Worcester Polytechnic Institute

Robotics Engineering Department

Collective Transport Major Qualifying Project

Custom Khepera Gripper User Guide

Created by:
Yasmine Aoua
Chandler Garcia
Julian Poindexter
Zachary Rivernider
William Stanley

April 27, 2023

Contents

1 Introduction

This is a basic user guide to help the user operate the custom gripper. Upon review of this document, readers will be able to:

1. Connect the gripper to the Khepera IV
2. Identify all of the features provided in the gripper
3. Write to the internal registers through I2C
4. Read from the internal registers through I2C
5. Understand how to functionally implement the features of the gripper

2 Gripper Assembly

1. Attach the 4 spacers to the Khepera IV robot, as shown in Figure 1. Note that some of the Kheperas do not have the best terminals. If the specific attachment is being difficult to screw into the Khepera then skip it. Also note that the connection only needs to be finger tight.

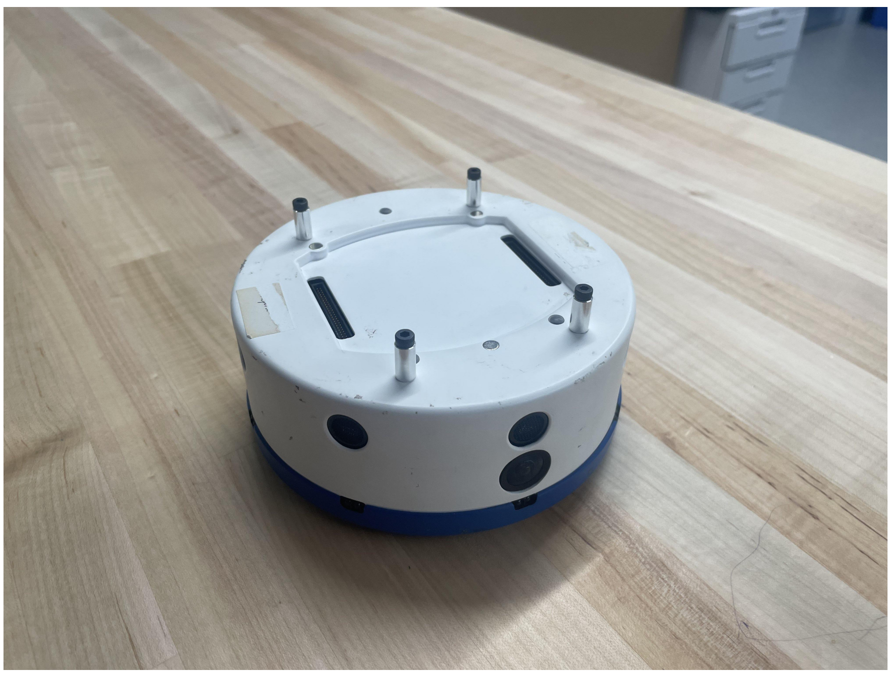

Figure 1: Khepera IV robot with proper spacers.

2. Line up the robot front symbol on the bottom of the PCB, as shown in Figure 2, to point towards the camera on the Khepera IV.

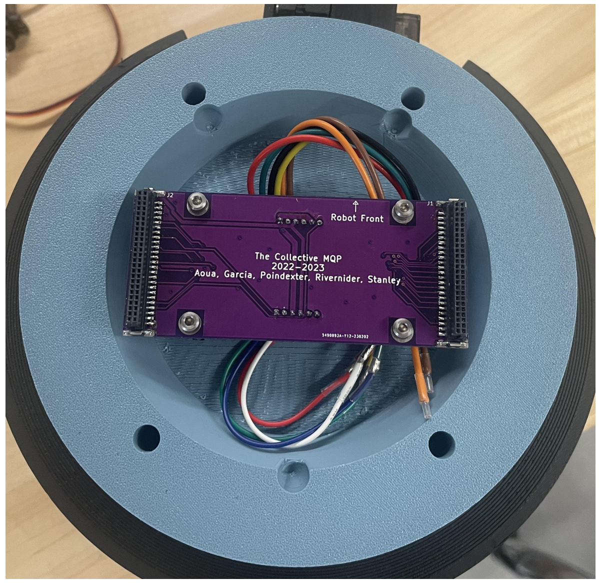

Figure 2: Front indicator mark on the custom PCB

3. Carefully place the gripper assembly on the Khepera IV so that the connectors are meshed together. A complete image of the assembly can be found in Figure 3.

