Gecko FAQ

SECTION I – GENERAL FAQ

Q.) The Gecko Dos and Don'ts:

Here is a quick list of what you should never do to your gecko:

NEVER connect AC voltage to the drive.
NEVER plug a stepper drive into a servo motor, or vice versa.
NEVER reverse polarity going to the drive.
NEVER power a drive with more than 80V.
NEVER use a motor rated higher than 7A with a stepper.
NEVER use a motor rated higher than 20A with a servo.
NEVER unplug the drive with power applied.
NEVER connect the COMMON terminal to POWER GROUND.
NEVER try running more than one motor with a single drive.
NEVER expose the drive to any contaminants; keep the drive in a control box.
NEVER expose the drive to excessive moisture.
NEVER daisy chain your drives together. (Described later.)

Q.) What size should my power supply filter capacitor be?

Your filter capacitor on your power supply is determined by your power supply voltage and current. Use the following formula to find the optimal value in µF:

(80,000 * I) / V = C

Example:

Using a power supply of 65V and 5A, the equation would look as follows:

(80,000 * 5) / 65 = 6153µF

You would then choose the capacitor value closest to this with a voltage rating of at least √2 times your power supply voltage.

Note: If you are in an area with 50Hz as your AC frequency, use 100,000 instead of 80,000 in the equation.

Q.) What are the advantages/disadvantages between steppers and servos?

A.) Step motors and servo motors service similar applications, ones where precise positioning and speed are required.

The biggest difference is that steppers are operated "open loop". This means there is no feedback required from the motor. You send a step pulse to the drive and take on faith it will be executed. Seems like a problem but it's not.

If you have a quartz watch with hour and minute hands, then you have a step motor on your wrist. The electronics generates 1 step pulse per second, driving a 60 step per revolution motor which turns at 1 RPM. It keeps nearly perfect time. Any errors are due entirely to the electronics timing accuracy (quartz crystal oscillator).

Top Ten Stepper Advantages:

1) Stable. Can drive a wide range of frictional and inertial loads.
2) Needs no feedback. The motor is also the position transducer.
3) Inexpensive relative to other motion control systems.
4) Standardized frame size and performance.
5) Plug and play. Easy to setup and use.
6) Safe. If anything breaks, the motor stops.
7) Long life. Bearings are the only wear-out mechanism.
8) Excellent low speed torque. Can drive many loads without gearing.
9) Excellent repeatability. Returns to the same location accurately.
10) Overload safe. Motor cannot be damaged by mechanical overload.

Top Ten DC Servo Advantages:

1) High output power relative to motor size and weight.
2) Encoder determines accuracy and resolution.
3) High efficiency. Can approach 90% at light loads.
4) High torque to inertia ratio. Can rapidly accelerate loads.
5) Has "reserve" power. 2-3 times continuous power for short periods.
6) Has "reserve" torque. 5-10 times rated torque for short periods.
7) Motor stays cool. Current draw proportional to load.
8) Usable high speed torque. Maintains rated torque to 90% of NL RPM
9) Audibly quiet at high speeds.
10) Resonance and vibration free operation.

Top Ten Stepper Disadvantages:

1) Low efficiency. Motor draws substantial power regardless of load.
2) Torque drops rapidly with speed (torque is the inverse of speed).
3) Low accuracy. 1:200 at full load, 1:2000 at light loads.
4) Prone to resonance. Requires micro-stepping to move smoothly.
5) No feedback to indicate missed steps.
6) Low torque to inertia ratio. Cannot accelerate loads very rapidly.
7) Motor gets very hot in high performance configurations.
8) Motor will not "pick up" after momentary overload.
9) Motor is audibly very noisy at moderate to high speeds.
10) Low output power for size and weight.

Top Ten DC Servo (brush type) Disadvantages (besides higher relative cost):

1) Requires "tuning" to stabilize feedback loop.
2) Motor "runs away" when something breaks. Safety circuits required.
3) Complex. Requires encoder.
4) Brush wear limits life to 2,000 hrs. Service is then required.
5) Peak torque is limited to a 1% duty cycle.
6) Motor can be damaged by sustained overload.
7) Bewildering choice of motors, encoders, servo drives.
8) Power supply current 10 times average to use peak torque. See (5).
9) Motor develops peak power at higher speeds. Gearing often required.
10) Poor motor cooling. Ventilated motors are easily contaminated.

