G320X MANUAL

DC BRUSH SERVO MOTOR DRIVE

Thank you for purchasing the G320X drive. The G320X DC servo drive is warranted to be free of manufacturing defects for 3 years from the date of purchase. Any customer who is dissatisfied with it or is unable to make it work will be refunded the purchase price if the G320X is returned within 90 days of the purchase date.

PLEASE READ FIRST BEFORE USING THE G320X:

If you are not familiar with DC servo drives please do the following setup instructions with the motor on the bench before mounting it on the mechanism it will eventually run. This will allow you to get a baseline motor behavior of what to expect. Before you start, you must have a suitable encoder mounted and properly aligned on the motor. Follow the manufacturer's instructions on mounting and aligning the encoder if the motor doesn't already come with one.

Next you must have a DC power supply suitable for the motor. The power supply current rating must equal the maximum current you expect to run the motor at.

Finally, have a STEP and DIRECTION pulse source available.

Before going on, turn the "P", "I", "D", and LIMIT trimpots to the 11 o'clock position. The trimpots are single-turn so be careful not to over-torque them.

G320X TERMINAL PINOUT

TERMINAL 1   Power Ground
Connect the negative lead of your power supply to this terminal.

TERMINAL 2   Power (+)
Connect the positive lead of your power supply to this terminal. It must be between +18VDC to +80VDC.

TERMINAL 3   Armature (-)
Connect the black lead of your motor to this terminal.

TERMINAL 4   Armature (+)
Connect the red lead of your motor to this terminal.

TERMINAL 5   ERR/RES
This is the ERROR and RESET pin. For a full explanation read the section titled "ERROR/RESET PIN".

TERMINAL 6   Encoder Ground
Connect the encoder power supply ground to this terminal.

TERMINAL 7   Encoder +5VDC
Connect the encoder +5VDC pin to this terminal.

TERMINAL 8   Channel A
Connect the Channel A pin of your encoder to this terminal.

TERMINAL 9   Channel B
Connect the Channel B pin of your encoder to this terminal.

TERMINAL 10   Direction
Connect the DIRECTION signal to this terminal.

TERMINAL 11   Step
Connect the STEP signal to this terminal.

TERMINAL 12   S/D Common
Connect this terminal to either +5VDC or signal ground.

DIP SWITCH SETTINGS

The G320X has a 10 position DIP switch that is accessible through the cutout in the drive's cover. These switch settings control many of the features of the G320X and are labeled SW1 through SW10.

EXPLANATION OF SWITCH FUNCTIONS

SW1 Not used

SW2, **SW3** MUL1 and MUL0 respectively, set the G320X pulse multiplier
SW2 "ON" and SW3 "ON" = Step pulse times 1 (default)
SW2 "ON" and SW3 "OFF" = Step pulse times 2
SW2 "OFF" and SW3 "ON" = Step pulse times 5
SW2 "OFF" and SW3 "OFF" = Step pulse times 10

SW4, **SW5** SR1 and SR0 respectively, set the G320X following error limit
SW4 "ON" and SW5 "ON" = +/- 256 count following error limit (default)
SW4 "OFF" and SW5 "ON" = +/- 512 count following error limit
SW4 "ON" and SW5 "OFF" = +/- 1024 count following error limit
SW4 "OFF" and SW5 "OFF" = +/- 2048 count following error limit

SW6 HEDS
SW6 "OFF" = Default
SW6 "ON" = Turned on if using encoders with HEDS optical heads or open collector encoders. Disables encoder failure detection allowing user to run encoders that don't have line drivers or active pullup.

SW7 TORQ
SW7 "ON" = Use LIMIT trimpot setting only (default)
SW7 "OFF" = Allow 20A for 1 second, then use LIMIT trimpot setting

SW8, **SW9**, **SW10** GAIN2, GAIN1, and GAIN0 respectively, set the current mode servo gain
SW8 "ON", SW9 "ON", SW10 "ON" = Lowest gain
SW8 "ON", SW9 "OFF", SW10 "ON" = Low gain
SW8 "ON", SW9 "ON", SW10 "OFF" = Medium-low gain
SW8 "ON", SW9 "OFF", SW10 "OFF" = Medium gain 1 (default)
SW8 "OFF", SW9 "ON", SW10 "ON" = Medium gain 2
SW8 "OFF", SW9 "OFF", SW10 "ON" = Medium-high gain
SW8 "OFF", SW9 "ON", SW10 "OFF" = High gain
SW8 "OFF", SW9 "OFF", SW10 "OFF" = Highest gain

G320X TERMINAL WIRING:

IMPORTANT: When first testing the G320X, connect ERR/RES (Terminal 5) to ENC+ (Terminal 7)

IMPORTANT: Do not connect the motor to the G320X until STEP 6

IMPORTANT: Please follow the next steps in the sequence they are given

STEP 1: CONNECTING THE ENCODER

The encoder must be at minimum a 25 line-count digital quadrature encoder and must operate on a single +5VDC power supply. If the encoder supply current is more than 50 mA, use an external +5VDC supply. It may have an INDEX output, which will not be used. If it has differential outputs, use only the "+" phase outputs.

