



# USB Control and Configuration

## Products:

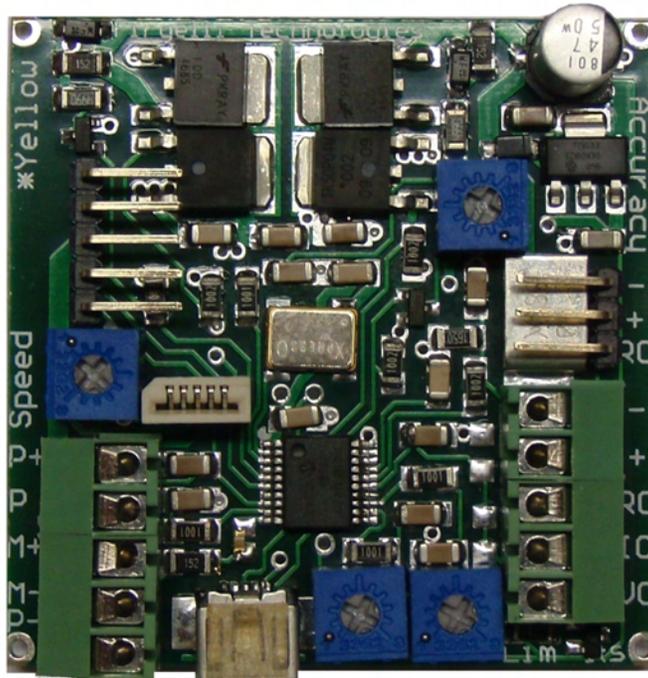
LAC

L12-SS-GG-VV-P

L16-SS-GG-VV-P

PQ12-SS-GG-VV-P

This note provides further information regarding the Linear Actuator Control board, with the intent to allow custom computer control and configuration.



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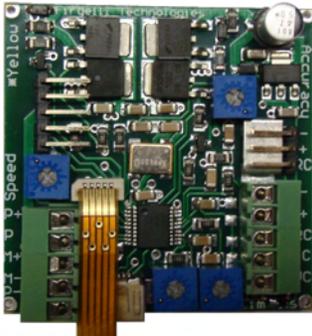
sales@firgelli.com  
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## Manual Quick Start:

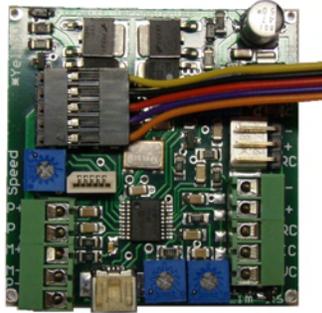
The LAC board is static sensitive. Ensure your work area is static safe prior to removing the board from the static bag or optional housing.



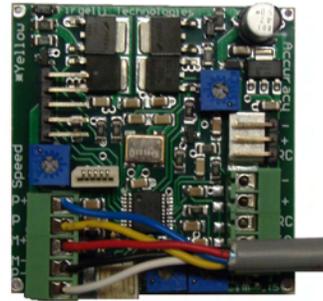
With all power and USB cables disconnected, connect an actuator to either the screw terminal header or the Fircelli connectors as described in the datasheet.



*PQ12-P : Copper faces contacts*

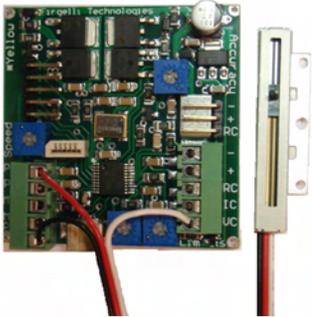


*L12-P and L16-P*



*Other -P : Wire colours may differ*

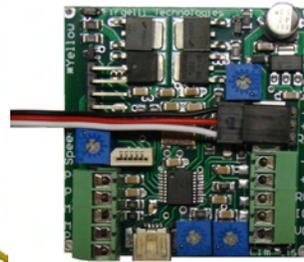
Connect the external potentiometer, control signal, or RC connector.



