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This document provides details for the DHB-10 Arlo Firmware v1.0, made for using the DHB-10 Dual H-Bridge 10 Amp Motor Controller with the Arlo Complete Robot System.

For tutorials using the Arlo Robot and DHB-10 with various Parallax microcontroller development boards, see http://learn.parallax.com/arlo. For details about the DHB-10 features and hardware, see the Downloads section of the 28231 product page at www.parallax.com.

Movement commands

The following commands move the motors attached to the DHB-10.

TURN

Turn in place, rotating by motor positions

Syntax	**TURN <Total Motor Movement> <Top Speed>**
Parameters	**Total motor movement**, split between both motors in positions from -32767 to 32767
	Top Speed in positions per second from 1 to 512
Details	The TURN command turns the Arlo robot in place, but instead of using degrees, the first parameter is the number of positions to move each wheel. The second parameter is the top speed for both motors. The wheelbase on an Arlo robot is about 15.5 inches, or the distance traveled over a motor rotation of 118.4 encoder positions. Multiplying that by pi gives 372 encoder positions traveled for each motor, when rotating the Arlo 360 degrees in place, so for every 372 encoder position units in the TURN command, the Arlo will rotate 360 degrees.
Example: Turn in place, with a total accumulated travel of 200 positions, split between both wheels, and a top speed of 50 positions per second	`TURN 200 50`

ARC

Travel along the arc of a circle of a given radius, with a given top speed, for a given number of degrees

Syntax	**ARC <Radius> <Top Speed> <Arc Angle>**
Parameters	**Radius** in positions from 1 to 32767
	Top Speed in positions per second from 1 to 32767
	Arc Angle in degrees from -32767 to 32767

Details	To circle around a point, along a predefined radius, use the ARC command. The first parameter sets the radius, with a negative number indicating a center to the left of the Arlo robot and a positive number indicating a center to the right of the robot. The second parameter sets the top speed of the fastest moving wheel, and the third parameter sets the number of degrees to travel around the center, with a positive number representing forward travel and a negative number representing travel in reverse. When using the ARC command with a radius of zero, the Arlo will rotate in place, clockwise for a positive number of degrees and counterclockwise for a negative number of degrees.

Example: Make a 180 degree turn with the outside wheel moving at a top speed of 40 positions per second, around a radius with a length of 50 positions.	**`ARC 50 40 180`**

GO

Set and hold the motor output power, independently for each motor.

Syntax	**GO <Left Wheel Power> <Right Wheel Power>**
Parameters	**Left Wheel Power** in 1/127th of total power from -127 to 127
	Right Wheel Power in 1/127th of total available power from -127 to 127
Details	The GO command has two parameters, separated by spaces. The first sets the power of the left motor and the second sets the power of the right motor. Power levels range from -127, for full reverse, to 127, for full forward, with 0 as no power. Forward movements turn the left motor counterclockwise as viewed from the side, and turn the right motor clockwise. As the battery drains, full power will decrease. At small motor powers, the motor may not be able to overcome static and dynamic friction, preventing it from moving until a higher power level is set. Setting the motors to dissimilar power levels will cause the Arlo robot to travel along an arc, and setting one motor to a positive value and the other to a negative of the same value, will cause the Arlo robot to turn in place.

Example: Set the left motor to a move forward at power level of 90/127, about 70% of full power, and set the right motor to move in reverse at a power level of negative 20, about 16% of full power	**`GO 90 -20`**

GOSPD

Accelerate and sustain a speed, independently for each motor.

Syntax	**GOSPD <Left Wheel Speed> <Right Wheel Speed>**
Parameters	**Left Wheel Speed** in positions Per Second from -32767 to 32767
	Right Wheel Speed in positions Per Second from -32767 to 32767
Details	The GOSPD command has two parameters, separated by spaces. The first sets the speed of the left motor and the second sets the speed of the right motor. The speeds are in encoder positions per second, and can be positive or negative. Positive movements turn the left motor counterclockwise as viewed from the side, and turn the right motor clockwise. The resolution is two positions per second, so odd numbers are rounded to even numbers. If streamed GOSPD commands, the DHB-10 will continuously adjust the motor power, to match the power level or motor speed in the most recent command. To stop the motors before they have reached their destination, issue a GOSPD command, and set the speeds to zero, and the motors will immediately decelerate and hold their positions.
Example: Set the left motor to a speed of 50 positions per second and set the right motor to a speed of 40 positions per second	**`GOSPD 50 40`**

MOVE

Accelerate, travel, and decelerate across a distance in positions, defined separately for each motor. Motors complete their travel at the same time, regardless of the differences in distance.

