

iRobot® Create

OPEN INTERFACE

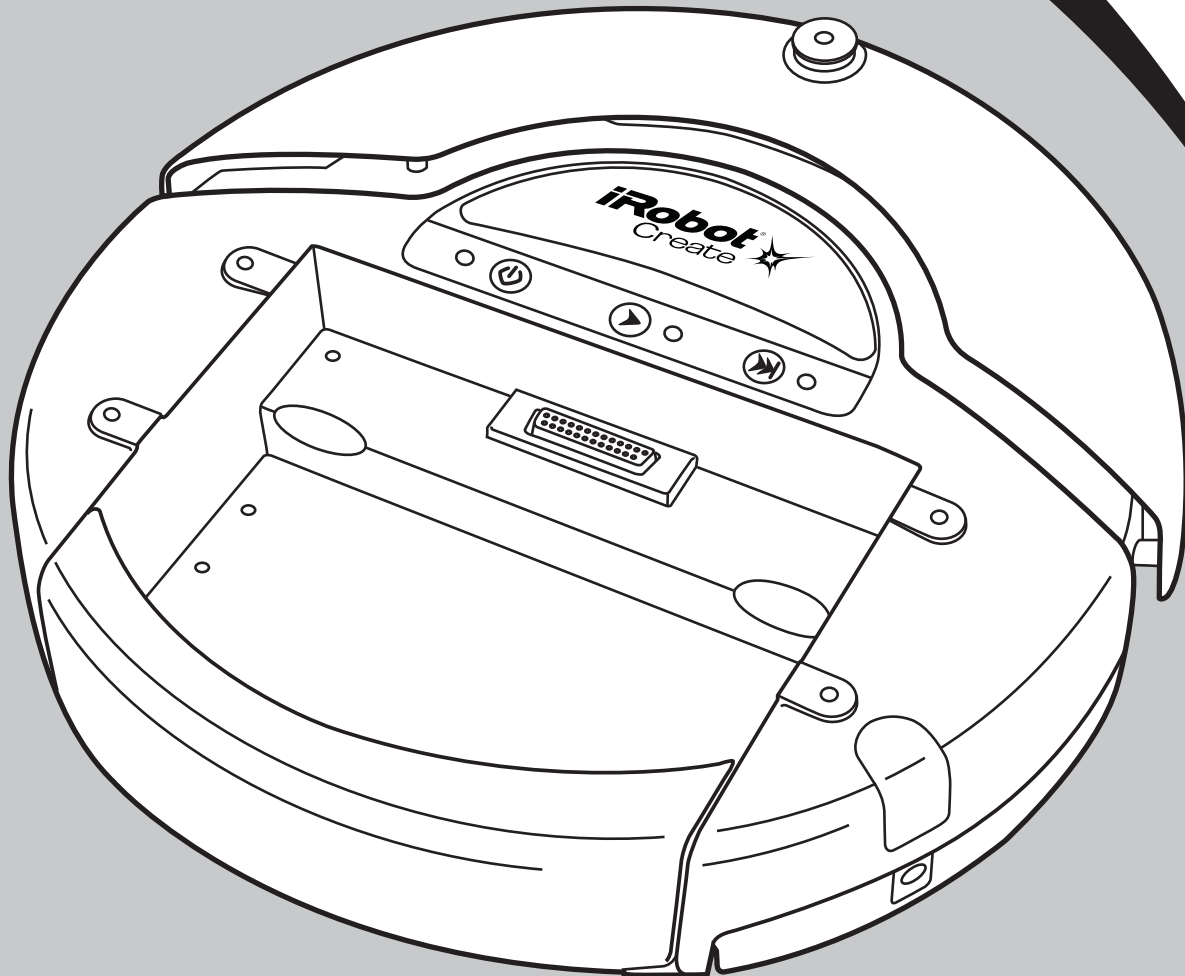


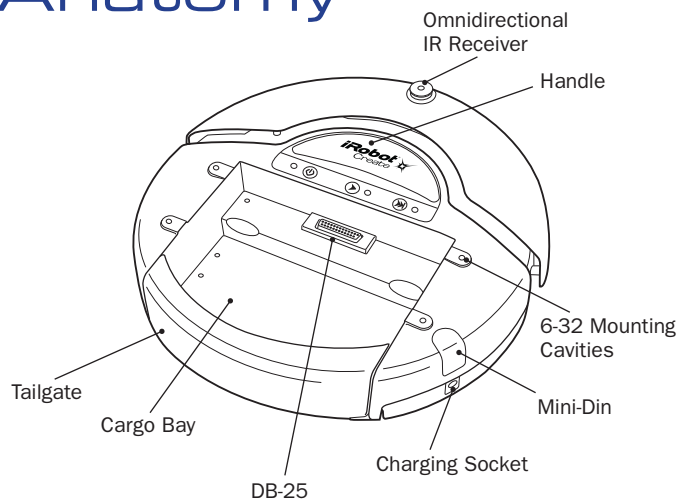
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iRobot Create® Open Interface Overview

The Create Open Interface (OI) consists of an electronic interface and a software interface for controlling Create's behavior and reading its sensors. The electronic interface includes a 7 pin Mini-DIN connector and a DB-25 connector in the Cargo Bay for connecting hardware and electronics for sensors and actuators such as a robotic arm or light sensor to Create. The software interface lets you manipulate Create's behavior and read its sensors through a series of commands including mode commands, actuator commands, song commands, demo commands, and sensor commands that you send to Create's serial port by way of a PC or microcontroller that is connected to the Mini-DIN connector or Cargo Bay Connector.

Anatomy

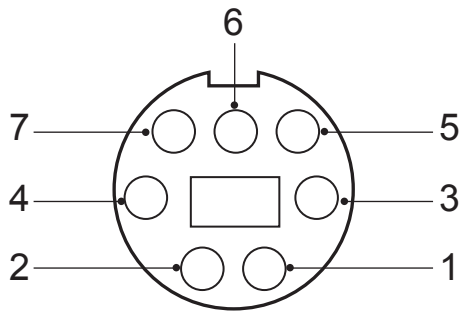


Physical Connections

To use the OI, a processor capable of generating serial commands such as a PC or a microcontroller must be connected to the external Mini-DIN connector or the Cargo Bay Connector on Create. These connectors provide two-way, serial communication at TTL (0 – 5V) levels. The connectors also provide an unregulated direct connection to iRobot Create's battery, which you can use to power the OI applications. The Cargo Bay Connector also provides a regulated 5V power supply and several input and output pins (see details below). The Mini-DIN connector is located in the rear right side of Create, beneath a snap-fit plastic guard, while the Cargo Bay Connector is located in the front middle of the cargo bay.

Mini-DIN Connector

This diagram shows the pinout of the top view of the female connector in Create. Note that pins 5, 6 and 7 are towards the outside circumference of Create.

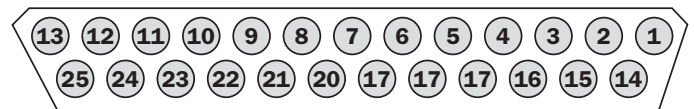


Pin	Name	Description
1	Vpwr	Create battery + (unregulated)
2	Vpwr	Create battery + (unregulated)
3	RXD	0 – 5V Serial input to Create
4	TXD	0 – 5V Serial output from Create
5	BRC	Baud Rate Change
6	GND	Create battery ground
7	GND	Create battery ground

Since the RXD and TXD pins use 0 – 5V logic voltage and the PC serial ports use different voltages (rs232 levels), it is necessary to shift voltage levels. To do this, use an iRobot Create serial cable rather than a normal serial cable, as the iRobot Create serial cable contains all of the necessary hardware to shift the voltage levels, whereas the normal serial cable does not.