Q.) Should I use servos or steppers in my machine?

If you are designing a machine and you get to motors, the first thing you should do is calculate the power you need. Never buy a motor (stepper or servo) first and then figure out if it will fit what you need.

Motors are motors. They couple power to your mechanism and power is what makes things happen. The choice of a motor comes after you know what's needed.

Power is velocity times force or torque times RPM. It doesn't matter if the motors are steppers, servos or a gerbil in a spinning squirrel cage at the start.

To separate what motor need (neglect the gerbil), is the power your mechanism needs.

Rule #1: If you need 100 Watts or less, use a step motor. If you need 200 Watts or more, you must use a servo. In between, either will do.

So, how do you figure the power you need?

Method 1: You have a plasma table, wood router or some other low work-load mechanism. You have a clear idea of how many IPM you want but you're not sure of what force you want at that speed.

Pick the weight of the heaviest item you are pushing around. If it weighs 40lbs, use 40lbs. multiply it by the IPM you want. Say that's 1,000 IPM. Divide the result by the magic number "531". The answer is 75.3 Watts so use a step motor.

Eq: Watts = IPM * Lbs / 531

Method 2: You have a Bridgeport CNC conversion you are doing. The machine has a 5 TPI screw and you need a work feed rate of 120 IPM. 120 IPM on a 5TPI screw 5 * 120 or 600 RPM.

How about force? Not a clue? Use your machinist's experience on a manual machine. The hand crank is about 6" inches in diameter. How much force would you place on the hand crank before you figure you're not doing something right? I hear about 10 Lbs.

10 Lbs is 160 oz, 160 oz on the end of a 3" moment-arm (6" diameter, remember?) is 480 in-oz (3 times 160) of torque on the leadscrew.

The equation for rotary power is: Watts = in-oz * RPM / 1351

For this example, Watts = 480 in-oz * 600 RPM / 1351 or 213 Watts.

213 Watts is servo territory. You have to use a servo motor to get that, about a NEMA-34 one.

Q.) When is a G100 necessary?

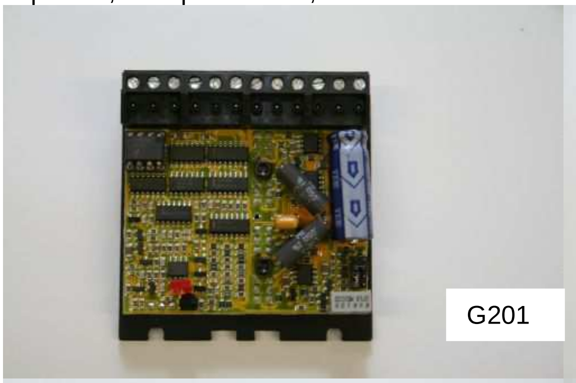
A G100 is necessary in only several applications, and they are:

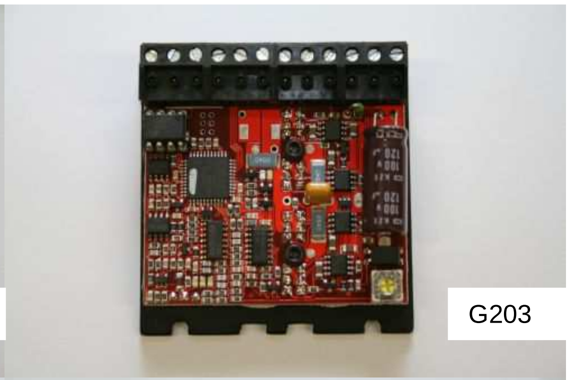
When 1350 RPM will not suffice
When a parallel port connection is not possible and it must be run through Ethernet
When more than 4 axes are required
When lots of I/O's are necessary