Syntax	**MOVE <Left Wheel Distance> <Right Wheel Distance> <Speed>**
Parameters	**Left Wheel Distance** in positions from -32767 to 32767
	Right Wheel Distance in positions from -32767 to 32767
	Speed in positions Per Second from 1 to 32767
Details	The MOVE command independently sets a distance for each motor to move. The first parameter sets the distance for the left motor and the second parameter sets the distance for the right motor. The third parameter sets the highest speed for the motor traveling the longer distance. The motor traveling the shorter distance will travel slower, so that both motors come to a stop at the same time.

Example: Move the left wheel forward, by 20 positions, and the right wheel in reverse, by 80 positions, at a top speed of 40 positions per second.	**MOVE 20 -60 40**

TRVL

Accelerate, travel, and decelerates across a predefined distance. Optionally follows an arc while travelling.

Syntax	**TRVL <Distance> <Top Speed> [Arc Angle]**
Parameters	**Distance** in positions from -32767 to 32767
	Top Speed in positions Per Second from 1 to 32767
	Arc Angle in Degrees from -32767 to 32767
Details	The TRVL command accepts two to three parameters. The first parameter sets the travel distance, and the second parameter sets the maximum speed. When issued a TRVL command without a third parameter, the DHB-10 will simultaneously accelerate both motors, then decelerate them to a stop, reaching the travel distance. The motors will stay at or below the maximum speed, between accelerating and decelerating. The optional third parameter specifies a rotation, in degrees. When used, the Arlo robot will follow the same distance, but it will turn the specified number of degrees while it is traveling. Increasing the number of degrees in the turn will decrease the radius. The fastest moving wheel, the one on the outside of the turn, will rotate at or below maximum speed, and the other wheel will rotate at a slower speed. When using the TRVL command with a distance of zero, the Arlo will rotate in place, clockwise for a positive number of degrees and counterclockwise for a negative number of degrees.
Example: Travel 200 positions, at a top speed of 80 positions per second Travel 250 positions, at a top speed of 80 positions per second, while turning 45 degrees	**TRVL 200 80** **TRVL 250 80 45**

Information Requests

The following commands request information gathered from the encoders, or from the DHB-10 itself.

SPD

Report Current Motor Speeds

Syntax	**SPD**	
Response, in positions Per Second	**Left Motor Speed**	**Right Motor Speed**
Details	To detect when a movement has finished, issue the SPD command. It will return two parameters, first the left motor speed, and second the right motor speed. The speeds are in encoder positions per second and are averaged over the previous half second. When the speeds are both zero, the Arlo robot has completed the latest command.	
Example: Request current motor speeds		**SPD** **20 -50**

HEAD

Report Current Heading

Syntax	**HEAD**	
Response, in Degrees	**Heading**	
Details	To read the angle the Arlo robot has rotated to, issue the HEAD command, which returns an angle, in degrees. At startup the angle is zero, and after rotating a full 360 degrees, the angle will restart at zero.	
Example: Request current heading		**HEAD** **320**

DIST

Report Accumulative Distance Each Motor has Traveled

Syntax	**DIST**	
Response, in positions Per Second	**Left Motor Distance**	**Right Motor Distance**

Details	To read the accumulated number of positions each motor has traveled, issue the DIST command, which returns two parameters: first the left motor distance, and second the right motor distance. Traveling in reverse subtracts from the distance and traveling forward adds to the distance.
Example: Request accumulated distance of each wheel	**DIST** **1230 1520**

RST

Reset Wheel Travel Distance to Zero

Syntax	**RST**
Details	To reset the distance for each motor and angle of rotation to zero, issue the RST command.
Example: Reset accumulated distance for each wheel to zero	**RST**

HWVER

Return the hardware version of the DHB-10

Syntax	**HWVER**
Response	**Hardware Version**
Details	The hardware version is stored in the EEPROM, built into the DHB-10, in a location where updating firmware or loading custom firmware does not modify the hardware version.
Example: Request hardware version	**HWVER** **1**

VER

Return the version of the firmware currently loaded onto the DHB-10.

Syntax	**VER**
Response	**Firmware Version**
Details:	The firmware version is stored with the firmware and changes when a new version of the firmware is loaded into the DHB-10.

