



ROBOTICS

build kits · khanin.info

Building instructions

RB-01

The Ultrasonic Robot

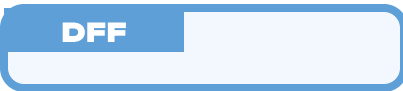
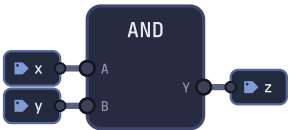
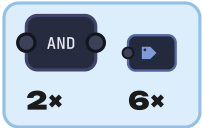
lessons 1-5 · a bumper, ultrasound and logic without a pro

simulator: cs.khanin.info



How to read these instructions

3



step number – follow strictly in order

parts for this step: how many to place

a part with labels on its pins

labels with the same name are connected

chip ports: input [and output]

blue frame – building a chip

grey tab – the main canvas

yellow ring – what has changed

remove a part together with its labels

double-click a label – new name

chip built in the lesson with this number

check: this is how it should work

Keys

V	VCC (1)
G	GND (0)
N	transistor
I	switch
O	lamp
L	label
K	clock
U	button
[	port in
]	port out

Ctrl+G – into a chip
on a Mac Ctrl = Cmd



A little history



In 1948 Grey Walter built «tortoises»: a photocell, a bump contact, two radio valves and two motors. It bumped – backed off and turned. No program – just like our «bug».

In the 1950s factory carts followed a wire in the floor: two sensors on the sides, the wire slips under one – it steers. In 1984 Braitenberg described vehicles where a sensor drives a wheel directly. That is lesson 5.

In 1978 Polaroid put an ultrasonic range finder into a camera: beep – count the echo.

In 2002 a robot vacuum drove «straight until a bump – turn». Today the HC-SR04 – like on our robot.

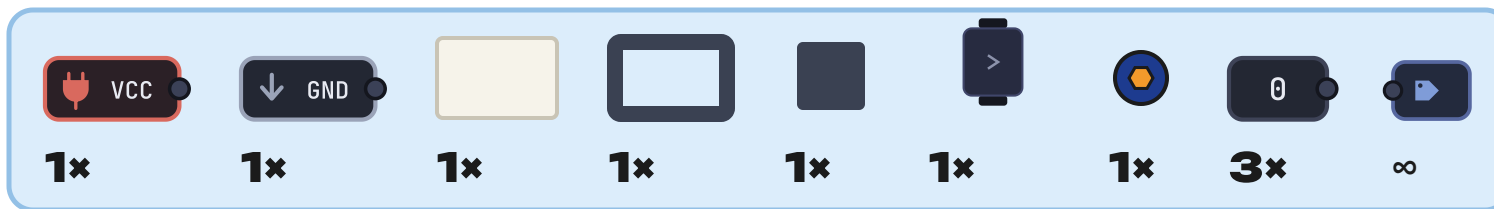
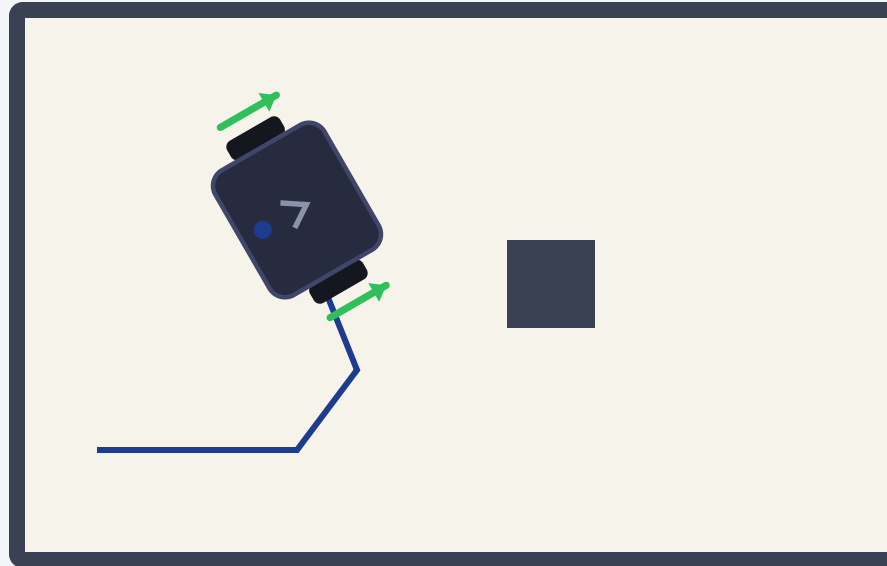


Polaroid is a trademark of its owner. This kit is not affiliated with or endorsed by it; the name is mentioned to tell the story.



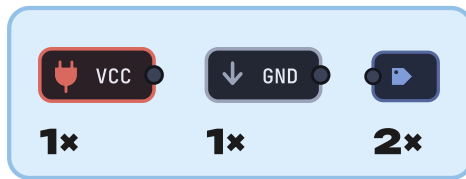
The chassis

two wheels, no steering – turning by the wheel difference



CANVAS

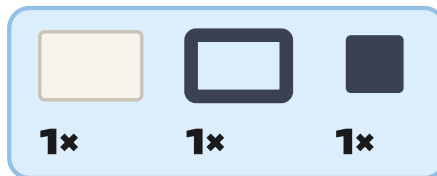
1



2

paper first, the contour over it – corner to corner; size – with the handle (written by it)

3

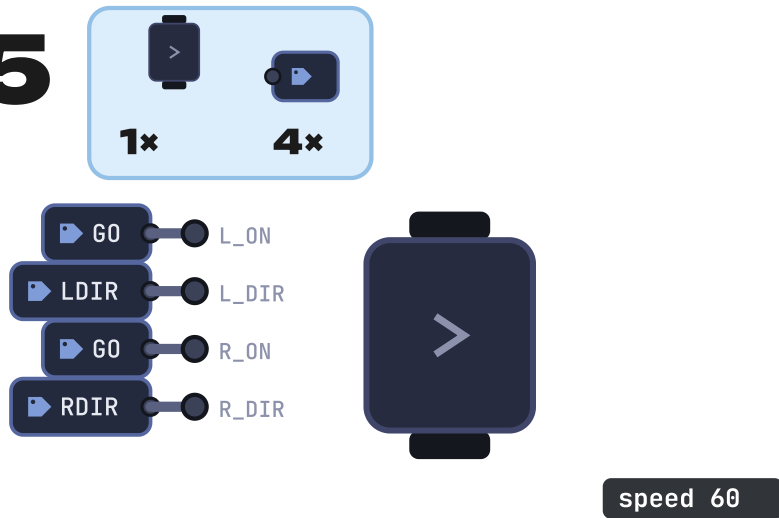


CANVAS ...