TERMINAL 6   Encoder Ground
                 Connect the encoder power supply ground to this terminal.

TERMINAL 7   Encoder +5VDC
                   Connect the encoder +5VDC to this terminal

TERMINAL 8   Channel A
                   Connect the encoder channel "A" to this terminal

TERMINAL 9   Channel B
                   Connect the encoder channel "B" to this terminal

To determine the optimal encoder line count, please follow the instructions below.

1.) Determine the motor's no load RPM
2.) Calculate rated RPM as 80% of no load RPM
3.) Divide (#2) by 60 to get revolutions per second
4.) Determine the CNC program's maximum step pulse frequency (in Hz)
5.) Divide (#4) by (#3), which will give you the maximum counts per revolution
6.) Divide (#5) by 4, which will give you the max line count
7.) Pick the first standard line count below (#6)

An example of using that formula with a 45kHz step pulse frequency and a maximum motor RPM of 3000:

(45,000 / 40) / 4 = 281.25

This application would be best served with a 281 or lower line count to achieve that speed with the given input frequency. A higher line count will work and will give a higher resolution at the expense of motor speed.

STEP 2: CONNECTING THE POWER SUPPLY

IMPORTANT: Never put a switch on the DC side of the power supply! This will damage, if not destroy, your drive!

Keep the power supply leads short and use the largest wire gauge that will easily fit in the terminals. If the lead length is more than 18" use a 1000uF capacitor across the G320X power supply terminals. Make sure your power supply can provide the peak current the motor may draw. The power supply voltage must be between 18 VDC and 80 VDC.

TERMINAL 1   POWER GROUND
                   Connect the power supply (-) to this terminal.

TERMINAL 2   +18 TO 80 VDC
                   Connect the power supply (+) to this terminal

STEP 3: TESTING THE ENCODER

At this point the encoder should be tested for functionality. You can test the encoder on the G320X by watching the indicator LEDs on the board.

Turn on the power supply. The FAULT indicator (red LED) should be on for 1 second and then turn off, if the required switch or jumper is between ERR/RES and ENC+. The IN-POSITION indicator (green LED) should turn on and remain on. The POWER indicator (green LED) should always be on. Turn the motor shaft VERY slowly by hand. The IN-POSITION indicator (green LED) will turn off when you turn the motor more than two encoder counts. The Warn indicator (yellow LED) will turn on when you have turned the motor more than 128 encoder counts.

The FAULT indicator (red LED) will turn on when you turn the motor past the following error limit (see option switch section). After 1 second the FAULT light will turn off and the IN-POSITION LED will come back on.

STEP 4: CONNECTING CONTROL INPUTS

The STEP and DIRECTION signal drivers must be 3.3V or 5V TTL signals and have edge transition times of 100 ns or faster. The COMMON input can be connected to signal ground or a +5VDC supply. The G320X default motor direction is CW when the DIRECTION pin is left unconnected.

TERMINAL 10	Direction
	Connect the DIRECTION line to this terminal.
TERMINAL 11	Step
	Connect the STEP line to this terminal.
TERMINAL 12	Common
	Connect this terminal to the signal ground or +5VDC.

STEP 5: TESTING THE STEP AND DIRECTION INPUTS

Set the STEP pulse generator to 40 pulses per second. If you are using a CNC program, use the "JOG" command. Turn on the power supply; the FAULT indicator (red) will turn off after 1 second and the IN-POSITION indicator (green) will turn on. Start sending step pulses (JOG). The IN-POSITION indicator (green) will turn off almost immediately, the WARN indicator (yellow) will turn on 3 seconds later and the FAULT indicator (red) will turn on 3 seconds after that. Once the FAULT indicator (red) turns on, stop sending step pulses. Send step pulses in the opposite DIRECTION and the above process should repeat.

STEP 6: CONNECTING THE MOTOR

Turn the power supply and the step pulse source off. Verify that the "P", "I", "D", and LIMIT trimpots are in the 11 o'clock position.

TERMINAL 3	Armature (-)
	Connect the BLACK motor lead to this terminal.
TERMINAL 4	Armature (+)
	Connect the RED motor lead to this terminal.

