Gecko G3x0
Error
Reset
Controller

Rev 2

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.

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.

The GERC connectors

J1 – Power

The GERC requires a ***regulated*** source of 5 volts at 100 ma, and an unregulated source of 12 volts supplying at least 50 ma, more if relays are used.

The +5 is applied to J1 pin 2. There are several good sources of such power, two common ones being

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, or

2. a small separate power supply, salvaged from an external hard drive or CDROM case 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 computer power supply for the source of 5 volts.

The +12 is applied to J1 pin 1. If relays are to be used, the supply must (obviously) supply enough current to engage the chosen relays, plus 50 ma more for the EStop circuitry.

The relay coils cannot draw more than 125 ma per relay, or 500 ma total.

Even if relays are not used, a source of 12v power **must** be connected to J1 pin 1, as this pin powers the EStop logic as well.

It is recommended that you do *not* use the PC computer power supply for the source of 12 volts either. The power supply in the computer case should only power the electronics in that case; the devices in the controller case should be powered by a supply in the controller case.

The DC return for the GERC (aka, “ground”) appears at J1 pin 3, and 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, which means that the “ground” from the +5 power supply should ***not*** be connected to the GERC; it too should go directly to the system ground.

Appendix 1 shows a suitable connection scheme.
Notes:

1. If relays with a coil voltage higher than 12v are to be used, the GERC must be appropriately modified. Please specify this at time of purchase.

2. If relays are never going to be used (not recommended), the GERC can be modified to work with 5 volts only. Please specify this requirement at time of purchase.

J2 – EStop output

The EStop output allows the GERC_RLY to alert the controller (typically a PC) or an intelligent "break out" board that something bad has happened. Technically, it is the contacts of a single pole double throw (SPDT) relay. As such, it may be wired in two manners.

1. the contacts are closed for normal operation and open in the event of a problem. Connections would be made using pins 1 and 2. Alternately,
2. the contacts are open for normal operation, and close in the event of trouble. In such a case, connections would be made using pins 2 and 3.

If there is a choice (as determined by the controller software or the breakout board), it is recommended that option 1 be chosen.

Example: Direct connection to a parallel port

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

J2 pin 1 would go to the Ground connection of the parallel port.
J2 pin 2 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.

> For correct operation, the EStop pin on the PC parallel port must be actively pulled high via a resistor. The GERC_RLY does not "make it go high".

Thankfully, the input electronics of most parallel ports already do this.

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

J3 - Error/Reset

This is how the GERC_RLY communicates with the Geckos.

Using figure 1 (below) as a guide, connect a wire from the X Y Z and A points of J3 to Pin 5 of the relevant Gecko. (Four Geckos, four wires)

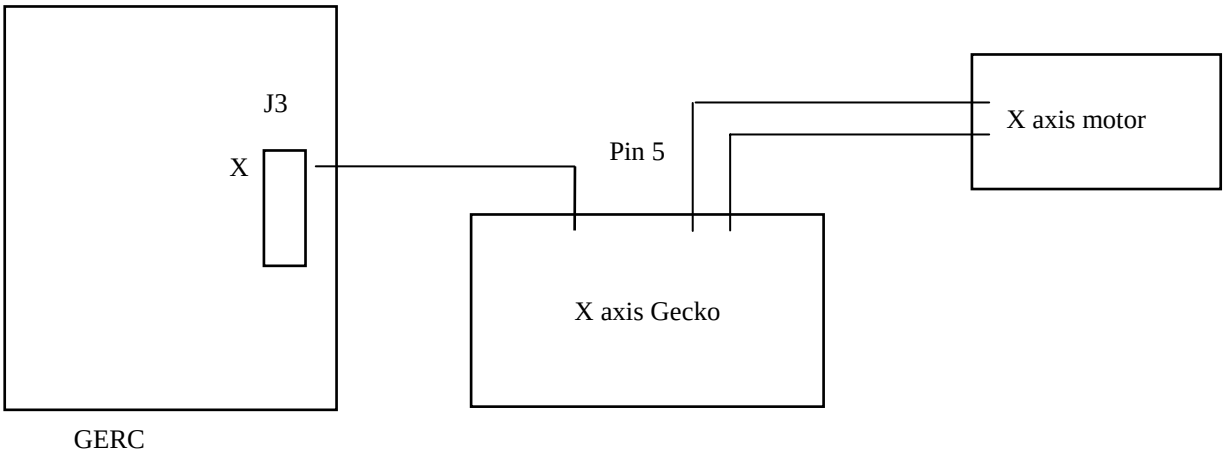


Figure 1

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.

