Gecko G3x0
Error
Reset
Controller

The Gecko Error/Reset Controller (hereafter called the GERC because it's easier to type) is a very flexible device, and capable of many different wiring configurations.

At its simplest, though, only seven connections *have* to be made in a four axis system, with all other connections being optional.

This document will describe the possible uses of this design, and the theory behind the design decisions. It is intended for purchasers of the preassembled units, but the information will also be of value to those building the unit from the bare boards or from scratch.

Where "colored wires" are named, those colors refer to the wires included with the version of the assembled GERC that includes all wiring. This will be referred to throughout this document as the GERC-AW.

All the standard legal disclaimers that have ever been written apply to this document.

If you are not completely proficient in electrical wiring and familiar with local ordinances, you should not proceed.

Design Theory

The Gecko G320 and G340 controllers are fabulous devices, but have one minor little annoyance - the Error/Reset pin. The operation of this pin is somewhat confusing, and the usage even more so.

The newest version of the Gecko 3x0 devices ease the use of this pin by allowing a person to wire all the pins in a system together, but this is still, in my opinion, an incomplete and inflexible solution.

Looking at the various circuits available from a number of sources, I decided that none of them precisely suited my needs and so decided to create yet another design. Considering that the problem was mostly one of *logic* and only partly electronics, I decided to use a microcontroller.

My design goals were these.

- Automatically provide the 5 second reset required at powerup.

  I don't think, in this day and age of electronics, I should have to stand around and wait for a light to go off.

- Fault all the axes should a single *active* axis fault.

  If something bad happens such that an axis faults, it's obviously important to turn everything off. The part may still be rescued and possible damage to the machine or tooling is eliminated.

1. Provide a means to disable all the motors without having to resort to a poweroff.

   Turning on big power supplies, like those found in servo supplies, puts a strain on many of the components in the supply. I wanted a means of resetting/disabling things without the “shock” of simply turning it off.

- Provide a means to disable a single axis without disturbing the fault detection logic.

  Sometimes I like to combine CNC movement with manual adjustment. For example, on a piece of material of unknown composition, I may manually adjust the Z axis until I’m confident of the depth of cut.

- In the event of a fault, indicate which axis caused the fault.

  If something bad happens to an axis, I want to know *which* axis. The Gecko gives this information, via an LED turned on *inside* the case. I want to see it outside the case.

- Allow an EStop input to disable both the motors (via relays) as well as disabling the Geckos.

  An external EStop *switch* should be a part of every servo system. This *switch* should be at a minimum a Big Red Button within easy reach. Much better still is a Big Red Button combined with limit switches on each axis.

  When stepper electronics fail, typically the motor refuses to turn. The most common form of servo electronics failure sends the motor running at maximum speed.

  This is the reason for relays. Should the servo electronics fail in such a manner, simply saying to the Gecko (via pin5) “please stop” will not work, causing extreme badness.

  However, for those people who, for whatever reason, choose not to add relays, the EStop input will also disable the Geckos via pin5.

- Send a signal to the controlling PC should a fault occur.

  The PC may have other apparatus connected to it besides just the servo motors. If something bad happens, the PC should be informed.

