Limit Temperature

Caution : Do not set the temperature lower/higher than the default value.

When the temperature alarm shutdown occurs, wait 20 minutes to cool the temperature before re-use.

Using the product when the temperature is high may and can cause damage.

The Lowest (Highest) Limit Voltage

It is the operation range of voltage.

50 to 250 (0x32 ~ 0x96) can be used. The unit is 0.1V.

For example, if the value is 80, it is 8V.

If Present Voltage (Address42) is out of the range, Voltage Range Error Bit (Bit0) of Status Packet is returned as '1' and Alarm is triggered as set in the addresses 17 and 18.

Max Torque

It is the torque value of maximum output. 0 to 1023 (0x3FF) can be used, and the unit is about 0.1%.

For example, Data 1023 (0x3FF) means that Dynamixel will use 100% of the maximum torque it can produce while Data 512 (0x200) means that Dynamixel will use 50% of the maximum torque. When the power is turned on, Torque Limit (Addresses 34 and 35) uses the value as the initial value.

Status Return Level

It decides how to return Status Packet. There are three ways like the below table.

Value	Return of Status Packet
0	No return against all commands (Except PING Command)
1	Return only for the READ command
2	Return for all commands

Alarm LED

Alarm Shutdown

Dynamixel can protect itself by detecting errors occur during the operation.

The errors can be set are as the table below.

It is possible to make duplicate set since the function of each bit is run by the logic of 'OR'. That is, if 0X05 (binary 00000101) is set, both Input Voltage Error and Overheating Error can be detected.

If errors occur, in case of Alarm LED, the LED blinks; in case of Alarm Shutdown, the motor output becomes 0 % by making the value of Torque Limit(Address 34, 35) as 0.

RAM Area

Torque Enable

Value	Meaning
0	Keeps Torque from generating by interrupting the power of motor.
1	Generates Torque by impressing the power to the motor.

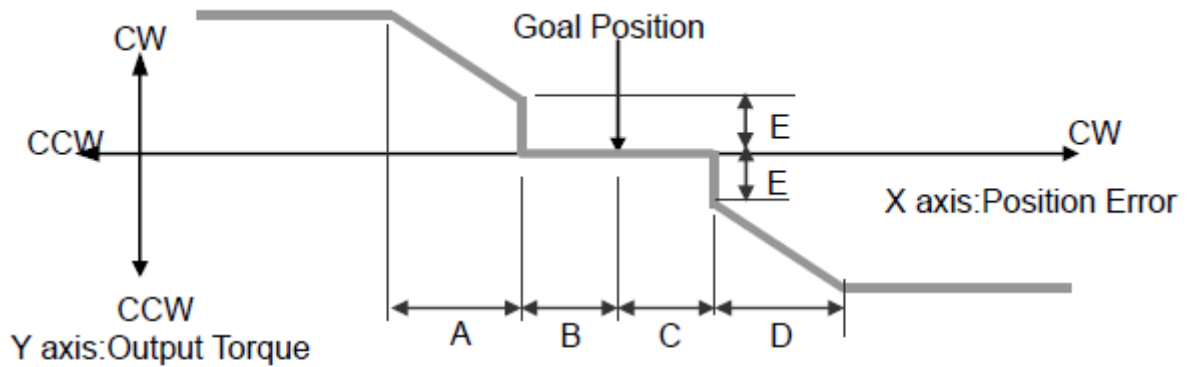
LED

Bit	Meaning
0	Turn OFF the LED
1	Turn ON the LED

Compliance

Compliance is to set the control flexibility of the motor.

The following diagram shows the relationship between output torque and position of the motor.



- A : CCW Compliance Slope(Address0x1D)**
B : CCW Compliance Margin(Address0x1B)
C : CW Compliance Margin(Address0x1A)
D : CW Compliance Slope (Address0x1C)
E : Punch(Address0x30,31)

Compliance Margin

It exists in each direction of CW/CCW and means the error between goal position and present position.

The range of the value is 0~255, and the unit is the same as Goal Position.(Address 30,31)

The greater the value, the more difference occurs.

Compliance Slope

It exists in each direction of CW/CCW and sets the level of Torque near the goal position.

Compliance Slope is set in 7 steps, the higher the value, the more flexibility is obtained.

Data representative value is actually used value. That is, even if the value is set to 25, 16 is used internally as the representative value.

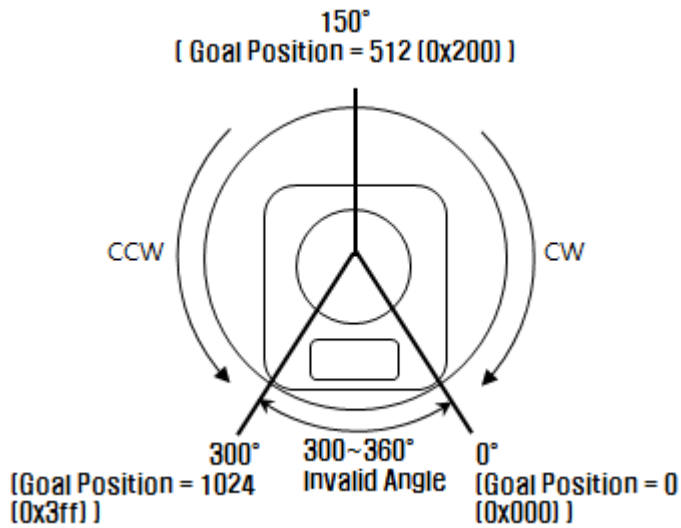
Step	Data Value	Data Representative Value
1	0 (0x00) ~ 3(0x03)	2 (0x02)
2	4(0x04) ~ 7(0x07)	4 (0x04)
3	8(0x08)~15(0x0F)	8 (0x08)
4	16(0x10)~31(0x1F)	16 (0x10)
5	32(0x20)~63(0x3F)	32 (0x20)
6	64(0x40)~127(0x7F)	64 (0x40)
7	128(0x80)~254(0xFE)	128 (0x80)

Goal Position

It is a position value of destination.

0 to 1023 (0x3FF) is available. The unit is 0.29 degree.

If Goal Position is out of the range, Angle Limit Error Bit (Bit1) of Status Packet is returned as '1' and Alarm is triggered as set in Alarm LED/Shutdown.



<The picture above is based on the front of relevant model>

Moving Speed

It is a moving speed to Goal Position.

The range and the unit of the value may vary depending on the operation mode.

- **Join Mode**
0~1023 (0X3FF) can be used, and the unit is about 0.111rpm.
If it is set to 0, it means the maximum rpm of the motor is used without controlling the speed.
If it is 1023, it is about 114rpm.
For example, if it is set to 300, it is about 33.3 rpm.
- **Wheel Mode**
0~2047(0X7FF) can be used, the unit is about 0.1%.
If a value in the range of 0~1023 is used, it is stopped by setting to 0 while rotating to CCW direction.
If a value in the range of 1024~2047 is used, it is stopped by setting to 1024 while rotating to CW direction.
That is, the 10th bit becomes the direction bit to control the direction.
In Wheel Mode, only the output control is possible, not speed.

For example, if it is set to 512, it means the output is controlled by 50% of the maximum output.

Torque Limit

It is the value of the maximum torque limit.

0 to 1023 (0x3FF) is available, and the unit is about 0.1%.

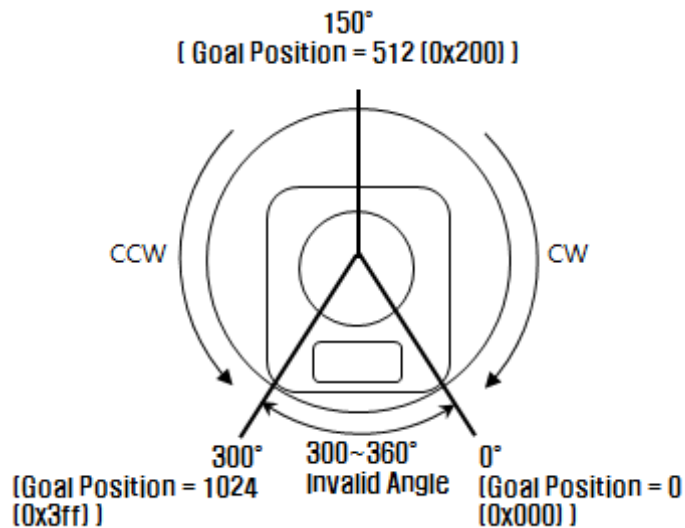
For example, if the value is 512, it is about 50%; that means only 50% of the maximum torque will be used.

If the power is turned on, the value of Max Torque (Address 14, 15) is used as the initial value.

Present Position

It is the current position value of Dynamixel.

The range of the value is 0~1023 (0x3FF), and the unit is 0.29 degree.



<The picture above is based on the front of relevant model>

Present Speed

It is the current moving speed.

0~2047 (0X7FF) can be used.

If a value is in the range of 0~1023, it means that the motor rotates to the CCW direction.

If a value is in the range of 1024~2047, it means that the motor rotates to the CW direction.

That is, the 10th bit becomes the direction bit to control the direction, and 0 and 1024 are equal.

The unit of this value varies depending on operation mode.

- Joint Mode

The unit is about 0.111rpm.

For example, if it is set to 300, it means that the motor is moving to the CCW direction at a rate of about 33.3rpm.

- Wheel Mode

The unit is about 0.1%.

For example, if it is set to 512, it means that the torque is controlled by 50% of the maximum torque to the CCW direction.

Present Load

It means currently applied load.

The range of the value is 0~2047, and the unit is about 0.1%.

If the value is 0~1023, it means the load works to the CCW direction.

If the value is 1024~2047, it means the load works to the CW direction.

That is, the 10th bit becomes the direction bit to control the direction, and 1024 is equal to 0.

For example, the value is 512, it means the load is detected in the direction of CCW about 50% of the maximum torque.

Present Voltage

It is the size of the current voltage supplied.

This value is 10 times larger than the actual voltage. For example, when 10V is supplied, the data value is 100 (0x64)

Present Temperature

It is the internal temperature of Dynamixel in Celsius.

Data value is identical to the actual temperature in Celsius. For example, if the data value is 85 (0x55), the current internal temperature is 85°C.

Registered Instruction

Value	Meaning
0	There are no commands transmitted by REG_WRITE
1	There are commands transmitted by REG_WRITE.

Moving

Value	Meaning
0	Goal position command execution is completed.

1	Goal position command execution is in progress.
---	---

Lock

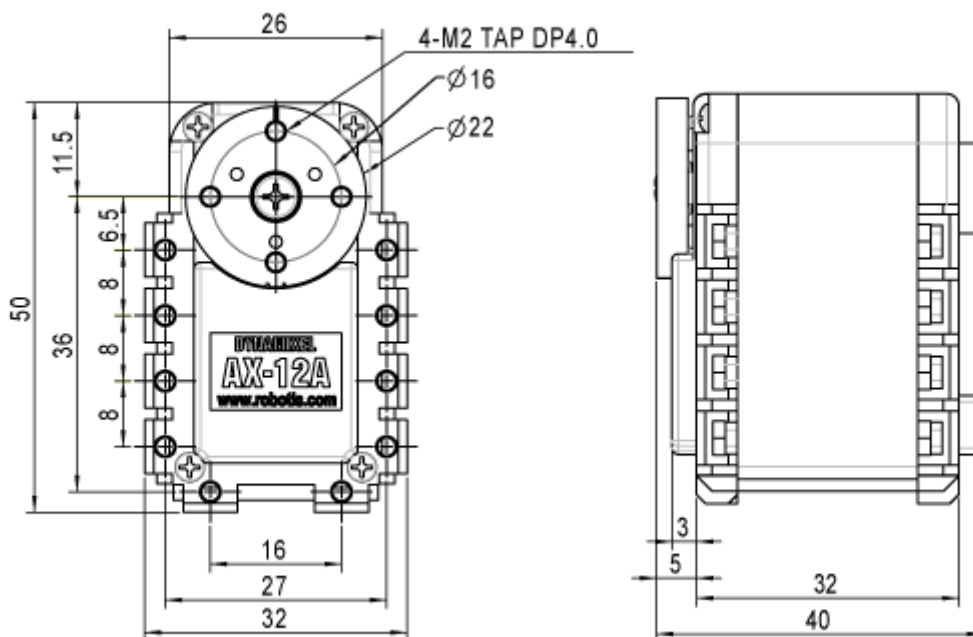
Value	Meaning
0	EEPROM area can be modified.
1	EEPROM area cannot be modified.

Punch

Current to drive motor is at minimum.

Can choose vales from 0x20 to 0x3FF.

Dimension



Arquitectures de paquet d'instrucció

To operate Dynamixel, Instruction Packet, which is binary type data, should be sent to Dynamixel from Main Controller. Instruction Packet has seven kinds of commands. (Refer to "[Instruction Packet](#)") In addition, Dynamixel receives Instruction Packet to perform a command and returns the result as Status Packet to Main Controller. This section describes examples of the usage of each command of Instruction Packet.

READ DATA

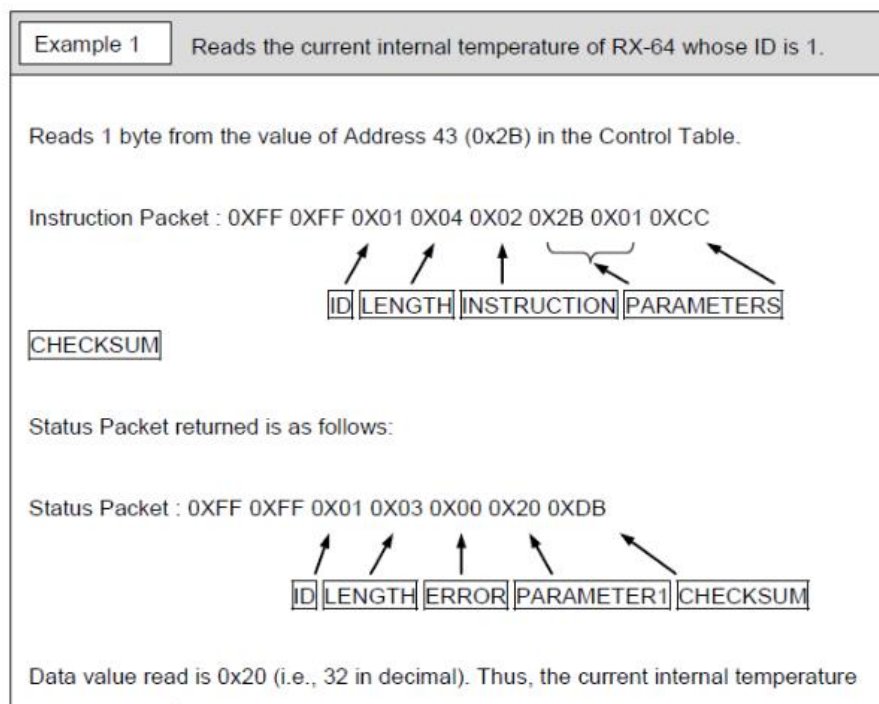
Function This command is to read data in the Control Table inside of RX-64.

Length 0X04

Instruction 0X02

Parameter1 Start Address of data to be read

Parameter2 Length of Data to be read



WRITE DATA

Function This command is to write data to the Control Table inside of RX-64.

Length N+3 (if the number of writing data is N)

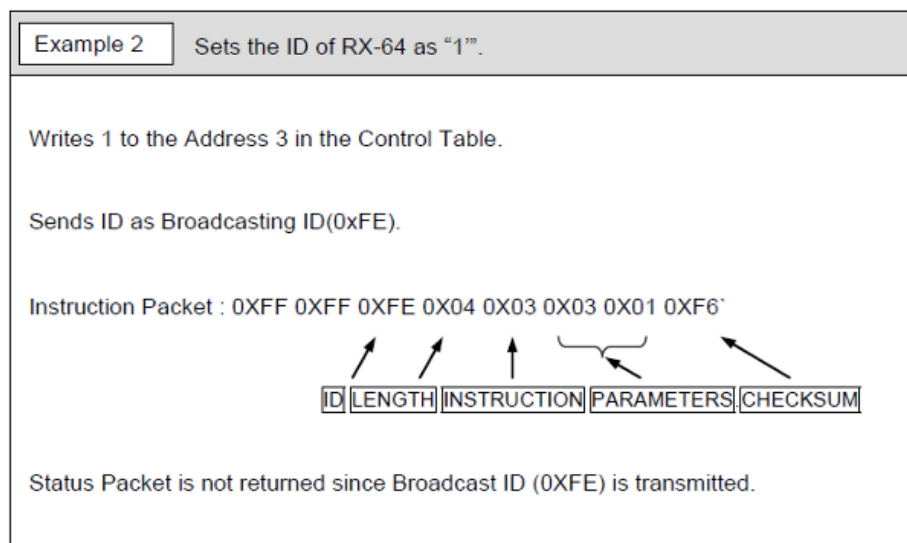
Instruction 0X03

Parameter1 Start address to write data

Parameter2 First data to write

Parameter3 Second data to write

Parameter N+1 Nth Data to write



REG WRITE

Function The REG_WRITE command is similar to the WRITE_DATA command in terms of function, but differs in terms of the timing that a command is executed. When Instruction Packet arrives, it is saved in Buffer and the Write operation remains in the standby state. At this moment, Registered Instruction (Address 44 (0x2C)) is set as "1". Then, when Action Instruction Packet arrives, Registered Instruction changes into "0" and the registered Write command is finally executed.

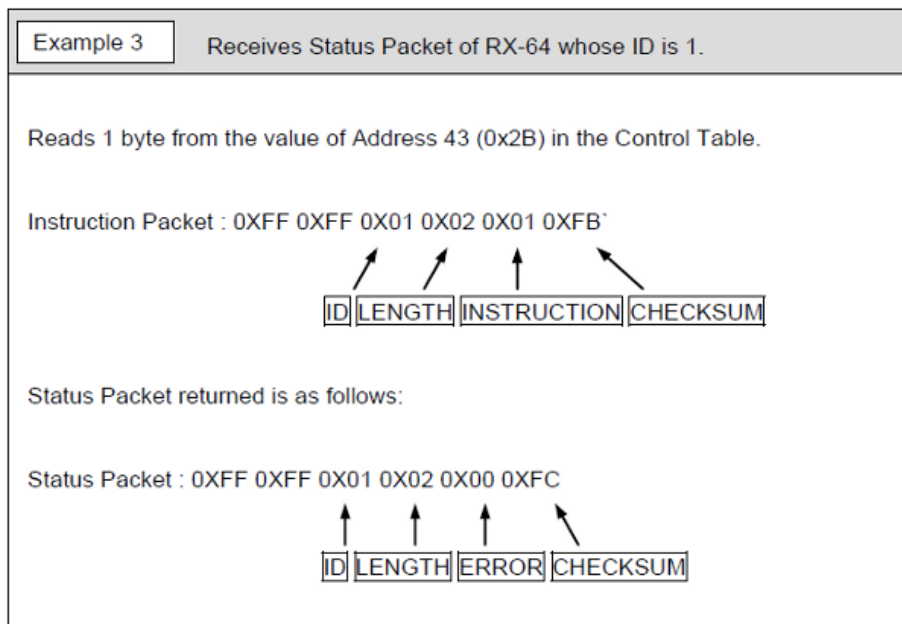
Length N+3 (if the number of Writing Data is N)

Instruction 0X04

Parameter1 Start Address to write Data

Parameter2 First data to write

Parameter N+1 Nth data to write



ACTION

Function This command is to execute the Write action registered by REG_WRITE

Length 0x02

Instruction 0x05

Parameter NONE

The Action command is useful when several RX-64s are moved with accuracy at the same time. When several running gears are controlled via communication, there is a little time difference in terms of enabling time between the first and the last running gear getting commands. RX-64 has resolved this problem by using Action Instruction.