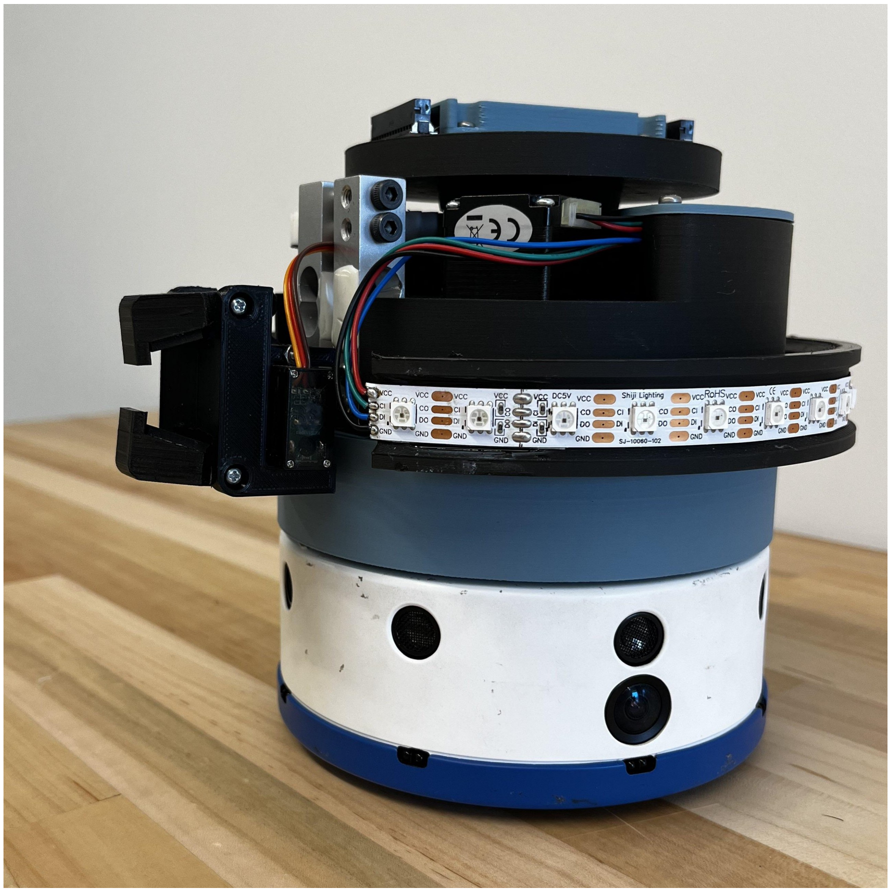

Figure 3: Full assembly of the custom gripper on the Khepera IV

3 Writing Registers

Writing to the registers from the Khepera is done through I2C with 7 bit addresses. The address for the gripper is **0x35**. All I2C transactions are accomplished in 16 bit registers and 8 bit addresses. The sequence of events to write a registers are as follows:

1. Begin transmission by sending the 7 bit address
2. Write the address for the desired register
3. Write the MSB of the data to be sent
4. Write the LSB of the data to be sent

There is no functionality for batch / sequence writes meaning all register changes must be done by addressing each register. A waveform diagram of writing a register can be found in Figure 4.

Figure 4: Waveform diagram for writing a register

4 Reading Registers

Reading from the registers to the Khepera is done through I2C with 7 bit addresses. The address for the gripper is **0x35**. All I2C transactions are accomplished in 16 bit registers and 8 bit addresses. The sequence of events to read from a registers are as follows:

1. Begin transmission by sending the 7 bit address
2. Write the address for the desired register
3. Restart transmission by sending the 7 bit address
4. Read two bytes from the gripper. The first byte returned will be the MSB of the register.

There is no functionality for batch / sequence reads meaning all register reads must be done by addressing each register. A waveform diagram of reading a register can be found in Figure 5.

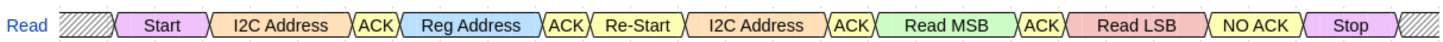

Figure 5: Waveform diagram for reading a register

5 Turret Registers

5.1 Desired turret position (0x0)

Description: This register holds the desired position for the turret. The value of this register only applies when the turret state is in position mode. The turret state is set through the register Turret State.