J4 - EStop switch input

The EStop switch 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_RLY to operate. When the switch contacts *open*, the GERC_RLY will stop motor activity (by first placing the Geckos into reset and then removing power to the Geckos).

Should the switch fail, the GERC_RLY will not allow the motors to turn. Should the wires leading to the switch be cut (by hot swarf, for example), the GERC_RLY will not allow the motors to turn.

The GERC_RLY is shipped with a wire jumpering 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 2.

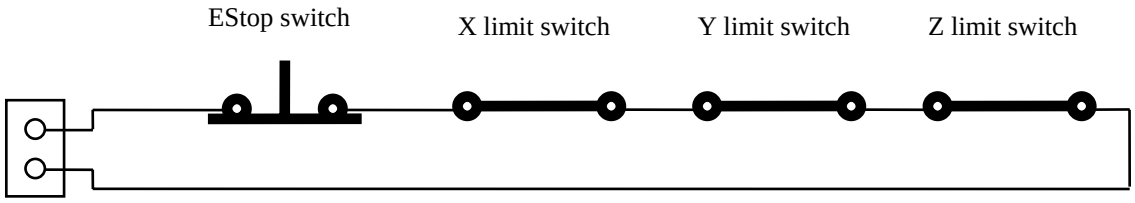


Figure 2

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.

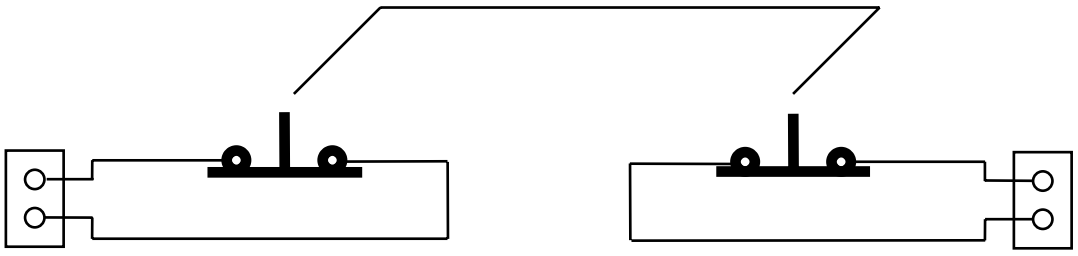


Figure 3

EStop Override

When limit switches are wired into the EStop circuitry (as recommended above), the table/knee/quill will have to be moved to a position such that the limit switch is no longer open.

On a machine with handwheels, this presents no problem. On fully automatic machines, that is, machines with no handwheels, a Catch-22 situation arises whereby the table can only be moved by the Geckos and the GERC_RLY will not allow the Geckos to operate until the table has moved.

For such machines, an EStop Override switch is required to "trick" the GERC into thinking that all is well. This ***must*** be a normally open switch and ***really*** should be a momentary switch. It must also be placed within easy reach of the keyboard, as you'll be holding this Override switch down with one hand will jogging via the keyboard with the other.

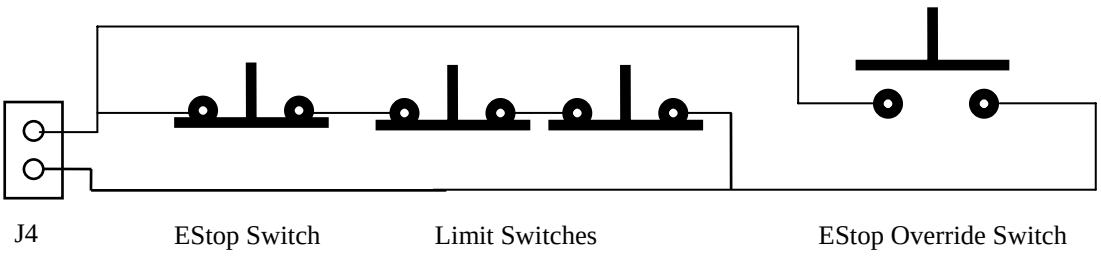


Figure 4

The actual series of operations to clear such an event is as follows.