PING

Function This command does not instruct anything. It is only used when receiving Status Packet or confirming the existence of RX-64 with a specific ID. .

Length 0x02

Instruction 0x01

Parameter NONE

Although Status Return Level (Address 16 (0x10)) is 0, it returns Status Packet all the time for Ping Instruction. But, it does not return Status Packet when Check Sum Error occurs in spite of using PING Instruction.

RESET

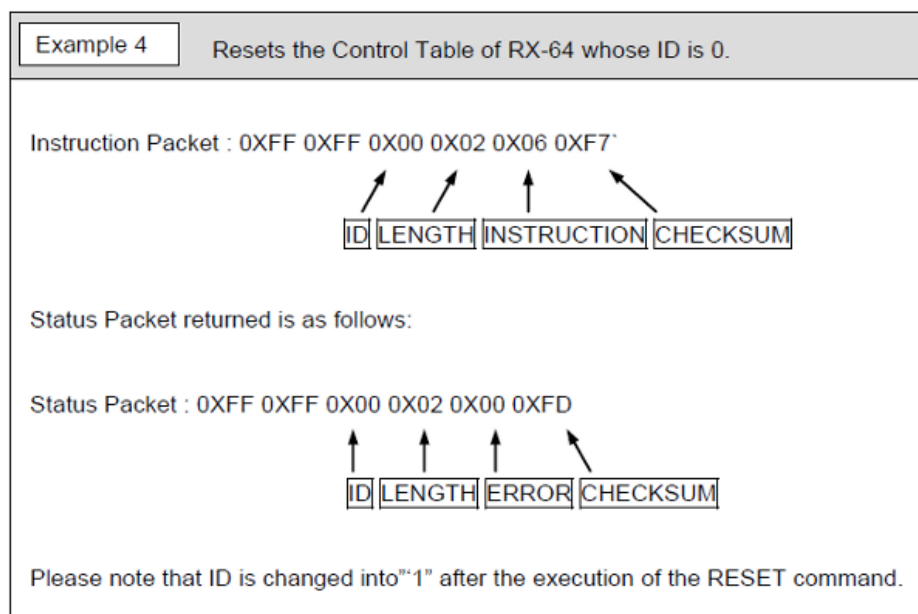
Function This command is to reset the Control Table of RX-64 to the factory default setting

Please be careful since the value set by users can be erased if RESET command is used.

Length 0X02

Instruction 0X06

Parameter NONE



SYNC WRITE

Function This command is used to control several RX-64s simultaneously with one Instruction Packet transmission. When this command is used, several commands are transmitted at once, so that the communication time is reduced when multiple RX-64s are controlled. However, the SYNC WRITE command can be used only if both of the address and length of the Control Table to write is identical. Besides, ID should be transmitted as Broadcasting ID.

Generally, in the event 1 command packet is 4 byte, 26 Dynamixel can be controlled simultaneously. Make sure that the length of packet does not to exceed 143 bytes since the volume of receiving buffer of RX-64 is 143 bytes.

ID 0XFE

Length (L+1) X N + 4 (L: Data Length per RX-64, N: the number of RX-64s)

Instruction 0X83

Parameter1 Start address to write Data

Parameter2 Length of Data to write

Parameter3 First ID of RX-64

Parameter4 First data of the first RX-64

Parameter5 Second data of the first RX-64

...

Parameter L+3 Lth Data of the first RX-64

Parameter L+4 ID of the second RX-64

Parameter L+5 First data of the second RX-64

Parameter L+6 Second data of the second RX-64

...

Parameter 2L+4 Lth data of the second RX-64

Example 5	Moves to the following position and speed for each RX-64.
RX-64 with ID 0 : Moves to the position of 0x010 at the speed of 0x150 RX-64 with ID 1 : Moves to the position of 0x220 at the speed of 0x360 RX-64 with ID 2: Moves to the position of 0x030 at the speed of 0x170 RX-64 with ID 3: Moves to the position of 0x220 at the 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`	
Status Packet is not returned since ID is transmitted as Broadcasting ID.	

BULK READ (This command only works for MX series)

Function This command is used for reading the values of several DYNAMIXELs simultaneously, by sending a single Instruction Packet. The packet length is lessened compared to sending many READ commands, and the idle time between the status packets being returned is also lessened to save communication time. But, this cannot be used to read many times on a single module, and if several of the same module ID is designated, only the firstly designated parameter will be processed.

ID 0XFE

Length 3N3+3

Instruction 0X92

Parameter1 0X00

Parameter2 Length of the data to be read from the first module [L]

Parameter3 ID of the first module

Parameter4 Starting address of the data to be read from the first module

...

Parameter 3N+2 : Length of the data to be read from the Nth module [L]

Parameter 3N+3 : ID of the Nth module

Parameter 3N+4 : Starting address of the data to be read from the Nth module

example)

DYANMIXEL with ID 1 : Brings the goal position value (2 bytes from 0x1E).

DYNAMIXEL with ID 2 : Brings the current position value (2 bytes from 0x24).

The command packet to order this movement is as follows:

0XFF 0XFF 0XFE 0X09 0X92 0X00 0X02 0X01 0X1E 0X02 0X02 0X24 0X1D

During this time, module with ID 2 monitors the status packet being sent from ID 1 of the data bus (the very previous parameter ID), then right when module ID 1's status packet completes transmission, sends its own status packet. The returned status packet is as follows:

0XFF 0XFF 0X01 0X04 0X00 0X00 0X80 0X7A 0XFF 0XFF 0X02 0X04 0X00 0X00 0X80 0X79

Status packets from each of module ID 1 and ID 2 will come in one after another.

Documentació llibreria Dynamixel™

```
int dxl_initialize(
    int
    devIndex    ,
    int baudnum
);
```

Parameters

– devIndex

It is the number of currently connected communication devices. (It may vary depending on the platform.)

For example, Windows distinguishes devices by COM Port.

– baudnum

It is Baud rate number to be set. It is the same number used by Dynamixel.

The following table shows the main Baudrate.

Address 4	Set BPS	Goal BPS	Error
1	1000000.0	1000000.0	0.000 %
3	500000.0	500000.0	0.000 %
4	400000.0	400000.0	0.000 %
7	250000.0	250000.0	0.000 %
9	200000.0	200000.0	0.000 %
16	117647.1	115200.0	-2.124 %
34	57142.9	57600.0	0.794 %
103	19230.8	19200.0	-0.160 %
207	9615.4	9600.0	-0.160 %

Return Values

– If the value is 1, it means success; however, if the value is 0, it means failure.

```
void dxl_terminate();
```

Parameters

– None

Return Values

– None

```
void dxl_set_txpacket_id(
    int id
);
```

Parameters

– **id**

It is Dynamixel ID to be transmitted to Instruction packet.

BROADCAST_ID(254) is used, Instruction packet is received by all Dynamixels.

Return Values

– None

```
void dxl_set_txpacket_instruction(
    int instruction
);
```

Parameters

– **instruction**

The following codes are command codes. One of the following values can be obtained.

Value	Name	Contents
1	INST_PING	No execution. It is used when controller is ready to receive Status Packet
2	INST_READ	This command reads data from Dynamixel
3	INST_WRITE	This command writes data to Dynamixel
4	INST_REG_WRITE	It is similar to WRITE_DATA, but it remains in the standby state without being executed until the ACTION command arrives.
5	INST_ACTION	This command initiates motions registered with REG WRITE

6	INST_RESET	This command restores the state of Dynamixel to the factory default setting.
131	INST_SYNC_WRITE	This command is used to control several Dynamixels simultaneously at a time.

Return Values

- None

```
void dxl_set_txpacket_instruction(
    int index,
    int value
);
```

Parameters

- **index**
It is the parameter number. It has the range from 0 ~ MAXNUM_TXPARAM-1.
 - **value**
It is the parameter value. It has the range from 0~255.
- Return Values
- None

```
void dxl_set_txpacket_length(
    int length
);
```

Parameters

- **length**
It is the Instruction packet's length.

Return Values

- None

```
void dxl_trx_packet( );
```

Parameters

- None

Return Values

- None

```
int dxl_get_highbyte(
    int word
);
```

Parameters

– **word**

WORD-type data to extract higher byte

Return Values

- Higher byte extracted from WORD-type data

```
int dxl_get_lowbyte(  
    int word  
);
```

Parameters

– **word**

WORD-type data to extract Lower byte

Return Values

- Lower byte extracted from WORD-type data

Codi Matlab del simulador i rutines de càlcul

SIMULADOR

```

clear;
close all;
clc;

%Definició de constants (en dm)
LONG = 0.8556;
L2 = 0.1723;
RADI = 0.9899;
L1 = 0.4750;
LEG = 1.68;
BRAC = 0.30;
H = 1.6;
R = 0.2;

ballangle = pi/4; % Aquest és l'angle del vector de posició de la pilota
en polars sobre el pla inicial
rotangle = pi/10; % Aquest valor ha de dependre de la distància de la
pilota al centre, es la inclinació de la plataforma entorn a l'eix de
rotació.

%TRANSFORMACIONS DE LA PLATAFORMA
RE = transl(0,0,H);
TAXIS = transl(0,0,R)*trotz(ballangle + (pi/2)); %Es suma pi mitjos a
l'angle de la pilota ja que la rotació per influir sobre aquesta s'entén
que ha de ser entorn a un eix perpendicular al vector posició
TR =RE*TAXIS*trotx(rotangle)*inv(TAXIS);

%DEFINICIO TRANSFORMADES DE PUNTS DE PLATAFORMA "TOP"
TP(:, :, 1) = TR*transl(L2, -LONG, 0);
TP(:, :, 2) = TR*transl(-L2, -LONG, 0);
TP(:, :, 3) = TR*trotz(-2*pi/3)*transl(L2, -LONG, 0)
TP(:, :, 4) = TR*trotz(-2*pi/3)*transl(-L2, -LONG, 0)
TP(:, :, 5) = TR*trotz(-4*pi/3)*transl(L2, -LONG, 0)
TP(:, :, 6) = TR*trotz(-4*pi/3)*transl(-L2, -LONG, 0)

%DEFINICIO TRANSFORMADES DE PUNTS DE LA BASE "BASE"
TB(:, :, 1) = transl(L1, -RADI, 0)*trotz(-2*pi/3);
TB(:, :, 2) = transl(-L1, -RADI, 0)*trotz(2*pi/3);
TB(:, :, 3) = trotz(-2*pi/3)*transl(L1, -RADI, 0)*trotz(-2*pi/3);
TB(:, :, 4) = trotz(-2*pi/3)*transl(-L1, -RADI, 0)*trotz(2*pi/3);
TB(:, :, 5) = trotz(-4*pi/3)*transl(L1, -RADI, 0)*trotz(-2*pi/3);
TB(:, :, 6) = trotz(-4*pi/3)*transl(-L1, -RADI, 0)*trotz(2*pi/3);

%Coordenades de TOP point en referència BASE
for i=1:6
    %Definim una nova transformada
    TBP(:, :, i) = inv(TB(:, :, i))*TP(:, :, i);
    %Calculem els valors dels orígens en aquesta nova base
    Centers(:, i) = TBP(:, :, i)*[0; 0; 0; 1];
end

%Càlcul de les solucions

```



```

for i=1:6
    [phi1, phi2]= SolveAngles(Centers(1,i),Centers(3,i),BRAC,sqrt(LEG^2-
Centers(2,i)^2)); %SolveAngles descrit a continuació
    Sol1(i)=phi1;
    Sol2(i)=phi2;
end

%Ara es tenen 2 vectors "Sol1" i "Sol2" amb les dues solucions, una a
cada vector

%Selecció de solucions i traducció a passos de l'actuador

%Degut a la distribució de les potes del robot alternades en direcció es
pren una o l'altre de manera alternada coincidint els punts descrits amb
el corresponent en la geometria real del robot. Aquesta decisió es pren
durant el muntatge. Es vol que els eixos definits en la plataforma siguin
paral·lels als de la càmera per facilitar els càlculs. Una vegada es
situa el robot respecte la càmera amb aquesta intenció cal comparar amb
el programat per fer coincidir les solucions amb els motors reals.

newSol = [Sol1(1),Sol2(2),Sol1(3),Sol2(4),Sol1(5),Sol2(6)];
parell = fals;
for i=1:6
    if parell == fals
        %Es reescriu newSol
        newSol(i) = arrodoneix((-newSol(i)-pi)*180/pi)/0.29)+512;
        par = cert;
    else
        %Es reescriu newSol
        newSol(i) = arrodoneix(-newSol(i)*180/pi)/0.29)+512;
        parell = fals;
    end
end

%Finalment es prepara el vector de posicions dels motors ordenats per ID
send_Pose = [newSol(1),newSol(6), newSol(5), newSol(4), newSol(3),
newSol(2)];

```

REPRESENTACIÓ

```

% DRAWING DEFINITIONS

figure(1);
hold on;
grid on;
view(45, 45);
axis([-1.2 1.2 -1.2 1.2 -1 3]);
camlight left;
lighting phong;
daspect([1 1 1]);

trplot(transl(0, 0, 0), 'arrow');
trplot(RE, 'arrow');

```

```

Mytrplot(RE*TAXIS, 1);

% CENTERS OF THE ATTACHMENTS

for i=1:6
    BA(i,:)= TB(:, :, i)*[0; 0; 0; 1];
    PA(i,:)= TP(:, :, i)*[0; 0; 0; 1];
end

for i=1:6
    Mytrplot(TB(:, :, i), 0.3);
    Mytrplot(TP(:, :, i), 0.3);
end

for i=1:6
    for j=1:100
        AA(:, i, j)= TB(:, :, i)*trotty(-
2*j*pi/100)*transl(ARM, 0, 0)*[0; 0; 0; 1];
    end
end

for i=1:6
    if i == 1
        for j=1:99
            plot3([AA(1, i, j) AA(1, i, j+1)], [AA(2, i, j) AA(2, i, j+1)],
[AA(3, i, j) AA(3, i, j+1)], 'b', 'LineWidth', 1);
        end
    else
        for j=1:99
            plot3([AA(1, i, j) AA(1, i, j+1)], [AA(2, i, j) AA(2, i, j+1)],
[AA(3, i, j) AA(3, i, j+1)], 'r', 'LineWidth', 1);
        end
    end
end

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% DRAWING GREEN LINES FOR THE ARMS
for i=1:6
    elbow = TB(:, :, i)*trotty(-Sol1(i))*transl(ARM, 0, 0)*[0; 0; 0; 1];
    plot3([BA(i, 1) elbow(1)], [BA(i, 2) elbow(2)], [BA(i, 3) elbow(3)],
'g', 'LineWidth', 1);
    plot3([elbow(1) PA(i, 1)], [elbow(2) PA(i, 2)], [elbow(3) PA(i, 3)],
'g', 'LineWidth', 1);
    length(i)= sqrt((elbow(1)-PA(i, 1))^2+(elbow(2)-PA(i, 2))^2+(elbow(3)-
PA(i, 3))^2);
    elbow = TB(:, :, i)*trotty(-Sol2(i))*transl(ARM, 0, 0)*[0; 0; 0; 1];
    plot3([BA(i, 1) elbow(1)], [BA(i, 2) elbow(2)], [BA(i, 3) elbow(3)],
'g', 'LineWidth', 1);
    plot3([elbow(1) PA(i, 1)], [elbow(2) PA(i, 2)], [elbow(3) PA(i, 3)],
'g', 'LineWidth', 1);
end

% DRAWING POLYGON BASE AND PLATFORM

fill3(BA(:, 1)', BA(:, 2)', BA(:, 3)', [0.125 0.125 0.125]);

```

```
fill3(PA(:,1)', PA(:,2)', PA(:,3)', [0.125 0.125 0.125]);
alpha(0.5);
```

SOLVE ANGLES

```
%Aquesta subrutina resol les equacions de clausura de forma analítica de
l'apartat 6.3
```

```
Funció [phi1, phi2] = SolveAngles(cx,cy,r1,r2)
```

```
%Es tria la funció arc tangent 2 de matlab que troba la solució de 4
quadrants per a valors X i Y reals atan2(X,Y)
```

```
alpha = atan2(cy, cx);
gamma = acos((r1^2 + cx^2 + cy^2 - r2^2)/(2*r1*sqrt(cx^2+cy^2)));
```

```
phi1 = alpha + gamma;
phi2 = alpha - gamma;
```

```
Fi funció
```

CALCUL GEOMÈTRIC VISIÓ

```
clear all;
```

```
rotangle = sym('rotangle');
ballangle = sym('ballangle');
vx = sym('vx');
vy = sym('vy');
vz = sym('vz');
lambda = sym('lambda');
```

```
%All measurements in cm
```

```
ALT_CAM = 47;
RADI = 2;
ALT_PLAT = 22;
POS_CAM = [0 0 ALT_CAM+ALT_PLAT];
```

```
%Es defineix el pla inclinat paral·lel a la plataforma a una distància R
%d'aquesta
```

```
RE = transl(0,0,ALT_PLAT);
TAXIS = transl(0,0,RADI)*trotz(ballangle + (pi/2));
TR =RE*TAXIS*trotz(rotangle);
```

```
%Es calcula el centre i el vector normal (fet unitari) d'aquest pla
```

```
centre = TR*[0;0;0;1];
normal = TR*[0;0;1;1];
normal = [normal(1);normal(2);normal(3)];
normal = normal/norm(normal);
```

```
%Es calcula el terme independent de l'equació del pla
tind = -[normal(1) normal(2) normal(3)]*[centre(1);centre(2);centre(3)];

%Es defineix la intersecció entre l'equació del pla i la recta que uneix
%centroide de la bola amb l'objectiu de la càmera
equation = normal(1)*(POS_CAM(1) + lambda*vx)+ ...
           normal(2)*(POS_CAM(2) + lambda*vy)+ ...
           normal(3)*(POS_CAM(3) + lambda*vz) + tind;

%Es resol per lambda
lambda = solve(equation, lambda);

%Es calcula el punt d'intersecció en les seves 3 dimensinos
punt = [POS_CAM(1) + lambda*vx; POS_CAM(2) + lambda*vy; POS_CAM(3) +
lambda*vz; 1];

punt_pla = simplify((TR)\punt);
```