*External Pot : Wiper wire to VC*



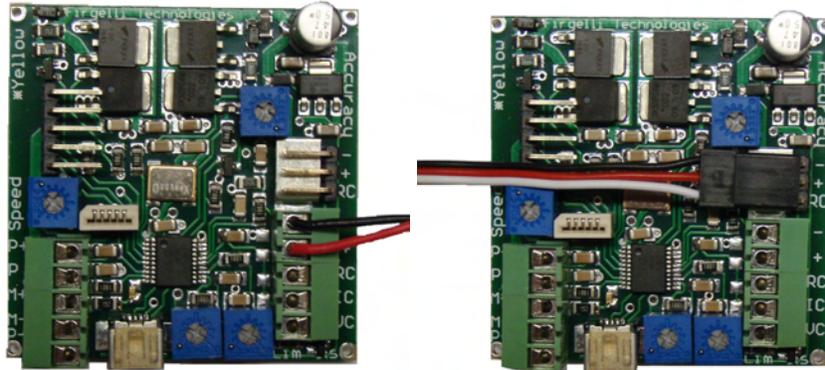
*Signal : Connect RC, IC, or VC*



*RC Receiver : Standard Connector*

If connecting a signal to RC, IC, or VC, make sure the signal ground is connected to the power supply ground (-).

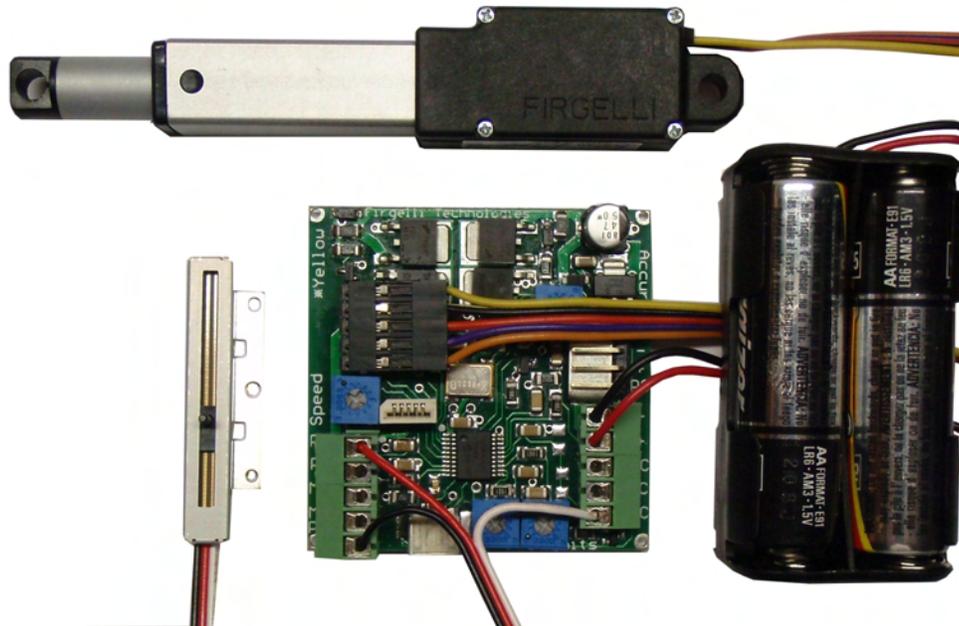
Apply power to the LAC board. If using the RC connector, **do not** connect a separate power supply. This can result in large currents flowing between power supplies. If you do wish to connect a separate supply, ensure the Red RC wire is disconnected.



*+/- Power terminals*

*RC connector : No other power*

Your system should now operate normally with Firgelli's default configuration.