1. Press and hold the EStop Override switch.
2. Reset the GERC_RLY by toggling the AllStop/Reset switch (as described below)
3. Reset your controller program (if required)

4. Jog the offending axis

J5 through J8 - 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!

J5 X axis relay
J6 Y axis relay
J7 Z axis relay
J8 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 5 on the next page for an example of such a wiring scheme.

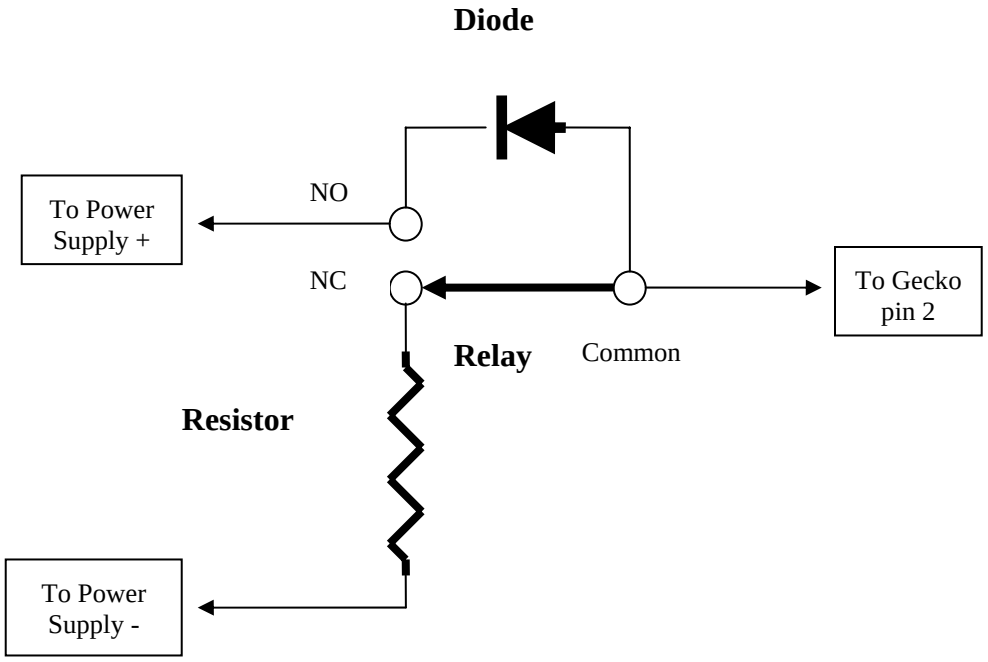


Figure 5

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.

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)
4. The GERC is designed for use with 12 volt relays. If the use of a different relay is required, a small modification to the GERC is required.

J11 – Front Panel Connector

J11 is the connection to the front panel LED/switch board.

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.