Example: Request firmware version	**VER** **1**

Communication Modes

The following commands modify the communication protocol for the DHB-10

PULSE

Enable PWM mode

Syntax	**PULSE**
Details	To disable command mode and return to pulse-driven inputs, issue the PULSE command. Any further communications will disable pulse-driven inputs and return to command mode.
Example: Return to pulse input mode	**PULSE**

SETLF

Add Line Feeds to Terminal Response

Syntax	**SETLF <Mode>**
Parameter	**Mode** can be either 1, ON, 0, or OFF
Default	OFF
Details	To add a line feed to the carriage return acknowledging each command, issue the SETLF ON command
Example: Disable linefeeds in command acknowledgement	**SETLF OFF**

DEC

Set Input and Output Base to Decimal

Syntax	**DEC**
Details	To return to base ten communications, after enabling hexadecimal communications, issue the DEC command.
Example: Set Input and Output Base to Decimal	**DEC**

HEX

Set Input and Output Base to Hexadecimal

Syntax	**HEX**
Details	When communicating in a hexadecimal base, the most significant bit is used as the sign.
Example: Set Input and Output Base to Hexadecimal	**HEX**

ECHO

Enable Terminal Echo

Syntax	**ECHO <Mode>**
Parameter	**Mode** can be either 1, ON, 0, or OFF
Default	OFF
Details	When echo is enabled, the DHB-10 echos back a retransmission of each character, immediately after it receives it.
Example: Enable echo	**ECHO ON**

VERB

Set Verbose Mode

Syntax	**VERB <Mode>**
Parameter	**Mode** can be either 1, ON, 0, or OFF
Default	ON
Details	When verbose mode is on, erroneous commands return descriptive text in addition to an error number and the command acknowledgement. When verbose mode is off, erroneous commands return an error number and an acknowledgement, without descriptive text.
Example: Enable verbose mode	**VERB 1**

RXPIN

Set and Switch Terminal Receive Pin

Syntax	**RXPIN <Receive Pin>**
Parameter	**Receive Pin** can be either CH1, CH2, or PROG
Default	CH1
Details:	The DHB-10 can communicate on the CH1 pin, the CH2 pin, or the Prop Plug port. Uses the RXPIN command, to set which pin to receive on.
Example: Set the receive pin to channel 1	`RXPIN CH1`

TXPIN

Set and Switch Terminal Transmit Pin

Syntax	**TXPIN <Transmit Pin>**
Parameter	**Transmit Pin** can be either CH1, CH2, or PROG
Default	CH1
Details	The DHB-10 can communicate on the CH1 pin, the CH2 pin, or the Prop Plug port. Use the TXPIN command to set which pin to transmit on. For applications that require separate pins to transmit and receive, send a TXPIN command with a parameter of CH2, and the DHB-10 motor driver will respond on the CH2 pin instead of the CH1 pin.
Example: Set the transmit pin to channel 2	`TXPIN CH2`

BAUD

Set and Switch Terminal Baud Rate

Syntax	**BAUD <Baud Rate>**
Parameter	**Baud Rate** in baud from 19200 to 115200
Default	19200

Details	To increase communications speed over the default 19200 baud rate, send a BAUD command, followed by the baud rate, from 19200 to 115200, to set the DHB-10 motor driver to transmit and receiver at the new baud rate.
Example: Set the baud rate to 57600	**BAUD 57600**

SCALE

Set PWM Pulse to Motor Power Ratio

Syntax	**SCALE <Full-power deviation>**
Parameter	**Full-power deviation** in microseconds from 100 to 1000
Default	500
Details	Use the SCALE command, followed by a number of microseconds, to set the pulse-width deviation to motor power ratio, when running in pulse mode. The default scale is 500 microseconds deviation, from a fixed center pulse of 1,500 microseconds.
Example: Set the full-scale pulse width to 1400 to 1600 microseconds; a range of a center pulse minus 100 microseconds to a center pulse plus 100 microseconds.	**SCALE 100**

PACE

Set Pacing Between Characters in Transmissions

Syntax	**PACE <Time>**
Parameter	**Time** between the start of each character transmission, in milliseconds, from 2 to 250
Default	0
Details	The DHB-10 motor driver does not accept baud rates below 19.2 kilobaud, but for slower microcontrollers, it does allow sending characters at a rate slower than the maximum that the baud rate allows. To set a slower transmission rate, use the PACE command, with a parameter setting the time in milliseconds, between the start of each character transmission.
Example: Set data transmission pacing to 100 ms per character	**PACE 100**

HOLD

Set Time to Power Motors after a Pulse in PWM mode

Syntax	**HOLD <Hold Time>**
Parameter	**Hold Time** in milliseconds from 0, 20 to 30000
Default	250
Details	When in pulse mode, the DHB-10 drives the motors for a set time period after each pulse. To adjust the time period, issue the HOLD command, followed by the number of milliseconds to run the motors after each pulse. Use a time of zero to continuously run the motors from a single pulse.
Example: Set response character rate to 200 ms per character	**HOLD 200**

Closed-loop Constants

The following commands modify constants for closed-loop motor control.