4

the chassis – on the left, nose to the right; labels – double-click a pin

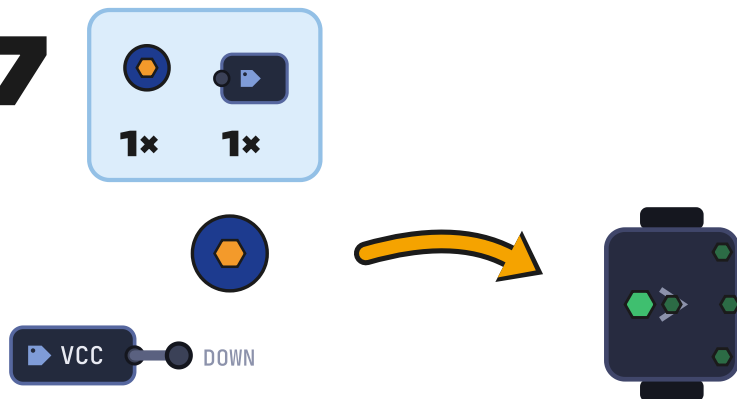
5



6

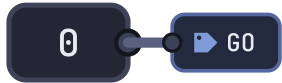
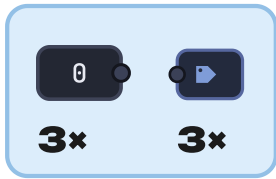
drag by the orange nut to the green point of the chassis – it snaps on

7



CANVAS ...

8



LDIR 1 · RDIR 1
forward



LDIR 0 · RDIR 0
back



LDIR 1 · RDIR 0
clockwise



LDIR 0 · RDIR 1
anticlockwise



The «bug»: a bumper and the CD4017

kh RB-01

bumped – backed off – turned



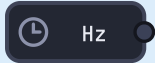
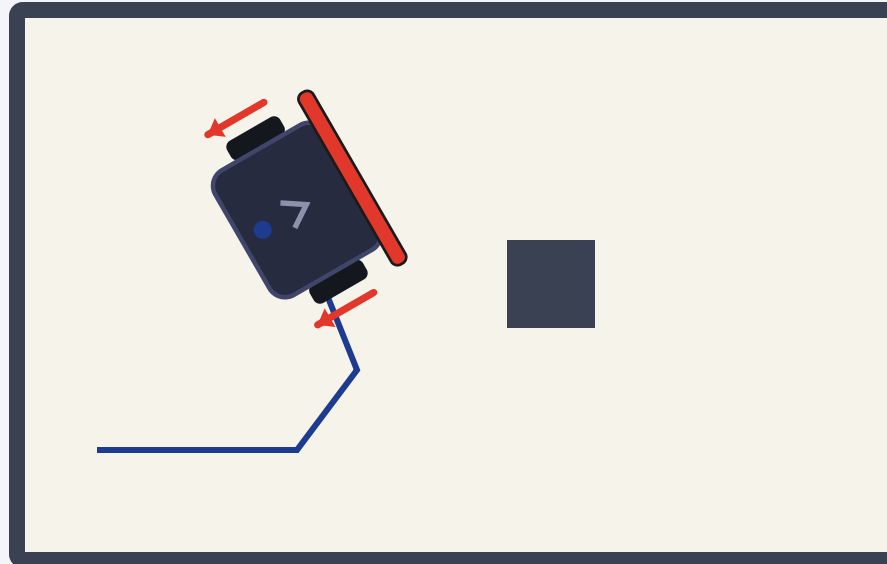
FWD



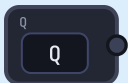
BACK



TURN



1x



1x



1x



1x



1x



1x



1x



1x



1x



1x



∞

CANVAS

1

library → import → robot-chips.json: a Robot folder, ten chips

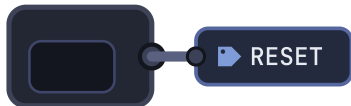
2

delete the lesson 1 trial – the LDIR and RDIR switches; keep the labels on the chassis

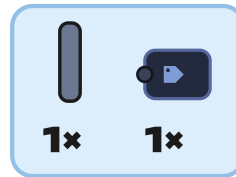
3



4



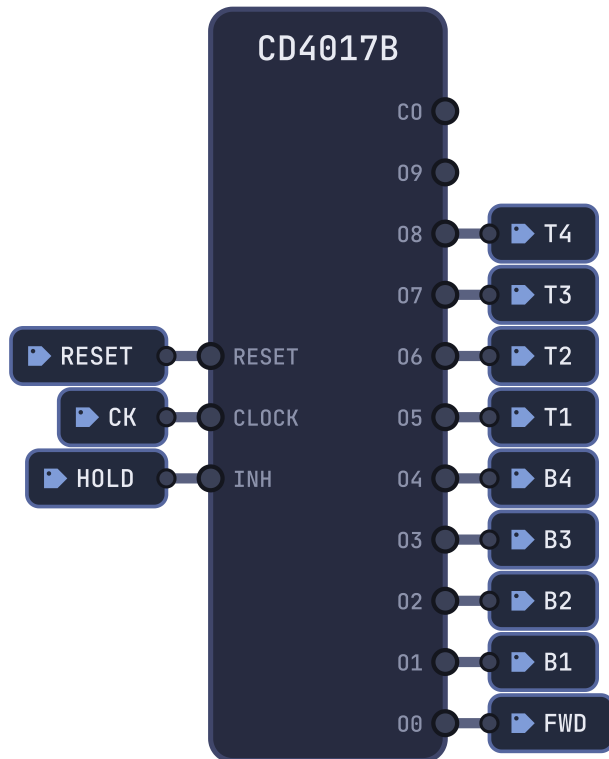
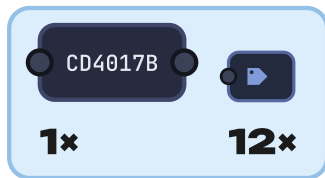
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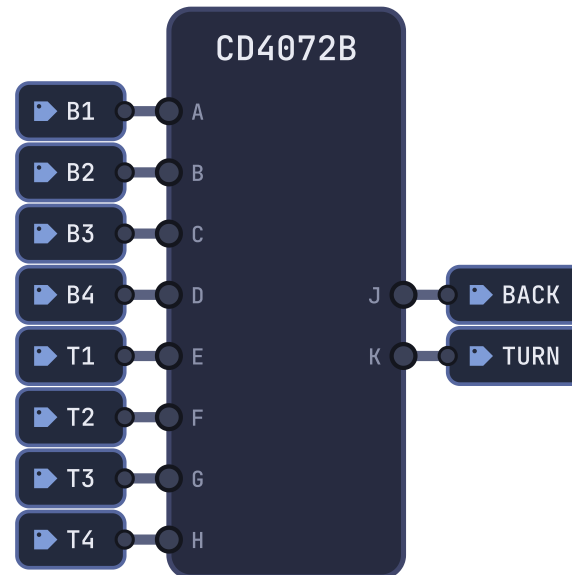
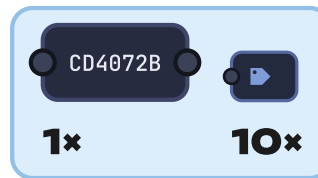
the chips are ready: pin names as in the TI datasheet; labels – double-click a pin