Register Address 0x0

Bit	Name	Description
15:0	Desired Position	Set the desired position for the turret. Input is on the scale of [0, 44,690] where 0 is 0 °and 44,690 is 359 °. Register Turret State must be set in position mode (mode 1).

5.2 Current Speed of the turret (0x2)

Description: This register has two functions dependent on the current turret state. It will either turn the gripper at a constant speed or relay the current speed of the module itself. The turret state is dependent on the Turret State register. See Section 5.8 to see the different turret modes.

1. When the turret state is in position mode this register is read only and shows the current speed setting that is being sent to the motor.
2. When the turret state is in speed mode, this register controls the speed that the turret is moving.

This value is a signed integer following two's complement.

Register Address 0x2

Bit	Name	Description
15:0	Current Speed of the Turret	This register has two modes dependent on the Turret State setting. Position Mode (Mode 1): This register becomes read only and outputs the current speed that is being sent to the stepper motor. Speed Mode (Mode 2): The stepper motor is set to move at the speed indicated in this register.

5.3 Max Speed of the Turret (0x3)

Description: This register limits the max speed that the turret can move. The unit for speed for this module is in Hz. It is the input frequency to the stepper module. This not the only speed limitation on the module. Within the firmware is an absolute max speed restriction that prevents the system from damaging itself. This max speed is limited to be 17,000 Hz.

Register Address 0x3

Bit	Name	Description
15:0	Max Speed of the Turret	Set the max speed of the turret. This is a system level limitation, the gripper is equipped with its own internal absolute speed limitation. The largest speed that can be inputted into the system is 17,000 Hz.

5.4 Max Control Tolerance (0x4)

Description: This register set the tolerance for the PID loop. The scale of the input is 124 bits per degree meaning a value of 124 would constitute a resolution of +/- 1 degree. This tolerance determines when the PID loop is within an acceptable range. To limit the power consumption of the module, there is hysteresis added to the PID control loop. The gripper will go to the desired point set in register 0x0 and then disable the motor entirely. Once the gripper is detected to exceed the tolerance bands it will then enable the PID to set the gripper back at the desired point (hysteresis).

Register Address 0x4

Bit	Name	Description
15:0	Tolerance of the Control Algorithm	The tolerance for the PID controller. The units for this register is based on the scale of the absolute encoder. This makes the input to be 124 bits per degree. In other words an input of 124 creates a tolerance of +/- 1 degree.

5.5 Turret Proportional Constant (0x5)

Description: This register is the fixed point notation for the proportional constant of the PID algorithm. This value is held as a Q12 value meaning the MSB has a weight of 2^3. To convert from decimal to floating point, multiply the decimal by 2^{12}.

Register Address 0x5

Bit	Name	Description
15:0	Proportional gain for the turret controller	This is a 16 bit Q12 value. To maximize the response of the system, all computations for the controller is fixed point. In this datatype the MSB has a weight of 2^3 and the LSB has a weight of 2^{-12}. To convert to decimal, divide the input of this register by 2^{12}.

5.6 Turret Integral Constant (0x6)

Description: This register is the fixed point notation for the integral constant of the PID algorithm. This value is held as a Q12 value meaning the MSB has a weight of 2^3. To convert from decimal to floating point, multiply the decimal by 2^{12}.

Register Address 0x6

Bit	Name	Description
15:0	Integral gain for the turret controller	This is a 16 bit Q12 value. To maximize the response of the system, all computations for the controller is fixed point. In this datatype the MSB has a weight of 2^3 and the LSB has a weight of 2^{-12}. To convert to decimal, divide the input of this register by 2^{12}.

5.7 Turret Derivative Constant (0x7)

Description: This register is the fixed point notation for the derivative constant of the PID algorithm. This value is held as a Q12 value meaning the MSB has a weight of 2^3. To convert from decimal to floating point, multiply the decimal by 2^{12}.

Register Address 0x7

Bit	Name	Description
15:0	Derivative gain for the turret controller	This is a 16 bit Q12 value. To maximize the response of the system, all computations for the controller is fixed point. In this datatype the MSB has a weight of 2^3 and the LSB has a weight of 2^{-12}. To convert to decimal, divide the input of this register by 2^{12}.

5.8 Turret State (0x8)

Description: This register holds the current state of the turret. There are 5 different modes that the turret can operate in to make it versatile for any application.

