Gecko G3x0
Error
Reset
Controller

Relays included version

Rev 2.

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.

- 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 result of these ruminations were the GERC, a small PCB that did all of the above.

I feel quite strongly that relays should be part of every servo system but found that some people were put off by the (modest) additional wiring requirements to incorporate them. Others were somewhat discouraged by the requirement to source and wire a separate 5 volt power supply.

So a second product was developed, the GERC_RLY. This device is an *All-In-One* version of the original GERC with relays, protection diodes, dynamic braking resistors and power supply built in.

Connecting the GERC_RLY

J1 – Power

Perhaps the most important connector on the PCB, J1 pin2 is used to connect the DC common of the GERC_RLY (more commonly - if less correctly - known as “ground”) to the DC common (ground) of the motor power supply.

While J6 to J9 (the relay connectors) have connections to the motor supply ground, this connection must also be made, as the relay connections are completely separated from the logic connections.

Power for external devices

A total of 200 milliamps (ma) of current is available for powering external devices.

An unregulated source of approximately 12 volts DC is available between J4 pin 2 (+) and J1 pin 2 (0).

A regulated 5 volts is available from J1 pin 1 (+) and J1 pin 2 (0).

The two sources may be used at the same time, but at no time must the total consumption exceed 200 ma.

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 2 and 3. 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 1 and 2.

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 2 would go to the Ground connection of the parallel port.
J2 pin 3 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 connections

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)

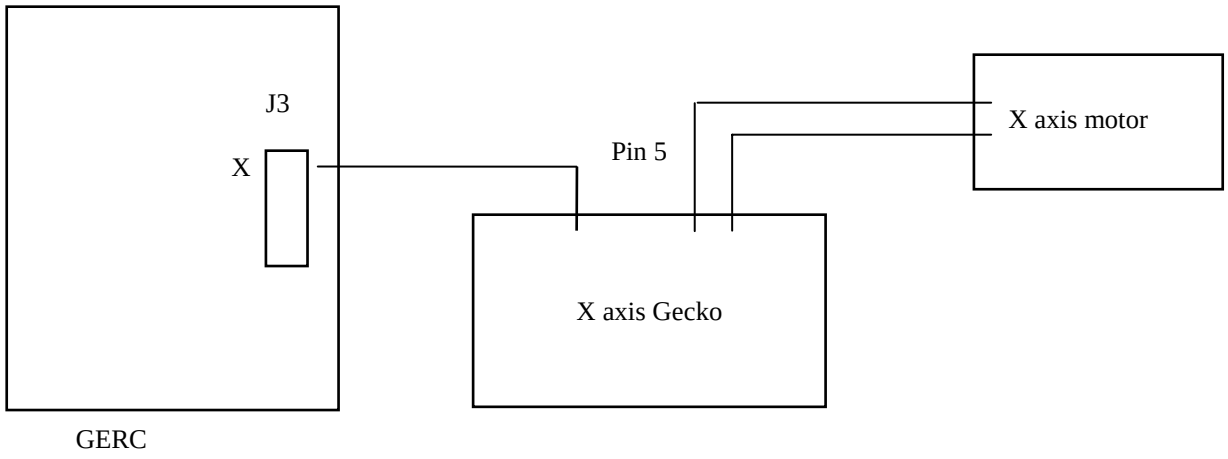


Figure 1

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

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.

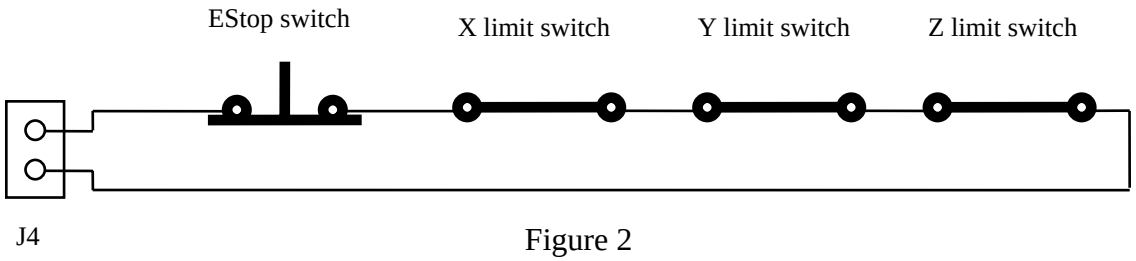


Figure 2

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.