6

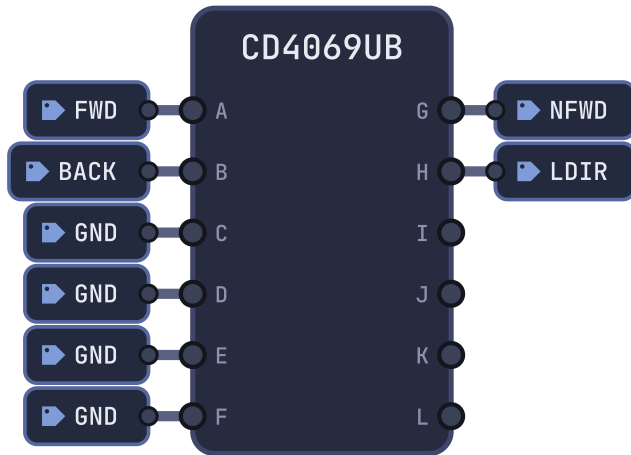
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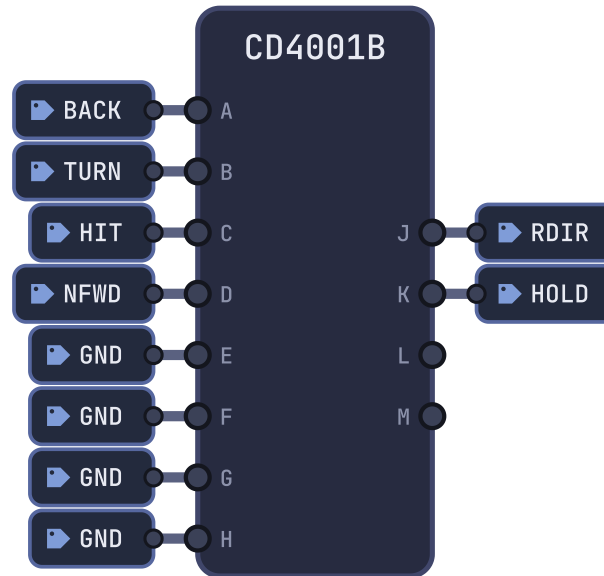
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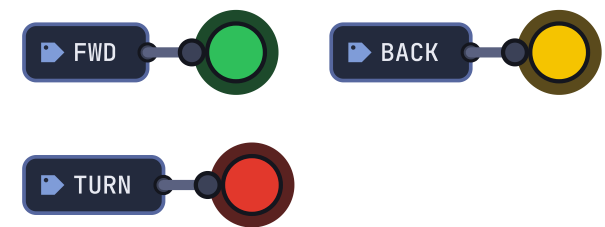
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10



11



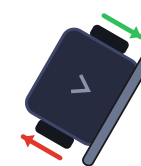
FWD
drives



bump



BACK
back 0.4 s



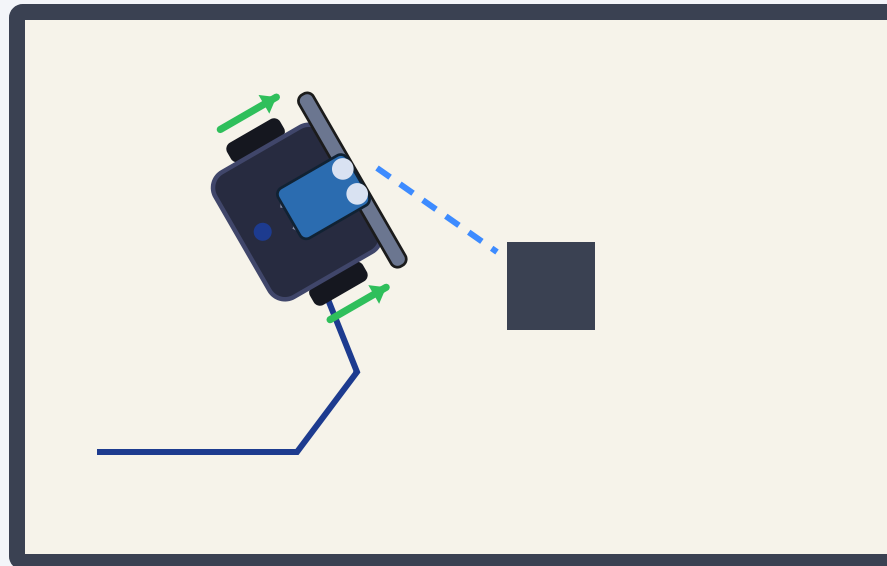
TURN
turn 0.4 s

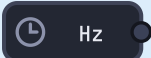


Ultrasound

kh RB-01

echo time is centimetres on the display



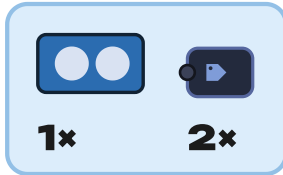
									
1×	2×	1×	1×	1×	1×	1×	4×	1×	∞

CANVAS

Sensors → Ultrasonic: delete the reflector – any wall gives an echo

1

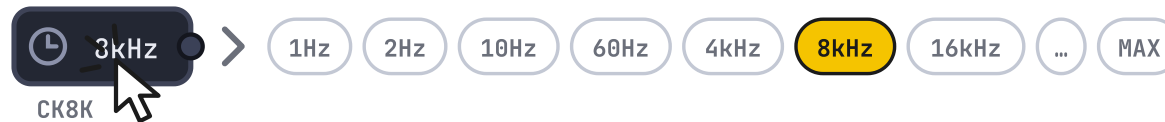
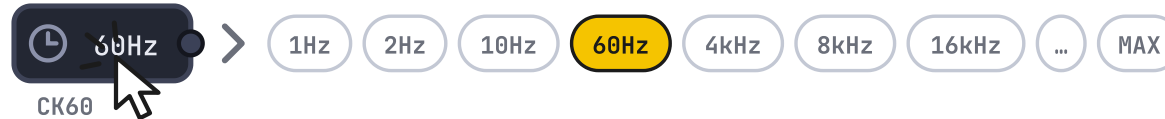
2