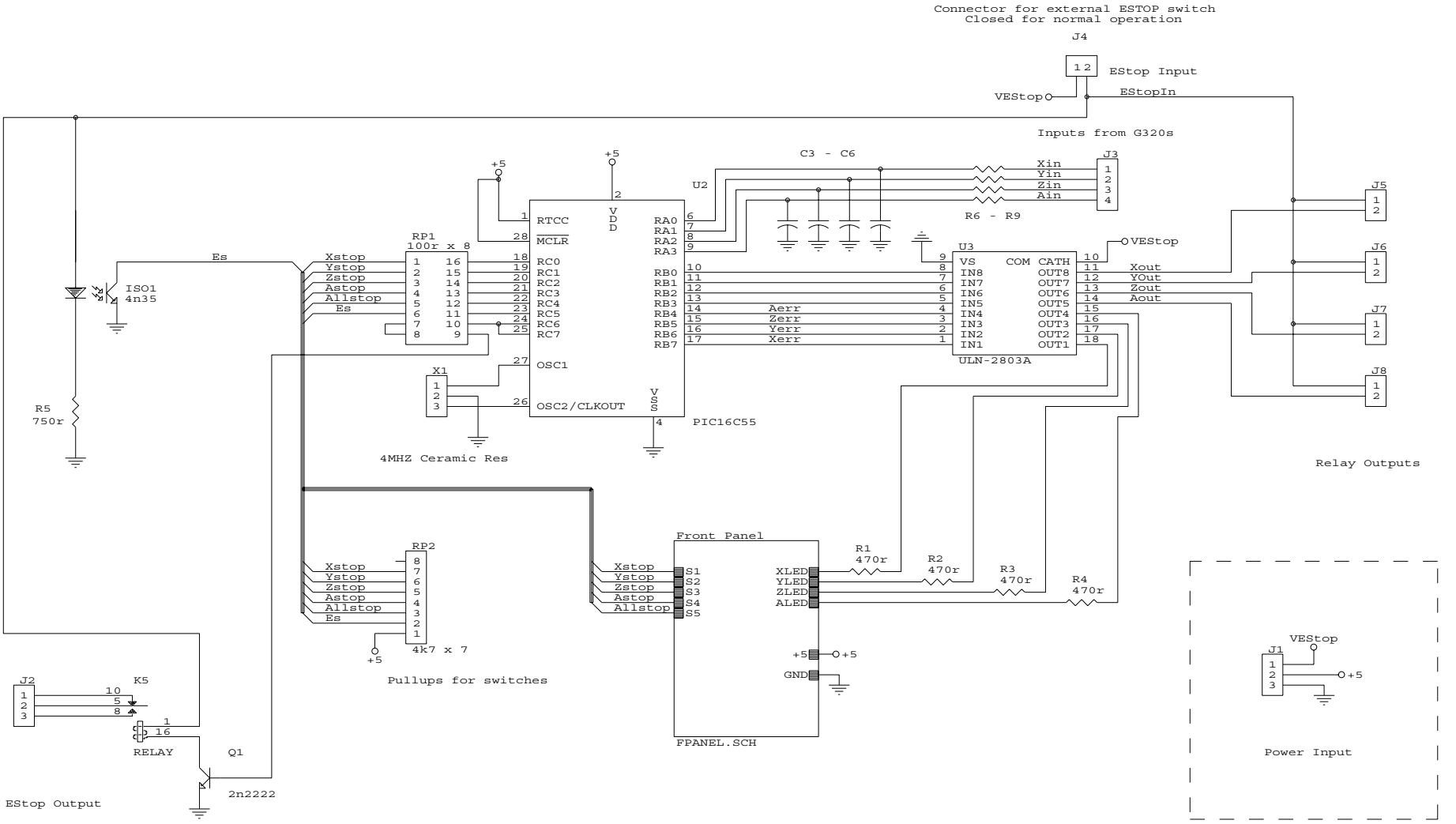
X LED, then Y LED, then Z LED, then A LED, then X LED again ...

> 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.



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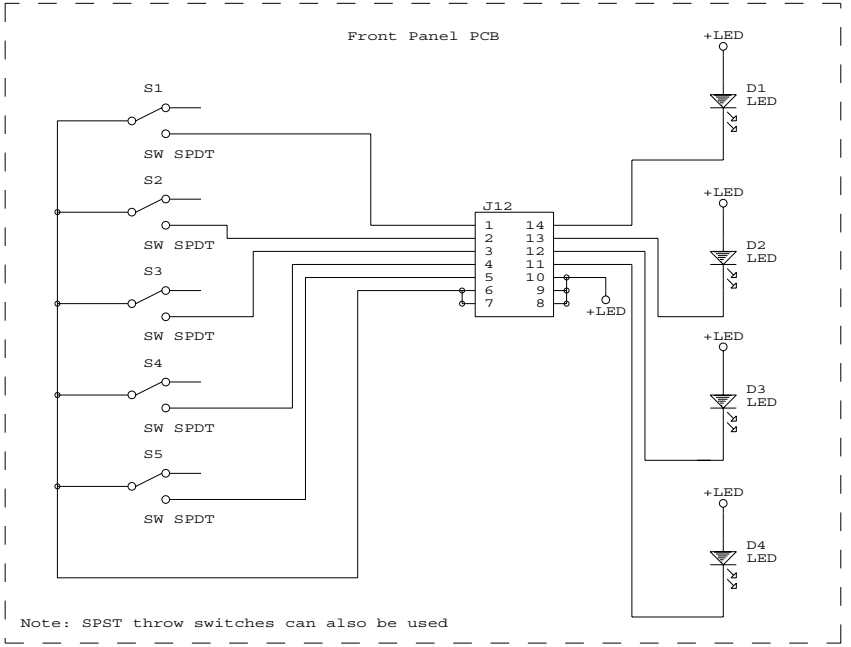