Register Address 0x8

Bit	Name	Description
15:3	Reserved	Controlled internally
2:0	State of the Turret	There are 5 states that the turret can be in. The value of this register corresponds to the mode number: 1. Mode 0: Back-drive-able - Disables the stepper motor and allows the turret to move freely. 2. Mode 1: Position - Go to a set position with PID based on the Desired Turret Position register. 3. Mode 2: Speed - Move the turret at a constant speed established in the Current Speed of the Turret Register 4. Mode 3: Hold - Locks the stepper motor to hinder its movement. Does not use PID to readjust orientation. Can be moved with enough force. 5. Mode 4: Push - Locks the stepper motor to hinder its movement. The motor is then controlled proportionally to the amount of force tangential to the module. A pushing movement on the gripper will turn the robot normally, but any turning forces on the ring will not cause the module to rotate.

5.9 Push Mode Proportional Constant (0x20)

Description: This register is the fixed point notation for the proportional constant of the Push feature. This value is held as a Q12 value meaning the MSB has a weight of 2^3. To convert from decimal to floating point, multiply the decimal by 2^{12}.

Register Address 0x20

Bit	Name	Description
15:0	Proportional gain for the Push mode of the turret	This is a 16 bit Q12 value. To maximize the response of the system, all computations for the controller is fixed point. In this datatype the MSB has a weight of 2^3 and the LSB has a weight of 2^{-12}. To convert to decimal, divide the input of this register by 2^{12}.

6 Absolute Position Registers

6.1 Raw Encoder Output (0x1)

Description: This register is read-only and displays the raw encoder output from the AS5600. This sensor outputs a PWM waveform where the pulse width is counted by the Pi-Pico. The minimum and maximum values for this sensor were found to be 1312 and 46002 respectively. The position of 1312 or the "0 position" is arbitrary and is whatever is perceived as 0 from the encoder. It can be changed manually by disassembling the module, but that is not recommended. See Section 6.4 for how to read a position in degrees with a heading that can be changed.

Register Address 0x1

Bit	Name	Description
15:0	Raw Encoder Output	Direct reading from the encoder sensors without any modifications. This value is on the scale of [1312, 46002] and translates to [0, 359] degrees. This a read only register.

6.2 Encoder Trim (0x1C)

Description: This register holds the trim value for the encoder. The system is designed to have an arbitrary zero location that is settable through this register. The value for this register must be within the ranges of [1312, 46002] which is the range of the raw encoder output. Where this value is set represents the zero location.

Register Address 0x1C

Bit	Name	Description
15:0	Encoder Trim	The position from the encoder, which is on the scale of [1312, 46002], that sets the 0 degree position of the gripper. This value must be set within the encoder range to not set an unrealistic position. .

6.3 Auto-Set Encoder Trim (0x1D)

Description: This register allows the user to auto-set the zero location that is placed in the Encoder Trim register. The user only needs to write 0x1 to this register and the current position becomes the 0 point location. The firmware is set to auto-reset the value back to 0. The flow of events to utilize this feature are:

1. Move the turret to the desired location
2. Write a value of 1 to this register

Register Address 0x1D

Bit	Name	Description
15:1	Reserved	Controlled internally
0	Auto-Set Encoder Trim	Automatically sets the 0 °point of the robot based on its current position. A value of 1 will set the current robot position as 0 °and is programmed to reset back to 0.

6.4 Encoder Position (0x1E)

Description: This register holds the calculated output of the encoder from the scale of [0, 44,690]. 0 represents 0 °and 44,690 represents 360 °. To convert from this output to degrees, multiply the result by $\frac{360}{44{,}690}$. For a more precise measurement, the angle can be expressed as

Register Address 0x1E

Bit	Name	Description
15:0	Encoder Position	The position from the encoder, which is on the scale of [0, 44,690] with the encoder trim. To convert from this value to degrees, multiply the output by $\frac{360}{44{,}690}$.

7 EEPROM Registers

7.1 Write EEPROM (0x1B)

Description: This register overwrites the EEPROM with all of the current register values. The register is set with a value of 1 and programmed to reset back to 0. During the writing process of the EEPROM, the robot will not be able to perform any other functions. A blue LED diagnostics illuminates while the EEPROM is being written. There is no need to ever read from the EEPROM, that is performed during initialization process.