⚠ **WARNING**: Modifying these constants may cause unexpected behavior, including unstable and unpredictable motor movement

KIP

Set Ki Limit by Motor Power

Syntax	**KIP <Ki Limit by Power Factor>**
Parameter	**Ki Limit by Power Factor** from 0 to 32767
Default	512
Details	The KIP command sets the a rate of decay of the maximum effect of the closed-loop proportional component, as the motor power increases. The decay begins after the live-zone set by the LZ command.
Example: Set closed-loop Ki accumulator to dampen as power increases, with a setting of 60	**KIP 60**

KIT

Set Ki Decay

Syntax	**KIT <Ki Decay Factor>**	
Parameter	**Ki Decay Factor** in percent decay per 20 ms period from 0 to 32767	
Default	65	
Details	The KIT command sets the rate of decay of the integral component used in closed-loop motor control.	
Example: Set closed-loop Ki accumulator decay rate to a setting of 50		**KIT 50**

KIMAX

Set Maximum Ki Accumulation Value

Syntax	**KIMAX <Ki Accumulator Limit>**	
Parameter	**Ki Accumulator Limit** in percent of full motor power from 0 to 100	
Default	10	
Details	The KIMAX command sets the MAXIMUM effect of the integral component used in closed-loop motor control.	
Example: Set closed-loop Ki accumulator maximum to 75%		**KIMAX 75**

KI

Set Ki Constant

Syntax	**KI <Ki Constant>**	
Parameter	**Ki Constant** from 0 to 32767	
Default	65	
Details	The KI command sets the integral component used in closed-loop motor control.	
Example: Set closed-loop Kp constant to 85		**KI 85**

KP

Set Kp Constant

Syntax	**KP <Kp Constant>**
Parameter	**Kp Constant** from 1 to 32767
Default	100
Details	The KP command sets the proportional component used in closed-loop motor control.
Example: Set closed-loop Ki constant to 50	**KP 50**

ACC

Set Acceleration Rate

Syntax	**ACC <Acceleration rate>**
Parameter	**Acceleration rate** in positions per second per second from 1 to 32767
Default	512
Details	The ACC command sets the maximum rate at which the motor position controller attempts to accelerate the motors. The resolution is nonlinear, so high values are rounded to the closest available value.
Example: Set acceleration rate to 500 positions per second per second	**ACC 500**

RAMP

Set Motor Power Ramping Rate

Syntax	**RAMP <Ramp rate>**
Parameter	**Ramp rate** from 20 to 32767
Default	320
Details	The RAMP command sets the maximum rate at which the motor power can increase. The resolution is nonlinear, so high values are rounded to the closest available value.

Example: Set the power ramp rate to 80	**RAMP 80**

LZ

Set Ki Limit by Motor Power Live Zone

Syntax	**LZ <Ki Limit by Power Live Zone>**
Parameter	**Ki Limit by Power Live Zone** in positions from 0 to 255
Default	8
Details	The LZ command, followed by a number of positions, sets a number of positions from the set point for which Kp will have full effect on the control system.
Example: Set closed-loop Ki accumulator to not dampen until power increases beyond a setting of 10	**LZ 10**

DZ

Set Ki and Kp Dead Zone

Syntax	**DZ <Ki and Kp Dead Zone>**
Parameter	**Ki and Kp Dead Zone** in positions from 0 to 32767
Default	1
Details	The DZ command, followed by a number of positions, sets the deadzone, which is the number of positions that the wheels can freely rotate, without the motor rotating.
Example: Set a +/- two-position dead zone	**DZ 2**

PPR

Set Motor Positions Per Robot Rotation

Syntax	**PPR <Total Distance>**
Parameter	**Total Distance** each individual wheel accumulates during a 360 degrees turn in place in positions from 1 to 32767

Default	744
Details	Use the PPR command to set the total number of positions to move a wheel to rotate Arlo robot in place. The wheelbase on an Arlo robot is about 15.5 inches, equivalent to the distance one wheel travels over a motor rotation of 118.4 encoder positions. Multiplying that by pi gives 372 encoder positions traveled for each motor, for a total of 744, when rotating the Arlo 360 degrees in place.
Example: Configure DHB-10 to control a robot with a 280 position movement for a 360° rotation	**`PPR 280`**