Cargo Bay Connector

The Cargo Bay Connector, located in the front middle of the cargo bay, contains 25 pins that you can use to attach electronics for peripheral devices such as additional sensors. The Cargo Bay Connector provides four digital inputs, an analog input, three digital outputs, three high-current low side driver outputs (useful for driving motors), a charging indicator, a power toggle input, serial Tx and Rx, a 5V reference, battery ground and battery voltage.



Pin	Name	Description
1	RXD	0 – 5V Serial input to Create
2	TXD	0 – 5V Serial output from Create
3	Power control toggle	Turns Create on or off on a low-to-high transition
4	Analog input	0 - 5V analog input to Create
5	Digital input 1	0 - 5V digital input to Create
6	Digital input 3	0 - 5V digital input to Create
7	Digital output 1	0 - 5V, 20 mA digital output from Create
8	Switched 5V	Provides a regulated 5V 100 mA supply and analog reference voltage when Create is switched on
9	Vpwr	Create battery voltage (unregulated), 0.5A
10	Switched Vpwr	Provides battery power @ 1.5 A when Create is powered on.
11	Switched Vpwr	Provides battery power @ 1.5 A when Create is powered on.
12	Switched Vpwr	Provides battery power @ 1.5 A when Create is powered on.
13	Robot charging	When Create is charging, this pin is high (5V)
14	GND	Create battery ground
15	Device Detect/Baud Rate Change Pin	0-5V digital input to Create which can also be used to change the baud rate to 19200 (see below)
16	GND	Create battery ground
17	Digital input 0	0 - 5V digital input to Create
18	Digital input 2	0 - 5V digital input to Create
19	Digital output 0	0 - 5V, 20 mA digital output from Create
20	Digital output 2	0 - 5V, 20 mA digital output from Create
21	GND	Create battery ground
22	Low side driver 0	0.5A low side driver from Create
23	Low side driver 1	0.5A low side driver from Create
24	Low side driver 2	1.5A low side driver from Create
25	GND	Create battery ground

Serial Port Settings

Baud: 57600 or 19200 (see below)

Data bits: 8

Parity: None

Stop bits: 1

Flow control: None

By default, iRobot Create communicates at 57600 baud. If you are using a microcontroller that does not support 57600 baud, there are two ways to force Create to switch to 19200:

Method 1:

When powering on Create, hold down the Play button. After about 4 seconds, Create plays a tune of descending pitches. Create will communicate at 19200 baud until the power is turned off, the battery is removed and reinserted, the battery voltage falls below the minimum required for processor operation, or the baud rate is explicitly changed by way of the OI.

Method 2:

Use the Baud Rate Change pin (pin 15 on the Cargo Bay Connector/pin 5 on the Mini-DIN connector) to change Create's baud rate. After turning on Create, wait 2 seconds and then pulse the Baud Rate Change low three times. Each pulse should last between 50 and 500 milliseconds. Create will communicate at 19200 baud until the processor loses battery power or the baud rate is explicitly changed by way of the OI.

iRobot Create Open Interface Modes

The Create OI has four operating modes: Off, Passive, Safe, and Full. After a battery change or when it is first supplied, the OI is in “off” mode. When it is off, the OI listens at the default baud rate (57600 or 19200 - see Serial Port Settings above) for an OI Start command. Once it receives the Start command, you can enter into any one of the four operating modes by sending a mode command to the OI. You can also switch between operating modes at any time by sending a command to the OI for the operating mode that you want to use.

Passive Mode

Upon sending the Start command or any one of the demo commands (which also starts the specific demo, e.g., Spot Cover, Cover, Cover and Dock, or Demo), the OI enters into Passive mode. When the OI is in Passive mode, you can request and receive sensor data using any of the sensors commands, but you cannot change the current command parameters for the actuators (motors, speaker, lights, low side drivers, digital outputs) to something else. To change how one of the actuators operates, you must switch from Passive mode to Full mode or Safe mode.

While in Passive mode, you can read Create’s sensors, watch Create perform any one of its ten built-in demos, and charge the battery.

Safe Mode

When you send a Safe command to the OI, Create enters into Safe mode. Safe mode gives you full control of Create, with the exception of the following safety-related conditions:

- Detection of a cliff while moving forward (or moving backward with a small turning radius, less than one robot radius).
- Detection of a wheel drop (on any wheel).
- Charger plugged in and powered.

Should one of the above safety-related conditions occur while the OI is in Safe mode, Create stops all motors and reverts to the Passive mode.

If no commands are sent to the OI when in Safe mode, Create waits with all motors and LEDs off and does not respond to Play or Advance button presses or other sensor input.

Note that charging terminates when you enter Safe Mode.

Full Mode

When you send a Full command to the OI, Create enters into Full mode. Full mode gives you complete control over Create, all of its actuators, and all of the safety-related conditions that are restricted when the OI is in Safe mode, as Full mode shuts off the cliff, wheel-drop and internal charger safety features. To put the OI back into Safe mode, you must send the Safe command.

If no commands are sent to the OI when in Full mode, Create waits with all motors and LEDs off and does not respond to Play or Advance button presses or other sensor input.

Note that charging terminates when you enter Full Mode.

Open Interface Command Reference

The following is a list of all of iRobot Create's Open Interface commands. Each command starts with a one-byte opcode. Some of the commands must be followed by data bytes. All of Create's OI commands including their required data bytes are described below.

NOTE: Always send the required number of data bytes for the command, otherwise, the processor will enter and remain in a "waiting" state until all of the required data bytes are received.

Getting Started Commands

The following commands start the Open Interface and get it ready for use.

Start **Opcode: 128** **Data Bytes: 0**

This command starts the OI. You must always send the Start command before sending any other commands to the OI.

- Serial sequence: [128].
- Available in modes: Passive, Safe, or Full
- Changes mode to: Passive. Create beeps once to acknowledge it is starting from "off" mode.

Baud **Opcode: 129** **Data Bytes: 1**

This command sets the baud rate in bits per second (bps) at which OI commands and data are sent according to the baud code sent in the data byte. The default baud rate at power up is 57600 bps, but the starting baud rate can be changed to 19200 by holding down the Play button while powering on Create until you hear a sequence of descending tones. Once the baud rate is changed, it persists until Create is power cycled by pressing the power button or removing the battery, or when the battery voltage falls below the minimum required for processor operation. You must wait 100ms after sending this command before sending additional commands at the new baud rate.

Note: at a baud rate of 115200, there must be at least 200µs between the onset of each character, or some characters may not be received.

- Serial sequence: [129][Baud Code]
- Available in modes: Passive, Safe, or Full
- Changes mode to: No Change
- Baud data byte 1: Baud Code (0 - 11)

Baud Code	Baud Rate in BPS
0	300
1	600
2	1200
3	2400
4	4800
5	9600
6	14400
7	19200
8	28800
9	38400
10	57600
11	115200

Mode Commands

Create has four operating modes: Off, Passive, Safe, and Full. Create powers on in the Passive mode. The following commands change Create's OI mode.