Connecting the GERC

Connector Description

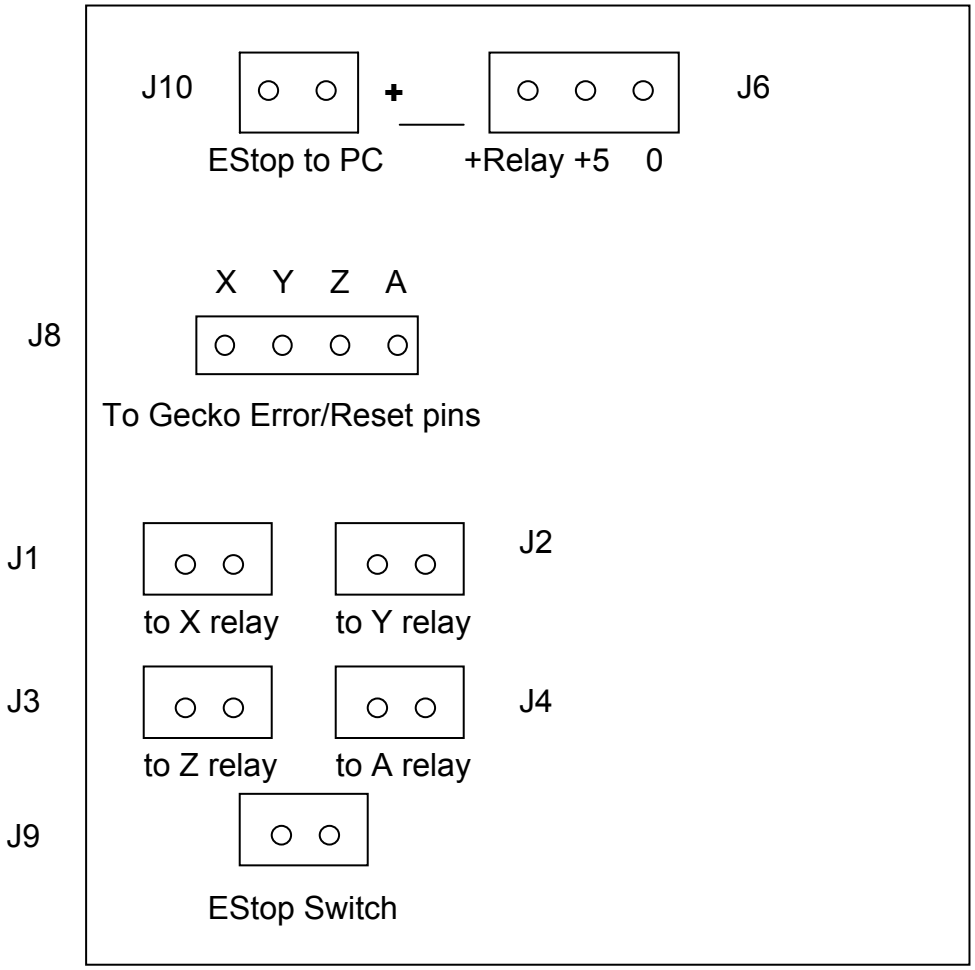

Figure 1

J1 through J4 - the relay connectors

These connectors are intended to supply power to the coil of *optional* relays. These relays are wired to interrupt power going from the power supply to the Gecko(s) and can also supply some dynamic braking for the axis .

The use of relays is strongly encouraged!

J1 X axis relay
J2 Y axis relay
J3 Z axis relay
J4 A axis relay

It is suggested that the relay(s) be used to interrupt the power coming from the motor power supply positive to the Gecko power input (pin 2), usually labeled

+24 to 80 VDC

Connect the relay COMMON terminal to the Gecko pin 2.
Connect the relay NO terminal to the power supply positive.
Connect a suitable value and size power resistor from the relay NC terminal to power supply negative.

Finally, as an added (and very cheap) safety measure, add a suitable diode.

Connect the diode Cathode (the band) to the relay NO terminal.
Connect the diode Anode to the relay COMMON terminal.

This diode will provide a place for the energy stored in the motor to go during the brief interval when power to the relay is removed, and the COMMON terminal is contacting neither the NO nor the NC terminal.

So wired, the GERC can disconnect the Geckos from power automatically *and* brake the motors, should it need to. See figure 2 on the next page for an example of such a wiring scheme.