STEP 7: TUNING THE SERVO

Turn on the power supply. The FAULT indicator should turn off and the IN-POSITION indicator should turn on after 1 second. If everything is correct you may hear faint sounds coming from the motor. This is normal. The motor is "dithering", or bouncing between adjacent encoder counts. The integral term in a PID loop has 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.

If the motor jumps slightly and the FAULT indicator immediately turns back on, then either the motor is wired backwards or the trimpots are misadjusted. Check the trimpot settings. If they are correct then switch exchange CH A and CH B. If it still doesn't work and you followed all the previous steps, call Geckodrive at the number at the end of this document.

Now try turning the motor gently by hand. The motor should resist being turned and the IN-POSITION indicator may flicker.

CAUTION: Do not move the motor manually for more than several seconds at a time; motor overheating will occur if you do.

Now turn on the power supply and step pulse source and ramp the speed up to see if the motor turns.

The default PID trimpot settings should work in most applications. The PID settings do not in any way affect the positioning accuracy of the G320X and only affects the settling time of the servo. To use an oscilloscope you must remove the cover and place the probe on TP1. There are four solder pads approximately 2mm in diameter near the DIP switch; the two closest to the center of the board are TP1 and the two closest to the edge of the board are GND.

REMOVING THE COVER:

1.) Remove the two 2-56 Phillips-head screws on the bottom of the drive.
2.) Slide the cover backwards while lifting until it clears the drive.

REPLACING THE COVER:

1.) Slide the cover forward over the drive until the holes in the cover line up with the holes in the bottom plate.
2.) Replace the screws on the bottom of the drive.

When the motor is critically damped you should see a graph very similar to the "Critically Damped" portion of the chart below.
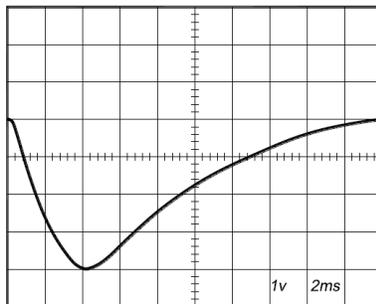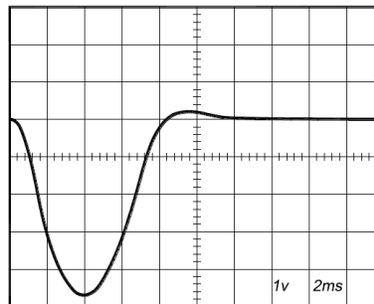

OVERDAMPED   CRITICALLY DAMPED   UNDERDAMPED
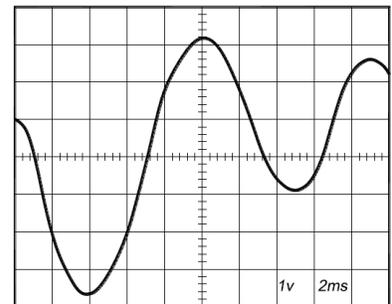
The manner in which the motor returns to its command position is called damping. At one extreme, called over damped response, the motor returns to position after a long, drawn out delay. At the other extreme, called under damped response, the motor returns to its position too rapidly, overshoots, returns and undershoots and so on until it finally settles at its command position. This is also called ringing; when extreme, the over/undershoot builds in amplitude until the motor enters violent oscillation. Between the two extremes is the optimal response called critical damping. Here the motor rapidly returns to its position with little or no overshoot in the minimal amount of time.

TRIMPOT SETTINGS

There are four user-settable trimpots on the G320X. Each one is a single turn trimpot with a range of motion from about the 8 o'clock position to the 4 o'clock position. A drawing is below:
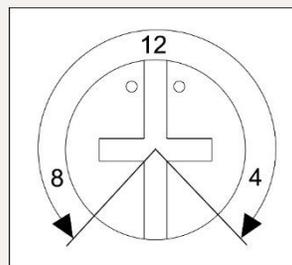
SETTING THE "P", "I", "D" TRIMPOTS

"P" and "D" settings generally track each other. If you increase "P" for greater stiffness, an increase in "D" is needed as well to restore critical damping. Be careful, increasing "P" without increasing "D" may cause the motor to break out into violent oscillation.

The higher "P" is set, the noisier the motor will be when stopped. This is because higher gain causes more vigorous dithering between encoder counts at rest. There is a trade-off between high gain (high stiffness) on one hand and excessive dithering (noise and motor heating) on the other.

The "I" setting takes out the remaining following error. Increasing the "I" setting will increase the servo stiffness; if it is increased too much the servo will oscillate.