Safe **Opcode: 131** **Data Bytes: 0**

This command puts the OI into Safe mode, enabling user control of Create. It turns off all LEDs. The OI can be in Passive, Safe, or Full mode to accept this command.

- Serial sequence: [131]
- Available in modes: Passive, Safe, or Full
- Changes mode to: Safe

Note: The effect and usage of the Control command (130) is identical to the Safe command. The Control command is deprecated but is present for backward compatibility with the Roomba Open Interface. Use Safe command instead.

Full **Opcode: 132** **Data Bytes: 0**

This command gives you complete control over Create by putting the OI into Full mode, and turning off the cliff, wheel-drop and internal charger safety features. That is, in Full mode, Create executes any command that you send it, even if the internal charger is plugged in, or the robot senses a cliff or wheel drop.

- Serial sequence: [132]
- Available in modes: Passive, Safe, or Full
- Changes mode to: Full

Note: Use the Start command (128) to change the mode to Passive.

Demo Commands

The following are commands to start iRobot Create's built-in demos.

Demo **Opcode: 136** **Data Bytes: 1**

This command starts the requested built-in demo.

- Serial sequence: [136][Which-demo]
- Available in modes: Passive, Safe, or Full
- Changes mode to: Passive
- Demo data byte 1: Demo number (-1 - 9)

Demo Names, Descriptions and Numbers

Number	Demo	Description
-1 (255)	Abort current demo	Stops the demo that Create is currently performing.
0	Cover	Create attempts to cover an entire room using a combination of behaviors, such as random bounce, wall following, and spiraling.
1	Cover and Dock	Identical to the Cover demo, with one exception. If Create sees an infrared signal from an iRobot Home Base, it uses that signal to dock with the Home Base and recharge itself.
2	Spot Cover	Create covers an area around its starting position by spiraling outward, then inward.
3	Mouse	Create drives in search of a wall. Once a wall is found, Create drives along the wall, traveling around circumference of the room.
4	Drive Figure Eight	Create continuously drives in a figure 8 pattern.
5	Wimp	Create drives forward when pushed from behind. If Create hits an obstacle while driving, it drives away from the obstacle.
6	Home	<p>Create drives toward an iRobot Virtual Wall as long as the back and sides of the virtual wall receiver are blinded by black electrical tape.</p> <p>A Virtual Wall emits infrared signals that Create sees with its Omnidirectional Infrared Receiver, located on top of the bumper.</p> <p>If you want Create to home in on a Virtual Wall, cover all but a small opening in the front of the infrared receiver with black electrical tape.</p> <p>Create spins to locate a virtual wall, then drives toward it. Once Create hits the wall or another obstacle, it stops.</p>

Number	Demo	Description
7	Tag	Identical to the Home demo, except Create drives into multiple virtual walls by bumping into one, turning around, driving to the next virtual wall, bumping into it and turning around to bump into the next virtual wall.
8	Pachelbel	Create plays the notes of Pachelbel's Canon in sequence when cliff sensors are activated.
9	Banjo	<p>Create plays a note of a chord for each of its four cliff sensors. Select the chord using the bumper, as follows:</p> <ul style="list-style-type: none"> • No bumper: G major. • Right/left bumper: D major 7 • Both bumpers (center): C major

You can also call the Cover, Cover and Dock and Spot Demos using the Opcodes specified below. This is present for ensuring backward compatibility with the Roomba OI.

Cover **Opcode: 135** **Data Bytes: 0**

This command starts the Cover demo.

- Serial sequence: [135]
- Available in modes: Passive, Safe, or Full
- Changes mode to: Passive

Cover and Dock **Opcode: 143** **Data Bytes: 0**

This command starts the Cover and Dock demo.

- Serial sequence: [143]
- Available in modes: Passive, Safe, or Full
- Changes mode to: Passive

Spot **Opcode: 134** **Data Bytes: 0**

This command starts the Spot Cover demo.

- Serial sequence: [134]
- Available in modes: Passive, Safe, or Full
- Changes mode to: Passive

Actuator Commands

The following commands control iRobot Create's actuators: wheels, speaker, LEDS, digital outputs and low side driver outputs.

Drive Opcode: 137 Data Bytes: 4

This command controls Create's drive wheels. It takes four data bytes, interpreted as two 16-bit signed values using two's complement. The first two bytes specify the average velocity of the drive wheels in millimeters per second (mm/s), with the high byte being sent first. The next two bytes specify the radius in millimeters at which Create will turn. The longer radii make Create drive straighter, while the shorter radii make Create turn more. The radius is measured from the center of the turning circle to the center of Create. A Drive command with a positive velocity and a positive radius makes Create drive forward while turning toward the left. A negative radius makes Create turn toward the right. Special cases for the radius make Create turn in place or drive straight, as specified below. A negative velocity makes Create drive backward.

NOTE: Internal and environmental restrictions may prevent Create from accurately carrying out some drive commands. For example, it may not be possible for Create to drive at full speed in an arc with a large radius of curvature.

- Serial sequence: [137] [Velocity high byte] [Velocity low byte] [Radius high byte] [Radius low byte]
- Available in modes: Safe or Full
- Changes mode to: No Change
- Drive data byte 1: Velocity (-500 – 500 mm/s)
- Drive data byte 2: Radius (-2000 – 2000 mm)

Special cases:

Straight = 32768 or 32767 = hex 8000 or 7FFF

Turn in place clockwise = hex FFFF

Turn in place counter-clockwise = hex 0001

Example:

To drive in reverse at a velocity of -200 mm/s while turning at a radius of 500mm, send the following serial byte sequence:

[137] [255] [56] [1] [244]

Velocity = -200 = hex FF38 = [hex FF] [hex 38] = [255] [56]

Radius = 500 = hex 01F4 = [hex 01] [hex F4] = [1] [244]

Drive Direct Opcode: 145 Data Bytes: 4

This command lets you control the forward and backward motion of Create's drive wheels independently. It takes four data bytes, which are interpreted as two 16-bit signed values using two's complement. The first two bytes specify the velocity of the right wheel in millimeters per second (mm/s), with the high byte sent first. The next two bytes specify the velocity of the left wheel, in the same format. A positive velocity makes that wheel drive forward, while a negative velocity makes it drive backward.

- Serial sequence: [145] [Right velocity high byte] [Right velocity low byte] [Left velocity high byte] [Left velocity low byte]
- Available in modes: Safe or Full
- Changes mode to: No Change
- Drive Direct data byte 1: Right wheel velocity (-500 – 500 mm/s)
- Drive Direct data byte 1: Left wheel velocity (-500 – 500 mm/s)

LEDs Opcode: 139 Data Bytes: 3

This command controls the LEDs on Create. The state of the Play and Advance LEDs is specified by two bits in the first data byte. The power LED is specified by two data bytes: one for the color and the other for the intensity.

- Serial sequence: [139] [LED Bits] [Power Color] [Power Intensity]
- Available in modes: Safe or Full
- Changes mode to: No Change
- LEDs data byte 1: LED Bits (0 – 10)

Advance and Play use green LEDs. 0 = off, 1 = on

Bit	7	6	5	4	3	2	1	0
LED	n/a	n/a	n/a	n/a	Advance	n/a	Play	n/a

Power uses a bicolor (red/green) LED. The intensity and color of this LED can be controlled with 8-bit resolution.