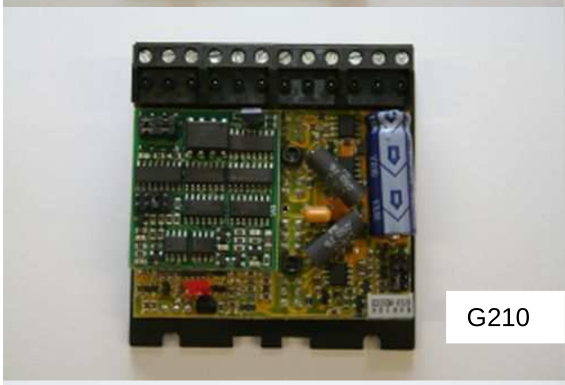
If you do not meet these criteria, the G100 will just become an over priced, overly complex breakout board.

Q.) How do I tell what kind of drive I have if I have no cover on it?

See below pictures to determine the type of drive you have without a cover on. Note: The PCB colors may not be the same as those in the picture. The key places to look are the large capacitor, the opto-isolator, and the thru-hole resistors.

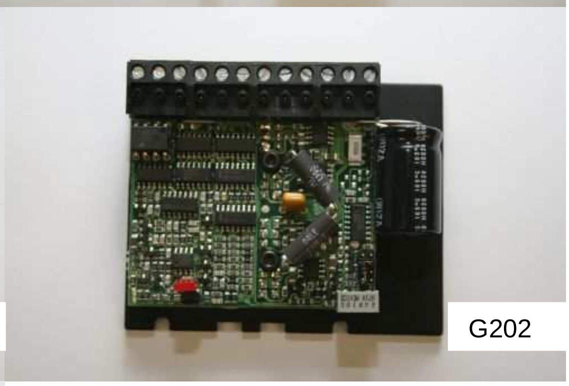

G201


G203


G210


G320


G340


G202


G212

Q.) How do I determine if my drive is broken?

To check your drive using a digital multimeter (DMM), follow these steps:

Turn off power to your drive.
Set the DMM to Ohms and put the negative lead on terminal 1 on the drive.
If the drive is a stepper, put the positive lead on terminals 3, 4, 5, and 6. If any of these shows 0Ω, there is a blown MOSFET. For a servo, do the same test but only put the positive across 3 and 4.
Now take the negative and put it on terminal 2 on the drive. If it is a stepper, put the positive on pins 3, 4, 5, and 6 and follow the same rules as above. If it is a servo, only test pins 2 to 3 and 2 to 4.
If there is a blown MOSFET, the drive must be sent back to us for evaluation. If there is more than one blown MOSFET, then it is not repairable.

Q.) How should I heatsink my drive?

There is not drive-specific heatsink for any Geckodrive, and there are a variety of ways to heatsink your drive. What you should do is ensure that your heatsink has fins to increase surface area, and have air flowing over it. A good heatsink to use is a standard CPU heatsink with some heatsink compound in between the drive's plate and the finned aluminum heatsink. The method to determining if it is being cooled adequately is to feel the drive while it is running. If it is uncomfortable to the touch, then the electronics are uncomfortable as well.

Q.) What should my settings be in Mach3?

With all drives except for the G203V, set the "Ports and Pins" setting to "Active Low". If it is a G203V, set it to "Active High". On all drives, set the step pulse width to 2µS.

Q.) Can I use a variable autotransformer with my drive?

No. Do not even think about it, for the following reasons:

1.) The Geckodrive mounting plate is connected to the 'Power Ground' terminal 1.

2.) The mounting plate hard anodizing is for the benefit of the 8 power MOSFETs, not to insulate the plate from whatever it gets mounted to. The mounting screws can and will ground the mounting plate to the mounting surface.

3.) The common anodes ('-' terminal) of the power supply full bridge rectifier connects to 'Power Ground' terminal 1 of the drive.

4.) If the 'neutral' side of the autotransformer is grounded to the chassis or the 'ground' wire connects to the chassis, it shorts-out the rectifier diode whose cathode goes to 'neutral' and whose anode goes to 'Power Ground' on the drive.