To see how a servo is compensated it is first necessary to induce a disturbance. The easiest way is to switch the DIRECTION input while commanding a constant speed via the STEP input. The abrupt direction change puts a momentary load on the motor while the oscilloscope shows how it responds (see oscilloscope traces above).

If you are using an oscilloscope, use channel 1 on TP1 and channel 2 on the DIRECTION input. Set the trigger to "normal", trigger source to channel 2 and trigger edge to "+". You should see a single sweep for every clockwise change in direction.

CURRENT LIMIT

The current LIMIT trimpot sets maximum continuous current the motor is permitted to have. It is adjustable from 0 amps to 20 amps. The trimpot setting is proportional to current; if it is set to full scale it will be outputting 20A, half scale will output 10A, quarter scale will output 5A, and so on. The trimpot will be full OFF (0A) when it is turned all the way clockwise, and will output full power (20A) when it is turned fully counter clockwise.

The behavior of the trimpot is controlled by DIP SW 7. If SW 7 is off, the G320X will limit the current to the trimpot setting until it runs into an excessive load. It will then start a 1 second timer and limit the current draw to 20A; if it does not overcome the load it will limit at the trimpot set current. The load must drop below the trimpot setting to reset the timer. If SW 10 is on (default), the G320X will constantly output what the LIMIT trimpot is set to. Normally the LIMIT trimpot is set to the motor's continuous rated current.

INDICATOR LEDs

The G320X has four indicator LEDs. These are:

IN-POSITION indicator (IN POS Green LED)
WARN indicator (WARN Yellow LED)
FAULT indicator (FAULT Red LED)
POWER indicator (POWER Green LED)

The FAULT indicator (red LED) is on while the drive is in power-on reset, the DISABLE input is held "low" or if the protection circuit is tripped due to a FAULT condition. All output switching stops are reset. The FAULT condition lasts for 1 second, and then self-resets to try again. If the G320X enters a FAULT condition it will dynamically brake the motor. This means if a FAULT occurs while the motor is moving the motor will very rapidly decelerate to a stop.

There are three conditions that will trip the protection circuit. One condition is a short-circuit. The second condition is if there is no encoder attached; the G320X detects if one or more encoder wires are not connected. The third condition is if the POSITION ERROR exceeds the set following error limit. This condition can have several causes:

1) The loop settings are severely under-damped and the motor breaks out into oscillation.
2) Excessive motor load due to acceleration or workload.
3) The speed command in excess of what the motor can deliver.
4) The current LIMIT is set too low.
5) The power supply current is insufficient for the demand.
6) The power supply voltage is below 18 VDC.
7) The motor is wired backwards, is broken or disconnected.
8) Encoder failure.

The IN-POSITION indicator (green LED) is lit when the motor is within 2 increments of motion of the commanded position. If the motor is out of position by more than two increments of motion the indicator will not be lit.

The Warn indicator (yellow LED) is lit whenever the motor is more than 128 counts off of the commanded position. Its purpose is to give warning that a large following error is probably developing and will result in the drive going into FAULT (red LED) if measures are not taken to arrest the increasing following error.

The Power indicator (green LED) is lit whenever there is power applied to the G320X.

ERROR / RESET PIN

This terminal functions as an ERROR output and as a RESET input. Because this terminal functions as both an input and an output, some detailed description is necessary.

When first testing the G320X, ERR/RES (Terminal 5) was connected to ENC+ (term. 7). It can be left that way if it is not necessary to read the state of the ERROR output. Otherwise, the following details are important.

The ERROR output is latched in the "ERROR" state (Terminal 5 = "0") by the power-on reset circuitry in the G320X. It will stay in this state indefinitely until it is cleared by applying +5V to this terminal for at least 1 second.

The voltage on this terminal is +5VDC when the G320X is functioning normally. The voltage on this terminal goes to 0VDC whenever the FAULT indicator is lit. This output can be used to signal your controller that an error has occurred.

Normally when the G320X is first powered up, it will be necessary to push the momentary switch to START for 1 second. This will clear the power-on reset condition and extinguish the FAULT LED. The motor will then be enabled and the drive will begin to operate. If at any time after that a condition occurs that causes the G320X to "FAULT out", such as not being able to complete a step command, the ERR/RES terminal will go to "0", signaling to the controller an error has occurred. This will require the operator to correct the problem that caused the FAULT and then push the switch to "START" for 1 second to re-enable the G320X.

At any time the operator can push the switch to the "STOP" position to immediately halt the G320X drive. Anytime the G320X is in the "FAULT" state (FAULT LED lit), all switching action stops, the motor freewheels and is unpowered.