- LEDs data byte 2: Power LED Color (0 – 255)
0 = green, 255 = red. Intermediate values are intermediate colors (orange, yellow, etc).
- LEDs data byte 3: Power LED Intensity (0 – 255)
0 = off, 255 = full intensity. Intermediate values are intermediate intensities.

Example:

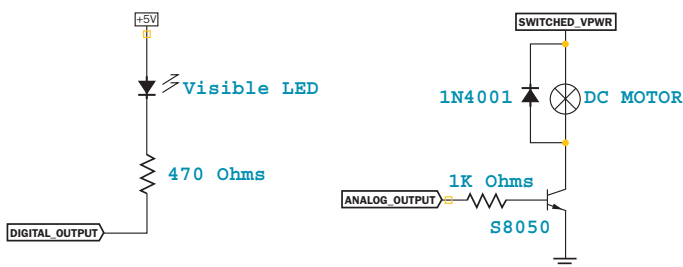
To turn on the Advance LED and light the Power LED green at half intensity, send the serial byte sequence [139] [8] [0] [128].

Digital Outputs **Opcode: 147** **Data Bytes: 1**

This command controls the state of the 3 digital output pins on the 25 pin Cargo Bay Connector. The digital outputs can provide up to 20 mA of current.

- Serial sequence: [147] [Output Bits]
- Available in modes: Safe or Full
- Changes mode to: No Change
- Digital Outputs data byte 1: Output Bits (0 – 7);
0 = low (0V); 1 = high (5V).

Example schematics



Warning: When the Robot is switched ON, the Digital Outputs are High for the first 3 seconds during the initialization of the bootloader

Bit	7	6	5	4	3	2	1	0
Output						digital-out-2 (pin 20)	digital-out-1 (pin 7)	digital-out-0 (pin 19)

PWM Low Side Drivers **Opcode: 144** **Data Bytes: 3**

This command lets you control the three low side drivers with variable power. With each data byte, you specify the PWM duty cycle for the low side driver (max 128). For example, if you want to control a driver with 25% of battery voltage, choose a duty cycle of $128 * 25\% = 32$.

- Serial sequence: [144] [Low Side Driver 2 Duty Cycle] [Low Side Driver 1 Duty Cycle] [Low Side Driver 0 Duty Cycle]
- Available in modes: Safe or Full
- Changes mode to: No Change
- Low Side Drivers data byte 1: Duty cycle for low side driver 2 (0 - 128)
- Low Side Drivers data byte 2: Duty cycle for low side driver 1 (0 - 128)
- Low Side Drivers data byte 3: Duty cycle for low side driver 0 (0 - 128)

Example:

To turn on low side driver 2 at 25% and low side driver 0 at 100%, send the serial byte sequence [144][32][0][128]

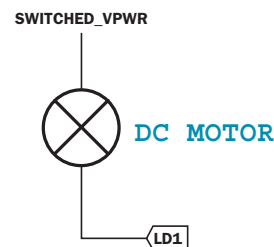
Low Side Drivers **Opcode: 138** **Data Bytes: 1**

This command lets you control the three low side drivers. The state of each driver is specified by one bit in the data byte.

Low side drivers 0 and 1 can provide up to 0.5A of current. Low side driver 2 can provide up to 1.5 A of current. If too much current is requested, the current is limited and the overcurrent flag is set (sensor packet 14).

- Serial sequence: [138] [Driver Bits]
- Available in modes: Safe or Full
- Changes mode to: No Change
- Low Side Drivers data byte 1: Driver bits (0 – 7)

Example schematic



0 = off, 1 = on at 100% PWM duty cycle

Bit	7	6	5	4	3	2	1	0
Output						Side Driver 2 (pin 24)	Low Side Driver 1 (pin 22)	Low Side Driver 0 (pin 23)

Example:

To turn on only low side driver 1, send the serial byte sequence [138] [2].

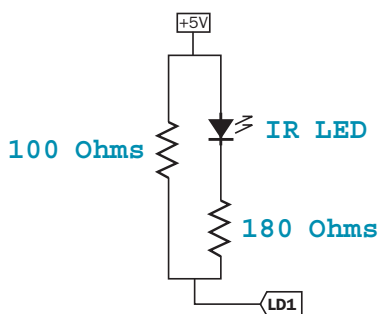
Note: Speed control of motors uses the PWM Low Side Drivers Command. This command exists for Backward compatibility with the Roomba OI.

Send IR Opcode: 151 Data Bytes: 1

This command sends the requested byte out of low side driver 1 (pin 23 on the Cargo Bay Connector), using the format expected by iRobot Create's IR receiver. You must use a preload resistor (suggested value: 100 ohms) in parallel with the IR LED and its resistor in order turn it on.

- Serial sequence: [151][Byte Value]
- Available in modes: Safe or Full
- Changes mode to: No Change
- Send IR data byte 1: Byte value to send (0 - 255)

Example Schematic



Song Opcode: 140 Data Bytes: 2N+2,

where N is the number of notes in the song

This command lets you specify up to sixteen songs to the OI that you can play at a later time. Each song is associated with a song number. The Play command uses the song number to identify your song selection. Each song can contain up to sixteen notes. Each note is associated with a note number that uses MIDI note definitions and a duration that is specified in fractions of a second. The number of data bytes varies, depending on the length of the song specified. A one note song is specified by four data bytes. For each additional note within a song, add two data bytes.

- Serial sequence: [140] [Song Number] [Song Length] [Note Number 1] [Note Duration 1] [Note Number 2] [Note Duration 2], etc.

- Available in modes: Passive, Safe, or Full
- Changes mode to: No Change
- Song data byte 1: Song Number (0 – 15)

The song number associated with the specific song. If you send a second Song command, using the same song number, the old song is overwritten.

- Song data byte 2: Song Length (1 – 16)

The length of the song, according to the number of musical notes within the song.

- Song data bytes 3, 5, 7, etc.: Note Number (31 – 127)

The pitch of the musical note Create will play, according to the MIDI note numbering scheme. The lowest musical note that Create will play is Note #31. Create considers all musical notes outside the range of 31 – 127 as rest notes, and will make no sound during the duration of those notes.

- Song data bytes 4, 6, 8, etc.: Note Duration (0 – 255)

The duration of a musical note, in increments of 1/64th of a second. Example: a half-second long musical note has a duration value of 32