3



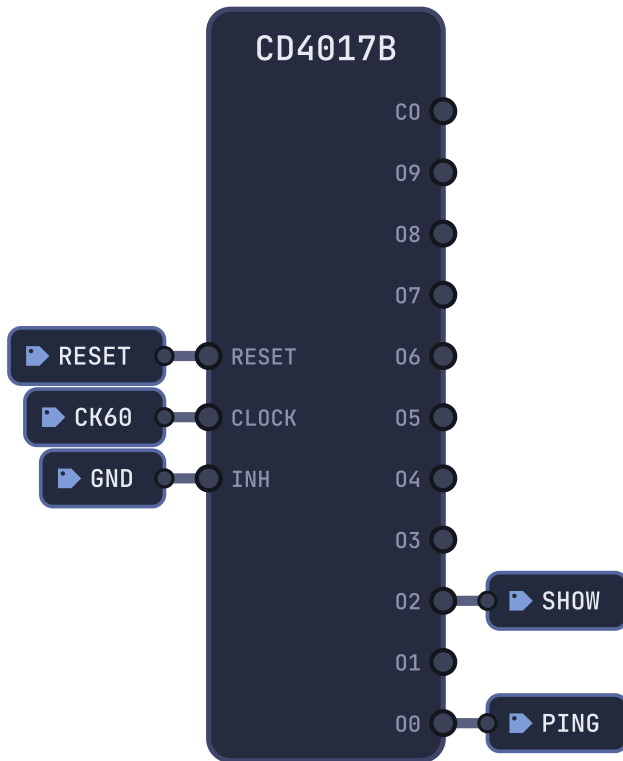
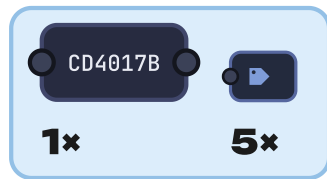
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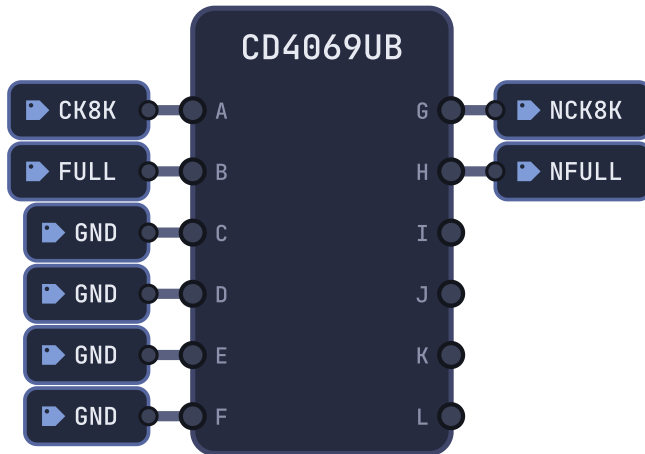
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the chips are ready: pin names as in the TI datasheet; labels – double-click a pin

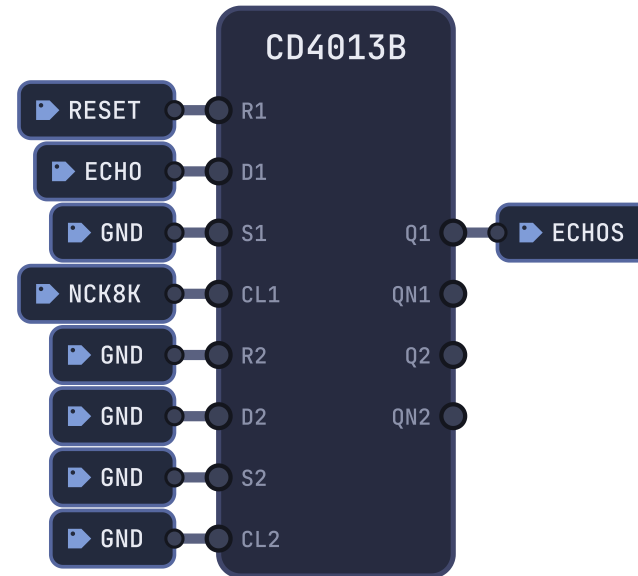
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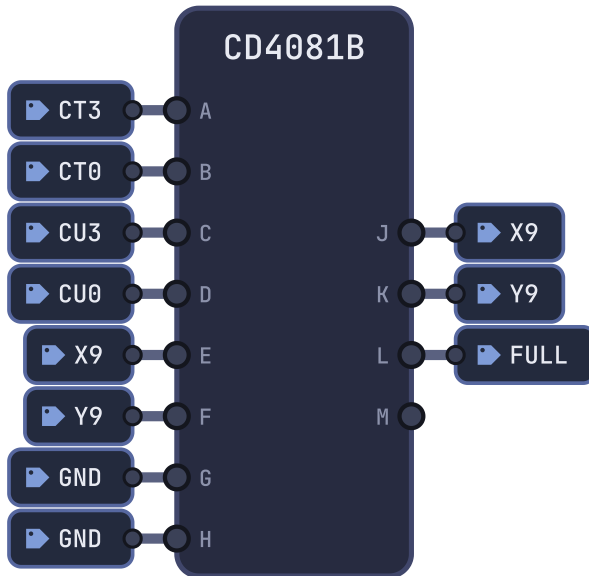
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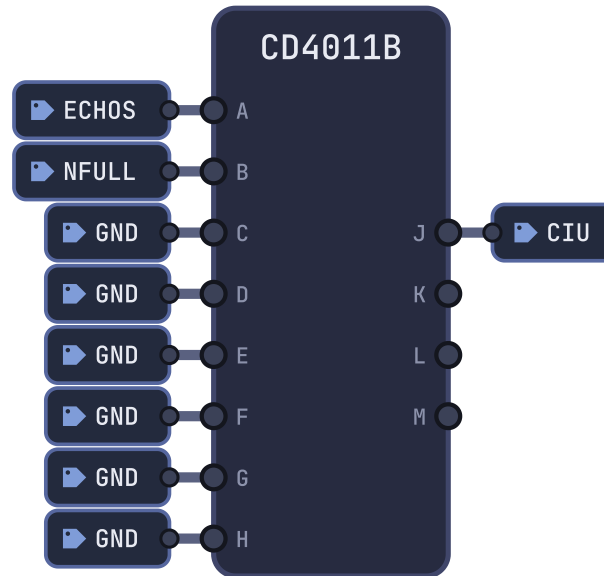