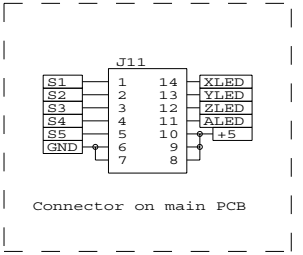

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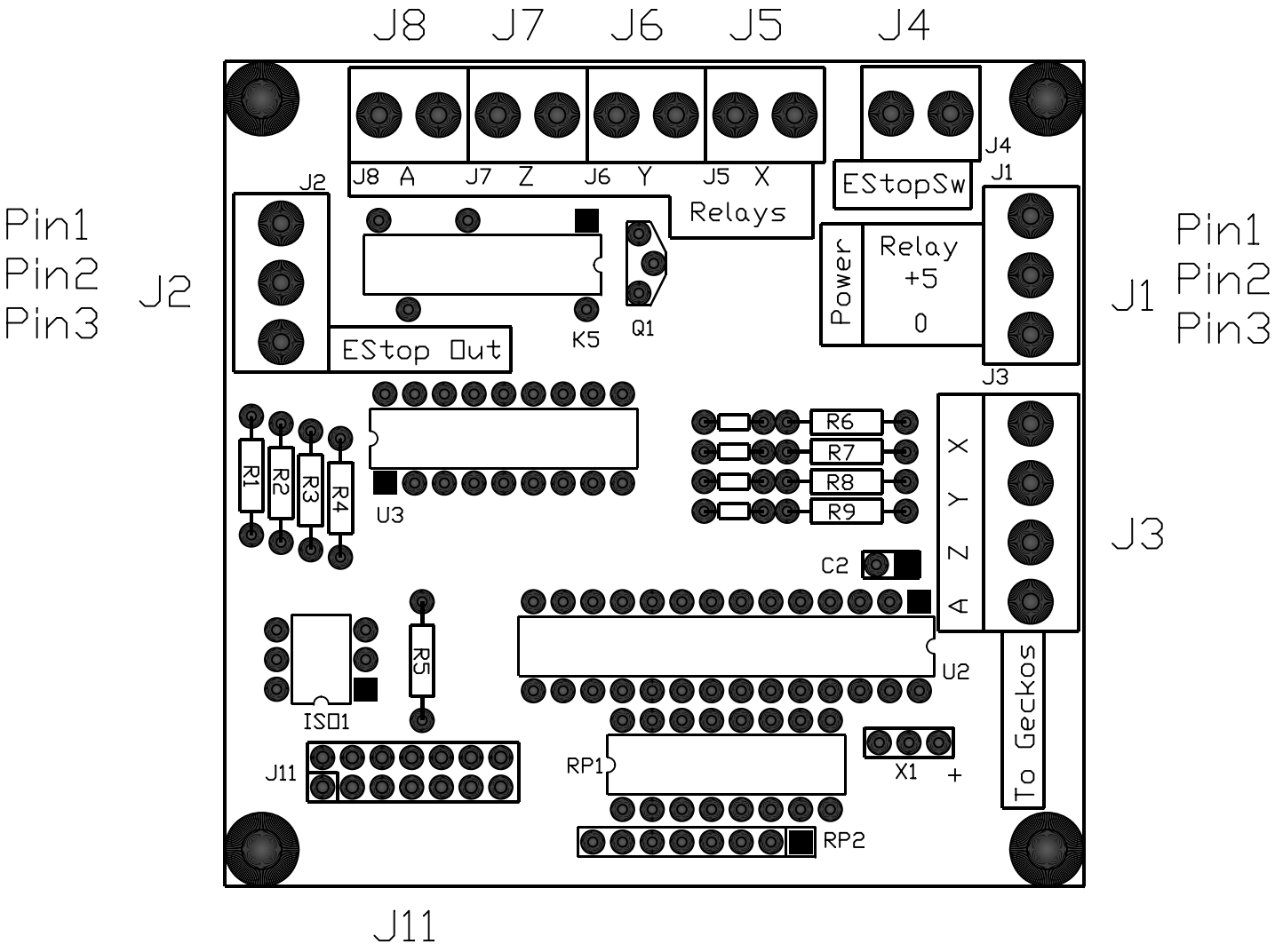
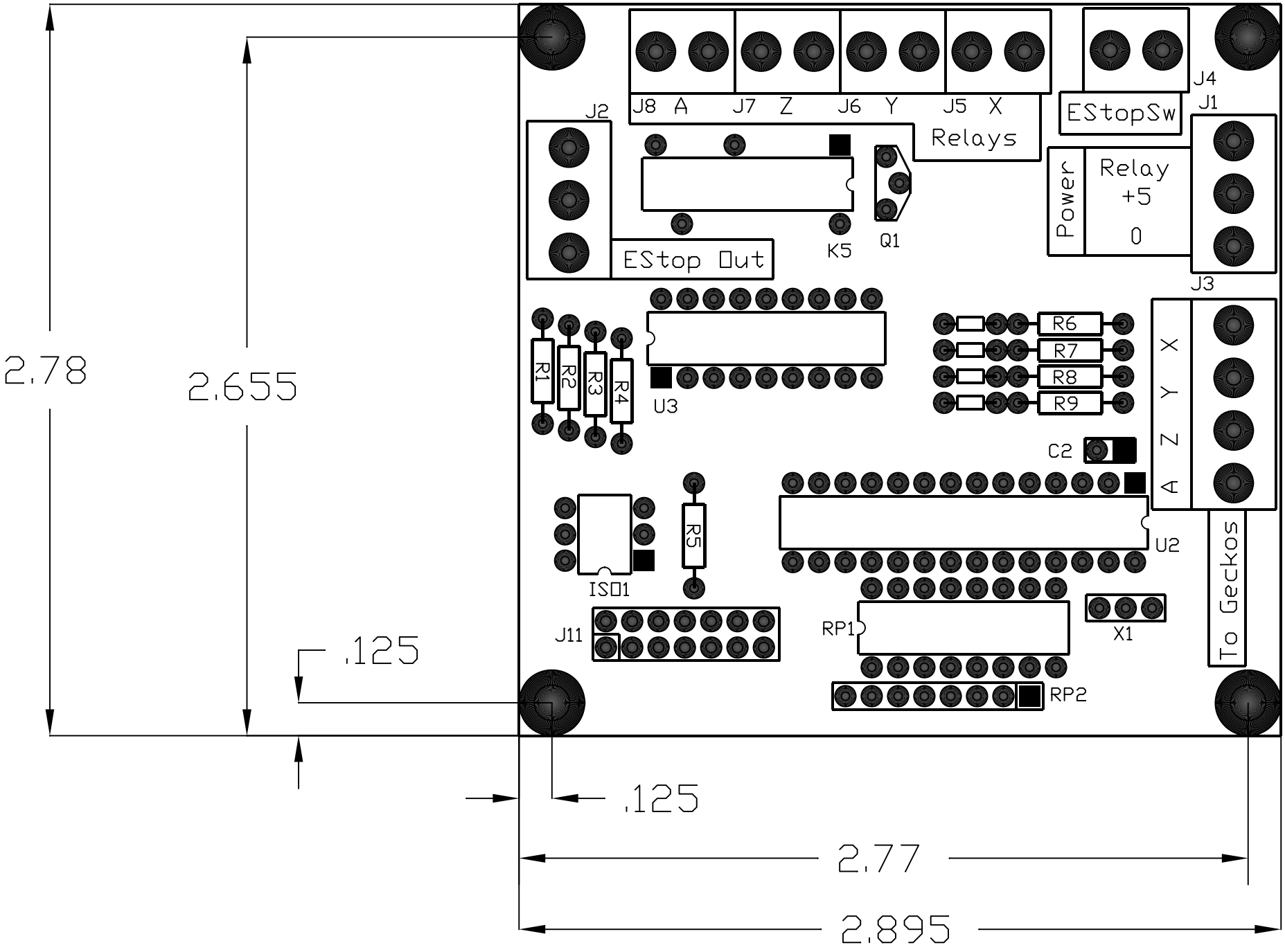