Note Durations

Number	Note	Frequency	Number	Note	Frequency	Number	Note	Frequency
			60	C	261.6	96	C	2093.0
			61	C#	277.2	97	C#	2217.5
			62	D	293.7	98	D	2349.3
			63	D#	311.1	99	D#	2489.0
			64	E	329.6	100	E	2637.0
			65	F	349.2	101	F	2793.8
			66	F#	370.0	102	F#	2960.0
31	G	49.0	67	G	392.0	103	G	3136.0
32	G#	51.0	68	G#	415.3	104	G#	3322.4
33	A	55.0	69	A	440.0	105	A	3520.0
34	A#	58.3	70	A#	466.2	106	A#	3729.3
35	B	61.7	71	B	493.9	107	B	3951.1
36	C	65.4	72	C	523.3	108	C	4186.0
37	C#	69.3	73	C#	554.4	109	C#	4434.9
38	D	73.4	74	D	587.3	110	D	4698.6
39	D#	77.8	75	D#	622.3	111	D#	4978.0
40	E	82.4	76	E	659.3	112	E	5274.0
41	F	87.3	77	F	698.5	113	F	5587.7
42	F#	92.5	78	F#	740.0	114	F#	5919.9
43	G	98.0	79	G	784.0	115	G	6271.9
44	G#	103.8	80	G#	830.6	116	G#	6644.9
45	A	110.0	81	A	880.0	117	A	7040.0
46	A#	116.5	82	A#	932.3	118	A#	7458.6
47	B	123.5	83	B	987.8	119	B	7902.1
48	C	130.8	84	C	1046.5	120	C	8372.0
49	C#	138.6	85	C#	1108.7	121	C#	8869.8
50	D	146.8	86	D	1174.7	122	D	9397.3
51	D#	155.6	87	D#	1244.5	123	D#	9956.1
52	E	164.8	88	E	1318.5	124	E	10548.1
53	F	174.6	89	F	1396.9	125	F	11175.3
54	F#	185.0	90	F#	1480.0	126	F#	11839.8
55	G	196.0	91	G	1568.0	127	G	12543.9
56	G#	207.7	92	G#	1661.2			
57	A	220.0	93	A	1760.0			
58	A#	233.1	94	A#	1864.7			
59	B	246.9	95	B	1975.5			

Play Song	Opcode: 141	Data Bytes: 1
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This command lets you select a song to play from the songs added to iRobot Create using the Song command. You must add one or more songs to Create using the Song command in order for the Play command to work. Also, this command does not work if a song is already playing. Wait until a currently playing song is done before sending this command. Note that the “song playing” sensor packet can be used to check whether Create is ready to accept this command.

- Serial sequence: [141] [Song Number]
- Available in modes: Safe or Full
- Changes mode to: No Change
- Play Song data byte 1: Song Number (0 – 15)
The number of the song Create is to play.

Input Commands

The following commands let you read the state of Create’s built-in sensors, digital and analog inputs, and some internal state variables. Create updates these values internally every 15 ms. Do not send these commands more frequently than that.

Sensors	Opcode: 142	Data Bytes: 1
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This command requests the OI to send a packet of sensor data bytes. There are 43 different sensor data packets. Each provides a value of a specific sensor or group of sensors.

For more information on sensor packets, refer to the next section, “Create Open Interface Sensor Packets.”

- Serial sequence: [142] [Packet ID]
- Available in modes: Passive, Safe, or Full
- Changes mode to: No Change
- Sensors data byte 1: Packet ID (0 - 42)

Identifies which of the 43 sensor data packets should be sent back by the OI. A value of 6 indicates a packet with all of the sensor data. Values of 0 through 5 indicate specific subgroups of the sensor data (see Sensors Quick Reference below).

Query List	Opcode: 149	Data Bytes: N + 1,
-------------------	--------------------	---------------------------

where N is the number of packets requested.

This command lets you ask for a list of sensor packets. The result is returned once, as in the Sensors command. The robot returns the packets in the order you specify.

- Serial sequence: [149][Number of Packets]
[Packet ID 1][Packet ID 2]...[Packet ID N]
- Available in modes: Passive, Safe, or Full
- Changes mode to: No Change
- Query List data byte 1: Number of packets requested (0 - 255)
- Query List data bytes 2 - N: IDs of packets requested (0 - 42)

Example:

To get the state of the left cliff sensor (packet 9) and the Virtual Wall detector (packet 13), send the following sequence:

[149] [2] [9] [13]

Stream **Opcode: 148** **Data Bytes: N + 1,**
where N is the number of packets requested.

This command starts a continuous stream of data packets. The list of packets requested is sent every 15 ms, which is the rate iRobot Create uses to update data.

This is the best method of requesting sensor data if you are controlling Create over a wireless network (which has poor real-time characteristics) with software running on a desktop computer.

- Serial sequence: [148] [Number of packets] [Packet ID 1] [Packet ID 2] [Packet ID 3] etc.
- Available in modes: Passive, Safe, or Full
- Changes mode to: No Change
- Stream data byte 1: Number of packets requested (0 - 43)
- Stream data bytes 2 - N: IDs of packets requested (0 - 42)

The format of the data returned is:

[19][N-bytes][Packet ID 1][Packet 1 data...]
[Packet ID 2][Packet 2 data...][Checksum]

N-bytes is the number of bytes between the n-bytes byte and the checksum.

The checksum is a 1-byte value. It is the 8-bit complement of all of the bytes between the header and the checksum. That is, if you add all of the bytes after the checksum, and the checksum, the low byte of the result will be 0.

Example:

To get data from Create's left cliff signal (packet 29) and Virtual Wall detector (packet 13), send the following command string to Create:

[148] [2] [29] [13]

NOTE: The left cliff signal is a 2-byte packet and the IR Sensor is a 1-byte packet.

Create starts streaming data that looks like this:

19	5	29	2 25	13	0	182
header	n-bytes	packet ID 1	Packet data 1 (2 bytes)	packet ID 2	packet data 2 (1 byte)	Checksum

NOTE: Checksum computation: (5 + 29 + 2 + 25 + 13 + 0 + 182) = 256 and (256 & 0xFF) = 0.

In the above stream segment, Create's left cliff signal value was 549 (0x0225) and there was no virtual wall signal.

It is up to you not to request more data than can be sent at the current baud rate in the 15 ms time slot. For example, at 57600 baud, a maximum of 86 bytes can be sent in 15 ms:

$$15 \text{ ms} / 10 \text{ bits (8 data + start + stop)} * 57600 = 86.4$$

If more data is requested, the data stream will eventually become corrupted. This can be confirmed by checking the checksum.

The header byte and checksum can be used to align your receiving program with the data. All data chunks start with 19 and end with the 1-byte checksum

Pause/Resume Stream **Opcode: 150** **Data Bytes: 1**

This command lets you stop and restart the stream without clearing the list of requested packets.

- Serial sequence: [150][Stream State]
- Available in modes: Passive, Safe, or Full
- Changes mode to: No Change
- Pause/Resume Stream data byte 1: Requested stream state (0 - 1)

An argument of 0 stops the stream without clearing the list of requested packets. An argument of 1 starts the stream using the list of packets last requested.

Script Commands

The following commands let you specify a script for iRobot Create to play at a later time.

Script	Opcode: 152	Data Bytes: N + 1
		where N is the number of bytes in the script.

This command specifies a script to be played later. A script consists of OI commands and can be up to 100 bytes long. There is no flow control, but “wait” commands (see below) cause Create to hold its current state until the specified event is detected.

- Serial sequence: [152] [Script Length] [Opcode 1] [Opcode 2] [Opcode 3] etc.
- Available in modes: Passive, Safe, or Full
- Changes mode to: No Change
- Script data byte 1: Script Length (0 – 100)
Specifies the length of the script in terms of the number of commands. Specify a length of 0 to clear the current script.
- Script data bytes 2 and above: Open Interface commands and data bytes

Tip: To make a script loop forever, use Play Script (153) as the last command.

Example Scripts:

Drive 40 cm and stop:

```
152 13 137 1 44 128 0 156 1 144 137 0 0 0 0
```

Toggle led on bump:

```
152 17 158 5 158 251 139 2 0 0 158 5 158 251 139 0 0 0 153
```

Drive in a square:

```
152 17 137 1 44 128 0 156 1 144 137 1 44 0 1 157 0 90 153
```

Play Script	Opcode: 153	Data Bytes: 0
-------------	-------------	---------------

This command loads a previously defined OI script into the serial input queue for playback.