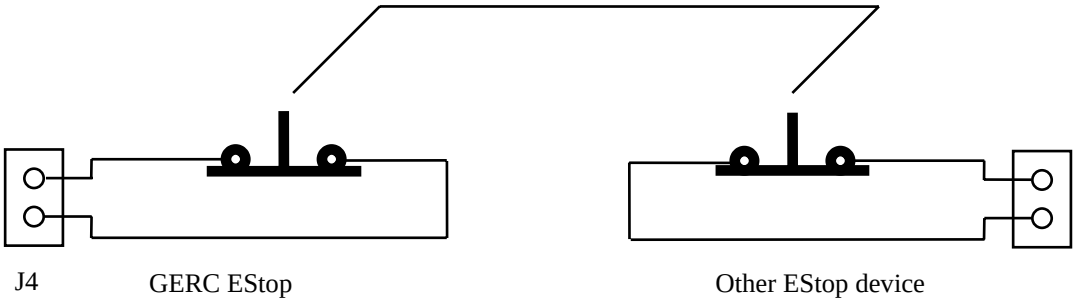


Figure 3

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.

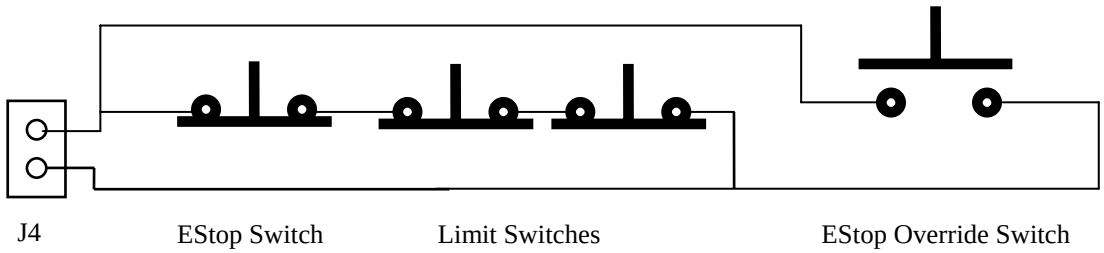


Figure 4

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 110 VAC power input

The GERC_RLY has an onboard power supply, but needs 110 Volts AC. This must be supplied through a power switch and fuse, in accordance with local regulations. It is the outer two connections that are used; the inner terminal is used for isolation only. A suitable value for a fuse would be 1 amp, quick blow. Typical current consumption is 100 ma.

J6-9 Relay Connections

J6 X axis power connector
J7 Y axis power connector
J8 Z axis power connector
J9 A axis power connector

These connectors are wired to the relay contacts.

DC power from the motor’s power supply comes in to pin 1 of the connector, and then to the Normally Open relay contact.

The Common relay contact is attached to the connector’s pin 2, and then to the Gecko’s pin2.

The Normally Closed relay contact is connected to a power resistor, used for dynamic braking. The other end of this power resistor goes to pin 3 of these connectors, which is then connected to the power supply negative (aka, “ground”).

The GERC_RLY, upon power up, examines the state of the axis enable switches (more on this later) and depending upon which switches are “up”, closes the appropriate relay contacts, which then powers the appropriate Gecko(s).

Should a Gecko fault or an EStop condition be detected, all relays are opened. Power is now removed from the Gecko(s), and a power resistor connected across the motor terminals. (This connection is actually through the Gecko, not directly to the motor, but the nature of the Gecko output stage is such that this is the correct way to do this.)

Here are the circumstances under which the GERC_RLY 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_RLY will disable all the axes.
3. The EStop switch is pressed.

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

Usage

Switches:

There are five switches on a GERC_RLY. 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.

Enabled 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 a Gecko detect a fault condition on an axis during normal operation (things working fine), the LED for that axis will blink quickly.