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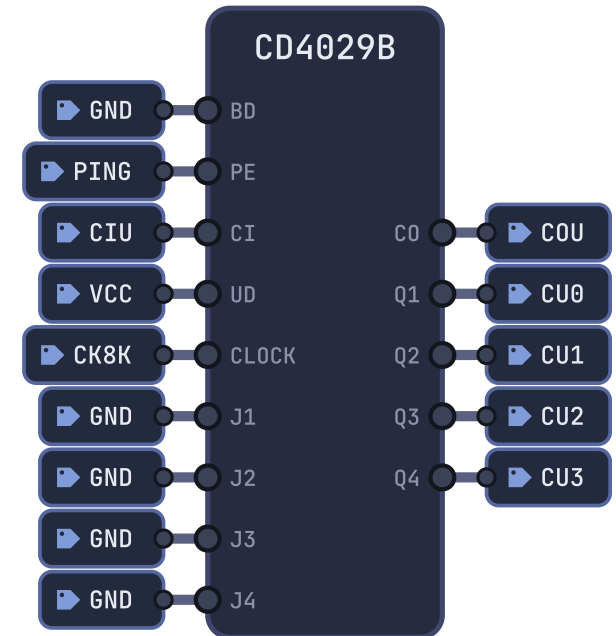
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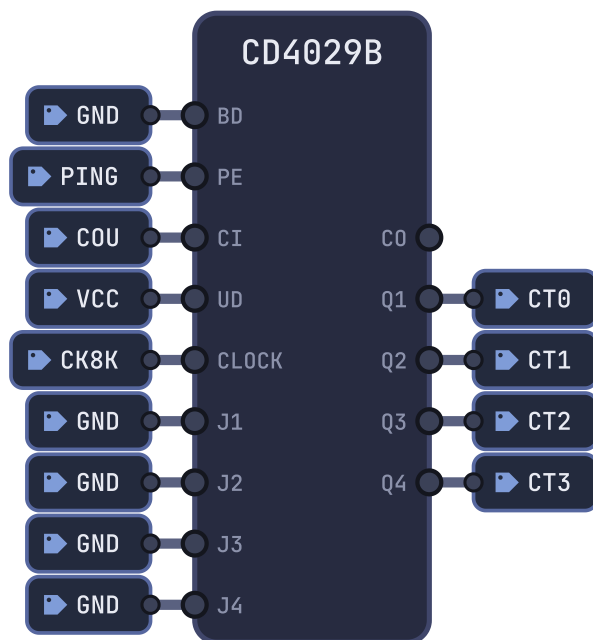
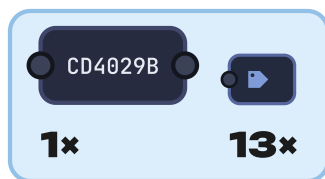
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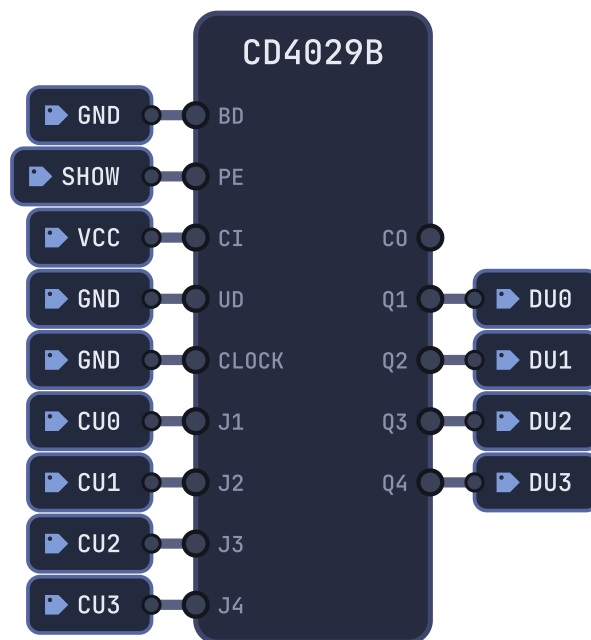
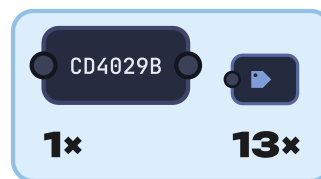
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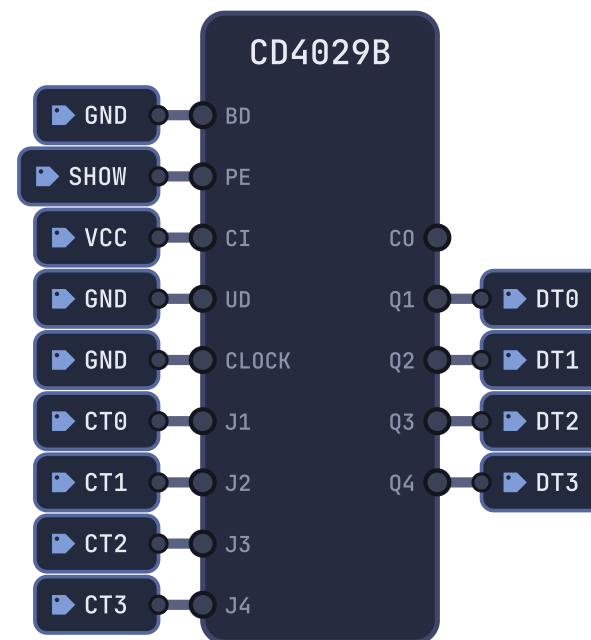
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13