Codi en C# de la llibreria extesa

```
#include "dxl_hal.h"
```

```
#include "dynamixel.h"
```

```
#define ID (2)
```

```
#define LENGTH (3)
```

```
#define INSTRUCTION (4)
```

```
#define ERRBIT (4)
```

```
#define PARAMETER (5)
```

```
#define DEFAULT_BAUDNUMBER (1)
```

```
unsigned char gbInstructionPacket[MAXNUM_TXPARAM+10] = {0};
```

```
unsigned char gbStatusPacket[MAXNUM_RXPARAM+10] = {0};
```

```
unsigned char gbRxPacketLength = 0;
```

```
unsigned char gbRxGetLength = 0;
```

```
int gbCommStatus = COMM_RXSUCCESS;
```

```
int giBusUsing = 0;
```

```
int dxl_initialize( int devIndex, int baudnum )
```

```
{
```

```
    float baudrate;
```

```
    baudrate = 2000000.0f / (float)(baudnum + 1);
```

```
    if( dxl_hal_open(devIndex, baudrate) == 0 )
```

```
        return 0;
```

```
        gbCommStatus = COMM_RXSUCCESS;

        giBusUsing = 0;

        return 1;
    }

void dxl_terminate()
{
    dxl_hal_close();
}

void dxl_tx_packet()
{
    unsigned char i;

    unsigned char TxNumByte, RealTxNumByte;

    unsigned char checksum = 0;

    if( giBusUsing == 1 )
        return;

    giBusUsing = 1;

    if( gbInstructionPacket[LENGTH] > (MAXNUM_TXPARAM+2) )
    {
        gbCommStatus = COMM_TXERROR;
```

```
        giBusUsing = 0;

        return;
    }

    if( gbInstructionPacket[INSTRUCTION] != INST_PING

        && gbInstructionPacket[INSTRUCTION] != INST_READ

        && gbInstructionPacket[INSTRUCTION] != INST_WRITE

        && gbInstructionPacket[INSTRUCTION] != INST_REG_WRITE

        && gbInstructionPacket[INSTRUCTION] != INST_ACTION

        && gbInstructionPacket[INSTRUCTION] != INST_RESET

        && gbInstructionPacket[INSTRUCTION] != INST_SYNC_WRITE )

    {

        gbCommStatus = COMM_TXERROR;

        giBusUsing = 0;

        return;

    }

    gbInstructionPacket[0] = 0xff;

    gbInstructionPacket[1] = 0xff;

    for( i=0; i<(gbInstructionPacket[LENGTH]+1); i++ )

        checksum += gbInstructionPacket[i+2];

    gbInstructionPacket[gbInstructionPacket[LENGTH]+3] = ~checksum;

    if( gbCommStatus == COMM_RXTIMEOUT || gbCommStatus ==
    COMM_RXCORRUPT )
```

```
    dxl_hal_clear();

    TxNumByte = gbInstructionPacket[LENGTH] + 4;
    RealTxNumByte = dxl_hal_tx( (unsigned char*)gbInstructionPacket, TxNumByte );

    if( TxNumByte != RealTxNumByte )
    {
        gbCommStatus = COMM_TXFAIL;
        giBusUsing = 0;
        return;
    }

    if( gbInstructionPacket[INSTRUCTION] == INST_READ )
        dxl_hal_set_timeout( gbInstructionPacket[PARAMETER+1] + 6 );
    else
        dxl_hal_set_timeout( 6 );

    gbCommStatus = COMM_TXSUCCESS;
}

void dxl_rx_packet()
{
    unsigned char i, j, nRead;
    unsigned char checksum = 0;
```



```
if( giBusUsing == 0 )
    return;

if( gbInstructionPacket[ID] == BROADCAST_ID )
{
    gbCommStatus = COMM_RXSUCCESS;
    giBusUsing = 0;
    return;
}

if( gbCommStatus == COMM_TXSUCCESS )
{
    gbRxGetLength = 0;
    gbRxPacketLength = 6;
}

nRead = dxl_hal_rx( (unsigned char*)&gbStatusPacket[gbRxGetLength],
gbRxPacketLength - gbRxGetLength );

gbRxGetLength += nRead;

if( gbRxGetLength < gbRxPacketLength )
{
    if( dxl_hal_timeout() == 1 )
    {
        if(gbRxGetLength == 0)
            gbCommStatus = COMM_RXTIMEOUT;
```

```
        else

            gbCommStatus = COMM_RXCORRUPT;

            giBusUsing = 0;

            return;

    }

}

// Find packet header

for( i=0; i<(gbRxGetLength-1); i++ )

{

    if( gbStatusPacket[i] == 0xff && gbStatusPacket[i+1] == 0xff )

    {

        break;

    }

    else if( i == gbRxGetLength-2 && gbStatusPacket[gbRxGetLength-1] == 0xff )

    {

        break;

    }

}

if( i > 0 )

{

    for( j=0; j<(gbRxGetLength-i); j++ )

        gbStatusPacket[j] = gbStatusPacket[j + i];

    gbRxGetLength -= i;

}
```

```
    }

    if( gbRxGetLength < gbRxPacketLength )
    {
        gbCommStatus = COMM_RXWAITING;
        return;
    }

    // Check id pairing
    if( gbInstructionPacket[ID] != gbStatusPacket[ID])
    {
        gbCommStatus = COMM_RXCORRUPT;
        giBusUsing = 0;
        return;
    }

    gbRxPacketLength = gbStatusPacket[LENGTH] + 4;
    if( gbRxGetLength < gbRxPacketLength )
    {
        nRead = dxl_hal_rx( (unsigned char*)&gbStatusPacket[gbRxGetLength],
        gbRxPacketLength - gbRxGetLength );

        gbRxGetLength += nRead;

        if( gbRxGetLength < gbRxPacketLength )
        {
            gbCommStatus = COMM_RXWAITING;
```

```
        return;
    }
}

// Check checksum
for( i=0; i<(gbStatusPacket[LENGTH]+1); i++ )
    checksum += gbStatusPacket[i+2];
checksum = ~checksum;

if( gbStatusPacket[gbStatusPacket[LENGTH]+3] != checksum )
{
    gbCommStatus = COMM_RXCORRUPT;
    giBusUsing = 0;
    return;
}

gbCommStatus = COMM_RXSUCCESS;
giBusUsing = 0;
}

void dxl_trx_packet()
{
    dxl_tx_packet();

    if( gbCommStatus != COMM_TXSUCCESS )
```

```
        return;

    do{

        dxl_rx_packet();

    }while( gbCommStatus == COMM_RXWAITING );

}

int dxl_get_result()

{

    return gbCommStatus;

}

void dxl_set_txpacket_id( int id )

{

    gbInstructionPacket[ID] = (unsigned char)id;

}

void dxl_set_txpacket_instruction( int instruction )

{

    gbInstructionPacket[INSTRUCTION] = (unsigned char)instruction;

}

void dxl_set_txpacket_parameter( int index, int value )

{

    gbInstructionPacket[PARAMETER+index] = (unsigned char)value;
```

```
}
```

```
void dxl_set_txpacket_length( int length )
```

```
{
```

```
    gbInstructionPacket[LENGTH] = (unsigned char)length;
```

```
}
```

```
int dxl_get_rxpacket_error( int errbit )
```

```
{
```

```
    if( gbStatusPacket[ERRBIT] & (unsigned char)errbit )
```

```
        return 1;
```

```
    return 0;
```

```
}
```

```
int dxl_get_rxpacket_length()
```

```
{
```

```
    return (int)gbStatusPacket[LENGTH];
```

```
}
```

```
int dxl_get_rxpacket_parameter( int index )
```

```
{
```

```
    return (int)gbStatusPacket[PARAMETER+index];
```

```
}
```

```
int dxl_makeword( int lowbyte, int highbyte )
```

```
{  
    unsigned short word;  
  
    word = highbyte;  
    word = word << 8;  
    word = word + lowbyte;  
    return (int)word;  
}
```

```
int dxl_get_lowbyte( int word )
```

```
{  
    unsigned short temp;  
  
    temp = word & 0xff;  
    return (int)temp;  
}
```

```
int dxl_get_highbyte( int word )
```

```
{  
    unsigned short temp;  
  
    temp = word & 0xff00;  
    temp = temp >> 8;  
    return (int)temp;  
}
```

```
}
```

```
void dxl_ping( int id )
```

```
{
```

```
    while(giBusUsing);
```

```
    gbInstructionPacket[ID] = (unsigned char)id;
```

```
    gbInstructionPacket[INSTRUCTION] = INST_PING;
```

```
    gbInstructionPacket[LENGTH] = 2;
```

```
    dxl_txrx_packet();
```

```
}
```

```
int dxl_read_byte( int id, int address )
```

```
{
```

```
    while(giBusUsing);
```

```
    gbInstructionPacket[ID] = (unsigned char)id;
```

```
    gbInstructionPacket[INSTRUCTION] = INST_READ;
```

```
    gbInstructionPacket[PARAMETER] = (unsigned char)address;
```

```
    gbInstructionPacket[PARAMETER+1] = 1;
```

```
    gbInstructionPacket[LENGTH] = 4;
```

```
    dxl_txrx_packet();
```



```
        return (int)gbStatusPacket[PARAMETER];
    }

void dxl_write_byte( int id, int address, int value )
{
    while(giBusUsing);

    gbInstructionPacket[ID] = (unsigned char)id;
    gbInstructionPacket[INSTRUCTION] = INST_WRITE;
    gbInstructionPacket[PARAMETER] = (unsigned char)address;
    gbInstructionPacket[PARAMETER+1] = (unsigned char)value;
    gbInstructionPacket[LENGTH] = 4;

    dxl_txrx_packet();
}

int dxl_read_word( int id, int address )
{
    while(giBusUsing);

    gbInstructionPacket[ID] = (unsigned char)id;
    gbInstructionPacket[INSTRUCTION] = INST_READ;
    gbInstructionPacket[PARAMETER] = (unsigned char)address;
    gbInstructionPacket[PARAMETER+1] = 2;
    gbInstructionPacket[LENGTH] = 4;
```

```
    dxl_txrx_packet();

    return dxl_makeword((int)gbStatusPacket[PARAMETER],
(int)gbStatusPacket[PARAMETER+1]);
}

void dxl_write_word( int id, int address, int value )
{
    while(giBusUsing);

    gbInstructionPacket[ID] = (unsigned char)id;
    gbInstructionPacket[INSTRUCTION] = INST_WRITE;
    gbInstructionPacket[PARAMETER] = (unsigned char)address;
    gbInstructionPacket[PARAMETER+1] = (unsigned char)dxl_get_lowbyte(value);
    gbInstructionPacket[PARAMETER+2] = (unsigned char)dxl_get_highbyte(value);
    gbInstructionPacket[LENGTH] = 5;

    dxl_txrx_packet();
}

int dxl_sync_write_word( int NUM_ACTUATOR, int address, const int ids[], int values[] )
{
    int i = 0;

    // wait for the bus to be free
```

```
while(giBusUsing);

// check how many actuators are to be broadcast to

if (NUM_ACTUATOR == 0) {

    // nothing to do, return

    return 0;

} else if (NUM_ACTUATOR == 1) {

    dxl_write_word( ids[0], address, values[0] );

    return 0;

}

// Multiple values, create sync write packet

// ID is broadcast id

dxl_set_txpacket_id(BROADCAST_ID);

// Instruction is sync write

dxl_set_txpacket_instruction(INST_SYNC_WRITE);

// Starting address where to write to

dxl_set_txpacket_parameter(0, address);

// Length of data to be written (each word = 2 bytes)

dxl_set_txpacket_parameter(1, 2);

// Loop over the active Dynamixel id's

for( i=0; i<NUM_ACTUATOR; i++ )

{

    // retrieve the id and value for each actuator and add to packet

    dxl_set_txpacket_parameter(2+3*i, ids[i]);

    dxl_set_txpacket_parameter(2+3*i+1, dxl_get_lowbyte(values[i]));
```

```
        dxl_set_txpacket_parameter(2+3*i+2, dxl_get_highbyte(values[i]));
    }

    // total length is as per formula above with L=2
    dxl_set_txpacket_length((2+1)*NUM_ACTUATOR + 4);

    // all done, send the packet
    dxl_txrx_packet();

    // there is no status packet return, so return the CommStatus
    return gbCommStatus;
}

// Function setting goal and speed for all Dynamixel actuators at the same time
// Uses the Sync Write instruction (also see dxl_sync_write_word)
// Inputs:  NUM_ACTUATOR - number of Dynamixel servos
//          ids - array of Dynamixel ids to write to
//          goal - array of goal positions
//          speed - array of moving speeds
//Returns:  commStatus

int dxl_set_goal_speed( int NUM_ACTUATOR, const int ids[], int goal[], int speed[] )
{
    int i = 0;
```

```
// wait for the bus to be free

while(giBusUsing);

// check how many actuators are to be broadcast to

if (NUM_ACTUATOR == 0) {

    // nothing to do, return

    return 0;

}

// Multiple values, create sync write packet

// ID is broadcast id

dxl_set_txpacket_id(BROADCAST_ID);

// Instruction is sync write

dxl_set_txpacket_instruction(INST_SYNC_WRITE);

// Starting address where to write to

dxl_set_txpacket_parameter(0,30);

// Length of data to be written (2 words = 4 bytes)

    dxl_set_txpacket_parameter(1, 4);

// Loop over the active Dynamixel id's

for( i=0; i<NUM_ACTUATOR; i++ )

{

    // retrieve the id and value for each actuator and add to packet

    dxl_set_txpacket_parameter(2+5*i, ids[i]);

    dxl_set_txpacket_parameter(2+5*i+1, dxl_get_lowbyte(goal[i]));

    dxl_set_txpacket_parameter(2+5*i+2, dxl_get_highbyte(goal[i]));
```

```
        dxl_set_txpacket_parameter(2+5*i+3, dxl_get_lowbyte(speed[i]));
        dxl_set_txpacket_parameter(2+5*i+4, dxl_get_highbyte(speed[i]));
    }

    // total length is as per formula above with L=4
    dxl_set_txpacket_length((4+1)*NUM_ACTUATOR + 4);

    // all done, send the packet
    dxl_ttrx_packet();

    // there is no status packet return, so return the CommStatus
    return gbCommStatus;
}
```

Codi de blocs del programa de control

```

function punt_pla = PosOnPlate( pixel_pos, orientation)
if pixel_pos(1) == -1 && pixel_pos(2) == -1
    punt_pla = [0 0];
else

%Camera resolution constants
X_PIX_RES = 320;
Y_PIX_RES = 240;
ANG_OBERT_X = 21*2*pi/360;
ANG_OBERT_Y = 18*2*pi/360;

%Coordinates correction
Xcorr = X_PIX_RES/2 - pixel_pos(1);
Ycorr = pixel_pos(2) - Y_PIX_RES/2;

%Angle calculation
angle_recta_x = atan(Xcorr*tan(ANG_OBERT_X)/(X_PIX_RES/2))*360/(2*pi);
angle_recta_y = atan(Ycorr*tan(ANG_OBERT_Y)/(Y_PIX_RES/2))*360/(2*pi);

%Director vector calculation
Xcm = tan(angle_recta_x*2*pi/360);
Ycm = tan(angle_recta_y*2*pi/360);
Zcm = -1;
Vec_cam_pilota = [Xcm,Ycm,Zcm];
Vec_cam_pilota = Vec_cam_pilota/norm(Vec_cam_pilota);
vx = Vec_cam_pilota(1);
vy = Vec_cam_pilota(2);
vz = Vec_cam_pilota(3);

%Giving the current orientation
rotangle = orientation(1)
ballangle = orientation(2)

%Solving
punt_pla = [ -(45*(cos(rotangle) + 24)*(vy*cos(ballangle) -
vx*sin(ballangle)))/(24*vz + vz*cos(rotangle) +
vx*cos(ballangle)*sin(rotangle) + vy*sin(ballangle)*sin(rotangle)), ...
(45*(24*cos(rotangle) + 1)*(vx*cos(ballangle) +
vy*sin(ballangle)))/(24*vz + vz*cos(rotangle) +
vx*cos(ballangle)*sin(rotangle) + vy*sin(ballangle)*sin(rotangle))];
end
end

function [ballangle, rot_angle2] = Calc(yrot,xrot)
%Check if there's ball
if xrot == 0 && yrot == 0
    ballangle = 0; rot_angle2 = 0;
else
    %Calculate solution
    rot_angle2 = 2*atan((abs(sin(xrot/2))^2/abs(cos(xrot/2))^2 +
abs(sin(yrot/2))^2/abs(cos(yrot/2))^2 +

```

```

abs(sin(xrot/2)*sin(yrot/2))^2/(abs(cos(xrot/2))^2*abs(cos(yrot/2))^2))^(
1/2));
    rot_axis2 = [
sin(xrot/2)/(cos(xrot/2)*(abs(sin(xrot/2))^2/abs(cos(xrot/2))^2 +
abs(sin(yrot/2))^2/abs(cos(yrot/2))^2 +
abs(sin(xrot/2)*sin(yrot/2))^2/(abs(cos(xrot/2))^2*abs(cos(yrot/2))^2))^(
1/2)), sin(yrot/2)/(cos(yrot/2)*(abs(sin(xrot/2))^2/abs(cos(xrot/2))^2 +
abs(sin(yrot/2))^2/abs(cos(yrot/2))^2 +
abs(sin(xrot/2)*sin(yrot/2))^2/(abs(cos(xrot/2))^2*abs(cos(yrot/2))^2))^(
1/2)),
(sin(xrot/2)*sin(yrot/2))/(cos(xrot/2)*cos(yrot/2)*(abs(sin(xrot/2))^2/ab
s(cos(xrot/2))^2 + abs(sin(yrot/2))^2/abs(cos(yrot/2))^2 +
abs(sin(xrot/2)*sin(yrot/2))^2/(abs(cos(xrot/2))^2*abs(cos(yrot/2))^2))^(
1/2))];
    ballangle = atan2(rot_axis2(2),rot_axis2(1))+pi/2;
end
end