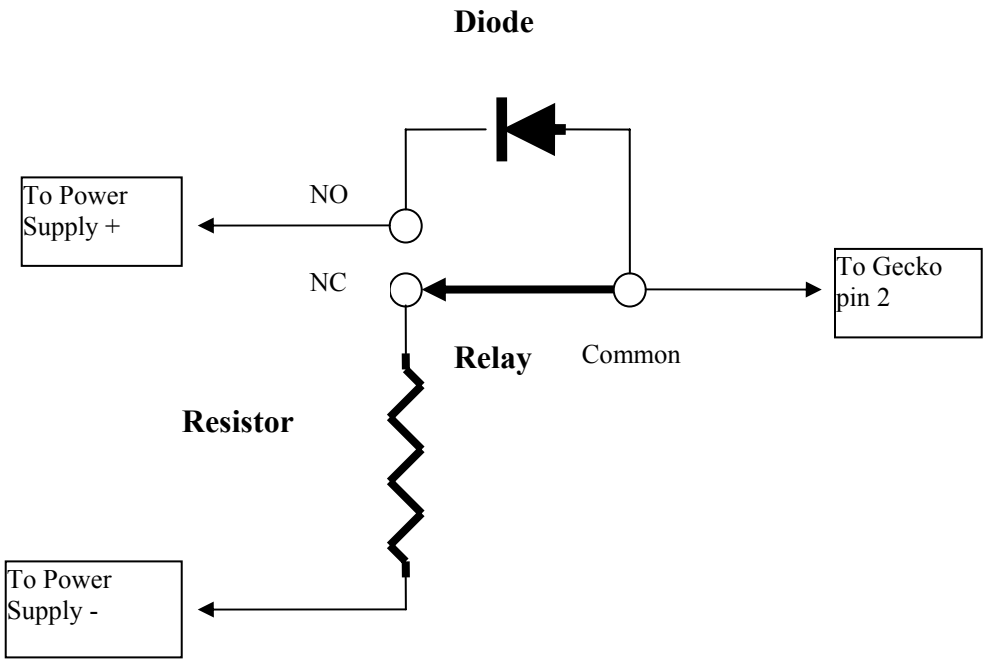

Figure 2

Now, what constitutes suitable ? In conversations with Mariss, he says

“5 to 10 watts”

and

“sized to carry no more than 10-15A when used with your supply voltage. It will carry dynamic breaking current during motor deceleration. Use a wirewound resistor only; they can sustain a pulse load in excess of 50 times their rated dissipation.”

As an example, with a 60 volt supply, a 4.7 ohm or 5.6 ohm resistor (the standard values between 4 ohms and 6 ohms) would be suitable.

As a choice for a diode, 5 amps at a PRV (Peak Reverse Voltage) of whatever the power supply voltage is should be OK. However, the difference in price between a 50 volt diode and a 200 volt diode is small, so use the 200 volt part. Some examples would be

S5DC-13
FR603
1n3881

Here are the circumstances under which the GERC will disconnect power to the Gecko.

1. The control switch for an axis is set to disable.
2. An axis faults. When one axis faults, the GERC will disable all the axes.
3. The EStop switch is pressed.

The GERC will disable the axes by pulling the Error/Reset pin (pin 5) of the Gecko low *and* by removing power from the relays.

The GERC-AW is supplied with four two-pin leads, blue, green, white and yellow, to use as relay connectors.

Notes:

1. A suitable relay for use in systems with motor voltages up to 36 volts or so is the P&B T9AS5D52-12 It is available from Jameco Electronics as part number 137357.
2. The absolute maximum relay coil current, per relay, is 125 ma.
3. The use of solid state relays is discouraged. (Remember, we're putting in a mechanical safety device because we're worried about an electronics failure)

J6 - the power connector.

The connector supplied with the GERC-AW has three leads, used as follows.

Red	+5 volts
Black	0 volts (ground)
Orange	Relay/EStop power

This is one of the two *required* connections

Red: The GERC requires +5 volts at 100 ma.

There are two good sources of such power.

1. The motor power supply can be utilized, with either
   - a three terminal linear regulator and suitable heatsink or
   - switching regulator used to reduce the motor voltage to 5 volts.

2. A small separate power supply, such as the one shown on the web site, can be used. *When a separate is supply is used, the ground lead of the supply must be connected to the main system ground.*

It is recommended that you do ***not*** use the PC power supply for a source of 5 volts.

Black: The black lead must be connected to the system ground, typically, the negative terminal of the main (motor) power supply filter cap. The use of a single point ground is ***strongly*** recommended.

Orange: The orange lead serves two purposes. Power for the relays is supplied by this point, as well as power for the EStop logic.

> *Even if relays are not used, a source of power from +12 volts to +36 volts **must** be connected.*

If relays are used, the power supplied must be appropriate for the relays. If 12 volt relays are used, then 12 volts must be supplied. The relays must not draw more than 125 ma each.

J8 - the Error/Reset connections

This is the other required connection, and is how the GERC communicates with the Geckos. Using figure 1 (above) and figure 3 (below) as a guide, connect a wire from the X Y Z and A points of J8 to Pin 5 of the relevant Gecko.