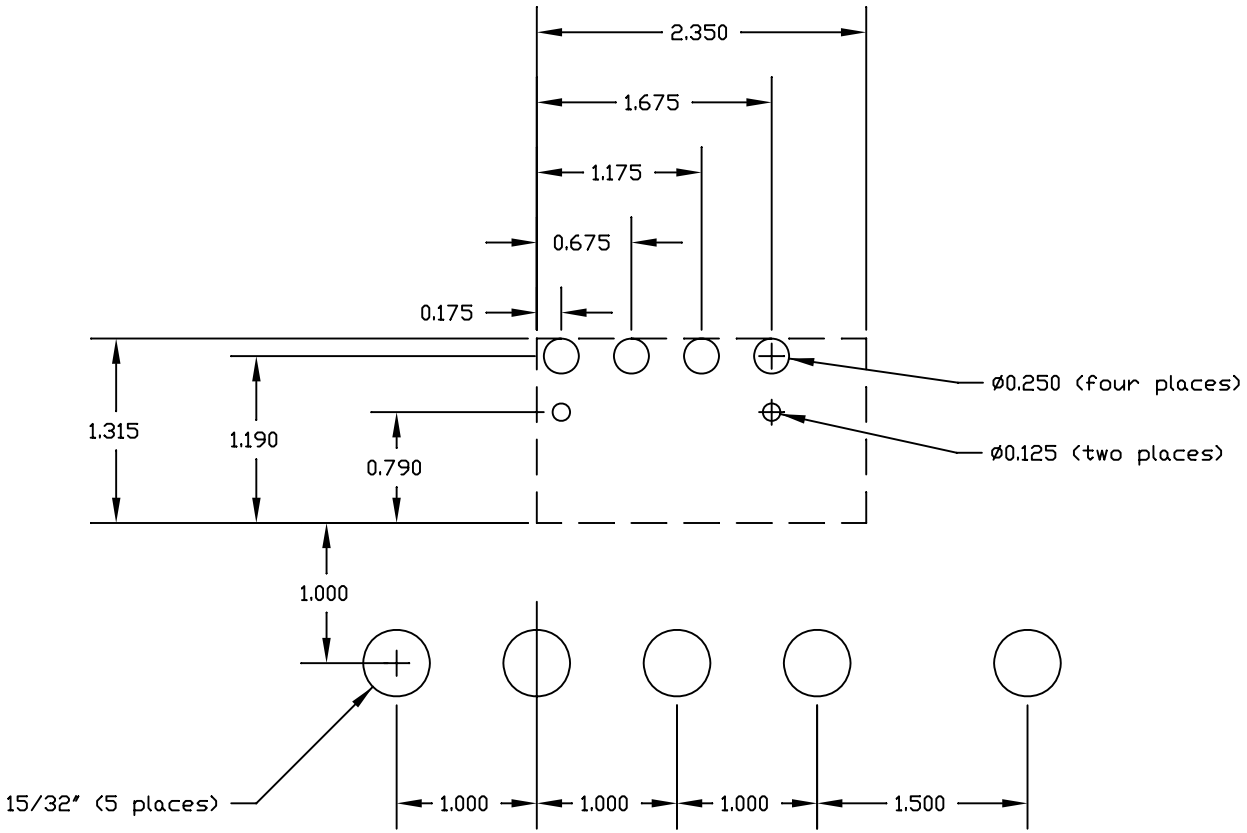
GERC connectors