Register Address 0x1B

Bit	**Name**	**Description**
15:1	Reserved	Controlled internally
0	Write EEPROM	Register to overwrite the EEPROM with all of the current register values. This register is set with a value of 1 and programmed to auto-reset back to 0.

8 Ring LED Registers

8.1 LED Brightness (0xD)

Description: This register sets the brightness of the LED's. LED's are a large source of power consumption, it is recommended to lower the brightness in order to conserve battery life. Note: The LED's do not update in color until the values are flushed.

Register Address 0xD

Bit	Name	Description
15:5	Reserved	Controlled internally
4:0	LED Brightness	Set the LED brightness. 0x0 turns off the LED's and 0x1F is the brightest setting.

8.2 LED Presets

Description: This sequence of registers hold preset colors for the individual addressable LED's. Since it would be tedious to change 24 bits per each of the 27 LED's, the system is established with 4 preset colors to make the system easier to control. This register holds the red and green concentrations for preset 0. It is recommended that preset 0 is kept as zeroes so that the LED's can be turned off. One possible suggestion for the distribution of colors are:

1. Preset 0: LED's off (All RGB values equal 0)
2. Preset 1: Red
3. Preset 2: Green
4. Preset 3: Blue

Note: The LED's do not update in color until the values are flushed.

8.2.1 LED Preset 0 Red and Green (0xE)

Register Address 0xE

Bit	Name	Description
15:8	Green Value for Preset 0	The color preset registers hold the 8 bit RGB values for the LED ring. These 8 bits represent the green concentration for preset 0.
7:0	Red Value for Preset 0	The color preset registers hold the 8 bit RGB values for the LED ring. These 8 bits represent the red concentration for preset 0.

8.2.2 LED Preset 0 Blue (0xF)

Register Address 0xF

Bit	Name	Description
15:8	Reserved	Controlled internally
7:0	Blue Value for Preset 0	The color preset registers hold the 8 bit RGB values for the LED ring. These 8 bits represent the blue concentration for preset 0.

8.2.3 LED Preset 1 Red and Green (0x10)

Register Address 0x10

Bit	Name	Description
15:8	Green Value for Preset 1	The color preset registers hold the 8 bit RGB values for the LED ring. These 8 bits represent the green concentration for preset 1.
7:0	Red Value for Preset 1	The color preset registers hold the 8 bit RGB values for the LED ring. These 8 bits represent the red concentration for preset 1.

8.2.4 LED Preset 1 Blue (0x11)

Register Address 0x11

Bit	Name	Description
15:8	Reserved	Controlled internally
7:0	Blue Value for Preset 1	The color preset registers hold the 8 bit RGB values for the LED ring. These 8 bits represent the blue concentration for preset 1.

8.2.5 LED Preset 2 Red and Green (0x12)

Register Address 0x12

Bit	Name	Description
15:8	Green Value for Preset 2	The color preset registers hold the 8 bit RGB values for the LED ring. These 8 bits represent the green concentration for preset 0.
7:0	Red Value for Preset 2	The color preset registers hold the 8 bit RGB values for the LED ring. These 8 bits represent the red concentration for preset 2.

8.2.6 LED Preset 2 Blue (0x13)

Register Address 0x13

Bit	Name	Description
15:8	Reserved	Controlled internally
7:0	Blue Value for Preset 2	The color preset registers hold the 8 bit RGB values for the LED ring. These 8 bits represent the blue concentration for preset 2.

8.2.7 LED Preset 3 Red and Green (0x14)

Register Address 0x14

Bit	Name	Description
15:8	Green Value for Preset 3	The color preset registers hold the 8 bit RGB values for the LED ring. These 8 bits represent the green concentration for preset 3.
7:0	Red Value for Preset 3	The color preset registers hold the 8 bit RGB values for the LED ring. These 8 bits represent the red concentration for preset 3.

8.2.8 LED Preset 3 Blue (0x15)

Register Address 0x15

Bit	Name	Description
15:8	Reserved	Controlled internally
7:0	Blue Value for Preset 3	The color preset registers hold the 8 bit RGB values for the LED ring. These 8 bits represent the blue concentration for preset 3.

8.3 Set LED Colors

8.3.1 LED 7-0 Colors (0x16)

Description: This sequence of registers control the individual addressable LED's. Each LED has 2 bits and 4 different combinations:

1. Value of 0: Sets the corresponding LED to preset 0
2. Value of 1: Sets the corresponding LED to preset 1
3. Value of 2: Sets the corresponding LED to preset 2
4. Value of 3: Sets the corresponding LED to preset 3

Note: The LED's do not update in color until the values are flushed.