- Serial sequence: [153]
- Available in modes: Passive, Safe, or Full
- Changes mode to: No Change

Show Script	Opcode: 154	Data Bytes: 0
-------------	-------------	---------------

This command returns the values of a previously stored script, starting with the number of bytes in the script and followed by the script’s commands and data bytes. It first halts the sensor stream, if one has been started with a Stream or Pause/Resume Stream command. To restart the stream, send Pause/Resume Stream (opcode 150).

- Serial sequence: [154]
- Available in modes: Passive, Safe, or Full
- Changes mode to: No Change

Wait Commands

The following commands cause Create to wait for a specific time, distance, angle of rotation, or event to occur. While it is waiting, Create does not change its state, nor does it react to any inputs, serial or otherwise. These commands are intended for use in scripting only.

Wait Time	Opcode: 155	Data Bytes: 1
-----------	-------------	---------------

This command causes Create to wait for the specified time. During this time, Create’s state does not change, nor does it react to any inputs, serial or otherwise.

- Serial sequence: [155] [time]
- Available in modes: Passive, Safe, or Full
- Changes mode to: No Change
- Wait Time data byte 1: Time (0 - 255)

Specifies time to wait in tenths of a second with a resolution of 15 ms.

Wait Distance Opcode: 156 Data Bytes: 2

This command causes iRobot Create to wait until it has traveled the specified distance in mm. When Create travels forward, the distance is incremented. When Create travels backward, the distance is decremented. If the wheels are passively rotated in either direction, the distance is incremented. Until Create travels the specified distance, its state does not change, nor does it react to any inputs, serial or otherwise.

NOTE: This command resets the distance variable that is returned in Sensors packets 19, 2 and 6.

- Serial sequence: [156] [Distance high byte] [Distance low byte]
- Available in modes: Passive, Safe, or Full
- Changes mode to: No Change
- Wait Distance data bytes 1-2: 16-bit signed distance in mm, high byte first (-32767 -32768)

Wait Angle Opcode: 157 Data Bytes: 2

This command causes Create to wait until it has rotated through specified angle in degrees. When Create turns counterclockwise, the angle is incremented. When Create turns clockwise, the angle is decremented. Until Create turns through the specified angle, its state does not change, nor does it react to any inputs, serial or otherwise.

NOTE: This command resets the angle variable that is returned in Sensors packets 20, 2 and 6.

- Serial sequence: [157] [Angle high byte] [Angle low byte]
- Available in modes: Passive, Safe, or Full
- Changes mode to: No Change
- Wait Angle data bytes 1-2: 16-bit signed angle in degrees, high byte first (-32767 -32768)

**Wait Event Opcode: 158 Data Bytes: 1
signed**

This command causes Create to wait until it detects the specified event. Until the specified event is detected, Create's state does not change, nor does it react to any inputs, serial or otherwise.

- Serial sequence: [158] [Event number]
- Available in modes: Passive, Safe, or Full
- Changes mode to: No Change
- Wait Event data byte 1: Signed event number (1 to 20 and -1 to -20)

To wait for the inverse of an event, send the negative of its number using two's complement notation. For example, to wait for no bumps, send the serial byte sequence [158] [-5], which is equivalent to [158] [251].

Wait Event: Unsigned Equivalent of Inverse

Event	Number	Unsigned Equivalent of Inverse
Wheel Drop	1	255
Front Wheel Drop	2	254
Left Wheel Drop	3	253
Right Wheel Drop	4	252
Bump	5	251
Left Bump	6	250
Right Bump	7	249
Virtual Wall	8	248
Wall	9	247
Cliff	10	246
Left Cliff	11	245
Front Left Cliff	12	244
Front Right Cliff	13	243
Right Cliff	14	242
Home Base	15	241
Advance Button	16	240
Play Button	17	239
Digital Input 0	18	238
Digital Input 1	19	237
Digital Input 2	20	236
Digital Input 3	21	235
OI Mode = Passive	22	234

iRobot Create Open Interface

Sensor Packets

Create sends back one of 43 different sensor data packets, depending on the value of the packet data byte, when responding to a Sensors command, Query List command, or Stream command's request for a packet of sensor data bytes. Some packets contain groups of other packets. Some of the sensor data values are 16 bit values.

Most of the packets (numbers 7 – 42) contain the value of a single sensor or variable, which can be either 1 byte or 2 bytes. Two-byte packets correspond to 16-bit values, sent high byte first.

Some of the packets (0-6) contain groups of the single-value packets.

Wait Event: Unsigned Equivalent of Inverse

Group Packet ID	Packet Size	Contains packets
0	26 bytes	7 - 26
1	10 bytes	7 - 16
2	6 bytes	17 - 20
3	10 bytes	21 - 26
4	14 bytes	27 - 34
5	12 bytes	35 - 42
6	52 bytes	7 - 42

Bumps and Wheel Drops Packet ID: 7 Data Bytes: 1 unsigned

The state of the bumper (0 = no bump, 1 = bump) and wheel drop sensors (0 = wheel raised, 1 = wheel dropped) are sent as individual bits.

Range: 0 - 31

Bit	7	6	5	4	3	2	1	0
Sensor	n/a	n/a	n/a	Wheeldrop Caster	Wheeldrop Left	Wheeldrop Right	Bump Left	Bump Right

Wall Packet ID: 8 Data Bytes: 1 unsigned

The state of the wall sensor is sent as a 1 bit value (0 = no wall, 1 = wall seen).

Range: 0 – 1

Cliff Left Packet ID: 9 Data Bytes: 1 unsigned

The state of the cliff sensor on the left side of Create is sent as a 1 bit value (0 = no cliff, 1 = cliff).

Range: 0 – 1

Cliff Front Left Packet ID: 10 Data Bytes: 1 unsigned

The state of the cliff sensor on the front left of Create is sent as a 1 bit value (0 = no cliff, 1 = cliff).

Range: 0 – 1

Cliff Front Right Packet ID: 11 Data Bytes: 1 unsigned

The state of the cliff sensor on the front right of Create is sent as a 1 bit value (0 = no cliff, 1 = cliff)

Range: 0 – 1

Cliff Right Packet ID: 12 Data Bytes: 1 unsigned

The state of the cliff sensor on the right side of Create is sent as a 1 bit value (0 = no cliff, 1 = cliff)

Range: 0 – 1

Virtual Wall Packet ID: 13 Data Bytes: 1 unsigned

The state of the virtual wall detector is sent as a 1 bit value (0 = no virtual wall detected, 1 = virtual wall detected). Note that the force field on top of the Home Base also trips this sensor.

Range: 0 – 1

Low Side Driver and Wheel Overcurrents Packet ID: 14 Data Bytes: 1 unsigned

The state of the three Low Side driver and two wheel overcurrent sensors are sent as individual bits (0 = no overcurrent, 1 = overcurrent).