5.) With the rectifier shorted, uncontrolled current flows from chassis to mounting plate to 'Power Ground' to remaining common anode rectifier diode back to autotransformer.

6.) This current melts the aluminum plate, over-currents and destroys the remaining bridge rectifier diodes and causes amusing fireworks until the circuit breaker shuts down the fun.

7.) The resulting molten aluminum causes some people to muse about anodizing and its shortcomings.

Q.) Can I get a step and direction signal from USB?

A.) No. Due to the nature of USB (Universal Serial Bus), it loses all timing information contained in step pulses. The USB is a serial, or sequential, port. Step and direction signals require a parallel port so that no timing information is lost.

Q.) What is daisy chaining?

A.) This is when you hook all of your drives power cable up in series. If an input has a (+) and a (-), it needs its own wire going to the source. This is called a star formation. Let's say you have three drives: Drive 1 is hooked up into the power supply, Drive 2 is hooked into Drive 1, and Drive 3 is hooked into Drive 2. The only drive that is actually hooked up into the power supply is Drive 1. If Drive 1 were to blow up or short circuit, it would take Drive 2, and therefore Drive 3, with it. The correct way would be to have Drive 1 plugged into the power supply, Drive 2 plugged into the power supply, and Drive 3 plugged into the power supply, all with separate cables.

Q.) Can I use a slow-blow or time delay fuse with a Geckodrive product?

A.) A slow blow or time delay fuse may not blow fast enough to prevent damage to your drive. We recommend that you use a fast blow fuse rated at a current that you would like to limit your drive from drawing (7A on steppers, 20A on servos).

Q.) What gauge wire should I use for wiring my drives?

A.) For terminals 1 and 2, the power terminals, use either 14 or 16 gauge wire. For all others, we recommend using 22 gauge wires.

Q.) What are the resistor color codes?

A.) On a color coded resistor, you must follow the below code. The second to last band is the multiplier band, and the final band is the tolerance band. The color codes are as follows:

Number bands:

Black	**–**	**0**
Brown	–	1
Red	**–**	**2**
Orange	–	3
Yellow	**–**	**4**
Green	–	5
Blue	**–**	**6**
Violet	–	7
Gray	**–**	**8**
White	–	9

Multiplier band:

Black	**–**	**1Ω**
Brown	–	10Ω
Red	**–**	**100Ω**
Orange	–	1KΩ
Yellow	**–**	**10KΩ**
Green	–	100KΩ
Blue	**–**	**1MΩ**
Violet	–	10MΩ
Gray	**–**	**Nothing**

White	–	Nothing
Gold	**-**	**0.1Ω**
Silver	-	0.01Ω

Tolerance Band

Black	**–**	**Nothing**
Brown	–	1%
Red	**–**	**2%**
Orange	–	Nothing
Yellow	**–**	**Nothing**
Green	–	0.5%
Blue	**–**	**0.25%**
Violet	–	0.1%
Gray	**–**	**0.05%**
White	–	Nothing
Gold	**-**	**5%**
Silver	-	10%

Q.) Can I use an SCR speed control as a power supply?

A.) No, and doing so will void your warranty. We do not recommend this for two reasons:

1) An SCR speed control, light-dimmer, etc. is a phase-triggered device. Once turned on, an SCR cannot be turned off until the voltage drops to zero across it. This happens 120 times a second with an AC voltage. Should the SCR trigger early in an AC cycle, the output voltage will rise to 162V for that cycle and destroy the drive.

2) An SCR control has no AC isolation. Trace the circuit from its output backwards and you will have a connection to your 115VAC receptacle. You touch the drive and you may as well be sticking your finger in a light socket. In other words, you can kill yourself.

Q.) Can I use twisted pair wire for my step and direction signals?

A.) You may use twisted pair wiring, but you can not run step and direction through the same twisted pair. Use one pair with STEP and COMMON, use another pair with DIRECTION and COMMON. Connect both pair's COMMON to the G203V COMMON terminal.

SECTION II – STEPPER FAQ

Q.) What is the difference between the G201, the G202, and the G203V?