Register Address 0x16

Bit	Name	Description
15:14	LED 7 Color	Sets LED 7 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.
13:12	LED 6 Color	Sets LED 6 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.
11:10	LED 5 Color	Sets LED 5 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.
9:8	LED 4 Color	Sets LED 4 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.
7:6	LED 3 Color	Sets LED 3 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.
5:4	LED 2 Color	Sets LED 2 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.
3:2	LED 1 Color	Sets LED 1 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.
1:0	LED 0 Color	Sets LED 0 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.

8.3.2 LED 15-8 Colors (0x17)

Description: This sequence of registers control the individual addressable LED's. Each LED has 2 bits and 4 different combinations:

1. Value of 0: Sets the corresponding LED to preset 0
2. Value of 1: Sets the corresponding LED to preset 1
3. Value of 2: Sets the corresponding LED to preset 2
4. Value of 3: Sets the corresponding LED to preset 3

Note: The LED's do not update in color until the values are flushed.

Register Address 0x17

Bit	Name	Description
15:14	LED 15 Color	Sets LED 15 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.
13:12	LED 14 Color	Sets LED 14 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.
11:10	LED 13 Color	Sets LED 13 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.
9:8	LED 12 Color	Sets LED 12 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.
7:6	LED 11 Color	Sets LED 11 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.
5:4	LED 10 Color	Sets LED 10 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.
3:2	LED 9 Color	Sets LED 9 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.
1:0	LED 8 Color	Sets LED 8 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.

8.3.3 LED 23-16 Colors (0x18)

Description: This sequence of registers control the individual addressable LED's. Each LED has 2 bits and 4 different combinations:

1. Value of 0: Sets the corresponding LED to preset 0

2. Value of 1: Sets the corresponding LED to preset 1
3. Value of 2: Sets the corresponding LED to preset 2
4. Value of 3: Sets the corresponding LED to preset 3

Note: The LED's do not update in color until the values are flushed.

Register Address 0x18

Bit	Name	Description
15:14	LED 23 Color	Sets LED 23 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.
13:12	LED 22 Color	Sets LED 22 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.
11:10	LED 21 Color	Sets LED 21 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.
9:8	LED 20 Color	Sets LED 20 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.
7:6	LED 19 Color	Sets LED 19 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.
5:4	LED 18 Color	Sets LED 18 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.
3:2	LED 17 Color	Sets LED 17 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.
1:0	LED 16 Color	Sets LED 16 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.

8.3.4 LED 26-24 Colors (0x19)

Description: This sequence of registers control the individual addressable LED's. Each LED has 2 bits and 4 different combinations:

1. Value of 0: Sets the corresponding LED to preset 0
2. Value of 1: Sets the corresponding LED to preset 1
3. Value of 2: Sets the corresponding LED to preset 2
4. Value of 3: Sets the corresponding LED to preset 3

Note: The LED's do not update in color until the values are flushed.

Register Address 0x19

Bit	Name	Description
15:6	Reserved	Controlled internally.
5:4	LED 26 Color	Sets LED 26 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.
3:2	LED 25 Color	Sets LED 25 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.
1:0	LED 24 Color	Sets LED 24 to one of the color presets indicated in the registers. A value of 0 would represent color preset 0.

8.4 LED Flush (0x1A)

Description: This register flushes the internal register values to the LED's. Writing this register to 1 causes the LED's to update and will auto-reset back to 0.

Register Address 0x1A

Bit	Name	Description
15:1	Reserved	Controlled internally
0	LED Flush	Register to flush the contents of the LED registers to the LED's. A value of 1 will set the LED's. This register is programmed to auto-reset back to 0.

9 Force Sensor Registers

9.1 Parallel Force Sensor (0xB)

Description: This register holds the most recent force sensor measurement parallel to the gripper. The contents of this register is centered around 2048 (the mid-point of the 12 bit ADC) so that anything less than 2048 represents a negative force and anything over represents a positive force. This value also accounts for the calibration sequence of the ADC to maintain accurate and consistent readings. The calibration sequence always runs on start-up, but can be triggered in the Calibrate Calibrate Force Sensors register. This procedure throws away 100 values and then averages the next 400 samples. This offset is then subtracted from the raw ADC result to normalize the value to 0 and then translated by 2048. The resolution of this sensor is 2.92496 grams per bit.