Driver	Current Limit
LD0	0.5A
LD1	0.5A
LD2	1.6A
Wheels	1.0A

Range: 0 - 31

Bit	7	6	5	4	3	2	1	0
Motor	n/a	n/a	n/a	Left Wheel	Right Wheel	LD-2	LD-0	LD-1

Unused Bytes Packet IDs: 15 - 16 Data Bytes: 1

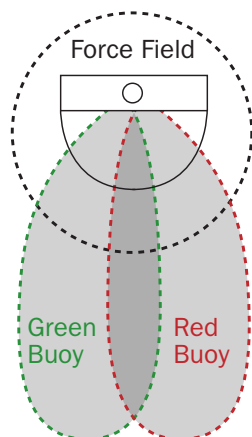
Unused bytes: Two unused bytes are sent after the overcurrent byte when the requested packet is 0, 1, or 6. The value of the two unused bytes is always 0.

Range: 0

**Infrared Byte Packet ID: 17 Data Bytes: 1
unsigned**

This value identifies the IR byte currently being received by iRobot Create. A value of 255 indicates that no IR byte is being received. These bytes include those sent by the Roomba Remote, the Home Base, Create robots using the Send IR command, and user-created devices.

Range: 0 – 255

Dock beam configuration


Sent by iRobot Device	Character Value	Character Name
Remote Control	129	Left
	130	Forward
	131	Right
	132	Spot
	133	Max
	134	Small
	135	Medium
	136	Large / Clean
	137	PAUSE
	138	Power
	139	arc-forward-left
	140	arc-forward-right
	141	drive-stop

Sent by iRobot Device	Character Value	Character Name
Scheduling Remote	142	Send All
	143	Seek Dock
Home Base	240	Reserved
	248	Red Buoy
	244	Green Buoy
	242	Force Field
	252	Red Buoy and Green Buoy
	250	Red Buoy and Force Field
	246	Green Buoy and Force Field
	254	Red Buoy, Green Buoy and Force Field

**Buttons Packet ID: 18 Data Bytes: 1
unsigned**

The state of Create's Play and Advance buttons are sent as individual bits (0 = button not pressed, 1 = button pressed).

Range: 0 - 5

Bit	7	6	5	4	3	2	1	0
Button	n/a	n/a	n/a	n/a	n/a	Advance	n/a	Play

**Distance Packet ID: 19 Data Bytes: 2
signed**

The distance that Create has traveled in millimeters since the distance it was last requested is sent as a signed 16-bit value, high byte first. This is the same as the sum of the distance traveled by both wheels divided by two. Positive values indicate travel in the forward direction; negative values indicate travel in the reverse direction. If the value is not polled frequently enough, it is capped at its minimum or maximum.

Range: -32768 – 32767

Cliff Front Right Signal Packet ID: 30 Data Bytes: 2
unsigned

The strength of the front right cliff sensor's signal is returned as an unsigned 16-bit value, high byte first.

Range: 0-4095

Cliff Right Signal Packet ID: 31 Data Bytes: 2
unsigned

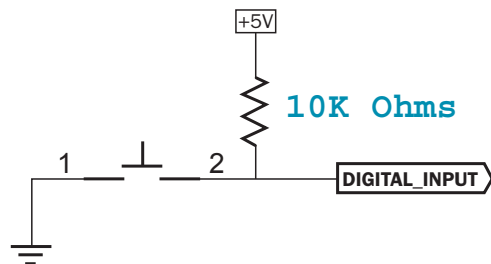
The strength of the right cliff sensor's signal is returned as an unsigned 16-bit value, high byte first.

Range: 0-4095

Cargo Bay Digital Inputs Packet ID: 32 Data Bytes: 1
unsigned

The state of the digital inputs on the 25-pin Cargo Bay Connector are sent as individual bits (0 = low, 1 = high (5V)). Note that the Baud Rate Change pin is active low; it is high by default.

Example Schematic



Range: 0 - 31

Bit	7	6	5	4	3	2	1	0
Button	n/a	n/a	n/a	Device Detect /Baud Rate Change (pin 15)	Digital Input 3 (pin 6)	Digital Input 2 (pin 18)	Digital Input 1 (pin 5)	Digital Input 0 (pin 17)

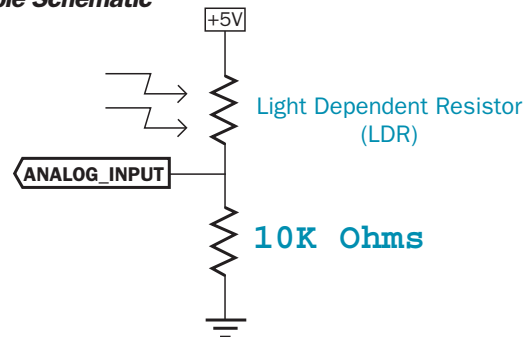
Device Detect pin can be used to change Baud Rate. When device detect/ baud rate change Bit is low, the Baud Rate is 19200. Otherwise it is 57600

Cargo Bay Analog Signal Packet ID: 33 Data Bytes: 2
unsigned

The 10-bit value of the analog input on the 25-pin Cargo Bay Connector is returned, high byte first. 0 = 0 volts; 1023 = 5 volts. The analog input is on pin 4.

Range: 0 - 1023

Example Schematic



Charging Sources Available Packet ID: 34 Data Bytes: 1
unsigned

iRobot Create's connection to the Home Base and Internal Charger are returned as individual bits, as below.

Range: 0 - 3

1 = charging source present and powered; 0 = charging source not present or not powered.

Bit	7	6	5	4	3	2	1	0
Charging Source	n/a	n/a	n/a	n/a	n/a	n/a	Home Base	Internal Charger

OI Mode Packet ID: 35 Data Bytes: 1
unsigned

Create's connection to the Home Base and Internal Charger are returned as individual bits, as below.

Range: 0 - 3

Number	Mode
0	Off
1	Passive
2	Safe
3	Full

Song Number	Packet ID: 36	Data Bytes: 1
unsigned		

The currently selected OI song is returned.

Range: 0-15

Song Playing	Packet ID: 37	Data Bytes: 1
unsigned		

The state of the OI song player is returned. 1 = OI song currently playing; 0 = OI song not playing.

Range: 0-1

Number of Stream Packets	Packet ID: 38	Data Bytes: 1
unsigned		

The number of data stream packets is returned.

Range: 0-43

Requested Velocity	Packet ID: 39	Data Bytes: 2
signed		

The velocity most recently requested with a Drive command is returned as a signed 16-bit number, high byte first.

Range: -500 - 500 mm/s

Requested Radius	Packet ID: 40	Data Bytes: 2
signed		

The radius most recently requested with a Drive command is returned as a signed 16-bit number, high byte first.

Range: -32768 - 32767 mm

Requested Right Velocity	Packet ID: 41	Data Bytes: 2
signed		

The right wheel velocity most recently requested with a Drive Direct command is returned as a signed 16-bit number, high byte first.

Range: -500 - 500 mm/s

Requested Left Velocity	Packet ID: 42	Data Bytes: 2
signed		

The left wheel velocity most recently requested with a Drive Direct command is returned as a signed 16-bit number, high byte first.