```

```
function send_Pose = Simulation(ballangle, rotangle)
```

```
%Back to rads
```

```
rotangle = rotangle*pi/180;
```

```
%Build instruction array
```

```
send_Pose = zeros(1,6);
```

```

send_Pose(1)= round(-(100*(180*acos((5*((cos(pi/2 +
ballangle)*sin(rotangle))/10 - (3^(1/2))*((4967757600021511*cos(pi/2 +
ballangle)*sin(rotangle))/202824096036516704239472512860160 - (sin(pi/2 +
ballangle)*sin(rotangle))/5 - (1723*cos(pi/2 +
ballangle)^2)/(10000*(cos(pi/2 + ballangle)^2 + sin(pi/2 + ballangle)^2))
+ (10626033506446012029*sin(pi/2 +
ballangle)^2)/(101412048018258352119736256430080000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) +
(347072593137687375735139019169242339*cos(pi/2 + ballangle)*sin(pi/2 +
ballangle))/(405648192073033408478945025720320000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) + (10626033506446012029*cos(pi/2
+
ballangle)^2*cos(rotangle))/(101412048018258352119736256430080000*(cos(pi
/2 + ballangle)^2 + sin(pi/2 + ballangle)^2)) -
(1723*cos(rotangle)*sin(pi/2 + ballangle)^2)/(10000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) -
(347072593137687375735139019169242339*cos(pi/2 +
ballangle)*cos(rotangle)*sin(pi/2 +
ballangle))/(405648192073033408478945025720320000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2))))/2 + (4967757600021511*sin(pi/2
+ ballangle)*sin(rotangle))/405648192073033408478945025720320 +
(8559446344837063453*cos(pi/2 +
ballangle)^2)/(811296384146066816957890051440640000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) + (2139*sin(pi/2 +
ballangle)^2)/(5000*(cos(pi/2 + ballangle)^2 + sin(pi/2 + ballangle)^2))
- (17473295873545924696264063428914813*cos(pi/2 + ballangle)*sin(pi/2 +
ballangle))/(202824096036516704239472512860160000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) + (2139*cos(pi/2 +
ballangle)^2*cos(rotangle))/(5000*(cos(pi/2 + ballangle)^2 + sin(pi/2 +
ballangle)^2)) + (8559446344837063453*cos(rotangle)*sin(pi/2 +
ballangle)^2)/(811296384146066816957890051440640000*(cos(pi/2 +

```


$$\begin{aligned}
& \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2)) + \\
& (17473295873545924696264063428914813 * \cos(\text{pi}/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle})) / (202824096036516704239472512860160000 * (\cos(\text{pi}/2 + \\
& \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2)) - \\
& 8163333372622185/9007199254740992)^2 + ((4967757600021511 * \cos(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 405648192073033408478945025720320 - (\sin(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 10 + (3^{(1/2)} * ((\cos(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 5 + (4967757600021511 * \sin(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 202824096036516704239472512860160 + \\
& (8559446344837063453 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2) / (405648192073033408478945025720320000 * (\cos(\text{pi}/2 + \\
& \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2)) + (2139 * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) / (2500 * (\cos(\text{pi}/2 + \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2)) \\
& - (17473295873545924696264063428914813 * \cos(\text{pi}/2 + \text{ballangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle})) / (101412048018258352119736256430080000 * (\cos(\text{pi}/2 + \\
& \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2)) + (2139 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (2500 * (\cos(\text{pi}/2 + \text{ballangle})^2 + \sin(\text{pi}/2 + \\
& \text{ballangle})^2)) + (8559446344837063453 * \cos(\text{rotangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) / (405648192073033408478945025720320000 * (\cos(\text{pi}/2 + \\
& \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2)) + \\
& (17473295873545924696264063428914813 * \cos(\text{pi}/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle})) / (101412048018258352119736256430080000 * (\cos(\text{pi}/2 + \\
& \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2))) / 2 - (1723 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2) / (20000 * (\cos(\text{pi}/2 + \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2)) \\
& + (10626033506446012029 * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) / (202824096036516704239472512860160000 * (\cos(\text{pi}/2 + \\
& \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2)) + \\
& (347072593137687375735139019169242339 * \cos(\text{pi}/2 + \text{ballangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle})) / (811296384146066816957890051440640000 * (\cos(\text{pi}/2 + \\
& \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2)) + (10626033506446012029 * \cos(\text{pi}/2 + \\
& + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (202824096036516704239472512860160000 * (\cos(\text{pi} \\
& /2 + \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2)) - \\
& (1723 * \cos(\text{rotangle}) * \sin(\text{pi}/2 + \text{ballangle})^2) / (20000 * (\cos(\text{pi}/2 + \\
& \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2)) - \\
& (347072593137687375735139019169242339 * \cos(\text{pi}/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle})) / (811296384146066816957890051440640000 * (\cos(\text{pi}/2 + \\
& \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2)) - \\
& 1395617217125071/2251799813685248)^2 + ((2139 * \cos(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / (2500 * (\cos(\text{pi}/2 + \text{ballangle})^2 + \sin(\text{pi}/2 + \\
& \text{ballangle})^2)) - \cos(\text{rotangle}) / 5 + (1723 * \sin(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / (10000 * (\cos(\text{pi}/2 + \text{ballangle})^2 + \sin(\text{pi}/2 + \\
& \text{ballangle})^2)) + 9/5)^2 - 6831/2500) / (3 * ((2139 * \cos(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / (2500 * \cos(\text{pi}/2 + \text{ballangle})^2 + 2500 * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) - \cos(\text{rotangle}) / 5 + (1723 * \sin(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / (10000 * \cos(\text{pi}/2 + \text{ballangle})^2 + 10000 * \sin(\text{pi}/2 \\
& + \text{ballangle})^2) + 9/5)^2 + ((4967757600021511 * \cos(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 405648192073033408478945025720320 - (\sin(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 10 - (1723 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2) / (20000 * \cos(\text{pi}/2 + \text{ballangle})^2 + 20000 * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) + (10626033506446012029 * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) / (202824096036516704239472512860160000 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2 + 202824096036516704239472512860160000 * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) + (3^{(1/2)} * ((\cos(\text{pi}/2 + \text{ballangle}) * \sin(\text{rotangle})) / 5 + \\
& (4967757600021511 * \sin(\text{pi}/2 +
\end{aligned}$$

$$\begin{aligned}
& \text{ballangle}) * \sin(\text{rotangle})) / 202824096036516704239472512860160 + \\
& (8559446344837063453 * \cos(\pi/2 + \\
& \text{ballangle})^2) / (405648192073033408478945025720320000 * \cos(\pi/2 + \\
& \text{ballangle})^2 + 405648192073033408478945025720320000 * \sin(\pi/2 + \\
& \text{ballangle})^2) + (2139 * \sin(\pi/2 + \text{ballangle})^2) / (2500 * \cos(\pi/2 + \\
& \text{ballangle})^2 + 2500 * \sin(\pi/2 + \text{ballangle})^2) - \\
& (17473295873545924696264063428914813 * \cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (101412048018258352119736256430080000 * \cos(\pi/2 + \text{ballangle})^2 \\
& + 101412048018258352119736256430080000 * \sin(\pi/2 + \text{ballangle})^2) + \\
& (2139 * \cos(\pi/2 + \text{ballangle})^2 * \cos(\text{rotangle})) / (2500 * \cos(\pi/2 + \\
& \text{ballangle})^2 + 2500 * \sin(\pi/2 + \text{ballangle})^2) + \\
& (8559446344837063453 * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})^2) / (405648192073033408478945025720320000 * \cos(\pi/2 + \\
& \text{ballangle})^2 + 405648192073033408478945025720320000 * \sin(\pi/2 + \\
& \text{ballangle})^2) + (17473295873545924696264063428914813 * \cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (101412048018258352119736256430080000 * \cos(\pi/2 + \text{ballangle})^2 \\
& + 101412048018258352119736256430080000 * \sin(\pi/2 + \text{ballangle})^2))) / 2 + \\
& (347072593137687375735139019169242339 * \cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (811296384146066816957890051440640000 * \cos(\pi/2 + \text{ballangle})^2 \\
& + 811296384146066816957890051440640000 * \sin(\pi/2 + \text{ballangle})^2) + \\
& (10626033506446012029 * \cos(\pi/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (202824096036516704239472512860160000 * \cos(\pi/ \\
& 2 + \text{ballangle})^2 + 202824096036516704239472512860160000 * \sin(\pi/2 + \\
& \text{ballangle})^2) - (1723 * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})^2) / (20000 * \cos(\pi/2 + \text{ballangle})^2 + 20000 * \sin(\pi/2 + \\
& \text{ballangle})^2) - (347072593137687375735139019169242339 * \cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (811296384146066816957890051440640000 * \cos(\pi/2 + \text{ballangle})^2 \\
& + 811296384146066816957890051440640000 * \sin(\pi/2 + \text{ballangle})^2) - \\
& 1395617217125071 / 2251799813685248)^(2)^(1/2))) + \\
& 180 * \arctan((4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 405648192073033408478945025720320 - \\
& (\cos(\text{rotangle}) * i) / 5 - (\sin(\pi/2 + \text{ballangle}) * \sin(\text{rotangle})) / 10 + \\
& (3^(1/2) * ((\cos(\pi/2 + \text{ballangle}) * \sin(\text{rotangle})) / 5 + \\
& (4967757600021511 * \sin(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 202824096036516704239472512860160 + \\
& (8559446344837063453 * \cos(\pi/2 + \\
& \text{ballangle})^2) / (405648192073033408478945025720320000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2))) + (2139 * \sin(\pi/2 + \\
& \text{ballangle})^2) / (2500 * (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2))) \\
& - (17473295873545924696264063428914813 * \cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (101412048018258352119736256430080000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2))) + (2139 * \cos(\pi/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (2500 * (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \\
& \text{ballangle})^2)) + (8559446344837063453 * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})^2) / (405648192073033408478945025720320000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2))) + \\
& (17473295873545924696264063428914813 * \cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (101412048018258352119736256430080000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2))) / 2 - (1723 * \cos(\pi/2 + \\
& \text{ballangle})^2) / (20000 * (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) \\
& + (10626033506446012029 * \sin(\pi/2 + \\
& \text{ballangle})^2) / (202824096036516704239472512860160000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& (347072593137687375735139019169242339 * \cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (811296384146066816957890051440640000 * (\cos(\pi/2 +
\end{aligned}$$

```

ballangle)^2 + sin(pi/2 + ballangle)^2)) + (cos(pi/2 +
ballangle)*sin(rotangle)*2139*1i)/(2500*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2)) + (sin(pi/2 +
ballangle)*sin(rotangle)*1723*1i)/(10000*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2)) + (10626033506446012029*cos(pi/2 +
ballangle)^2*cos(rotangle))/(202824096036516704239472512860160000*(cos(pi
/2 + ballangle)^2 + sin(pi/2 + ballangle)^2)) -
(1723*cos(rotangle)*sin(pi/2 + ballangle)^2)/(20000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) -
(347072593137687375735139019169242339*cos(pi/2 +
ballangle)*cos(rotangle)*sin(pi/2 +
ballangle))/(811296384146066816957890051440640000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) -
1395617217125071/2251799813685248 + (9*1i)/5) - 180*pi))/(29*pi)) + 512;
send_Pose(2)= round((100*(180*acos((5*((1723*sin(pi/2 +
ballangle)*sin(rotangle))/(20000*(cos(pi/2 + ballangle)^2 + sin(pi/2 +
ballangle)^2)) - (2139*cos(pi/2 +
ballangle)*sin(rotangle))/(5000*(cos(pi/2 + ballangle)^2 + sin(pi/2 +
ballangle)^2)) - cos(rotangle)/5 + (1723*3^(1/2)*cos(pi/2 +
ballangle)*sin(rotangle))/(20000*(cos(pi/2 + ballangle)^2 + sin(pi/2 +
ballangle)^2)) + (2139*3^(1/2)*sin(pi/2 +
ballangle)*sin(rotangle))/(5000*(cos(pi/2 + ballangle)^2 + sin(pi/2 +
ballangle)^2)) + 9/5)^2 + ((sin(pi/2 + ballangle)*sin(rotangle))/10 -
(4967757600021511*cos(pi/2 +
ballangle)*sin(rotangle))/405648192073033408478945025720320 +
(2139*3^(1/2)*(cos(pi/2 + ballangle)^2/(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2) + (4967757600021511*cos(pi/2 +
ballangle)*sin(pi/2 +
ballangle))/(40564819207303340847894502572032*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2)) + (cos(rotangle)*sin(pi/2 +
ballangle)^2)/(cos(pi/2 + ballangle)^2 + sin(pi/2 + ballangle)^2) -
(4967757600021511*cos(pi/2 + ballangle)*cos(rotangle)*sin(pi/2 +
ballangle))/(40564819207303340847894502572032*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2))))/10000 -
(1723*3^(1/2)*((4967757600021511*sin(pi/2 +
ballangle)^2)/(40564819207303340847894502572032*(cos(pi/2 + ballangle)^2
+ sin(pi/2 + ballangle)^2)) + (cos(pi/2 + ballangle)*sin(pi/2 +
ballangle))/(cos(pi/2 + ballangle)^2 + sin(pi/2 + ballangle)^2) +
(4967757600021511*cos(pi/2 +
ballangle)^2*cos(rotangle))/(40564819207303340847894502572032*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) - (cos(pi/2 +
ballangle)*cos(rotangle)*sin(pi/2 + ballangle))/(cos(pi/2 + ballangle)^2
+ sin(pi/2 + ballangle)^2)))/40000 + (1723*cos(pi/2 +
ballangle)^2)/(40000*(cos(pi/2 + ballangle)^2 + sin(pi/2 + ballangle)^2))
- (3^(1/2)*((cos(pi/2 + ballangle)*sin(rotangle))/5 +
(4967757600021511*sin(pi/2 +
ballangle)*sin(rotangle))/202824096036516704239472512860160 +
(1723*3^(1/2)*(sin(pi/2 + ballangle)^2/(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2) - (4967757600021511*cos(pi/2 +
ballangle)*sin(pi/2 +
ballangle))/(40564819207303340847894502572032*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2)) + (cos(pi/2 +
ballangle)^2*cos(rotangle))/(cos(pi/2 + ballangle)^2 + sin(pi/2 +
ballangle)^2) + (4967757600021511*cos(pi/2 +
ballangle)*cos(rotangle)*sin(pi/2 +
ballangle))/(40564819207303340847894502572032*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2))))/20000 +
(2139*3^(1/2)*((4967757600021511*cos(pi/2 +

```

$$\begin{aligned}
& \text{ballangle})^2)/(40564819207303340847894502572032*(\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) - (\cos(\pi/2 + \text{ballangle})*\sin(\pi/2 + \\
& \text{ballangle}))/(\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) + \\
& (4967757600021511*\cos(\text{rotangle})*\sin(\pi/2 + \\
& \text{ballangle})^2)/(40564819207303340847894502572032*(\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\pi/2 + \\
& \text{ballangle})*\cos(\text{rotangle})*\sin(\pi/2 + \text{ballangle}))/(\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2))/5000 + (8559446344837063453*\cos(\pi/2 + \\
& \text{ballangle})^2)/(811296384146066816957890051440640000*(\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - (2139*\sin(\pi/2 + \\
& \text{ballangle})^2)/(5000*(\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) \\
& - (3494659174709180688839410107378151*\cos(\pi/2 + \text{ballangle})*\sin(\pi/2 + \\
& \text{ballangle}))/ (40564819207303340847894502572032000*(\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) - (2139*\cos(\pi/2 + \\
& \text{ballangle})^2*\cos(\text{rotangle}))/ (5000*(\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \\
& \text{ballangle})^2)) + (8559446344837063453*\cos(\text{rotangle})*\sin(\pi/2 + \\
& \text{ballangle})^2)/(811296384146066816957890051440640000*(\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& (3494659174709180688839410107378151*\cos(\pi/2 + \\
& \text{ballangle})*\cos(\text{rotangle})*\sin(\pi/2 + \\
& \text{ballangle}))/ (40564819207303340847894502572032000*(\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)))/2 + (10626033506446012029*\sin(\pi/2 + \\
& \text{ballangle})^2)/(405648192073033408478945025720320000*(\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& (69414518627537478570806341768673849*\cos(\pi/2 + \text{ballangle})*\sin(\pi/2 + \\
& \text{ballangle}))/ (324518553658426726783156020576256000*(\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + (10626033506446012029*\cos(\pi/2 + \\
& + \\
& \text{ballangle})^2*\cos(\text{rotangle}))/ (405648192073033408478945025720320000*(\cos(\pi \\
& /2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& (1723*\cos(\text{rotangle})*\sin(\pi/2 + \text{ballangle})^2)/(40000*(\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - \\
& (69414518627537478570806341768673849*\cos(\pi/2 + \\
& \text{ballangle})*\cos(\text{rotangle})*\sin(\pi/2 + \\
& \text{ballangle}))/ (324518553658426726783156020576256000*(\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - \\
& 5582468868500283/9007199254740992)^2 + ((3^(1/2))*((\sin(\pi/2 + \\
& \text{ballangle})*\sin(\text{rotangle}))/5 - (4967757600021511*\cos(\pi/2 + \\
& \text{ballangle})*\sin(\text{rotangle}))/202824096036516704239472512860160 + \\
& (2139*3^(1/2)*(\cos(\pi/2 + \text{ballangle})^2)/(\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2) + (4967757600021511*\cos(\pi/2 + \\
& \text{ballangle})*\sin(\pi/2 + \\
& \text{ballangle}))/ (40564819207303340847894502572032*(\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\text{rotangle})*\sin(\pi/2 + \\
& \text{ballangle})^2)/(\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - \\
& (4967757600021511*\cos(\pi/2 + \text{ballangle})*\cos(\text{rotangle})*\sin(\pi/2 + \\
& \text{ballangle}))/ (40564819207303340847894502572032*(\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2)))/5000 - \\
& (1723*3^(1/2))*((4967757600021511*\sin(\pi/2 + \\
& \text{ballangle})^2)/(40564819207303340847894502572032*(\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\pi/2 + \text{ballangle})*\sin(\pi/2 + \\
& \text{ballangle}))/(\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) + \\
& (4967757600021511*\cos(\pi/2 + \\
& \text{ballangle})^2*\cos(\text{rotangle}))/ (40564819207303340847894502572032*(\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - (\cos(\pi/2 + \\
& \text{ballangle})*\cos(\text{rotangle})*\sin(\pi/2 + \text{ballangle}))/(\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2))/20000 + (1723*\cos(\pi/2 + \\
& \text{ballangle})^2)/(20000*(\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2))
\end{aligned}$$