Register Address 0xB

Bit	Name	Description
15:13	Reserved	Controlled internally
12:0	Parallel Force Sensor	Calibrated ADC result of the force sensor. A value of 2048 can be seen as no load on the sensor and every bit offset from this median grows at a rate of 2.92496 grams per bit.

9.2 Perpendicular Force Sensor (0xC)

Description: This register holds the most recent force sensor measurement perpendicular to the gripper. The contents of this register is centered around 2048 (the mid-point of the 12 bit ADC) so that anything less than 2048 represents a negative force and anything over represents a positive force. This value also accounts for the calibration sequence of the ADC to maintain accurate and consistent readings. The calibration sequence always runs on start-up, but can be triggered in the Calibrate Force Sensors register. This procedure throws away 100 values and then averages the next 400 samples. This offset is then subtracted from the raw ADC result to normalize the value to 0 and then translated by 2048. The resolution of this sensor is 2.92496 grams per bit.

Register Address 0xC

Bit	Name	Description
15:13	Reserved	Controlled internally
12:0	Perpendicular Force Sensor	Calibrated ADC result of the force sensor. A value of 2048 can be seen as no load on the sensor and every bit offset from this median grows at a rate of 2.92496 grams per bit.

9.3 Calibrate Force Sensors (0x1F)

Description: This register allows the user to calibrate the force sensors at anytime. This method throws away 100 values and then averages the next 400 samples. A value of 1 will begin the calibration procedure and will auto-reset back to 0 once complete. Since this procedure normalizes the forces that currently exist on the gripper, it is advised to remove all load from the robot and leave the robot undisturbed while it is calibrating. The blue feedback LED also illuminates during this initialization process.

Register Address 0x1F

Bit	Name	Description
15:1	Reserved	Controlled internally
0	Calibrate Force Sensors	Calibrate the Force Sensors calibration sequence. This method throws away 100 values and then averages the next 400 samples. A value of 1 will begin the calibration procedure and will auto-reset back to 0 once complete.

9.4 Filtered Parallel Force Sensor (0x22)

Description: This register holds the most recent filtered force sensor measurement parallel to the gripper. The contents of this register have the same format as the unfiltered values. The filter implemented is an average filters the averages the four most recent values. Four samples was an arbitrary amount chosen because it can be calculated by bit-shifting and will have less of a latency then 8.

Register Address 0x22

Bit	Name	Description
15:13	Reserved	Controlled internally
12:0	Parallel Force Sensor	Filtered ADC result of the force sensor. A value of 2048 can be seen as no load on the sensor and every bit offset from this median grows at a rate of 2.92496 grams per bit.

9.5 Filtered Perpendicular Force Sensor (0x23)

Description: This register holds the most recent filtered force sensor measurement perpendicular to the gripper. The contents of this register have the same format as the unfiltered values. The filter implemented is an average filters the averages the four most recent values. Four samples was an arbitrary amount chosen because it can be calculated by bit-shifting and will have less of a latency then 8.

Register Address 0x23

Bit	Name	Description
15:13	Reserved	Controlled internally
12:0	Perpendicular Force Sensor	Filtered ADC result of the force sensor. A value of 2048 can be seen as no load on the sensor and every bit offset from this median grows at a rate of 2.92496 grams per bit.

10 Gripper Registers

10.1 Gripper Position (0x9)

Description: This register sets the position of the gripper. To make operation easier, the gripper is controlled in two states: open and closed. A written value of 1 will cause the gripper to be open and a value of 0 will close it. The servo positions that represent open and closed are set in the Gripper Presets Register.

Register Address 0x9

Bit	Name	Description
15:1	Reserved	Controlled internally
0	Gripper Position	Boolean value for the current state of the gripper: 1. 0 Represents closed 2. 1 Represents open The position for an open and closed gripper is set in register Gripper Presets.

10.2 Gripper Presets (0xA)

Description: This register contains the gripper presets that represent an open and closed gripper. The input value is in degrees.

Register Address 0xA

Bit	Name	Description
15:8	Open Gripper Preset	Gripper position in degrees for the mechanism to be considered open.
7:0	Closed Gripper Preset	Gripper position in degrees for the mechanism to be considered closed.