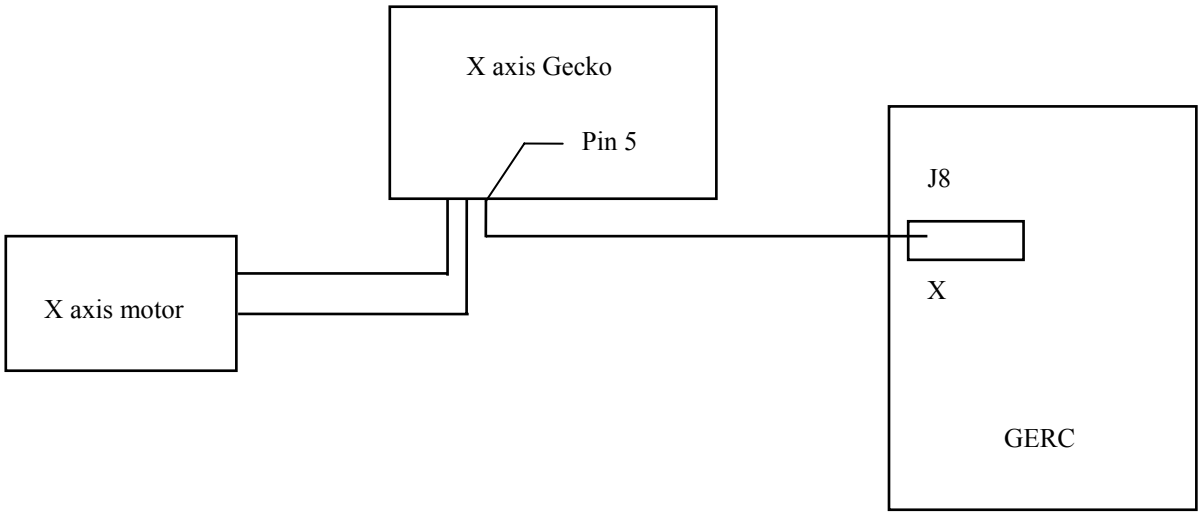

Figure 3

A four pin connector with a green, blue, white and yellow wire is supplied with the GERC-AW for this purpose. It is recommended that the relays be wired in the same color scheme as used by this connector.

Note: These inputs are a direct, unprotected connection to the microcontroller. Do not connect these inputs to anything except the Error/Reset pin of a Gecko G3x0.

J9 - EStop input

The EStop input is a designed to be connected to an external “Big Red Switch”, located in such a position that it is easy for the operator to activate it should the need arise.

This switch must be CLOSED for the GERC to operate. When the switch contacts open, the GERC will stop motor activity. This is a safety feature. Should the switch fail, the GERC will not allow the motors to turn. Should the wires leading to the switch be cut (by hot swarf, for example), the GERC will not allow the motors to turn.

The GERC is shipped with a jumper covering the EStop input, for testing purposes only. As a minimum, an external switch *really* should be connected. It is strongly recommended that EStop limit switches also be wired into the EStop loop, as shown below in Figure 3.

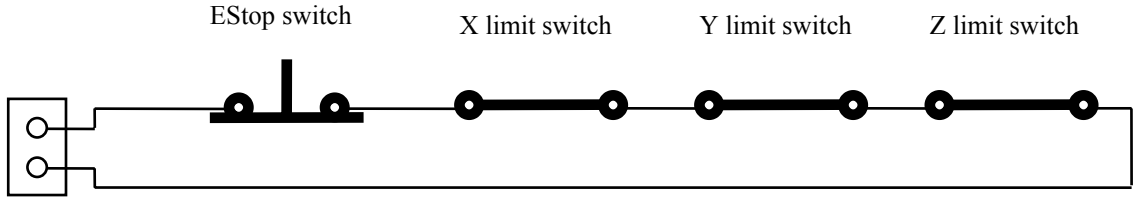

Figure 3

It is not enough to rely on limit switches wired to the controller. Should the Geckos fail such that the motors run full speed, limit switches wired to the controller will be ineffective.

The EStop switch carries relay power, and as such, the contacts cannot be shared with any other device.

If an EStop switch is to be used to turn off the lathe or mill motor, for example, as well as turning off the Geckos, then the EStop switch must be a multi pole device.

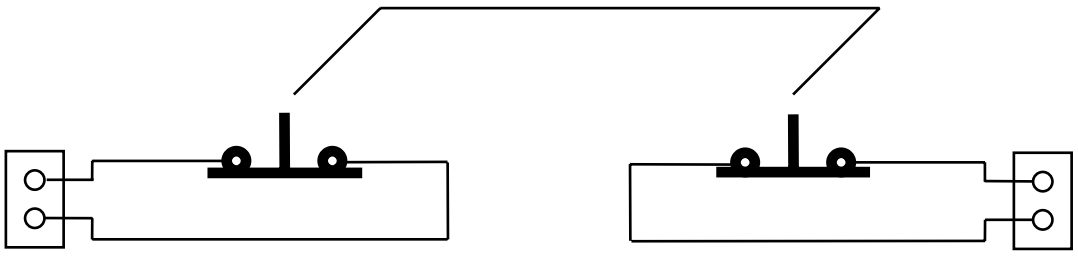

Figure 4

The orange two-wire connector is intended for this connection.