$$\begin{aligned}
& + (10626033506446012029 * \sin(\pi/2 + \\
& \text{ballangle})^2) / (202824096036516704239472512860160000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& (69414518627537478570806341768673849 * \cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (162259276829213363391578010288128000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + (10626033506446012029 * \cos(\pi/2 + \\
& + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (202824096036516704239472512860160000 * (\cos(\pi/ \\
& /2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& (1723 * \cos(\text{rotangle}) * \sin(\pi/2 + \text{ballangle})^2) / (20000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - \\
& (69414518627537478570806341768673849 * \cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (162259276829213363391578010288128000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2))) / 2 + (\cos(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 10 + (4967757600021511 * \sin(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 405648192073033408478945025720320 + \\
& (1723 * 3^{(1/2)} * (\sin(\pi/2 + \text{ballangle})^2 / (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2) - (4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\pi/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \\
& \text{ballangle})^2) + (4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2))) / 40000 + \\
& (2139 * 3^{(1/2)} * ((4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) - (\cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) + \\
& (4967757600021511 * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2))) / 10000 + (8559446344837063453 * \cos(\pi/2 + \\
& \text{ballangle})^2) / (1622592768292133633915780102881280000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - (2139 * \sin(\pi/2 + \\
& \text{ballangle})^2) / (10000 * (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) \\
& - (3494659174709180688839410107378151 * \cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (81129638414606681695789005144064000 * (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) - (2139 * \cos(\pi/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (10000 * (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \\
& \text{ballangle})^2)) + (8559446344837063453 * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})^2) / (1622592768292133633915780102881280000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& (3494659174709180688839410107378151 * \cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (81129638414606681695789005144064000 * (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) - 8163333372622185 / 9007199254740992)^2 - \\
& 6831 / 2500) / (3 * ((1723 * \sin(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / (20000 * \cos(\pi/2 + \text{ballangle})^2 + 20000 * \sin(\pi/2 \\
& + \text{ballangle})^2) - (2139 * \cos(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / (5000 * \cos(\pi/2 + \text{ballangle})^2 + 5000 * \sin(\pi/2 + \\
& \text{ballangle})^2) - \cos(\text{rotangle}) / 5 + (1723 * 3^{(1/2)} * \cos(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / (20000 * \cos(\pi/2 + \text{ballangle})^2 + 20000 * \sin(\pi/2 \\
& + \text{ballangle})^2) + (2139 * 3^{(1/2)} * \sin(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / (5000 * \cos(\pi/2 + \text{ballangle})^2 + 5000 * \sin(\pi/2 +
\end{aligned}$$

$$\begin{aligned}
& \text{ballangle})^2) + 9/5)^2 + ((\sin(\text{pi}/2 + \text{ballangle}) * \sin(\text{rotangle}))/10 - \\
& (4967757600021511 * \cos(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{rotangle}))/405648192073033408478945025720320 - \\
& (3^{(1/2)} * ((\cos(\text{pi}/2 + \text{ballangle}) * \sin(\text{rotangle}))/5 + \\
& (4967757600021511 * \sin(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{rotangle}))/202824096036516704239472512860160 + \\
& (8559446344837063453 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2) / (811296384146066816957890051440640000 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2 + 811296384146066816957890051440640000 * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) - (2139 * \sin(\text{pi}/2 + \text{ballangle})^2) / (5000 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2 + 5000 * \sin(\text{pi}/2 + \text{ballangle})^2) + (1723 * 3^{(1/2)} * (\sin(\text{pi}/2 + \\
& \text{ballangle})^2 / (\cos(\text{pi}/2 + \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2) - \\
& (4967757600021511 * \cos(\text{pi}/2 + \text{ballangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle}))/ (40564819207303340847894502572032 * \cos(\text{pi}/2 + \text{ballangle})^2 + \\
& 40564819207303340847894502572032 * \sin(\text{pi}/2 + \text{ballangle})^2) + (\cos(\text{pi}/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle}))/ (\cos(\text{pi}/2 + \text{ballangle})^2 + \sin(\text{pi}/2 + \\
& \text{ballangle})^2) + (4967757600021511 * \cos(\text{pi}/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle}))/ (40564819207303340847894502572032 * \cos(\text{pi}/2 + \text{ballangle})^2 + \\
& 40564819207303340847894502572032 * \sin(\text{pi}/2 + \text{ballangle})^2))) / 20000 + \\
& (2139 * 3^{(1/2)} * ((4967757600021511 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 * \cos(\text{pi}/2 + \text{ballangle})^2 + \\
& 40564819207303340847894502572032 * \sin(\text{pi}/2 + \text{ballangle})^2) - (\cos(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{pi}/2 + \text{ballangle}))/ (\cos(\text{pi}/2 + \text{ballangle})^2 + \sin(\text{pi}/2 + \\
& \text{ballangle})^2) + (4967757600021511 * \cos(\text{rotangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 * \cos(\text{pi}/2 + \text{ballangle})^2 + \\
& 40564819207303340847894502572032 * \sin(\text{pi}/2 + \text{ballangle})^2) + (\cos(\text{pi}/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\text{pi}/2 + \text{ballangle}))/ (\cos(\text{pi}/2 + \text{ballangle})^2 \\
& + \sin(\text{pi}/2 + \text{ballangle})^2))) / 5000 - \\
& (3494659174709180688839410107378151 * \cos(\text{pi}/2 + \text{ballangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle}))/ (40564819207303340847894502572032000 * \cos(\text{pi}/2 + \text{ballangle})^2 \\
& + 40564819207303340847894502572032000 * \sin(\text{pi}/2 + \text{ballangle})^2) - \\
& (2139 * \cos(\text{pi}/2 + \text{ballangle})^2 * \cos(\text{rotangle}))/ (5000 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2 + 5000 * \sin(\text{pi}/2 + \text{ballangle})^2) + \\
& (8559446344837063453 * \cos(\text{rotangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) / (811296384146066816957890051440640000 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2 + 811296384146066816957890051440640000 * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) + (3494659174709180688839410107378151 * \cos(\text{pi}/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle}))/ (40564819207303340847894502572032000 * \cos(\text{pi}/2 + \text{ballangle})^2 \\
& + 40564819207303340847894502572032000 * \sin(\text{pi}/2 + \text{ballangle})^2))) / 2 + \\
& (1723 * \cos(\text{pi}/2 + \text{ballangle})^2) / (40000 * \cos(\text{pi}/2 + \text{ballangle})^2 + \\
& 40000 * \sin(\text{pi}/2 + \text{ballangle})^2) + (10626033506446012029 * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) / (405648192073033408478945025720320000 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2 + 405648192073033408478945025720320000 * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) + (2139 * 3^{(1/2)} * (\cos(\text{pi}/2 + \text{ballangle})^2 / (\cos(\text{pi}/2 + \\
& \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2) + (4967757600021511 * \cos(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle}))/ (40564819207303340847894502572032 * \cos(\text{pi}/2 + \text{ballangle})^2 + \\
& 40564819207303340847894502572032 * \sin(\text{pi}/2 + \text{ballangle})^2) + \\
& (\cos(\text{rotangle}) * \sin(\text{pi}/2 + \text{ballangle})^2) / (\cos(\text{pi}/2 + \text{ballangle})^2 + \\
& \sin(\text{pi}/2 + \text{ballangle})^2) - (4967757600021511 * \cos(\text{pi}/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle}))/ (40564819207303340847894502572032 * \cos(\text{pi}/2 + \text{ballangle})^2 + \\
& 40564819207303340847894502572032 * \sin(\text{pi}/2 + \text{ballangle})^2))) / 10000 - \\
& (1723 * 3^{(1/2)} * ((4967757600021511 * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 * \cos(\text{pi}/2 + \text{ballangle})^2 + \\
& 40564819207303340847894502572032 * \sin(\text{pi}/2 + \text{ballangle})^2) + (\cos(\text{pi}/2 +
\end{aligned}$$

$$\begin{aligned}
& \text{ballangle}) * \sin(\pi/2 + \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \\
& \text{ballangle})^2) + (4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (40564819207303340847894502572032 * \cos(\pi/2 + \\
& \text{ballangle})^2 + 40564819207303340847894502572032 * \sin(\pi/2 + \text{ballangle})^2) \\
& - (\cos(\pi/2 + \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \text{ballangle})) / (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) / 40000 + \\
& (69414518627537478570806341768673849 * \cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (324518553658426726783156020576256000 * \cos(\pi/2 + \text{ballangle})^2 \\
& + 324518553658426726783156020576256000 * \sin(\pi/2 + \text{ballangle})^2) + \\
& (10626033506446012029 * \cos(\pi/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (405648192073033408478945025720320000 * \cos(\pi/ \\
& 2 + \text{ballangle})^2 + 405648192073033408478945025720320000 * \sin(\pi/2 + \\
& \text{ballangle})^2) + (1723 * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})^2) / (40000 * \cos(\pi/2 + \text{ballangle})^2 + 40000 * \sin(\pi/2 + \\
& \text{ballangle})^2) - (69414518627537478570806341768673849 * \cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (324518553658426726783156020576256000 * \cos(\pi/2 + \text{ballangle})^2 \\
& + 324518553658426726783156020576256000 * \sin(\pi/2 + \text{ballangle})^2) - \\
& 5582468868500283 / 9007199254740992) ^2) ^{(1/2)}) - \\
& 180 * \text{angle}((4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 405648192073033408478945025720320 - \\
& (\cos(\text{rotangle}) * i) / 5 - (\sin(\pi/2 + \text{ballangle}) * \sin(\text{rotangle})) / 10 - \\
& (2139 * 3^{(1/2)} * (\cos(\pi/2 + \text{ballangle})^2 / (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2) + (4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})^2) - \\
& (4967757600021511 * \cos(\pi/2 + \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2))) / 10000 + \\
& (1723 * 3^{(1/2)} * ((4967757600021511 * \sin(\pi/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) + \\
& (4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - (\cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2))) / 40000 - (1723 * \cos(\pi/2 + \\
& \text{ballangle})^2) / (40000 * (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) \\
& + (3^{(1/2)} * ((\cos(\pi/2 + \text{ballangle}) * \sin(\text{rotangle})) / 5 + \\
& (4967757600021511 * \sin(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 202824096036516704239472512860160 + \\
& (1723 * 3^{(1/2)} * (\sin(\pi/2 + \text{ballangle})^2 / (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2) - (4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\pi/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \\
& \text{ballangle})^2) + (4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2)))) / 20000 + \\
& (2139 * 3^{(1/2)} * ((4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) - (\cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) +
\end{aligned}$$

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(4967757600021511*cos(rotangle)*sin(pi/2 +
ballangle)^2)/(40564819207303340847894502572032*(cos(pi/2 + ballangle)^2
+ sin(pi/2 + ballangle)^2)) + (cos(pi/2 +
ballangle)*cos(rotangle)*sin(pi/2 + ballangle))/(cos(pi/2 + ballangle)^2
+ sin(pi/2 + ballangle)^2))/5000 + (8559446344837063453*cos(pi/2 +
ballangle)^2)/(811296384146066816957890051440640000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) - (2139*sin(pi/2 +
ballangle)^2)/(5000*(cos(pi/2 + ballangle)^2 + sin(pi/2 + ballangle)^2))
- (3494659174709180688839410107378151*cos(pi/2 + ballangle)*sin(pi/2 +
ballangle))/(40564819207303340847894502572032000*(cos(pi/2 + ballangle)^2
+ sin(pi/2 + ballangle)^2)) - (2139*cos(pi/2 +
ballangle)^2*cos(rotangle))/(5000*(cos(pi/2 + ballangle)^2 + sin(pi/2 +
ballangle)^2)) + (8559446344837063453*cos(rotangle)*sin(pi/2 +
ballangle)^2)/(811296384146066816957890051440640000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) +
(3494659174709180688839410107378151*cos(pi/2 +
ballangle)*cos(rotangle)*sin(pi/2 +
ballangle))/(40564819207303340847894502572032000*(cos(pi/2 + ballangle)^2
+ sin(pi/2 + ballangle)^2)))/2 - (10626033506446012029*sin(pi/2 +
ballangle)^2)/(405648192073033408478945025720320000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) -
(69414518627537478570806341768673849*cos(pi/2 + ballangle)*sin(pi/2 +
ballangle))/(324518553658426726783156020576256000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) - (cos(pi/2 +
ballangle)*sin(rotangle)*2139*1i)/(5000*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2)) + (sin(pi/2 +
ballangle)*sin(rotangle)*1723*1i)/(20000*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2)) - (10626033506446012029*cos(pi/2 +
ballangle)^2*cos(rotangle))/(405648192073033408478945025720320000*(cos(pi
/2 + ballangle)^2 + sin(pi/2 + ballangle)^2)) -
(1723*cos(rotangle)*sin(pi/2 + ballangle)^2)/(40000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) +
(69414518627537478570806341768673849*cos(pi/2 +
ballangle)*cos(rotangle)*sin(pi/2 +
ballangle))/(324518553658426726783156020576256000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) + (3^(1/2)*cos(pi/2 +
ballangle)*sin(rotangle)*1723*1i)/(20000*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2)) + (3^(1/2)*sin(pi/2 +
ballangle)*sin(rotangle)*2139*1i)/(5000*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2)) + 5582468868500283/9007199254740992 +
(9*1i)/5))/((29*pi)) + 512;
send_Pose(3)= round(-(100*(180*acos((5*((cos(rotangle)/5 + (2139*cos(pi/2
+ ballangle)*sin(rotangle))/(5000*(cos(pi/2 + ballangle)^2 + sin(pi/2 +
ballangle)^2)) + (1723*sin(pi/2 +
ballangle)*sin(rotangle))/(20000*(cos(pi/2 + ballangle)^2 + sin(pi/2 +
ballangle)^2)) + (1723*3^(1/2)*cos(pi/2 +
ballangle)*sin(rotangle))/(20000*(cos(pi/2 + ballangle)^2 + sin(pi/2 +
ballangle)^2)) - (2139*3^(1/2)*sin(pi/2 +
ballangle)*sin(rotangle))/(5000*(cos(pi/2 + ballangle)^2 + sin(pi/2 +
ballangle)^2)) - 9/5)^2 +
((182687704666362864775460604089520474184191503339*cos(pi/2 +
ballangle)*sin(rotangle))/91343852333181432387730302044767688728495783936
0 + (31989355364244487*sin(pi/2 +
ballangle)*sin(rotangle))/202824096036516704239472512860160 +
(6417*3^(1/2)*(cos(pi/2 + ballangle)^2/(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2) + (4967757600021511*cos(pi/2 +
ballangle)*sin(pi/2 +
ballangle))/(40564819207303340847894502572032*(cos(pi/2 + ballangle)^2 +

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$$\begin{aligned}
& \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})^2) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) - \\
& (4967757600021511 * \cos(\pi/2 + \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2))) / 22517998136852480000 - \\
& (1723 * 3^{(1/2)} * (\sin(\pi/2 + \text{ballangle})^2 / (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2) - (4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\pi/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \\
& \text{ballangle})^2) + (4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2))) / 20000 + \\
& (5169 * 3^{(1/2)} * ((4967757600021511 * \sin(\pi/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) + \\
& (4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - (\cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2))) / 90071992547409920000 + \\
& (2139 * 3^{(1/2)} * ((4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) - (\cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) + \\
& (4967757600021511 * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2))) / 5000 - (51117659292593251101 * \cos(\pi/2 + \\
& \text{ballangle})^2) / (811296384146066816957890051440640000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - \\
& (390769000281350167754710232147484294279985625642121 * \sin(\pi/2 + \\
& \text{ballangle})^2) / (913438523331814323877303020447676887284957839360000 * (\cos(\pi \\
& /2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& (314770915140144448647500194135055778559993401956009 * \cos(\pi/2 + \\
& \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (3653754093327257295509212081790707549139831357440000 * (\cos(\pi \\
& /2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - \\
& (390769000281350167754710232147484294279985625642121 * \cos(\pi/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (91343852333181432387730302044767688728495783 \\
& 9360000 * (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - \\
& (51117659292593251101 * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})^2) / (811296384146066816957890051440640000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - \\
& (314770915140144448647500194135055778559993401956009 * \cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (3653754093327257295509212081790707549139831357440000 * (\cos(\pi \\
& /2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& 4081666686311093 / 4503599627370496)^2 + \\
& ((182687704666362864775460604089520474184191503339 * \sin(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 91343852333181432387730302044767688728495783936 \\
& 0 - (31989355364244487 * \cos(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 202824096036516704239472512860160 + \\
& (2139 * 3^{(1/2)} * (\cos(\pi/2 + \text{ballangle})^2 / (\cos(\pi/2 + \text{ballangle})^2 +
\end{aligned}$$

$$\begin{aligned}
& \sin(\pi/2 + \text{ballangle})^2) + (4967757600021511 \cdot \cos(\pi/2 + \\
& \text{ballangle}) \cdot \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\text{rotangle}) \cdot \sin(\pi/2 + \\
& \text{ballangle})^2) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) - \\
& (4967757600021511 \cdot \cos(\pi/2 + \text{ballangle}) \cdot \cos(\text{rotangle}) \cdot \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2))) / 5000 + (5169 \cdot 3^{(1/2)} \cdot (\sin(\pi/2 + \\
& \text{ballangle})^2 / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) - \\
& (4967757600021511 \cdot \cos(\pi/2 + \text{ballangle}) \cdot \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\pi/2 + \\
& \text{ballangle})^2 \cdot \cos(\text{rotangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \\
& \text{ballangle})^2) + (4967757600021511 \cdot \cos(\pi/2 + \\
& \text{ballangle}) \cdot \cos(\text{rotangle}) \cdot \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2))) / 90071992547409920000 + \\
& (1723 \cdot 3^{(1/2)} \cdot ((4967757600021511 \cdot \sin(\pi/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\pi/2 + \text{ballangle}) \cdot \sin(\pi/2 + \\
& \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) + \\
& (4967757600021511 \cdot \cos(\pi/2 + \\
& \text{ballangle})^2 \cdot \cos(\text{rotangle})) / (40564819207303340847894502572032 \cdot (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - (\cos(\pi/2 + \\
& \text{ballangle}) \cdot \cos(\text{rotangle}) \cdot \sin(\pi/2 + \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2))) / 20000 - \\
& (6417 \cdot 3^{(1/2)} \cdot ((4967757600021511 \cdot \cos(\pi/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2)) - (\cos(\pi/2 + \text{ballangle}) \cdot \sin(\pi/2 + \\
& \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) + \\
& (4967757600021511 \cdot \cos(\text{rotangle}) \cdot \sin(\pi/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\pi/2 + \\
& \text{ballangle}) \cdot \cos(\text{rotangle}) \cdot \sin(\pi/2 + \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2))) / 22517998136852480000 - \\
& (314770915140143216008118620846243777019361960253097 \cdot \cos(\pi/2 + \\
& \text{ballangle})^2) / (3653754093327257295509212081790707549139831357440000 \cdot (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& (68425231124118957693 \cdot \sin(\pi/2 + \\
& \text{ballangle})^2) / (202824096036516704239472512860160000 \cdot (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& (390769000281350105697742769233253839667593503913097 \cdot \cos(\pi/2 + \\
& \text{ballangle}) \cdot \sin(\pi/2 + \\
& \text{ballangle})) / (913438523331814323877303020447676887284957839360000 \cdot (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& (68425231124118957693 \cdot \cos(\pi/2 + \\
& \text{ballangle})^2 \cdot \cos(\text{rotangle})) / (202824096036516704239472512860160000 \cdot (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - \\
& (314770915140143216008118620846243777019361960253097 \cdot \cos(\text{rotangle}) \cdot \sin(\pi/2 + \\
& \text{ballangle})^2) / (3653754093327257295509212081790707549139831357440000 \cdot (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - \\
& (390769000281350105697742769233253839667593503913097 \cdot \cos(\pi/2 + \\
& \text{ballangle}) \cdot \cos(\text{rotangle}) \cdot \sin(\pi/2 + \\
& \text{ballangle})) / (913438523331814323877303020447676887284957839360000 \cdot (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - \\
& 5582468868500283 / 9007199254740992)^2 - 6831 / 2500) / (3 \cdot ((\cos(\text{rotangle}) / 5 + \\
& (2139 \cdot \cos(\pi/2 + \text{ballangle}) \cdot \sin(\text{rotangle})) / (5000 \cdot \cos(\pi/2 + \text{ballangle})^2
\end{aligned}$$