Range: -500 - 500 mm/s

iRobot Create Open Interface Commands Quick Reference

Create OI Commands Quick Reference Table

Command	Opcode	Data Bytes: 1	Data Bytes: 2	Data Bytes: 3	Data Bytes: 4	Etc.
Start	128					
Baud	129	Baud Code: (0 – 11)				
Control	130					
Safe	131					
Full	132					
Spot	134					
Cover	135					
Demo	136	Demos (-1 - 9)				
Drive	137	Velocity (-500 – 500 mm/s)		Radius (-2000 – 2000 mm)		
Low Side Drivers	138	Output Bits (0 – 7)				
LEDs	139	LED Bits (0 – 10)	Power LED Color (0 – 255)	Power LED Intensity (0 – 255)		
Song	140	Song Number (0 - 15)	Song Length (1 - 16)	Note Number 1 (31 – 27)	Note Duration 1 (0 - 255)	Note Number 2, etc.
Play	141	Song Number: (0 – 15)				
Sensors	142	Packet ID: (0 – 42)				
Cover and Dock	143					
PWM Low Side Drivers	144	Low Side Driver 2 Duty Cycle (0 - 128)	Low Side Driver 1 Duty Cycle (0 - 128)	Low Side Driver 0 Duty Cycle (0 - 128)		
Drive Direct	145	Right wheel velocity (-500 – 500 mm/s)		Left wheel velocity (-500 – 500 mm/s)		
Digital Outputs	147	Output Bits (0 – 7)				
Stream	148	Number of Packets	Packet ID 1 (0 – 42)	Packet ID 2, etc.		
Query List	149	Packet ID 1 (0 – 42)	Packet ID 2, etc.			
Pause/Resume Stream	150	Range: 0-1				
Send IR	151	Byte (0 - 255)				
Script	152	Script Length: (1 – 100)	Command Opcode 1	Command Data Byte 1, etc.	Command Opcode 2	Etc.
Play Script	153					
Show Script	154					
Wait Time	155	Time (0 – 255 seconds/10)				
Wait Distance	156	Distance (-32767 - 32768 mm)				
Wait Angle	157	Angle (-32767 - 32768 degrees)				
Wait Event	158	Event ID (1 to 20 and -1 to -20)				

Baud Code (0 – 11)

Baud Code	Baud Rate in BPS
0	300
1	600
2	1200
3	2400
4	4800
5	9600
6	14400
7	19200
8	28800
9	38400
10	57600
11	115200

LEDs Data Byte 1: LED Bits (0 – 10)

Advance and Play use green LEDs: 0 = off, 1 = on

Bit	7	6	5	4	3	2	1	0
LED	n/a	n/a	n/a	n/a	Advance	n/a	Play	n/a

LEDs Data Bytes 2 and 3: Power LED Color and Intensity (0 - 255)

Power uses a bicolor (red/green) LED. The intensity and color of this LED can be controlled with 8-bit resolution.

LEDs data byte 2: Power LED Color (0 – 255)

0 = green, 255 = red. Intermediate values are intermediate colors (orange, yellow, etc).

LEDs data byte 3: Power LED Intensity (0 – 255)

0 = off, 255 = full intensity. Intermediate values are intermediate intensities.

Digital Outputs Data Byte 1: Output Bits (0 – 7)

0 = low (0V); 1 = high (5V).

The digital outputs can provide up to 20 mA of current.

Bit	7	6	5	4	3	2	1	0
Output						digital output 2 (pin 20)	digital output 1 (pin 7)	digital output 0 (pin 19)

Low Side Drivers Data Byte 1: Output bits (0 – 7)

0 = off, 1 = on at 100% pwm duty cycle

Bit	7	6	5	4	3	2	1	0
Output						Low Side Driver 2	Low Side Driver 1	Low Side Driver 0

iRobot Create Open Interface Sensor Packets Quick Reference

Create sends back one of 43 different sensor data packets in response to a Sensors command, depending on the value of the packet ID data byte. Some packets contain groups of other packets. Group packets send their component values in sequential order. Some of the sensor data values are 16 bit values. These values are sent as two bytes, high byte first.

Group Packet Sizes and Contents

Group Packet ID	Packet Size	Contains Packets
0	26 bytes	7 - 26
1	10 bytes	7 - 16
2	6 bytes	17 - 20
3	10 bytes	21 - 26
4	14 bytes	27 - 34
5	12 bytes	35 - 42
6	52 bytes	7 - 42

Packet Membership					Name	Bytes	Value Range	Units	
			4		27	Wall Signal	2	0 - 4095	
					28	Cliff Left Signal	2	0 - 4095	
					29	Cliff Front Left Signal	2	0 - 4095	
					30	Cliff Front Right Signal	2	0 - 4095	
					31	Cliff Right Signal	2	0 - 4095	
					32	User Digital Inputs	1	0 - 31	
					33	User Analog Input	2	0 - 1023	
					34	Charging Sources Available	1	0 - 3	
			5		35	OI Mode	1	0 - 3	
					36	Song Number	1	0 - 15	
					37	Song Playing	1	0 - 1	
					38	Number of Stream Packets	1	0 - 42	
					39	Velocity	2	-500 - 500	mm/s
					40	Radius	2	-32768 - 32767	mm
					41	Right Velocity	2	-500 - 500	mm/s
					42	Left Velocity	2	-500 - 500	mm/s

Group Packet Sizes and Contents

Packet Membership						Name	Bytes	Value Range	Units	
0	1			6	7	Bumps and Wheel Drops	1	0 - 31		
					8	Wall	1	0 - 1		
					9	Cliff Left	1	0 - 1		
					10	Cliff Front Left	1	0 - 1		
					11	Cliff Front Right	1	0 - 1		
					12	Cliff Right	1	0 - 1		
					13	Virtual Wall	1	0 - 1		
					14	Overcurrents	1	0 - 31		
					15	Unused	1	0		
					16	Unused	1	0		
	2			3		17	IR Byte	1	0 - 255	
						18	Buttons	1	0 - 15	
						19	Distance	2	-32768 - 32767	mm
						20	Angle	2	-32768 - 32767	mm
						21	Charging State	1	0 - 5	
						22	Voltage	2	0 - 65535	mV
						23	Current	2	-32768 - 32767	mA
						24	Battery Temperature	1	-128 - 127	degrees Celsius
						25	Battery Charge	2	0 - 65535	mAh
						26	Battery Capacity	2	0 - 65535	mAh

Charging State Codes

Code	Charging State
0	Not charging
1	Reconditioning Charging
2	Full Charging
3	Trickle Charging
4	Waiting
5	Charging Fault Condition

Bumps and Wheel Drops

Bit	7	6	5	4	3	2	1	0
Sensor	n/a	n/a	n/a	Wheel-drop Caster	Wheel-drop Left	Wheel-drop Right	Bump Left	Bump Right

Low Side Driver and Wheel Overcurrents

Bit	7	6	5	4	3	2	1	0
Motor	n/a	n/a	n/a	Left Wheel	Right Wheel	Low Side Driver 2	Low Side Driver 0	Low Side Driver 1

Buttons

Bit	7	6	5	4	3	2	1	0
Button	n/a	n/a	n/a	n/a	n/a	Advance	n/a	Play

Cargo Bay Digital Inputs

Bit	7	6	5	4	3	2	1	0
Button	n/a	n/a	n/a	Baud Rate Change (pin 15)	Digital Input 3 (pin 6)	Digital Input 2 (pin 18)	Digital Input 1 (pin 5)	Digital Input 0 (pin 17)

Charging Sources Available

Bit	7	6	5	4	3	2	1	0
Charging Source	n/a	n/a	n/a	n/a	n/a	n/a	Home Base	Internal Charger

OI Mode

Number	Mode
0	Off
1	Passive
2	Safe
3	Full