*Firgelli LAC : Battery Powered, L12-P Actuator, Potentiometer Controlled*

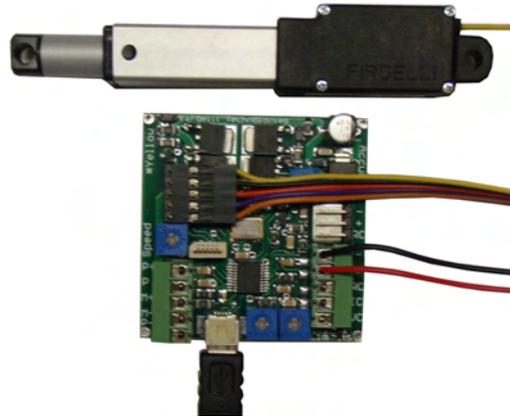
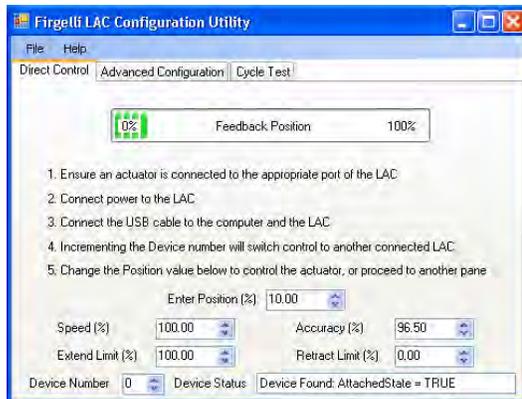
To manually adjust the LAC configuration, rotate the four potentiometers on the LAC to the desired locations. Counter clockwise reduces the corresponding value, while clockwise rotation increases the value. Power must be cycled before changes take effect.

**Limits** – The Potentiometer closer to the USB connector is the retract limit, and the one further away is the extend limit. For maximum stroke, set each potentiometer to fully clockwise. Rotating counter clockwise from this position will move the limits inward, from either end. If your settings overlap, the actuator will not move at all.

**Speed** – Fully counter clockwise, sets the speed to zero. Fully clockwise, sets the speed to maximum.

**Accuracy** – Fully clockwise rotation sets the precision to maximum. Rotating counter clockwise increases the distance around the desired position where the actuator will stop moving. If the actuator is jittery, reduce the precision slightly.

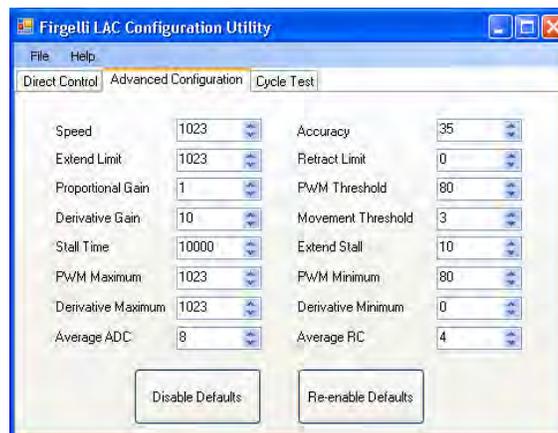
### Advanced USB control options:



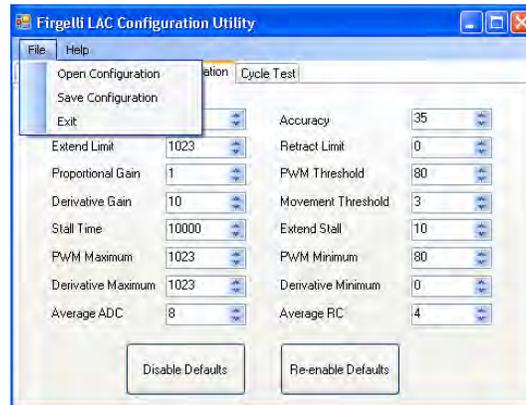
The included Advanced Configuration Program allows all the manual settings, and many other control values, to be set by USB.

The Direct Control Tab, shown above, allows simple USB control of Position and the four regular potentiometer controls. All these controls accept values from 0 to 100 percent.