$$\begin{aligned}
& + 5000 \cdot \sin(\pi/2 + \text{ballangle})^2) + (1723 \cdot \sin(\pi/2 + \\
& \text{ballangle}) \cdot \sin(\text{rotangle})) / (20000 \cdot \cos(\pi/2 + \text{ballangle})^2 + 20000 \cdot \sin(\pi/2 \\
& + \text{ballangle})^2) + (1723 \cdot 3^{(1/2)} \cdot \cos(\pi/2 + \\
& \text{ballangle}) \cdot \sin(\text{rotangle})) / (20000 \cdot \cos(\pi/2 + \text{ballangle})^2 + 20000 \cdot \sin(\pi/2 \\
& + \text{ballangle})^2) - (2139 \cdot 3^{(1/2)} \cdot \sin(\pi/2 + \\
& \text{ballangle}) \cdot \sin(\text{rotangle})) / (5000 \cdot \cos(\pi/2 + \text{ballangle})^2 + 5000 \cdot \sin(\pi/2 + \\
& \text{ballangle})^2) - 9/5)^2 + \\
& ((182687704666362864775460604089520474184191503339 \cdot \sin(\pi/2 + \\
& \text{ballangle}) \cdot \sin(\text{rotangle})) / 91343852333181432387730302044767688728495783936 \\
& 0 - (31989355364244487 \cdot \cos(\pi/2 + \\
& \text{ballangle}) \cdot \sin(\text{rotangle})) / 202824096036516704239472512860160 - \\
& (314770915140143216008118620846243777019361960253097 \cdot \cos(\pi/2 + \\
& \text{ballangle})^2) / (3653754093327257295509212081790707549139831357440000 \cdot \cos(\pi \\
& /2 + \text{ballangle})^2 + \\
& 3653754093327257295509212081790707549139831357440000 \cdot \sin(\pi/2 + \\
& \text{ballangle})^2) + (68425231124118957693 \cdot \sin(\pi/2 + \\
& \text{ballangle})^2) / (202824096036516704239472512860160000 \cdot \cos(\pi/2 + \\
& \text{ballangle})^2 + 202824096036516704239472512860160000 \cdot \sin(\pi/2 + \\
& \text{ballangle})^2) + (2139 \cdot 3^{(1/2)} \cdot (\cos(\pi/2 + \text{ballangle})^2 / (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) + (4967757600021511 \cdot \cos(\pi/2 + \\
& \text{ballangle}) \cdot \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 \cdot \cos(\pi/2 + \text{ballangle})^2 + \\
& 40564819207303340847894502572032 \cdot \sin(\pi/2 + \text{ballangle})^2) + \\
& (\cos(\text{rotangle}) \cdot \sin(\pi/2 + \text{ballangle})^2) / (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2) - (4967757600021511 \cdot \cos(\pi/2 + \\
& \text{ballangle}) \cdot \cos(\text{rotangle}) \cdot \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 \cdot \cos(\pi/2 + \text{ballangle})^2 + \\
& 40564819207303340847894502572032 \cdot \sin(\pi/2 + \text{ballangle})^2))) / 5000 + \\
& (5169 \cdot 3^{(1/2)} \cdot (\sin(\pi/2 + \text{ballangle})^2 / (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2) - (4967757600021511 \cdot \cos(\pi/2 + \\
& \text{ballangle}) \cdot \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 \cdot \cos(\pi/2 + \text{ballangle})^2 + \\
& 40564819207303340847894502572032 \cdot \sin(\pi/2 + \text{ballangle})^2) + (\cos(\pi/2 + \\
& \text{ballangle})^2 \cdot \cos(\text{rotangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \\
& \text{ballangle})^2) + (4967757600021511 \cdot \cos(\pi/2 + \\
& \text{ballangle}) \cdot \cos(\text{rotangle}) \cdot \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 \cdot \cos(\pi/2 + \text{ballangle})^2 + \\
& 40564819207303340847894502572032 \cdot \sin(\pi/2 + \\
& \text{ballangle})^2))) / 90071992547409920000 - \\
& (6417 \cdot 3^{(1/2)} \cdot ((4967757600021511 \cdot \cos(\pi/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 \cdot \cos(\pi/2 + \text{ballangle})^2 + \\
& 40564819207303340847894502572032 \cdot \sin(\pi/2 + \text{ballangle})^2) - (\cos(\pi/2 + \\
& \text{ballangle}) \cdot \sin(\pi/2 + \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \\
& \text{ballangle})^2) + (4967757600021511 \cdot \cos(\text{rotangle}) \cdot \sin(\pi/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 \cdot \cos(\pi/2 + \text{ballangle})^2 + \\
& 40564819207303340847894502572032 \cdot \sin(\pi/2 + \text{ballangle})^2) + (\cos(\pi/2 + \\
& \text{ballangle}) \cdot \cos(\text{rotangle}) \cdot \sin(\pi/2 + \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2))) / 22517998136852480000 + \\
& (1723 \cdot 3^{(1/2)} \cdot ((4967757600021511 \cdot \sin(\pi/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 \cdot \cos(\pi/2 + \text{ballangle})^2 + \\
& 40564819207303340847894502572032 \cdot \sin(\pi/2 + \text{ballangle})^2) + (\cos(\pi/2 + \\
& \text{ballangle}) \cdot \sin(\pi/2 + \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \\
& \text{ballangle})^2) + (4967757600021511 \cdot \cos(\pi/2 + \\
& \text{ballangle})^2 \cdot \cos(\text{rotangle})) / (40564819207303340847894502572032 \cdot \cos(\pi/2 + \\
& \text{ballangle})^2 + 40564819207303340847894502572032 \cdot \sin(\pi/2 + \text{ballangle})^2) \\
& - (\cos(\pi/2 + \text{ballangle}) \cdot \cos(\text{rotangle}) \cdot \sin(\pi/2 + \text{ballangle})) / (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2))) / 20000 + \\
& (390769000281350105697742769233253839667593503913097 \cdot \cos(\pi/2 +
\end{aligned}$$

$$\begin{aligned}
& \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (913438523331814323877303020447676887284957839360000 * \cos(\pi/2 \\
& + \text{ballangle})^2 + \\
& 913438523331814323877303020447676887284957839360000 * \sin(\pi/2 + \\
& \text{ballangle})^2) + (68425231124118957693 * \cos(\pi/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (202824096036516704239472512860160000 * \cos(\pi/ \\
& 2 + \text{ballangle})^2 + 202824096036516704239472512860160000 * \sin(\pi/2 + \\
& \text{ballangle})^2) - \\
& (314770915140143216008118620846243777019361960253097 * \cos(\text{rotangle}) * \sin(\pi \\
& /2 + \\
& \text{ballangle})^2) / (3653754093327257295509212081790707549139831357440000 * \cos(\pi \\
& /2 + \text{ballangle})^2 + \\
& 3653754093327257295509212081790707549139831357440000 * \sin(\pi/2 + \\
& \text{ballangle})^2) - \\
& (390769000281350105697742769233253839667593503913097 * \cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (913438523331814323877303020447676887284957839360000 * \cos(\pi/2 \\
& + \text{ballangle})^2 + \\
& 913438523331814323877303020447676887284957839360000 * \sin(\pi/2 + \\
& \text{ballangle})^2) - 5582468868500283 / (9007199254740992)^2)^{(1/2)}) + \\
& 180 * \text{angle}((182687704666362864775460604089520474184191503339 * \sin(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 91343852333181432387730302044767688728495783936 \\
& 0 - (31989355364244487 * \cos(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 202824096036516704239472512860160 - \\
& (\cos(\text{rotangle}) * i) / 5 + (2139 * 3^{(1/2)} * (\cos(\pi/2 + \text{ballangle})^2 / (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) + (4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})^2) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) - \\
& (4967757600021511 * \cos(\pi/2 + \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2))) / 5000 + (5169 * 3^{(1/2)} * (\sin(\pi/2 + \\
& \text{ballangle})^2 / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) - \\
& (4967757600021511 * \cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\pi/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \\
& \text{ballangle})^2) + (4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2))) / 90071992547409920000 + \\
& (1723 * 3^{(1/2)} * ((4967757600021511 * \sin(\pi/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) + \\
& (4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - (\cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2))) / 20000 - \\
& (6417 * 3^{(1/2)} * ((4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) - (\cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) + \\
& (4967757600021511 * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\pi/2 +
\end{aligned}$$

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ballangle)*cos(rotangle)*sin(pi/2 + ballangle))/(cos(pi/2 + ballangle)^2
+ sin(pi/2 + ballangle)^2)))/22517998136852480000 -
(314770915140143216008118620846243777019361960253097*cos(pi/2 +
ballangle)^2)/(3653754093327257295509212081790707549139831357440000*(cos(
pi/2 + ballangle)^2 + sin(pi/2 + ballangle)^2)) +
(68425231124118957693*sin(pi/2 +
ballangle)^2)/(202824096036516704239472512860160000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) +
(390769000281350105697742769233253839667593503913097*cos(pi/2 +
ballangle)*sin(pi/2 +
ballangle))/(913438523331814323877303020447676887284957839360000*(cos(pi/
2 + ballangle)^2 + sin(pi/2 + ballangle)^2)) - (cos(pi/2 +
ballangle)*sin(rotangle)*2139*1i)/(5000*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2)) - (sin(pi/2 +
ballangle)*sin(rotangle)*1723*1i)/(20000*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2)) + (68425231124118957693*cos(pi/2 +
ballangle)^2*cos(rotangle))/(202824096036516704239472512860160000*(cos(pi
/2 + ballangle)^2 + sin(pi/2 + ballangle)^2)) -
(314770915140143216008118620846243777019361960253097*cos(rotangle)*sin(pi
/2 +
ballangle)^2)/(3653754093327257295509212081790707549139831357440000*(cos(
pi/2 + ballangle)^2 + sin(pi/2 + ballangle)^2)) -
(390769000281350105697742769233253839667593503913097*cos(pi/2 +
ballangle)*cos(rotangle)*sin(pi/2 +
ballangle))/(913438523331814323877303020447676887284957839360000*(cos(pi/
2 + ballangle)^2 + sin(pi/2 + ballangle)^2)) - (3^(1/2)*cos(pi/2 +
ballangle)*sin(rotangle)*1723*1i)/(20000*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2)) + (3^(1/2)*sin(pi/2 +
ballangle)*sin(rotangle)*2139*1i)/(5000*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2)) - 5582468868500283/9007199254740992 + (9*1i)/5)
- 180*pi))/(29*pi)) + 512;
send_Pose(4)= round((100*(180*acos((5*((cos(rotangle)/5 + (2139*cos(pi/2
+ ballangle)*sin(rotangle))/(5000*(cos(pi/2 + ballangle)^2 + sin(pi/2 +
ballangle)^2)) - (1723*sin(pi/2 +
ballangle)*sin(rotangle))/(20000*(cos(pi/2 + ballangle)^2 + sin(pi/2 +
ballangle)^2)) + (1723*3^(1/2)*cos(pi/2 +
ballangle)*sin(rotangle))/(20000*(cos(pi/2 + ballangle)^2 + sin(pi/2 +
ballangle)^2)) + (2139*3^(1/2)*sin(pi/2 +
ballangle)*sin(rotangle))/(5000*(cos(pi/2 + ballangle)^2 + sin(pi/2 +
ballangle)^2)) - 9/5)^2 + ((sin(pi/2 + ballangle)*sin(rotangle))/5 -
(4967757600021511*cos(pi/2 +
ballangle)*sin(rotangle))/202824096036516704239472512860160 -
(2139*3^(1/2)*(cos(pi/2 + ballangle)^2/(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2) + (4967757600021511*cos(pi/2 +
ballangle)*sin(pi/2 +
ballangle))/(40564819207303340847894502572032*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2)) + (cos(rotangle)*sin(pi/2 +
ballangle)^2)/(cos(pi/2 + ballangle)^2 + sin(pi/2 + ballangle)^2) -
(4967757600021511*cos(pi/2 + ballangle)*cos(rotangle)*sin(pi/2 +
ballangle))/(40564819207303340847894502572032*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2))))/5000 +
(1723*3^(1/2)*((4967757600021511*sin(pi/2 +
ballangle)^2)/(40564819207303340847894502572032*(cos(pi/2 + ballangle)^2
+ sin(pi/2 + ballangle)^2)) + (cos(pi/2 + ballangle)*sin(pi/2 +
ballangle))/(cos(pi/2 + ballangle)^2 + sin(pi/2 + ballangle)^2) +
(4967757600021511*cos(pi/2 +
ballangle)^2*cos(rotangle))/(40564819207303340847894502572032*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) - (cos(pi/2 +

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$$\begin{aligned}
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) / 20000 + (1723 * \cos(\pi/2 + \\
& \text{ballangle})^2) / (20000 * (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) \\
& + (10626033506446012029 * \sin(\pi/2 + \\
& \text{ballangle})^2) / (202824096036516704239472512860160000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& (69414518627537478570806341768673849 * \cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (162259276829213363391578010288128000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + (10626033506446012029 * \cos(\pi/2 \\
& + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (202824096036516704239472512860160000 * (\cos(\pi \\
& /2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& (1723 * \cos(\text{rotangle}) * \sin(\pi/2 + \text{ballangle})^2) / (20000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - \\
& (69414518627537478570806341768673849 * \cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (162259276829213363391578010288128000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& 5582468868500285/9007199254740992)^2 + ((\cos(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 5 + (4967757600021511 * \sin(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 202824096036516704239472512860160 - \\
& (1723 * 3^{(1/2)} * (\sin(\pi/2 + \text{ballangle})^2 / (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2) - (4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\pi/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \\
& \text{ballangle})^2) + (4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2))) / 20000 - \\
& (2139 * 3^{(1/2)} * ((4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) - (\cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) + \\
& (4967757600021511 * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2))) / 5000 + (8559446344837063453 * \cos(\pi/2 + \\
& \text{ballangle})^2) / (811296384146066816957890051440640000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - (2139 * \sin(\pi/2 + \\
& \text{ballangle})^2) / (5000 * (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) \\
& - (3494659174709180688839410107378151 * \cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032000 * (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) - (2139 * \cos(\pi/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (5000 * (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \\
& \text{ballangle})^2)) + (8559446344837063453 * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})^2) / (811296384146066816957890051440640000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& (3494659174709180688839410107378151 * \cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032000 * (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) + 4081666686311093/4503599627370496)^2 - \\
& 6831/2500) / (3 * ((\cos(\text{rotangle}) / 5 + (2139 * \cos(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / (5000 * \cos(\pi/2 + \text{ballangle})^2 + 5000 * \sin(\pi/2 + \\
& \text{ballangle})^2) - (1723 * \sin(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / (20000 * \cos(\pi/2 + \text{ballangle})^2 + 20000 * \sin(\pi/2
\end{aligned}$$