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G320X Servodrive

OPTION SW

← ON

GAIN0 10
GAIN1 9
GAIN2 8
TORQ 7
HEDS 6
SR0 5
SR1 4
MUL0 3
MUL1 2
RESV 1

← Option Switches

← Status LEDs

IN POS
WARN
FAULT
POWER
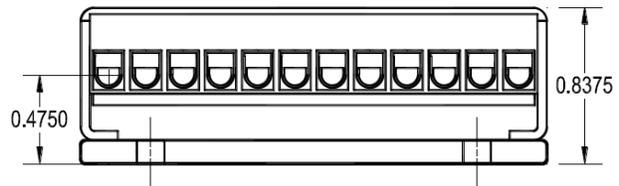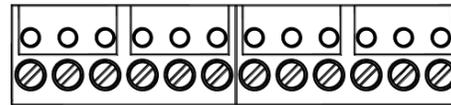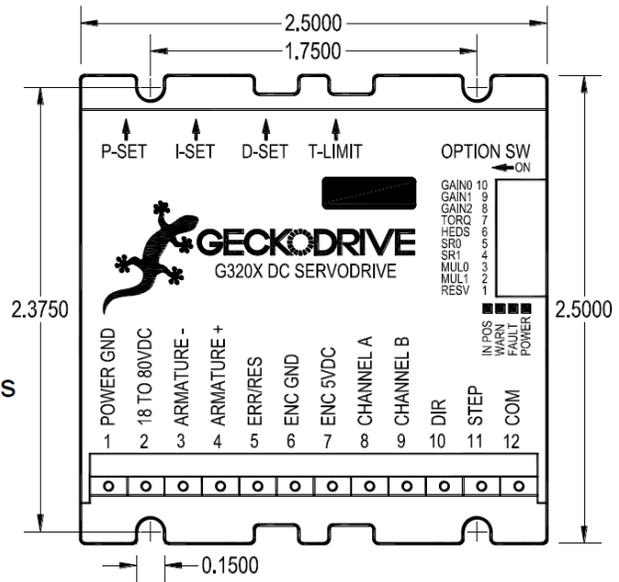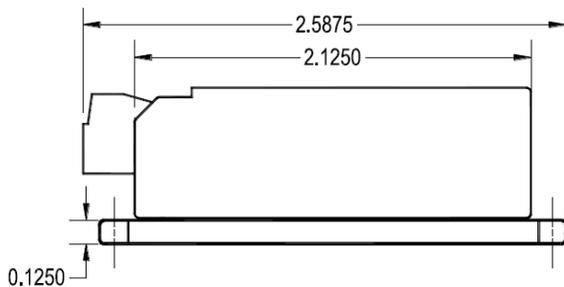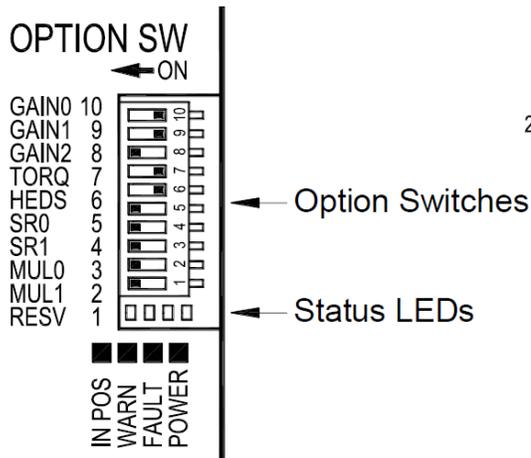
G320X SPECIFICATIONS

Power Supply: +18VDC to +80VDC
Quiescent Current: 30mA
Motor Current: 0 to 20 Amps
Motor Inductance: At least 1mH
Short Circuit Protect: 22A trip
Lock Range: +/- 256, 512, 1024, or 2048
Feedback: Quadrature TTL Encoder 5V Compatible
Feedback Resolution: X4 Encoder Line Count
Feedback Voltages: <1V for Logic 0 and >4V for Logic 1
Switching Frequency: 20kHz
Current Limit: 0 to 20 Amps Trimpot Adjustable
Analog PID: Proportional, Derivative, Integral Coefficient Trimpots
Step Pulse Frequency: 0 to 300kHz
Step LED "ON" Time (min): 1uS
Step LED "OFF" Time (min): 2.5uS
Size: 2.5" x 2.5" x 0.8375"
Package: Blue aluminum anodized cover, black aluminum hard anodized bottom heatsink
Weight: 3.6 oz. (100g)
Encoder Supply: +5VDC 50mA maximum
Pulse Multiplier: 1, 2, 5, or 10 times input step rate