The Advanced Configuration Tab provides full configuration control. Values can be set to override the defaults, and the potentiometers, by pressing the Disable Defaults button. The entered values will then be retained even when power is cycled. To return to the default state, reconnect to the LAC Configuration Utility and press the Re-enable Defaults button.



Advanced configuration settings can be saved and re-opened, through the File menu.



Brief descriptions for each value can be seen by moving the mouse over the corresponding label (“Stall Time”, “Accuracy”, etc). More detailed descriptions are given in the Custom Windows Programs section of this document.

The Cycle Test Tab makes application specific cycle testing simple.



Set any desired Advanced Control Options, and ensure the limits are set such that stall conditions do not occur. If a certain duty cycle is being tested, enter the desired delay time. This time in milliseconds is how long the actuator will stop at each limit before continuing the cycle. The Successful Cycles indicator will increment once per cycle (An extension and retraction). This value is reset every time a new test is begun. If the actuator fails and is unable to reach either of the limits, the test will not increment or continue. Press the Cycle test button again to stop the test at any time.

## Custom Control Programs:

The supplied .dll file can be used to interface with the Firgelli LAC using a variety of Windows based programming languages, including Visual C++ and Labview. The standard functions are described in the mpusbapi.h file, while the LAC specific details are described below.

The MPUSBOpen function is used to retrieve INHandle and OUTHandle. Once a valid connection is established, all LAC functions are accessed using MPUSBWrite(...) and MPUSBRead(...). Be sure to close any openHandles with MPUSBClose before exiting your program. Labview example code is available.

Format: 3-byte packet

Control, Data Low, Data High

```
Buffer[0]=Control  
Buffer[1]=Data Low  
Buffer[2]=Data High
```

Write: MPUSBWrite(OUTHandle, Buffer, 3, &ActualLength, 1000)

Read : MPUSBRead(INHandle, Buffer, 3, &ActualLength, 1000)

Control Values:

0x01 SET_ACCURACY	0x10 GET_FEEDBACK
0x02 SET_RETRACT_LIMIT	
0x03 SET_EXTEND_LIMIT	0x20 SET_POSITION
0x04 SET_MOVEMENT_THRESHOLD	0x21 SET_SPEED
0x05 SET_STALL_TIME	
0x06 SET_PWM_THRESHOLD	0x30 DISABLE_MANUAL
0x07 SET_DERIVATIVE_THRESHOLD	
0x08 SET_DERIVATIVE_MAXIMUM	0xFF RESET
0x09 SET_DERIVATIVE_MINIMUM	
0x0A SET_PWM_MAXIMUM	
0x0B SET_PWM_MINIMUM	
0x0C SET_PROPORTIONAL_GAIN	
0x0D SET_DERIVATIVE_GAIN	
0x0E SET_AVERAGE_RC	
0x0F SET_AVERAGE_ADC	

Note: Whenever a command is sent, the LAC will echo back the command. The exception is SET\_POSITION, which returns the current position.

## 0x01 SET\_ACCURACY:

This is the value controlled by the Accuracy Potentiometer. A value between 0-1023 is accepted. When the feedback position is plus or minus this value, the actuator will stop moving. Reducing this too far will result in the actuator continuously moving back and forth, never reaching the set point. The default value is four. To find the equivalent distance, use the formula:

$$\frac{Value}{1024} \times Stroke$$

For example, a value of four will give you +/- 0.117mm accuracy when controlling a 30mm actuator.

$$\frac{4}{1024} \times 30\text{mm} = 0.117\text{mm}$$

## 0x02 SET\_RETRACT\_LIMIT and 0x03 SET\_EXTEND\_LIMIT

These are the values that are set with the Limits Potentiometers. Setting the Extend\_Limit to 1023 and the Retract\_Limit to zero will allow movement over the full range. However, it is recommended to offset these values to ensure the actuator is never driven into the physical end stops. This increases cycle life considerably. To set the desired limits take the distance (mm) from the physical stop you wish to limit the actuator to, and plug it into the following equation.

$$\frac{Distance}{Stroke} \times 1023$$

For example, to set the limits to 1mm from the end stop of a 30mm stroke actuator, set EXTEND\_LIMIT to 34.

$$\frac{1}{30} \times 1023 = 34$$

## 0x04 SET\_MOVEMENT\_THRESHOLD

This value determines the minimum actuator speed that is considered a stall. When the actuator speed drops below this value, the stall timer begins counting.