$$\begin{aligned}
& + \text{ballangle})^2) + (1723*3^{(1/2)}*\cos(\text{pi}/2 + \\
& \text{ballangle})*\sin(\text{rotangle}))/ (20000*\cos(\text{pi}/2 + \text{ballangle})^2 + 20000*\sin(\text{pi}/2 + \\
& \text{ballangle})^2) + (2139*3^{(1/2)}*\sin(\text{pi}/2 + \\
& \text{ballangle})*\sin(\text{rotangle}))/ (5000*\cos(\text{pi}/2 + \text{ballangle})^2 + 5000*\sin(\text{pi}/2 + \\
& \text{ballangle})^2) - 9/5)^2 + ((\sin(\text{pi}/2 + \text{ballangle})*\sin(\text{rotangle}))/5 - \\
& (4967757600021511*\cos(\text{pi}/2 + \\
& \text{ballangle})*\sin(\text{rotangle}))/202824096036516704239472512860160 + \\
& (1723*\cos(\text{pi}/2 + \text{ballangle})^2)/(20000*\cos(\text{pi}/2 + \text{ballangle})^2 + \\
& 20000*\sin(\text{pi}/2 + \text{ballangle})^2) + (10626033506446012029*\sin(\text{pi}/2 + \\
& \text{ballangle})^2)/(202824096036516704239472512860160000*\cos(\text{pi}/2 + \\
& \text{ballangle})^2 + 202824096036516704239472512860160000*\sin(\text{pi}/2 + \\
& \text{ballangle})^2) - (2139*3^{(1/2)}*(\cos(\text{pi}/2 + \text{ballangle})^2/(\cos(\text{pi}/2 + \\
& \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2) + (4967757600021511*\cos(\text{pi}/2 + \\
& \text{ballangle})*\sin(\text{pi}/2 + \\
& \text{ballangle}))/ (40564819207303340847894502572032*\cos(\text{pi}/2 + \text{ballangle})^2 + \\
& 40564819207303340847894502572032*\sin(\text{pi}/2 + \text{ballangle})^2) + \\
& (\cos(\text{rotangle})*\sin(\text{pi}/2 + \text{ballangle})^2)/(\cos(\text{pi}/2 + \text{ballangle})^2 + \\
& \sin(\text{pi}/2 + \text{ballangle})^2) - (4967757600021511*\cos(\text{pi}/2 + \\
& \text{ballangle})*\cos(\text{rotangle})*\sin(\text{pi}/2 + \\
& \text{ballangle}))/ (40564819207303340847894502572032*\cos(\text{pi}/2 + \text{ballangle})^2 + \\
& 40564819207303340847894502572032*\sin(\text{pi}/2 + \text{ballangle})^2)))/5000 + \\
& (1723*3^{(1/2)}*((4967757600021511*\sin(\text{pi}/2 + \\
& \text{ballangle})^2)/(40564819207303340847894502572032*\cos(\text{pi}/2 + \text{ballangle})^2 + \\
& 40564819207303340847894502572032*\sin(\text{pi}/2 + \text{ballangle})^2) + (\cos(\text{pi}/2 + \\
& \text{ballangle})*\sin(\text{pi}/2 + \text{ballangle}))/(\cos(\text{pi}/2 + \text{ballangle})^2 + \sin(\text{pi}/2 + \\
& \text{ballangle})^2) + (4967757600021511*\cos(\text{pi}/2 + \\
& \text{ballangle})^2*\cos(\text{rotangle}))/ (40564819207303340847894502572032*\cos(\text{pi}/2 + \\
& \text{ballangle})^2 + 40564819207303340847894502572032*\sin(\text{pi}/2 + \text{ballangle})^2) \\
& - (\cos(\text{pi}/2 + \text{ballangle})*\cos(\text{rotangle})*\sin(\text{pi}/2 + \text{ballangle}))/(\cos(\text{pi}/2 + \\
& \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2)))/20000 + \\
& (69414518627537478570806341768673849*\cos(\text{pi}/2 + \text{ballangle})*\sin(\text{pi}/2 + \\
& \text{ballangle}))/ (162259276829213363391578010288128000*\cos(\text{pi}/2 + \text{ballangle})^2 \\
& + 162259276829213363391578010288128000*\sin(\text{pi}/2 + \text{ballangle})^2) + \\
& (10626033506446012029*\cos(\text{pi}/2 + \\
& \text{ballangle})^2*\cos(\text{rotangle}))/ (202824096036516704239472512860160000*\cos(\text{pi}/ \\
& 2 + \text{ballangle})^2 + 202824096036516704239472512860160000*\sin(\text{pi}/2 + \\
& \text{ballangle})^2) + (1723*\cos(\text{rotangle})*\sin(\text{pi}/2 + \\
& \text{ballangle})^2)/(20000*\cos(\text{pi}/2 + \text{ballangle})^2 + 20000*\sin(\text{pi}/2 + \\
& \text{ballangle})^2) - (69414518627537478570806341768673849*\cos(\text{pi}/2 + \\
& \text{ballangle})*\cos(\text{rotangle})*\sin(\text{pi}/2 + \\
& \text{ballangle}))/ (162259276829213363391578010288128000*\cos(\text{pi}/2 + \text{ballangle})^2 \\
& + 162259276829213363391578010288128000*\sin(\text{pi}/2 + \text{ballangle})^2) + \\
& 5582468868500285/9007199254740992)^2)^{(1/2)}) - 180*\text{angle}((\sin(\text{pi}/2 + \\
& \text{ballangle})*\sin(\text{rotangle}))/5 - (4967757600021511*\cos(\text{pi}/2 + \\
& \text{ballangle})*\sin(\text{rotangle}))/202824096036516704239472512860160 - \\
& (\cos(\text{rotangle})*\text{li})/5 - (2139*3^{(1/2)}*(\cos(\text{pi}/2 + \text{ballangle})^2/(\cos(\text{pi}/2 + \\
& \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2) + (4967757600021511*\cos(\text{pi}/2 + \\
& \text{ballangle})*\sin(\text{pi}/2 + \\
& \text{ballangle}))/ (40564819207303340847894502572032*(\cos(\text{pi}/2 + \text{ballangle})^2 + \\
& \sin(\text{pi}/2 + \text{ballangle})^2)) + (\cos(\text{rotangle})*\sin(\text{pi}/2 + \\
& \text{ballangle})^2)/(\cos(\text{pi}/2 + \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2) - \\
& (4967757600021511*\cos(\text{pi}/2 + \text{ballangle})*\cos(\text{rotangle})*\sin(\text{pi}/2 + \\
& \text{ballangle}))/ (40564819207303340847894502572032*(\cos(\text{pi}/2 + \text{ballangle})^2 + \\
& \sin(\text{pi}/2 + \text{ballangle})^2)))/5000 + \\
& (1723*3^{(1/2)}*((4967757600021511*\sin(\text{pi}/2 + \\
& \text{ballangle})^2)/(40564819207303340847894502572032*(\cos(\text{pi}/2 + \text{ballangle})^2 \\
& + \sin(\text{pi}/2 + \text{ballangle})^2)) + (\cos(\text{pi}/2 + \text{ballangle})*\sin(\text{pi}/2 + \\
& \text{ballangle}))/(\cos(\text{pi}/2 + \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2) +
\end{aligned}$$

```

(4967757600021511*cos(pi/2 +
ballangle)^2*cos(rotangle))/(40564819207303340847894502572032*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) - (cos(pi/2 +
ballangle)*cos(rotangle)*sin(pi/2 + ballangle))/(cos(pi/2 + ballangle)^2
+ sin(pi/2 + ballangle)^2))/20000 + (1723*cos(pi/2 +
ballangle)^2)/(20000*(cos(pi/2 + ballangle)^2 + sin(pi/2 + ballangle)^2))
+ (10626033506446012029*sin(pi/2 +
ballangle)^2)/(202824096036516704239472512860160000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) +
(69414518627537478570806341768673849*cos(pi/2 + ballangle)*sin(pi/2 +
ballangle))/(162259276829213363391578010288128000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) - (cos(pi/2 +
ballangle)*sin(rotangle)*2139*1i)/(5000*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2)) + (sin(pi/2 +
ballangle)*sin(rotangle)*1723*1i)/(20000*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2)) + (10626033506446012029*cos(pi/2 +
ballangle)^2*cos(rotangle))/(202824096036516704239472512860160000*(cos(pi
/2 + ballangle)^2 + sin(pi/2 + ballangle)^2)) +
(1723*cos(rotangle)*sin(pi/2 + ballangle)^2)/(20000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) -
(69414518627537478570806341768673849*cos(pi/2 +
ballangle)*cos(rotangle)*sin(pi/2 +
ballangle))/(162259276829213363391578010288128000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) - (3^(1/2)*cos(pi/2 +
ballangle)*sin(rotangle)*1723*1i)/(20000*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2)) - (3^(1/2)*sin(pi/2 +
ballangle)*sin(rotangle)*2139*1i)/(5000*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2)) + 5582468868500285/9007199254740992 +
(9*1i/5))/(29*pi)) + 512;
send_Pose(5)= round(- (100*(180*acos((5*((cos(rotangle)/5 + (2139*cos(pi/2
+ ballangle)*sin(rotangle))/(5000*(cos(pi/2 + ballangle)^2 + sin(pi/2 +
ballangle)^2)) + (1723*sin(pi/2 +
ballangle)*sin(rotangle))/(20000*(cos(pi/2 + ballangle)^2 + sin(pi/2 +
ballangle)^2)) - (1723*3^(1/2)*cos(pi/2 +
ballangle)*sin(rotangle))/(20000*(cos(pi/2 + ballangle)^2 + sin(pi/2 +
ballangle)^2)) + (2139*3^(1/2)*sin(pi/2 +
ballangle)*sin(rotangle))/(5000*(cos(pi/2 + ballangle)^2 + sin(pi/2 +
ballangle)^2)) - 9/5)^2 + ((4967757600021511*cos(pi/2 +
ballangle)*sin(rotangle))/405648192073033408478945025720320 +
(3^(1/2)*((2139*3^(1/2))*((4967757600021511*cos(pi/2 +
ballangle)^2)/(40564819207303340847894502572032*(cos(pi/2 + ballangle)^2
+ sin(pi/2 + ballangle)^2)) - (cos(pi/2 + ballangle)*sin(pi/2 +
ballangle))/(cos(pi/2 + ballangle)^2 + sin(pi/2 + ballangle)^2) +
(4967757600021511*cos(rotangle)*sin(pi/2 +
ballangle)^2)/(40564819207303340847894502572032*(cos(pi/2 + ballangle)^2
+ sin(pi/2 + ballangle)^2)) + (cos(pi/2 +
ballangle)*cos(rotangle)*sin(pi/2 + ballangle))/(cos(pi/2 + ballangle)^2
+ sin(pi/2 + ballangle)^2)))/5000 - (4967757600021511*sin(pi/2 +
ballangle)*sin(rotangle))/202824096036516704239472512860160 -
(1723*3^(1/2)*(sin(pi/2 + ballangle)^2/(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2) - (4967757600021511*cos(pi/2 +
ballangle)*sin(pi/2 +
ballangle))/(40564819207303340847894502572032*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2)) + (cos(pi/2 +
ballangle)^2*cos(rotangle))/(cos(pi/2 + ballangle)^2 + sin(pi/2 +
ballangle)^2) + (4967757600021511*cos(pi/2 +
ballangle)*cos(rotangle)*sin(pi/2 +
ballangle))/(40564819207303340847894502572032*(cos(pi/2 + ballangle)^2 +

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$$\begin{aligned}
& \sin(\pi/2 + \text{ballangle})^2)))/20000 - (\cos(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle}))/5 + (8559446344837063453 * \cos(\pi/2 + \\
& \text{ballangle})^2) / (811296384146066816957890051440640000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + (2139 * \sin(\pi/2 + \\
& \text{ballangle})^2) / (5000 * (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) \\
& - (17473295873545924696264063428914813 * \cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (202824096036516704239472512860160000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + (2139 * \cos(\pi/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (5000 * (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \\
& \text{ballangle})^2)) + (8559446344837063453 * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})^2) / (811296384146066816957890051440640000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& (17473295873545924696264063428914813 * \cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (202824096036516704239472512860160000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2))) / 2 - (\sin(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 10 + (2139 * 3^{(1/2)} * (\cos(\pi/2 + \\
& \text{ballangle})^2 / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) + \\
& (4967757600021511 * \cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})^2) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) - \\
& (4967757600021511 * \cos(\pi/2 + \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2))) / 10000 + \\
& (1723 * 3^{(1/2)} * ((4967757600021511 * \sin(\pi/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) + \\
& (4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - (\cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2))) / 40000 + (1723 * \cos(\pi/2 + \\
& \text{ballangle})^2) / (40000 * (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) \\
& - (10626033506446012029 * \sin(\pi/2 + \\
& \text{ballangle})^2) / (405648192073033408478945025720320000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - \\
& (347072593137687375735139019169242339 * \cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (1622592768292133633915780102881280000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - (10626033506446012029 * \cos(\pi/2 \\
& + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (405648192073033408478945025720320000 * (\cos(\pi \\
& / 2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& (1723 * \cos(\text{rotangle}) * \sin(\pi/2 + \text{ballangle})^2) / (40000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& (347072593137687375735139019169242339 * \cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (1622592768292133633915780102881280000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - \\
& 5582468868500283 / 9007199254740992)^2 + \\
& ((2139 * 3^{(1/2)} * ((4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) - (\cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) + \\
& (4967757600021511 * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\pi/2 +
\end{aligned}$$

$$\begin{aligned}
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) / 10000 - (4967757600021511 * \sin(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 405648192073033408478945025720320 - \\
& (1723 * 3^{(1/2)} * (\sin(\pi/2 + \text{ballangle})^2 / (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2) - (4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\pi/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \\
& \text{ballangle})^2) + (4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2))) / 40000 - (\cos(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 10 + (8559446344837063453 * \cos(\pi/2 + \\
& \text{ballangle})^2) / (1622592768292133633915780102881280000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + (2139 * \sin(\pi/2 + \\
& \text{ballangle})^2) / (10000 * (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) \\
& - (3^{(1/2)} * ((4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 202824096036516704239472512860160 - (\sin(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 5 + (2139 * 3^{(1/2)} * (\cos(\pi/2 + \\
& \text{ballangle})^2 / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) + \\
& (4967757600021511 * \cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})^2) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) - \\
& (4967757600021511 * \cos(\pi/2 + \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2))) / 5000 + \\
& (1723 * 3^{(1/2)} * ((4967757600021511 * \sin(\pi/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 * (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2) + \\
& (4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (40564819207303340847894502572032 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - (\cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \text{ballangle})) / (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2))) / 20000 + (1723 * \cos(\pi/2 + \\
& \text{ballangle})^2) / (20000 * (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) \\
& - (10626033506446012029 * \sin(\pi/2 + \\
& \text{ballangle})^2) / (202824096036516704239472512860160000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - \\
& (347072593137687375735139019169242339 * \cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (811296384146066816957890051440640000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - (10626033506446012029 * \cos(\pi/2 \\
& + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (202824096036516704239472512860160000 * (\cos(\pi \\
& / 2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& (1723 * \cos(\text{rotangle}) * \sin(\pi/2 + \text{ballangle})^2) / (20000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& (347072593137687375735139019169242339 * \cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (811296384146066816957890051440640000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2))) / 2 - \\
& (17473295873545924696264063428914813 * \cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (405648192073033408478945025720320000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + (2139 * \cos(\pi/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (10000 * (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \\
& \text{ballangle})^2)) + (8559446344837063453 * \cos(\text{rotangle}) * \sin(\pi/2 +
\end{aligned}$$

$$\begin{aligned}
& \text{ballangle})^2) / (1622592768292133633915780102881280000 * (\cos(\text{pi}/2 + \\
& \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2)) + \\
& (17473295873545924696264063428914813 * \cos(\text{pi}/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle})) / (405648192073033408478945025720320000 * (\cos(\text{pi}/2 + \\
& \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2)) + \\
& 8163333372622185/9007199254740992)^2 - 6831/2500)) / (3 * ((\cos(\text{rotangle})/5 + \\
& (2139 * \cos(\text{pi}/2 + \text{ballangle}) * \sin(\text{rotangle})) / (5000 * \cos(\text{pi}/2 + \text{ballangle})^2 \\
& + 5000 * \sin(\text{pi}/2 + \text{ballangle})^2) + (1723 * \sin(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / (20000 * \cos(\text{pi}/2 + \text{ballangle})^2 + 20000 * \sin(\text{pi}/2 \\
& + \text{ballangle})^2) - (1723 * 3^{(1/2)} * \cos(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / (20000 * \cos(\text{pi}/2 + \text{ballangle})^2 + 20000 * \sin(\text{pi}/2 \\
& + \text{ballangle})^2) + (2139 * 3^{(1/2)} * \sin(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / (5000 * \cos(\text{pi}/2 + \text{ballangle})^2 + 5000 * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) - 9/5)^2 + ((4967757600021511 * \cos(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 405648192073033408478945025720320 - (\sin(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 10 + (1723 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2) / (40000 * \cos(\text{pi}/2 + \text{ballangle})^2 + 40000 * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) + (3^{(1/2)} * ((8559446344837063453 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2) / (811296384146066816957890051440640000 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2 + 811296384146066816957890051440640000 * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) - (4967757600021511 * \sin(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 202824096036516704239472512860160 - (\cos(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 5 + (2139 * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) / (5000 * \cos(\text{pi}/2 + \text{ballangle})^2 + 5000 * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) - (1723 * 3^{(1/2)} * (\sin(\text{pi}/2 + \text{ballangle})^2 / (\cos(\text{pi}/2 + \\
& \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2) - (4967757600021511 * \cos(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * \cos(\text{pi}/2 + \text{ballangle})^2 + \\
& 40564819207303340847894502572032 * \sin(\text{pi}/2 + \text{ballangle})^2) + (\cos(\text{pi}/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (\cos(\text{pi}/2 + \text{ballangle})^2 + \sin(\text{pi}/2 + \\
& \text{ballangle})^2) + (4967757600021511 * \cos(\text{pi}/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * \cos(\text{pi}/2 + \text{ballangle})^2 + \\
& 40564819207303340847894502572032 * \sin(\text{pi}/2 + \text{ballangle})^2)) / 20000 + \\
& (2139 * 3^{(1/2)} * ((4967757600021511 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 * \cos(\text{pi}/2 + \text{ballangle})^2 + \\
& 40564819207303340847894502572032 * \sin(\text{pi}/2 + \text{ballangle})^2) - (\cos(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{pi}/2 + \text{ballangle})) / (\cos(\text{pi}/2 + \text{ballangle})^2 + \sin(\text{pi}/2 + \\
& \text{ballangle})^2) + (4967757600021511 * \cos(\text{rotangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 * \cos(\text{pi}/2 + \text{ballangle})^2 + \\
& 40564819207303340847894502572032 * \sin(\text{pi}/2 + \text{ballangle})^2) + (\cos(\text{pi}/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\text{pi}/2 + \text{ballangle})) / (\cos(\text{pi}/2 + \text{ballangle})^2 \\
& + \sin(\text{pi}/2 + \text{ballangle})^2))) / 5000 - \\
& (17473295873545924696264063428914813 * \cos(\text{pi}/2 + \text{ballangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle})) / (202824096036516704239472512860160000 * \cos(\text{pi}/2 + \text{ballangle})^2 \\
& + 202824096036516704239472512860160000 * \sin(\text{pi}/2 + \text{ballangle})^2) + \\
& (2139 * \cos(\text{pi}/2 + \text{ballangle})^2 * \cos(\text{rotangle})) / (5000 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2 + 5000 * \sin(\text{pi}/2 + \text{ballangle})^2) + \\
& (8559446344837063453 * \cos(\text{rotangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) / (811296384146066816957890051440640000 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2 + 811296384146066816957890051440640000 * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) + (17473295873545924696264063428914813 * \cos(\text{pi}/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle})) / (202824096036516704239472512860160000 * \cos(\text{pi}/2 + \text{ballangle})^2 \\
& + 202824096036516704239472512860160000 * \sin(\text{pi}/2 + \text{ballangle})^2)) / 2 - \\
& (10626033506446012029 * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) / (405648192073033408478945025720320000 * \cos(\text{pi}/2 +
\end{aligned}$$

$$\begin{aligned}