14



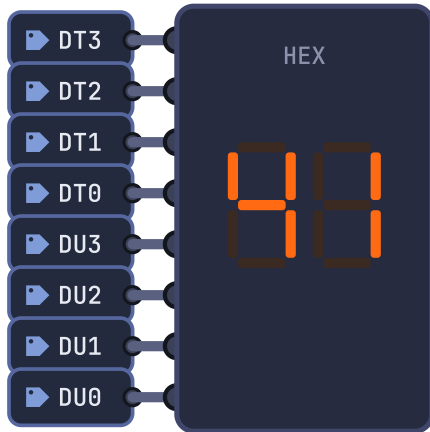
15



16

Fast

Fast mode: the counter needs every 8 kHz tick



a wall 41 cm away



farther than 99 cm

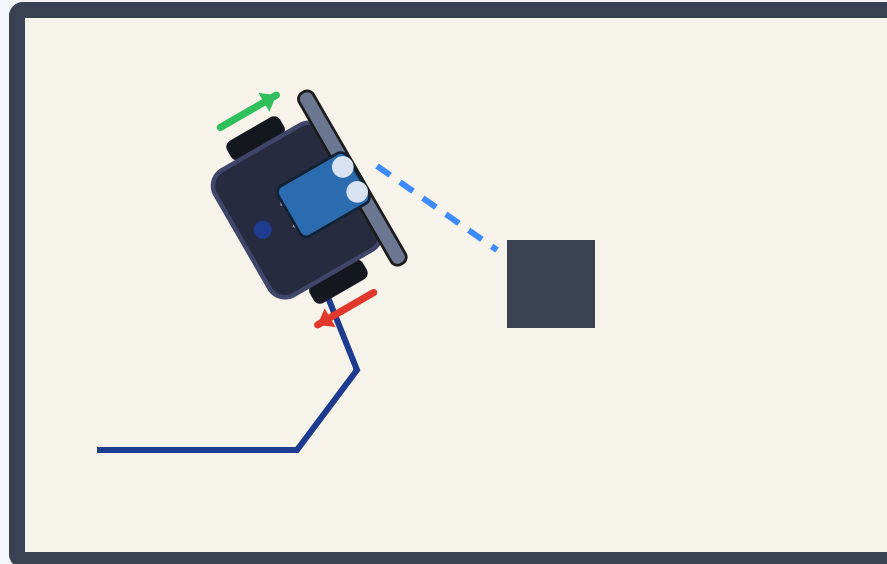


Without touching

closer than 20 cm – turn before the bump



NEAR



CD4585B

1x

CD4071B

1x

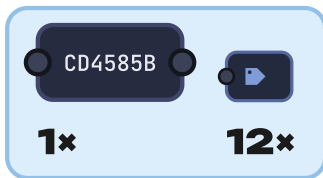
1x

∞

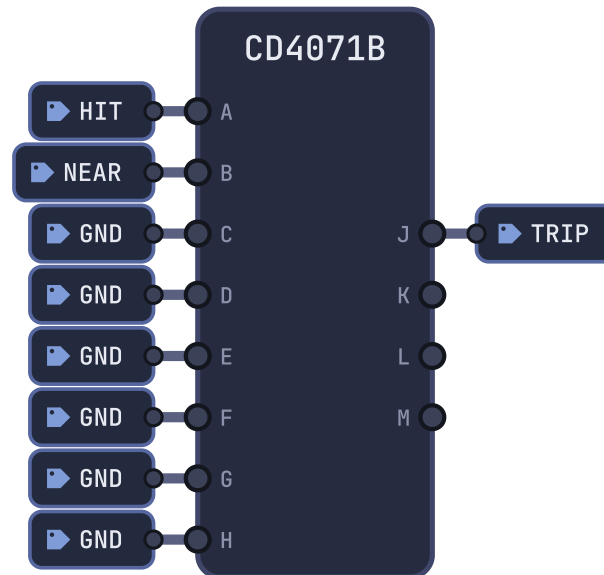
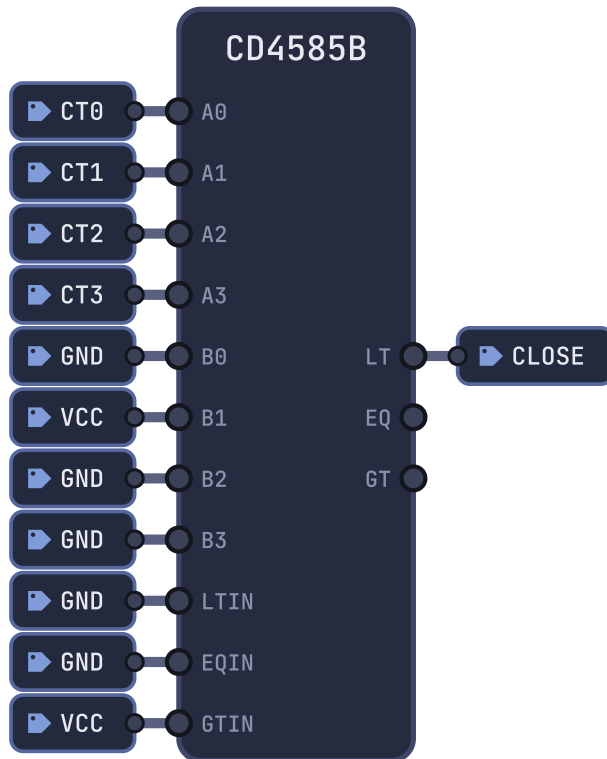
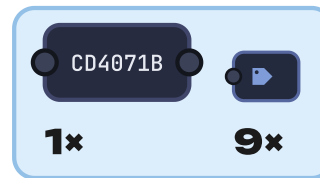
1

the chips are ready: pin names as in the TI datasheet; labels – double-click a pin

2



3



CANVAS ...

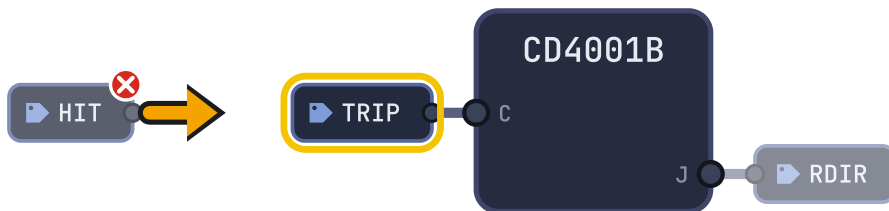
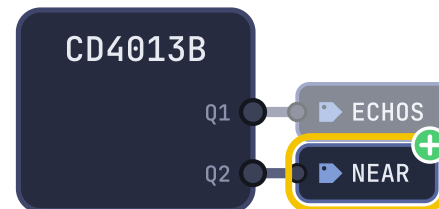
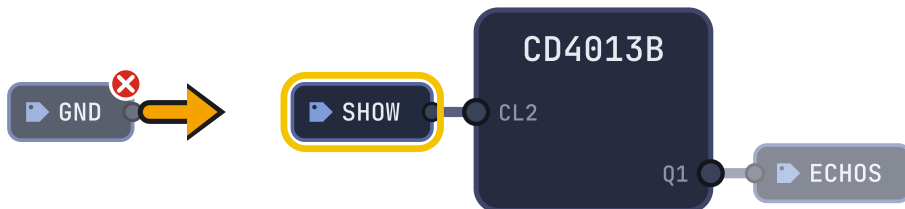
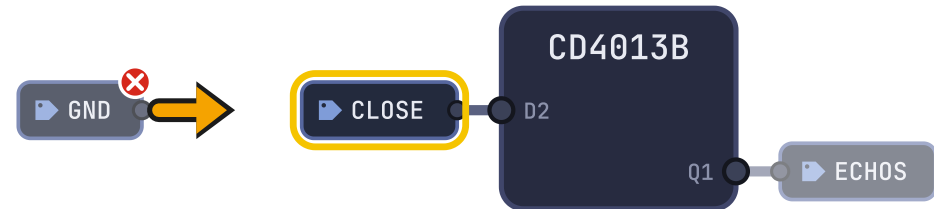
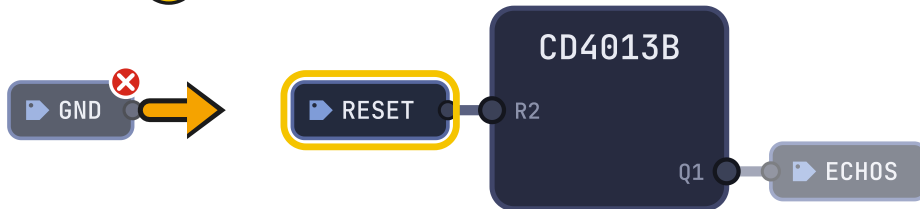
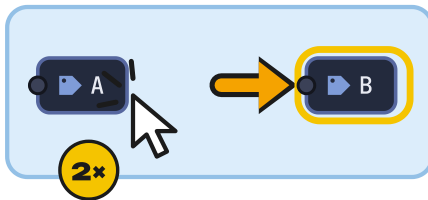
4