J10 – EStop output

The EStop output allows the GERC to alert the controller (typically a PC) that something bad has happened. Technically, it is the emitter and collector of an opto-isolated NPN transistor.

The red and black two-wire connector is intended to be used with the EStop output.

Assuming that the controller is a PC sending step and direction pulses through a parallel port, the connection is a follows.

The – (black) connection would go to the Ground connection of the parallel port.
The + (red) connection would go to one of the inputs pins of the parallel port.

Consult the documentation for the controller software to determine which pin the software expects for an EStop signal.

The EStop is active high. That is, in normal operation, the transistor "switch" is closed, such that the EStop pin on the PC port is grounded. Under an EStop condition, the switch is "opened", and the pin is no longer grounded.

> *For correct operation, then, the EStop pin on the PC parallel port must be actively pulled high via a resistor. The GERC does not "make it go high". The GERC either "makes it go low" or leaves it alone.*

Thankfully, the input electronics of most parallel ports already do this. For those that don't, the "breakout" boards commonly available will do it for you. See Dan Mauch at Camtronics for such a board.

Finally, don't forget to configure the software in the PC for an active high EStop signal.

Usage

Switches:

There are five switches on a GERC. The first four are used to enable or disable the X, Y, Z, A axes. They must be up (pointing to the LEDs) to enable an axis.

The rightmost switch is the AllStop/Reset switch. It must be up as well for things to operate. Down is All Stop (no matter what the state of the other four switches)

Down, then up again, is Reset.

Normal condition, then, is all switches UP.

LEDs:

There are four LED conditions.

Disabled axis

When an axis is ENABLED, the LED for that axis is ON steady.

With all axes enabled, all LEDs are on steady.
With all axes disabled, no LEDs are on.

Normal operation, then, is all LEDs on.

Reset

Any time the unit is reset, the LED for an *enabled* axis will blink slowly for 5 seconds or so. If all axes are enabled, all the LEDs will blink (in unison). During this time, the Geckos are being reset, and the fault LEDs on the Geckos (hidden away inside your chassis where you can't see them) should go out.

Two things cause a reset.

1. Power turned on.
2. Toggling the AllStop/Reset switch.

Axis fault

Should an axis fault during normal operation (things working fine), the LED for that axis will blink quickly.

A single blinking LED indicates a faulted axis.

The GERC will never show more than one axis faulted, even though more than one axis may have faulted. The instant an axis faults, the GERC immediately disables all the axes.

Estop event

When an EStop event occurs, all the LEDs blink rapidly until the EStop condition is cleared. Once the EStop condition is cleared, the LEDs then blink in sequence.

X LED, then Y LED, then Z LED, then A LED, then X LED again ...

> Note: Once the EStop condition is cleared, the GERC requires a reset, either by toggling the AllStop/Reset switch or by a power cycle, before the motors will again be allowed to operate.
>
> This is a safety measure, so that a machine stopped by an Estop event does not unexpectedly begin to move again.

Normal Operation at Powerup:

Assuming all switches are up … all axes enabled …

> All GERC LEDS blink in unison
>
> Within 5 seconds, the Gecko LEDs go out.
>
> Just after 5 seconds, the GERC LEDs stop blinking and remain on constantly.

Construction Notes:

Here are few quick points for those people who have purchased the bare boards.

1. The yellow blob tantalum cap is polarized. Pay close attention to this item. (I need a magnifying glass to see the darn markings)

2. The PCB has a silk-screened location for a 2.2k resistor. However, one of three resistor values may in fact be required there, depending upon the voltage used for the relays.

Relay Voltage	Resistor
5 – 12 volts	470 ohm
12 – 24 volts	1 kohm
24 – 36 volts	2.2 kohm

*Relay power **must** be supplied for proper operation, even if relays are not used.*

1. The ribbon cable is attached to the **back** of the switch/LED board. This allows the ribbon cable to nicely clear the switches and LEDs.