& \text{ballangle})^2 + 405648192073033408478945025720320000 * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) + (2139 * 3^{(1/2)} * (\cos(\text{pi}/2 + \text{ballangle})^2 / (\cos(\text{pi}/2 + \\
& \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2) + (4967757600021511 * \cos(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * \cos(\text{pi}/2 + \text{ballangle})^2 + \\
& 40564819207303340847894502572032 * \sin(\text{pi}/2 + \text{ballangle})^2) + \\
& (\cos(\text{rotangle}) * \sin(\text{pi}/2 + \text{ballangle})^2) / (\cos(\text{pi}/2 + \text{ballangle})^2 + \\
& \sin(\text{pi}/2 + \text{ballangle})^2) - (4967757600021511 * \cos(\text{pi}/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * \cos(\text{pi}/2 + \text{ballangle})^2 + \\
& 40564819207303340847894502572032 * \sin(\text{pi}/2 + \text{ballangle})^2)) / 10000 + \\
& (1723 * 3^{(1/2)} * ((4967757600021511 * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 * \cos(\text{pi}/2 + \text{ballangle})^2 + \\
& 40564819207303340847894502572032 * \sin(\text{pi}/2 + \text{ballangle})^2) + (\cos(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{pi}/2 + \text{ballangle})) / (\cos(\text{pi}/2 + \text{ballangle})^2 + \sin(\text{pi}/2 + \\
& \text{ballangle})^2) + (4967757600021511 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (40564819207303340847894502572032 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2 + 40564819207303340847894502572032 * \sin(\text{pi}/2 + \text{ballangle})^2) \\
& - (\cos(\text{pi}/2 + \text{ballangle}) * \cos(\text{rotangle}) * \sin(\text{pi}/2 + \text{ballangle})) / (\cos(\text{pi}/2 + \\
& \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2)) / 40000 - \\
& (347072593137687375735139019169242339 * \cos(\text{pi}/2 + \text{ballangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle})) / (1622592768292133633915780102881280000 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2 + 1622592768292133633915780102881280000 * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) - (10626033506446012029 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (405648192073033408478945025720320000 * \cos(\text{pi}/ \\
& 2 + \text{ballangle})^2 + 405648192073033408478945025720320000 * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) + (1723 * \cos(\text{rotangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) / (40000 * \cos(\text{pi}/2 + \text{ballangle})^2 + 40000 * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) + (347072593137687375735139019169242339 * \cos(\text{pi}/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle})) / (1622592768292133633915780102881280000 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2 + 1622592768292133633915780102881280000 * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) - 5582468868500283 / 9007199254740992)^2)^{(1/2)}) - 180 * \text{pi} + \\
& 180 * \text{angle}((4967757600021511 * \cos(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 405648192073033408478945025720320 - \\
& (\cos(\text{rotangle}) * i) / 5 + \\
& (3^{(1/2)} * ((2139 * 3^{(1/2)} * ((4967757600021511 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 * (\cos(\text{pi}/2 + \text{ballangle})^2 \\
& + \sin(\text{pi}/2 + \text{ballangle})^2)) - (\cos(\text{pi}/2 + \text{ballangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle})) / (\cos(\text{pi}/2 + \text{ballangle})^2 + \sin(\text{pi}/2 + \text{ballangle})^2) + \\
& (4967757600021511 * \cos(\text{rotangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle})^2) / (40564819207303340847894502572032 * (\cos(\text{pi}/2 + \text{ballangle})^2 \\
& + \sin(\text{pi}/2 + \text{ballangle})^2)) + (\cos(\text{pi}/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\text{pi}/2 + \text{ballangle})) / (\cos(\text{pi}/2 + \text{ballangle})^2 \\
& + \sin(\text{pi}/2 + \text{ballangle})^2)) / 5000 - (4967757600021511 * \sin(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 202824096036516704239472512860160 - \\
& (1723 * 3^{(1/2)} * (\sin(\text{pi}/2 + \text{ballangle})^2 / (\cos(\text{pi}/2 + \text{ballangle})^2 + \\
& \sin(\text{pi}/2 + \text{ballangle})^2) - (4967757600021511 * \cos(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * (\cos(\text{pi}/2 + \text{ballangle})^2 + \\
& \sin(\text{pi}/2 + \text{ballangle})^2)) + (\cos(\text{pi}/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (\cos(\text{pi}/2 + \text{ballangle})^2 + \sin(\text{pi}/2 + \\
& \text{ballangle})^2) + (4967757600021511 * \cos(\text{pi}/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\text{pi}/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032 * (\cos(\text{pi}/2 + \text{ballangle})^2 + \\
& \sin(\text{pi}/2 + \text{ballangle})^2)) / 20000 - (\cos(\text{pi}/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 5 + (8559446344837063453 * \cos(\text{pi}/2 + \\
& \text{ballangle})^2) / (811296384146066816957890051440640000 * (\cos(\text{pi}/2 +
\end{aligned}$$

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ballangle)^2 + sin(pi/2 + ballangle)^2)) + (2139*sin(pi/2 +
ballangle)^2)/(5000*(cos(pi/2 + ballangle)^2 + sin(pi/2 + ballangle)^2))
- (17473295873545924696264063428914813*cos(pi/2 + ballangle)*sin(pi/2 +
ballangle))/(202824096036516704239472512860160000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) + (2139*cos(pi/2 +
ballangle)^2*cos(rotangle))/(5000*(cos(pi/2 + ballangle)^2 + sin(pi/2 +
ballangle)^2)) + (8559446344837063453*cos(rotangle)*sin(pi/2 +
ballangle)^2)/(811296384146066816957890051440640000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) +
(17473295873545924696264063428914813*cos(pi/2 +
ballangle)*cos(rotangle)*sin(pi/2 +
ballangle))/(202824096036516704239472512860160000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)))/2 - (sin(pi/2 +
ballangle)*sin(rotangle))/10 + (2139*3^(1/2)*(cos(pi/2 +
ballangle)^2/(cos(pi/2 + ballangle)^2 + sin(pi/2 + ballangle)^2) +
(4967757600021511*cos(pi/2 + ballangle)*sin(pi/2 +
ballangle))/(40564819207303340847894502572032*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2)) + (cos(rotangle)*sin(pi/2 +
ballangle)^2)/(cos(pi/2 + ballangle)^2 + sin(pi/2 + ballangle)^2) -
(4967757600021511*cos(pi/2 + ballangle)*cos(rotangle)*sin(pi/2 +
ballangle))/(40564819207303340847894502572032*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2)))/10000 +
(1723*3^(1/2)*((4967757600021511*sin(pi/2 +
ballangle)^2)/(40564819207303340847894502572032*(cos(pi/2 + ballangle)^2
+ sin(pi/2 + ballangle)^2)) + (cos(pi/2 + ballangle)*sin(pi/2 +
ballangle))/(cos(pi/2 + ballangle)^2 + sin(pi/2 + ballangle)^2) +
(4967757600021511*cos(pi/2 +
ballangle)^2*cos(rotangle))/(40564819207303340847894502572032*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) - (cos(pi/2 +
ballangle)*cos(rotangle)*sin(pi/2 + ballangle))/(cos(pi/2 + ballangle)^2
+ sin(pi/2 + ballangle)^2))/40000 + (1723*cos(pi/2 +
ballangle)^2)/(40000*(cos(pi/2 + ballangle)^2 + sin(pi/2 + ballangle)^2))
- (10626033506446012029*sin(pi/2 +
ballangle)^2)/(405648192073033408478945025720320000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) -
(347072593137687375735139019169242339*cos(pi/2 + ballangle)*sin(pi/2 +
ballangle))/(1622592768292133633915780102881280000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) - (cos(pi/2 +
ballangle)*sin(rotangle)*2139*1i)/(5000*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2)) - (sin(pi/2 +
ballangle)*sin(rotangle)*1723*1i)/(20000*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2)) - (10626033506446012029*cos(pi/2 +
ballangle)^2*cos(rotangle))/(405648192073033408478945025720320000*(cos(pi
/2 + ballangle)^2 + sin(pi/2 + ballangle)^2)) +
(1723*cos(rotangle)*sin(pi/2 + ballangle)^2)/(40000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) +
(347072593137687375735139019169242339*cos(pi/2 +
ballangle)*cos(rotangle)*sin(pi/2 +
ballangle))/(1622592768292133633915780102881280000*(cos(pi/2 +
ballangle)^2 + sin(pi/2 + ballangle)^2)) + (3^(1/2)*cos(pi/2 +
ballangle)*sin(rotangle)*1723*1i)/(20000*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2)) - (3^(1/2)*sin(pi/2 +
ballangle)*sin(rotangle)*2139*1i)/(5000*(cos(pi/2 + ballangle)^2 +
sin(pi/2 + ballangle)^2)) - 5582468868500283/9007199254740992 +
(9*1i)/5))/29*pi)) + 512;
send_Pose(6)= round(-(100*(180*angle((4967757600021511*cos(pi/2 +
ballangle)*sin(rotangle))/405648192073033408478945025720320 -
(cos(rotangle)*1i)/5 - (sin(pi/2 + ballangle)*sin(rotangle))/10 +

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$$\begin{aligned}
& (1723 \cdot \cos(\pi/2 + \text{ballangle})^2) / (20000 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + (10626033506446012029 \cdot \sin(\pi/2 + \\
& \text{ballangle})^2) / (202824096036516704239472512860160000 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - (3^{1/2} \cdot ((\cos(\pi/2 + \\
& \text{ballangle}) \cdot \sin(\text{rotangle})) / 5 + (4967757600021511 \cdot \sin(\pi/2 + \text{ballangle}) \cdot \sin(\text{rotangle})) / 202824096036516704239472512860160 - \\
& (8559446344837063453 \cdot \cos(\pi/2 + \text{ballangle})^2) / (405648192073033408478945025720320000 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + (2139 \cdot \sin(\pi/2 + \\
& \text{ballangle})^2) / (2500 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + (3494659174709180688839410107378151 \cdot \cos(\pi/2 + \text{ballangle}) \cdot \sin(\pi/2 + \\
& \text{ballangle})) / (20282409603651670423947251286016000 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + (2139 \cdot \cos(\pi/2 + \\
& \text{ballangle})^2 \cdot \cos(\text{rotangle})) / (2500 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - (8559446344837063453 \cdot \cos(\text{rotangle}) \cdot \sin(\pi/2 + \\
& \text{ballangle})^2) / (405648192073033408478945025720320000 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - \\
& (3494659174709180688839410107378151 \cdot \cos(\pi/2 + \text{ballangle}) \cdot \cos(\text{rotangle}) \cdot \sin(\pi/2 + \\
& \text{ballangle})) / (20282409603651670423947251286016000 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2))) / 2 + \\
& (69414518627537478570806341768673849 \cdot \cos(\pi/2 + \text{ballangle}) \cdot \sin(\pi/2 + \text{ballangle})) / (162259276829213363391578010288128000 \cdot (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + (\cos(\pi/2 + \text{ballangle}) \cdot \sin(\text{rotangle}) \cdot 2139 \cdot i) / (2500 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2)) - (\sin(\pi/2 + \text{ballangle}) \cdot \sin(\text{rotangle}) \cdot 1723 \cdot i) / (10000 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2)) + (10626033506446012029 \cdot \cos(\pi/2 + \text{ballangle})^2 \cdot \cos(\text{rotangle})) / (202824096036516704239472512860160000 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& (1723 \cdot \cos(\text{rotangle}) \cdot \sin(\pi/2 + \text{ballangle})^2) / (20000 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - \\
& (69414518627537478570806341768673849 \cdot \cos(\pi/2 + \text{ballangle}) \cdot \cos(\text{rotangle}) \cdot \sin(\pi/2 + \text{ballangle})) / (162259276829213363391578010288128000 \cdot (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& 1395617217125071 / 2251799813685248 + (9 \cdot i) / 5) - \\
& 180 \cdot \arcsin(5 \cdot ((4967757600021511 \cdot \cos(\pi/2 + \text{ballangle}) \cdot \sin(\text{rotangle})) / 405648192073033408478945025720320 - (\sin(\pi/2 + \\
& \text{ballangle}) \cdot \sin(\text{rotangle})) / 10 + (1723 \cdot \cos(\pi/2 + \text{ballangle})^2) / (20000 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2))) + (10626033506446012029 \cdot \sin(\pi/2 + \\
& \text{ballangle})^2) / (202824096036516704239472512860160000 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - (3^{1/2} \cdot ((\cos(\pi/2 + \\
& \text{ballangle}) \cdot \sin(\text{rotangle})) / 5 + (4967757600021511 \cdot \sin(\pi/2 + \text{ballangle}) \cdot \sin(\text{rotangle})) / 202824096036516704239472512860160 - \\
& (8559446344837063453 \cdot \cos(\pi/2 + \text{ballangle})^2) / (405648192073033408478945025720320000 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + (2139 \cdot \sin(\pi/2 + \\
& \text{ballangle})^2) / (2500 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + (3494659174709180688839410107378151 \cdot \cos(\pi/2 + \text{ballangle}) \cdot \sin(\pi/2 + \\
& \text{ballangle})) / (20282409603651670423947251286016000 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + (2139 \cdot \cos(\pi/2 + \\
& \text{ballangle})^2 \cdot \cos(\text{rotangle})) / (2500 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - (8559446344837063453 \cdot \cos(\text{rotangle}) \cdot \sin(\pi/2 + \\
& \text{ballangle})^2) / (405648192073033408478945025720320000 \cdot (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - \\
& (3494659174709180688839410107378151 \cdot \cos(\pi/2 +
\end{aligned}$$

$$\begin{aligned}
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (20282409603651670423947251286016000 * (\cos(\pi/2 + \text{ballangle})^2 + \\
& \sin(\pi/2 + \text{ballangle})^2))) / 2 + \\
& (69414518627537478570806341768673849 * \cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (162259276829213363391578010288128000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + (10626033506446012029 * \cos(\pi/2 + \\
& + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (202824096036516704239472512860160000 * (\cos(\pi/ \\
& /2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& (1723 * \cos(\text{rotangle}) * \sin(\pi/2 + \text{ballangle})^2) / (20000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - \\
& (69414518627537478570806341768673849 * \cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (162259276829213363391578010288128000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& 1395617217125071 / 2251799813685248)^2 + (\cos(\text{rotangle}) / 5 - (2139 * \cos(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / (2500 * (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \\
& \text{ballangle})^2)) + (1723 * \sin(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / (10000 * (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \\
& \text{ballangle})^2)) - 9/5)^2 + ((\cos(\pi/2 + \text{ballangle}) * \sin(\text{rotangle})) / 10 + \\
& (3^{1/2}) * ((4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 202824096036516704239472512860160 - (\sin(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 5 + (1723 * \cos(\pi/2 + \\
& \text{ballangle})^2) / (10000 * (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) \\
& + (10626033506446012029 * \sin(\pi/2 + \\
& \text{ballangle})^2) / (101412048018258352119736256430080000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& (69414518627537478570806341768673849 * \cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (81129638414606681695789005144064000 * (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) + (10626033506446012029 * \cos(\pi/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (101412048018258352119736256430080000 * (\cos(\pi \\
& /2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + \\
& (1723 * \cos(\text{rotangle}) * \sin(\pi/2 + \text{ballangle})^2) / (10000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - \\
& (69414518627537478570806341768673849 * \cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (81129638414606681695789005144064000 * (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2))) / 2 + (4967757600021511 * \sin(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 405648192073033408478945025720320 - \\
& (8559446344837063453 * \cos(\pi/2 + \\
& \text{ballangle})^2) / (811296384146066816957890051440640000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) + (2139 * \sin(\pi/2 + \\
& \text{ballangle})^2) / (5000 * (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) \\
& + (3494659174709180688839410107378151 * \cos(\pi/2 + \text{ballangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032000 * (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) + (2139 * \cos(\pi/2 + \\
& \text{ballangle})^2 * \cos(\text{rotangle})) / (5000 * (\cos(\pi/2 + \text{ballangle})^2 + \sin(\pi/2 + \\
& \text{ballangle})^2)) - (8559446344837063453 * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})^2) / (811296384146066816957890051440640000 * (\cos(\pi/2 + \\
& \text{ballangle})^2 + \sin(\pi/2 + \text{ballangle})^2)) - \\
& (3494659174709180688839410107378151 * \cos(\pi/2 + \\
& \text{ballangle}) * \cos(\text{rotangle}) * \sin(\pi/2 + \\
& \text{ballangle})) / (40564819207303340847894502572032000 * (\cos(\pi/2 + \text{ballangle})^2 \\
& + \sin(\pi/2 + \text{ballangle})^2)) - 8163333372622185 / 9007199254740992)^2 - \\
& 6831 / 2500) / (3 * ((4967757600021511 * \cos(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 405648192073033408478945025720320 - (\sin(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 10 - (3^{1/2}) * ((\cos(\pi/2 + \\
& \text{ballangle}) * \sin(\text{rotangle})) / 5 + (4967757600021511 * \sin(\pi/2 +
\end{aligned}$$

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ballangle)*sin(rotangle))/202824096036516704239472512860160 -
(8559446344837063453*cos(pi/2 +
ballangle)^2)/(40564819207303340847894502572032000*cos(pi/2 +
ballangle)^2 + 40564819207303340847894502572032000*sin(pi/2 +
ballangle)^2) + (2139*sin(pi/2 + ballangle)^2)/(2500*cos(pi/2 +
ballangle)^2 + 2500*sin(pi/2 + ballangle)^2) +
(3494659174709180688839410107378151*cos(pi/2 + ballangle)*sin(pi/2 +
ballangle))/(20282409603651670423947251286016000*cos(pi/2 + ballangle)^2
+ 20282409603651670423947251286016000*sin(pi/2 + ballangle)^2) +
(2139*cos(pi/2 + ballangle)^2*cos(rotangle))/(2500*cos(pi/2 +
ballangle)^2 + 2500*sin(pi/2 + ballangle)^2) -
(8559446344837063453*cos(rotangle)*sin(pi/2 +
ballangle)^2)/(40564819207303340847894502572032000*cos(pi/2 +
ballangle)^2 + 40564819207303340847894502572032000*sin(pi/2 +
ballangle)^2) - (3494659174709180688839410107378151*cos(pi/2 +
ballangle)*cos(rotangle)*sin(pi/2 +
ballangle))/(20282409603651670423947251286016000*cos(pi/2 + ballangle)^2
+ 20282409603651670423947251286016000*sin(pi/2 + ballangle)^2)))/2 +
(1723*cos(pi/2 + ballangle)^2)/(20000*cos(pi/2 + ballangle)^2 +
20000*sin(pi/2 + ballangle)^2) + (10626033506446012029*sin(pi/2 +
ballangle)^2)/(20282409603651670423947251286016000*cos(pi/2 +
ballangle)^2 + 20282409603651670423947251286016000*sin(pi/2 +
ballangle)^2) + (69414518627537478570806341768673849*cos(pi/2 +
ballangle)*sin(pi/2 +
ballangle))/(162259276829213363391578010288128000*cos(pi/2 + ballangle)^2
+ 162259276829213363391578010288128000*sin(pi/2 + ballangle)^2) +
(10626033506446012029*cos(pi/2 +
ballangle)^2*cos(rotangle))/(20282409603651670423947251286016000*cos(pi/
2 + ballangle)^2 + 20282409603651670423947251286016000*sin(pi/2 +
ballangle)^2) + (1723*cos(rotangle)*sin(pi/2 +
ballangle)^2)/(20000*cos(pi/2 + ballangle)^2 + 20000*sin(pi/2 +
ballangle)^2) - (69414518627537478570806341768673849*cos(pi/2 +
ballangle)*cos(rotangle)*sin(pi/2 +
ballangle))/(162259276829213363391578010288128000*cos(pi/2 + ballangle)^2
+ 162259276829213363391578010288128000*sin(pi/2 + ballangle)^2) +
1395617217125071/2251799813685248)^2 + (cos(rotangle)/5 - (2139*cos(pi/2
+ ballangle)*sin(rotangle))/(2500*cos(pi/2 + ballangle)^2 + 2500*sin(pi/2
+ ballangle)^2) + (1723*sin(pi/2 +
ballangle)*sin(rotangle))/(10000*cos(pi/2 + ballangle)^2 + 10000*sin(pi/2
+ ballangle)^2) - 9/5)^2)^(1/2)))/(29*pi)) + 512;

```

end

Pressupost

S'evalua aquí el cost de construcció i disseny del prototip, tant en mitjans humans com materials.

Cost del personal

Analista: $35\text{€/h} \times 450\text{h} = 15750\text{€}$

Programador: $30\text{€/h} \times 300\text{h} = 9000\text{€}$

Taller: $15\text{€/h} \times 50\text{h} = 750\text{€}$

Cost dels equips informàtics

Ordenador tipus PC: Preu de compra de l'ordinador, la pantalla i perifèrics essencials: 1000€

Cost del robot

Plataforma i suport: 30€

Impressió 3D de la base, braços i peça de la plataforma: 155€

Altres elements estructurals: 70€

Actuadors i adaptador USB2Dynamixel: 410€

Cost del sistema de visió:

Càmera Grasshopper Grass-03K2C-C i cable Fireware: 1200€

Estructura de suport: 200€

TOTAL

28565 €