Alt/⌘+click – blue

5



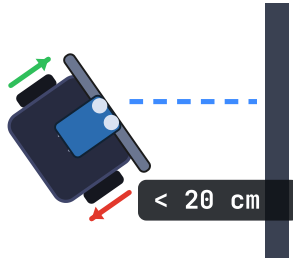
6



7

Fast

Fast mode: the counter needs every 8 kHz tick



NEAR

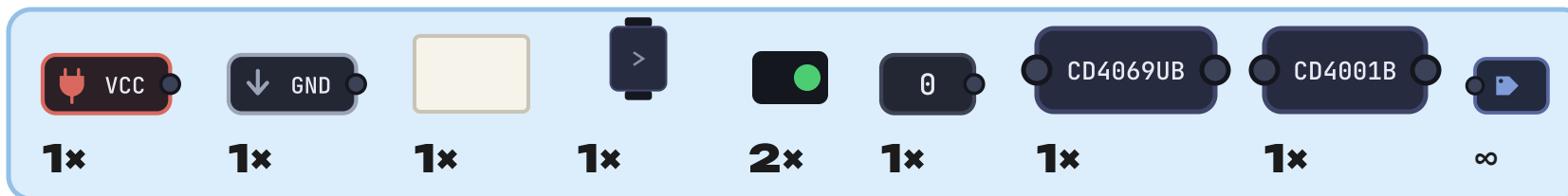
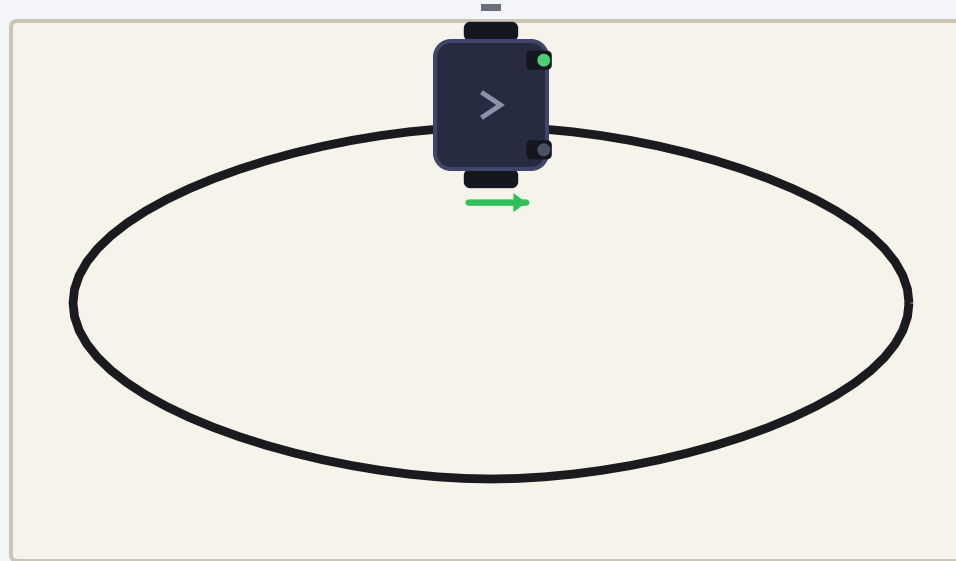
closer than 20 cm – NEAR, a turn before the bump



Along the line

kh RB-01

a sensor sees the line – its wheel stops



CANVAS

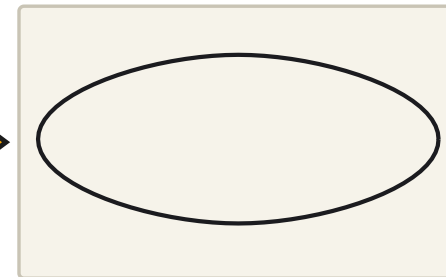
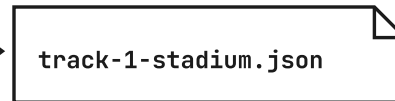
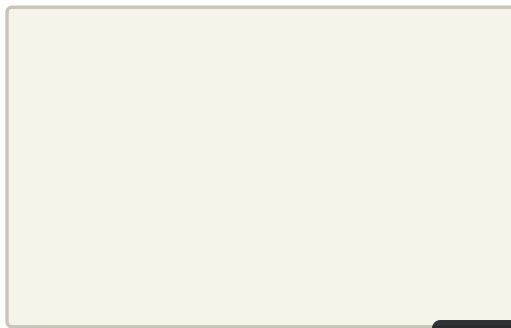
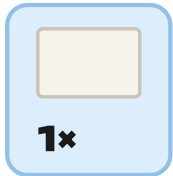
1

a separate project – a new canvas

2



3



800 × 500

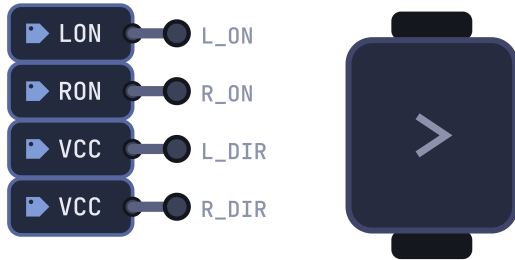
paper ↑ → a track file

4

the robot on the line: the line between the sensors

CANVAS ...

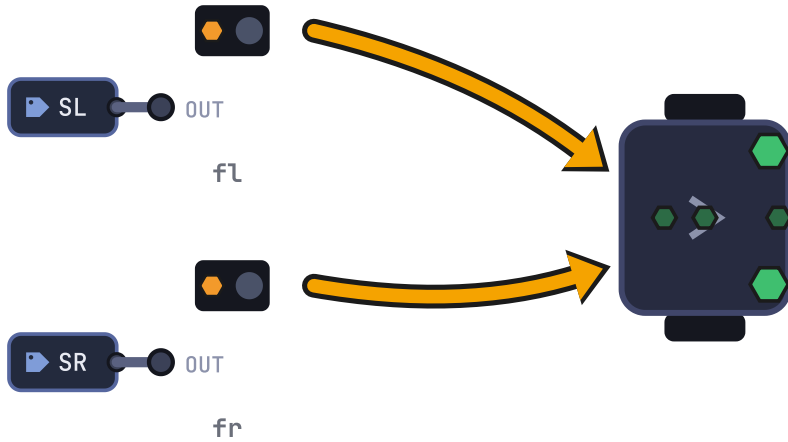
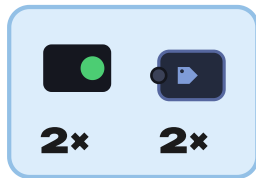
5