A.) The G201 is our most basic high end drive. It is meant for experienced CNC users and OEMs who will be wiring it exactly the same way for almost every application. It has no internal protection, and is functionally identical to our other steppers for the most part.

The G202 has short circuit protection and an internal 470µF capacitor so you do not need to attach one if your power cables are longer than 18”. It is the same as the G201 aside from these two features, and it has a slightly larger footprint (see G202 manual for exact dimensions).

The G203V is protected against almost everything you can throw at it. It has short circuit protection, temperature protection, an internal fuse, common ground, and a plethora of other features. This drive is for the hobby user who needs protection against a variety of issues that could cause problems for their system.

Q.)What is the difference between the G201 (or G202) and the G210 (or G212)?

The G201 and the G210 are functionally identical, except that the G210 has a step pulse multiplier. This step pulse multiplier will only be used if your step pulse signal is very weak or if you have to set the drive to common ground rather than its default setting of common +5V.

Q.) What should my drive supply voltage be?

You should find out your motors inductance and use it in the following formula:

32 * √mH Inductance on the motor = Drive Supply Voltage

The answer is going to be your motors maximum running voltage. Anything above this is going to potentially damage your motor.

Q.) How do I determine the size of the current set resistor?

The current set resistor is determined by taking your motor phase current and substituting it for *I* in the following equation:

Standard:
47 * *I* / (7 – *I*) = Resistor value in KΩ

Low Current:
47 * *I* / (2 – *I*) = Resistor value in KΩ

Example:
47 * 5 / (7 – 5) = 117.5KΩ

You then choose the nearest 5% resistor value below that amount.

If you have a G250, G251, or G540, do not use the above formula. These drives use a linear current set resistor formula, meaning that every amp of current requires 1K of resistance. If your motor is 1.5A, then use a 1.5K resistor; if it is a 3A motor, then use a 3K resistor, and so on.

Q.)What does the standby jumper block do?

The standby jumper block causes the drive to either enter standby mode or not. When current standby is enabled, the current will be reduced to 30% after one second of inactivity. If it is disabled, then the current will stay at full current whether idle or not.

You would keep the current standby disabled on an axis where constant torque is necessary, such as a Z axis. Keeping standby enabled will help reduce motor heat.

Q.) Can I run the G201 / G210 / G202 / G212 / G203V above 80V/7A?

A.) The steppers are rated to 80V/7A maximum, and you can run the voltage and current up to but not past those limits. Anything past either 80V or 7A voids the warranty on the drive.

Q.) Do my motors produce more torque while microstepping or full stepping?

A.) It's a give and take kind of situation:

1) For the same peak current, a microstepped motor will have 71% (1/sqrt 2) the holding torque of

a full-step drive. This is because motor torque is the vector sum of the phase currents. Advantage: Goes to full-steppers.

2) Most people want motors to turn, not just 'hold'. As soon a full-step driven motor turns, its torque drops to 65% of its holding torque. Where did the missing torque go? To resonating the motor is where. Motor manufacturers sometimes specify 'dynamic torque'; this is specified at 5 full steps per second. It is always between 60 to 65% of holding torque. Not mentioned is the horrible racket the motor makes at 5 full steps per second.

Microstepped motors do not resonate at low speeds, so no torque is invested in resonance. Microstepped motors keep all their holding torque while turning slowly. 65% for full-steppers, 71% for microsteppers. Advantage: By a hair (6%), goes to microsteppers.

3) Things get a little dicey as speed increases. Microstepping ceases to have any benefit above 3 to 4 revolutions per second. The motor is now turning fast enough to not respond to the start-stop nature of full steps. You can say the step pulse rate is above the mechanical low-pass frequency limit (100Hz or so) of the motor. Motion becomes smooth either way.

Simple drives persist in microstepping anyway above this speed. This means they still try to make the motor phase currents sine and cosine past this speed. A little problem with that and it's called 'area under the curve'. The area under the sine function (0 to 180 degrees) is only 78% of a square wave (full-step). Advantage: Goes to full-step again.