2.78
2.655
.125
.125
2.77
2.895
J8 A
J7 Z
J6 Y
J5 X
Relays
J4
EStopSw
J2
J1
Power
Relay
+5
0
EStop Out
K5
Q1
J3
R1
R2
R3
R4
U3
R6
R7
R8
R9
X
Y
Z
A
C2
R5
U2
ISO1
J11
RP1
X1
RP2
To Geckos

Drilling pattern for front panel LED display

(when used with large switches)

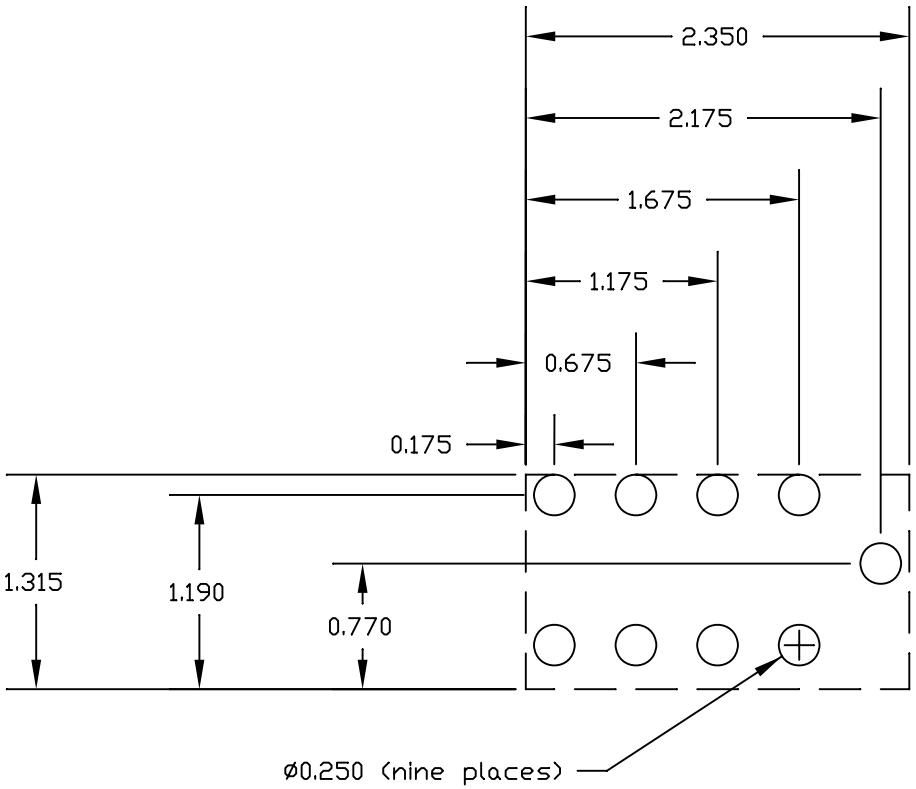


15/32" holes may be adjusted to personal taste

within the limits of lead wire length

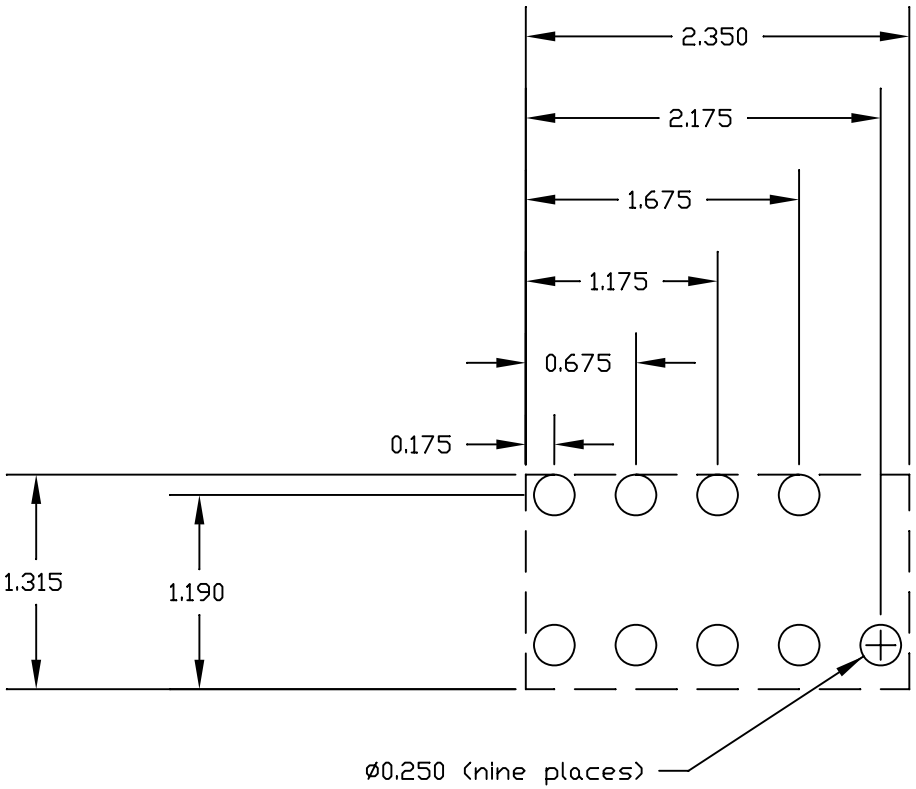
Recommended drilling pattern for front panel LED display

(when used with 1/4" switches soldered to PCB)



Optional drilling pattern for front panel LED display

(when used with 1/4" switches soldered to PCB)



Appendix A Single Point Ground