## 0x05 SET\_STALL\_TIME

This is the amount of time in milliseconds that the actuator will wait before turning off the motor when a stall is detected. This timer is triggered when the actuator determines the speed of movement is below an acceptable level. The actuator will exit this state when the input signal tells the actuator to move in the opposite direction.

#### 0x06 SET\_PWM\_THRESHOLD

This value sets the distance around the set point where the PWM PD controller is active. When the distance between the feedback and set point is greater than this value the actuator speed is set to maximum.

#### 0x07 SET\_DERIVATIVE\_THRESHOLD

This value is compared to the measured speed to determine when the PWM should be increased to attempt to exit a stall condition. This is normally set to the same value as the MOVEMENT\_THRESHOLD.

#### 0x08 SET\_MAX\_DERIVATIVE

This value sets the maximum value that the derivative term can contribute to the control speed.

#### 0x09 SET\_MIN\_DERIVATIVE

This is the minimum value that the derivative can contribute to the control speed.

#### 0x0A SET\_MAX\_PWM\_VALUE

This is the value that is manually controlled by the speed potentiometer. This is the speed that the actuator runs at when outside the PWM\_THRESHOLD. Setting this to 1023 will allow the actuator to achieve full speed. The actuator may exceed this value while attempting to overcome a stall condition.

#### 0x0B SET\_MIN\_PWM\_VALUE

This is the minimum PWM value that can be applied by the PD control.

#### 0x0C SET\_Kp

This is the constant for the proportional control term. Increasing this value will make the actuator approach the set point faster; reducing this will make the approach slower. If the actuator is overshooting the set point before stopping, then reducing this value will reduce the amount of overshoot.

#### 0x0D SET\_Kd

This value sets the rate at which the differential portion of the controller increases during a stall condition. This is not a true differential term. However, the effect is similar. As long as the actuator detects a stall condition, the derivative term is incremented. If the stall condition is resolved the stall timer will be reset, otherwise the stall timer will elapse and stop the motor.

## 0x0E SET\_AVERAGE\_RC

This value determines the number of samples used in filtering the RC input signal before the actuator moves to a new position. Increasing this value can increase stability but does effect response time. The default value is four. The delay time can be calculated by multiplying this value by 20ms. This value does not affect the feedback filter delay. The actuators control response to a valid input signal will not be affected.

## 0x0F SET\_AVERAGE\_ADC

This value determines the number of samples used in filtering the feedback and analog input signals (if active). Increasing this value has a similar delay effect as described above, however this delay does affect actuator control response. Since this delay allows the actuator to move a certain distance before updating the speed based on the PD values, other values may need to be re-tuned if this value is changed.

## 0x10 GET\_FEEDBACK

This command causes the actuator to respond with a feedback packet containing the current actuator position. This is read directly from the ADC and may not be equal to the set point if the actuator has not yet reached it.

## 0x20 SET\_POSITION

This command allows USB control and disables RC, I, and V inputs until the system is rebooted. The data sent with this command determines what position the actuator moves too.

$$\frac{Distance}{Stroke} \times 1023$$

For example, to half way extend(25mm) a 50mm actuator, send 512. (The calculated value is rounded to a whole number).

## 0x30 DISABLE\_MANUAL

This command saves the current configuration settings to EEPROM and disables the four potentiometers. On reboot, these values will continue to be used instead of the potentiometer values. Analog inputs will still function as normal.

## 0xF0 RESET

This command turns the manual control potentiometers on and resets the configuration settings to factory default.

## Related Documents:

- Extending actuator life

*Technical assistance and design support services — Disclaimer of Warranties; Release of Claims*

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