More sophisticated drives transition from sine-cosine currents to square-wave quadrature currents about then. Same as full-steppers. Advantage: Draw.

4) As speed increases even more, another really big problem crops up; mid-band resonance. This is the bane of full-steppers and microsteppers alike.

Maybe you have experienced it; the motor is turning 5 to 15 revs per second when you hear a descending growing sound from the motor and then it stalls for no good reason at all. Faster it's OK; slower it's OK, but not OK in that range. All you know is there is a big notch in the speed-torque curve. This is mid-band instability or parametric resonance.

Simple drives have no defense against this except to try not running the motor in this speed range. Better drives have circuitry to suppress this phenomena and it involves rate damping.

This is the equivalent of shock absorbers (rate dampers) on a car, without them a car bounces repeatedly. Imagine a washboard road surface in sync with this bounce; there would be sparks flying from the undercarriage in short order. With rate dampers the 'bounce' is suppressed to a single cycle. Mid-band compensation does the same with steppers.

5) More than any other type of motor, step motor performance is tied to the kind of drive connected to it. More than any other type motor, a stepper can be driven from very simple drives (full-step unipolar L/R) to very complex ones (microstepping full-bridge bipolar synchronous PWM mid-band compensated).

Q.) How hot is too hot for a step motor?

A.) The maximum heat for most steppers is around 100ºC (212ºF), but it is generally never good to have the motor heat go above 85ºC (185ºF).

Q.) Should I wire my motor in series or parallel?

A.) When you buy a six or eight wire motor, you are really purchasing two motors in one: A low current motor when wired in series, and a high current motor when wired in parallel. You have the choice between either motor for your application. They each have their own advantages and disadvantages, most notably being the amount of current they use and the heat they produce as a result at a given power supply voltage. The parallel wired motor will produce twice the power output but four times as much heat as a series connected motor. Generally speaking, use a parallel connection if you need high speed power output and a series connection if you do not require a high power output.

Q.) I should be getting much more speed from my motor but I am not. Why is my motor running slowly?

A.) You may not be getting the most out of your motor for a variety of reasons. Check all of these:

1.) Check your current set resistor with an ohm-meter.
2.) Check your step pulse frequency.
3.) Check your motor’s inductance.

Q.) Can I run more than one motor on a drive?

A.) The drive can put out a maximum of 7A and 80V, which would work out to 80V and 3.5A per motor. Also, our drives have mid-band resonance compensation, which senses the rate of load change and is applied as a correction. If you have two motors on one drive, it does not know which motor to correct for. One motor would pump the other into resonance and would stall.

If your speeds are less than 3 RPS or less, you can run more than one motor per drive. However, that is only 180 RPM, which is something that will probably be too low.

Q.) Why do you recommend not using round steppers?

A.) Round steppers use rare earth magnets, and lose their magnetization over time. Because most of these were made in the 1980’s and before, they have already lost a substantial amount of magnetization. Square steppers use permanent magnets however, and provide much higher torque than their round brethren.

Q.) What causes steppers to lose steps?

A.) A stepper will lose steps if it is being run at an RPM that is too high for the given load. This is the beginning of the drive stalling, and it is stalling on the steps that it is missing. Slow down the speed, and it should fix the problem.

Q.) Can I use a motor with inductance below .5mH?

A.)Little motors have low phase current and even lower inductance owing to their small size.

Let's start with the assumption switching frequency ripple current shouldn't exceed 10% of the motor's rated current. For you that value is 120mA peak to peak. Let's also assume using the lowest practical power supply voltage, 24VDC.

Ripple current = V / 2f * L = 1.5A (where f = 20kHz and V = 24VDC)

This means ripple current is greater than the rated phase current! Rearrange to solve for L using 120mA for I:

L = V / 2f * I = 0.005H or 5mH total phase inductance per winding.

If you already have 0.4 mH, add a minimum of 4.6 mH in series with each winding. Use ferrite core inductors rated at 1.5A minimum. Any less and the inductors will saturate, their inductance will plummet and they will be of no use at all. Use a 10K current set resistor to set the drive to 1.2A.