6

drag by the orange nut to the green point of the chassis – it snaps on

7



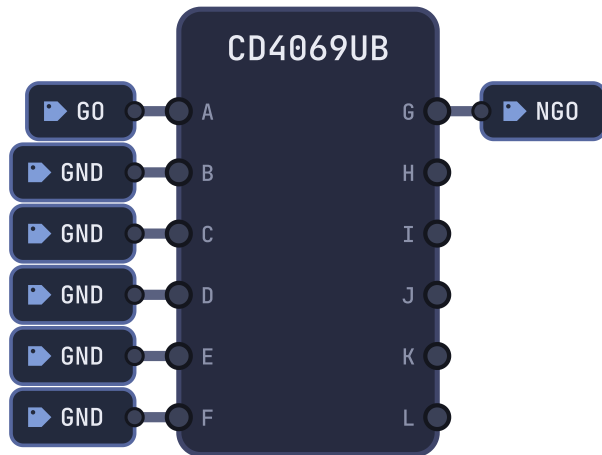
8



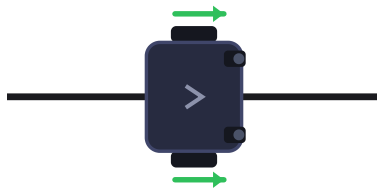
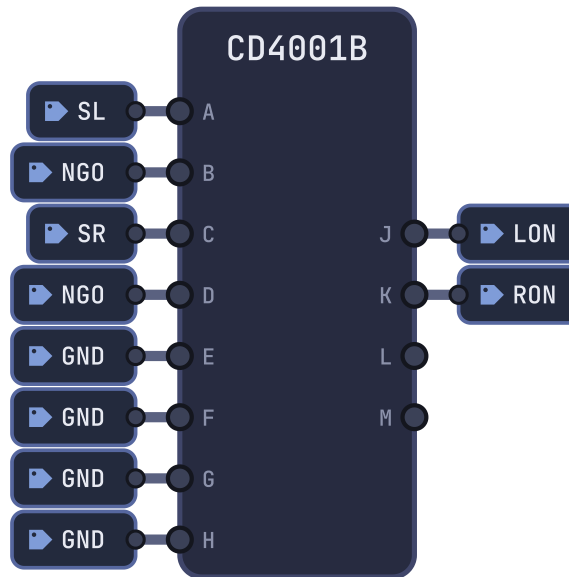
9

the chips are ready: pin names as in the TI datasheet; labels – double-click a pin

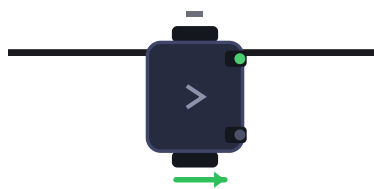
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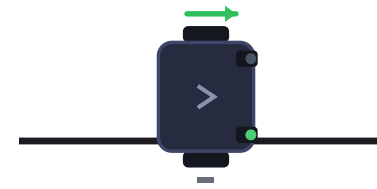
11



straight



left



right

Kit parts

how many times you place each part over all the lessons



2×



2×



4×



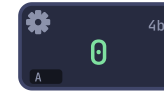
1×



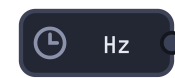
1×



1×



1×



3×



1×



203×



2×



1×



1×



2×



1×



1×



1×



2×



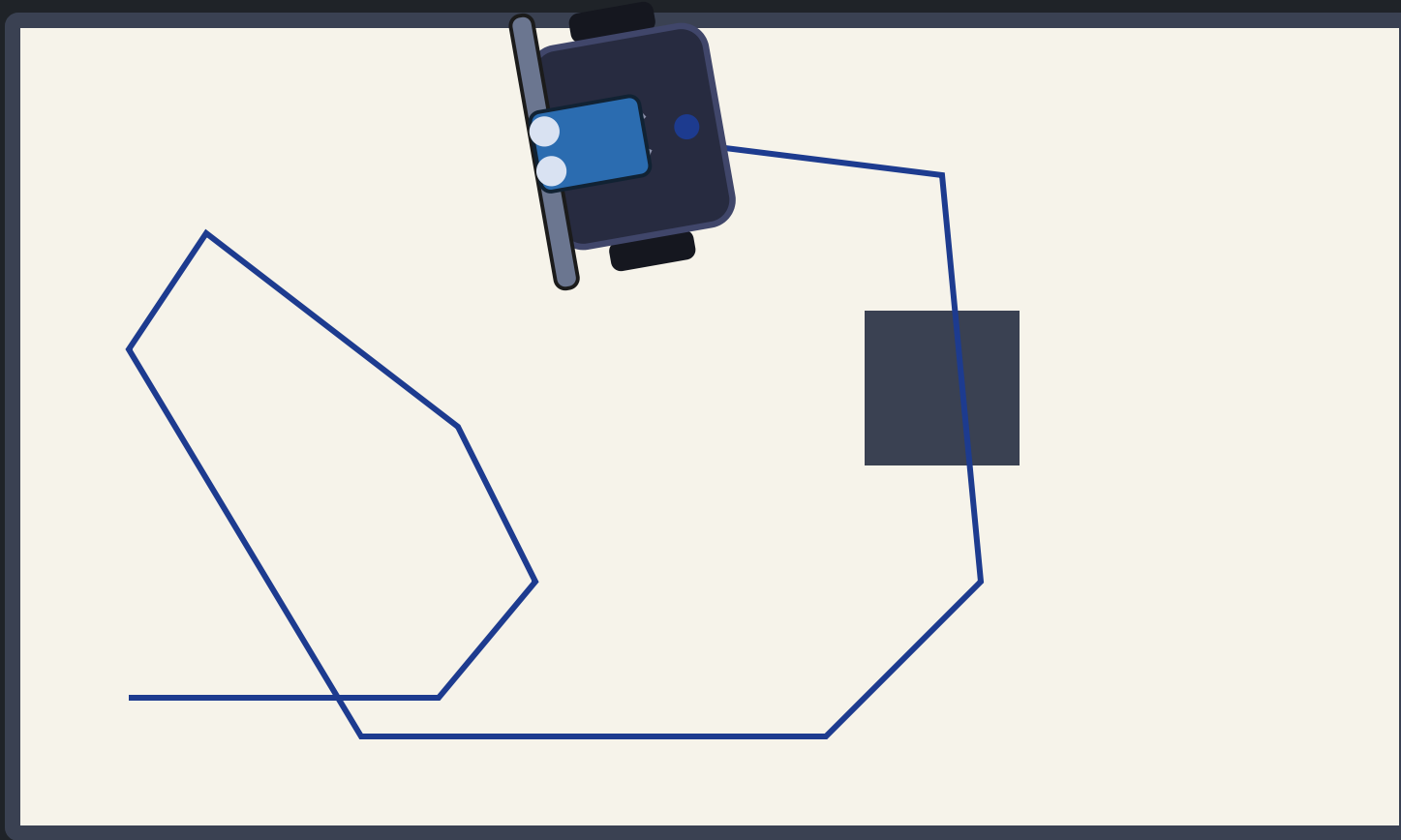
1×

Kit chips

ready TI chips from the kit file robot-chips.json – how many you place

CD4017B	CD4072B	CD4069UB	CD4001B	CD4013B	CD4081B	CD4011B	CD4029B
2×	1×	3×	2×	1×	1×	1×	4×
CD4585B	CD4071B						
1×	1×						

Done!



15 chips · 2,800 transistors

G0 – and the robot drives on its own: it turns 20 cm before the walls

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RB-01