SECTION III – SERVO FAQ

Q.) How do I determine my optimal encoder line count?

To determine your encoder line count, you must use the following equation:

(Step Pulse Frequency / RPS) / 4 = Optimal encoder line count

To determine your RPS, take 80% of your motors rated maximum no load RPM and divide by 60. Example:

3000RPM max motor, with a step pulse frequency of 45kHz

(45,000 / 40) / 4 = 281.25

You then choose the closest line count below your optimal line count, in this case 275.

Q.) Will my G320 work with a brushless AC motor?

The G320 and G340 are meant for brush type DC servo motors only. Running anything aside from that with the G320 or G340 will result in possible destruction of the drive.

Q.) How do I determine my ideal current?

A.) Take your power output from your motor and multiply by 1.25 to determine your wattage required from the power supply (because servo motors are typically 80% efficient). Then divide by your voltage to determine your optimal current.

Example:

1.25 * 746W = 932.5W

932.5W / 80V = 11.65A

Q.) Why does my motor "sing" when it is idle?

A.) The singing is because the motor is dithering or bouncing between adjacent encoder line counts. The integral term in a PID loop has an infinite DC gain over time and will amplify even the smallest position error. Because encoder feedback can only occur on count edges, the loop is "blind" until it encounters an encoder count edge. It then reverses the motor direction until another edge is found, then the process repeats.

Q.) What is the difference between the G320 and the G340?

A.) The G320 and the G340 are functionally identical, except that the G340 has a step pulse multiplier. This step pulse multiplier is going to have a niche application, and will be required in only two instances: If your encoder line count is very high or if your step pulse signal is very low in frequency. You can also use the G902 (the step pulse multiplier in the G340) jumper settings to set the drive to common ground or common +5V.

The G902 has a jumper setting to choose either a multiplication of 1, 2, 5, or 10 times for each step pulse. This means that if you were to have a 2000 line encoder, a setting of 10 on the G902 would make it equivalent to a 200 line encoder. The maximum frequency of the G902 is

200 kHz, so if you have it at a setting of 10 at a step pulse frequency of 45 kHz, it will be limited to going to 200 kHz, not 450 kHz as it would in a perfect world.

Q.) Can I run the G320 / G340 above 80V/20A?

A.) The servos are rated to 80V/20A maximum, and you can run the voltage and current up to but not past those limits. Anything past either 80V or 20A voids the warranty on the drive.

Q.) Can I run two motors with one drive?

A.) Because servos use encoders, the drive would not know which encoder to send the corresponding pulses to. Due to this, there is no possibility of running two motors with a G320.

Q.) Can I run a 0 – 24V encoder with my G320 or G340?

A.) You must use a +5V encoder with the gecko servo drives. Anything other than that, regardless of how it is powered, is not recommended with the G320 or G340 and will void the warranty.

SECTION IV - USEFUL EQUATIONS

Current Set Resistor Value

47 * I / (7 – I) = Resistor value in KΩ

Low Current Setting

47 * I / (2 – I) = Resistor value in KΩ

Determining Push

In. oz. * TPI * π / 8 = lbs of push

Determining Watts

I^2 * R = W

Determining Encoder Line Count

(Step Pulse Frequency / Revolutions Per Second) / 4 = Encoder Line Count

Ex: (45kHz / 70) / 4 = 162.5
Then choose the next lowest standard encoder line count, in this case 150.

Determining Filter Capacitor Size

(80,000 * I) / V = C Value

I = PS current, not drive current
V = PS Voltage

Ex: (80,000 * 16) / 50 = 25,600µF

Determining Inches Per Minute

RPM / TPI = IPM

Determining Optimal Drive Supply Voltage

Drive Supply Voltage = 32 * √mH Inductance

Example of a motor with 4mH inductance:

32 * √4mH = 64VDC

Determining Total Watts Needed

(Weight in pounds of heaviest object being moved / IPM desired) / 531 = Watts

Example with a 40lb. object and 1000IPM desired speed:

(40 / 1000) / 531 = 75.3W

Because the answer, 75.3W, falls below 100W total you should use a stepper motor.