A single blinking LED indicates a faulted axis.

The GERC_RLY will never show more than one axis faulted, even though more than one axis may have faulted. The instant an axis faults, the GERC_RLY 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_RLY 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_RLY LEDS blink in unison
>
> Within 5 seconds, the Gecko LEDs go out.
>
> Just after 5 seconds, the GERC_RLY LEDs stop blinking and remain on constantly.

GERC_RLY Controller connection guide

110 VAC in

Use outer connections only

X motor power supply +

X Gecko Pin 2

X motor power supply - (Gnd)

Y motor power supply +

Y Gecko Pin 2

Y motor power supply - (Gnd)

Z motor power supply +

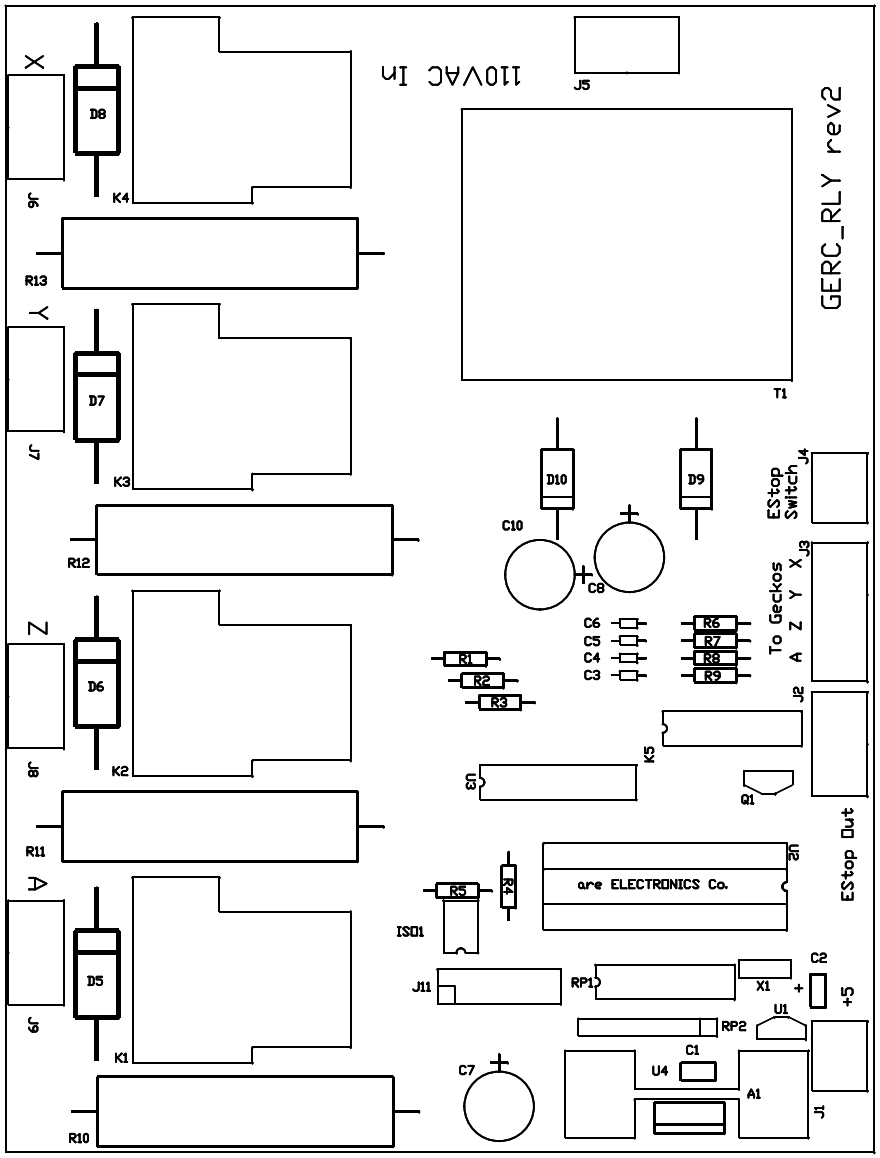
Z Gecko Pin 2

Z motor power supply - (Gnd)

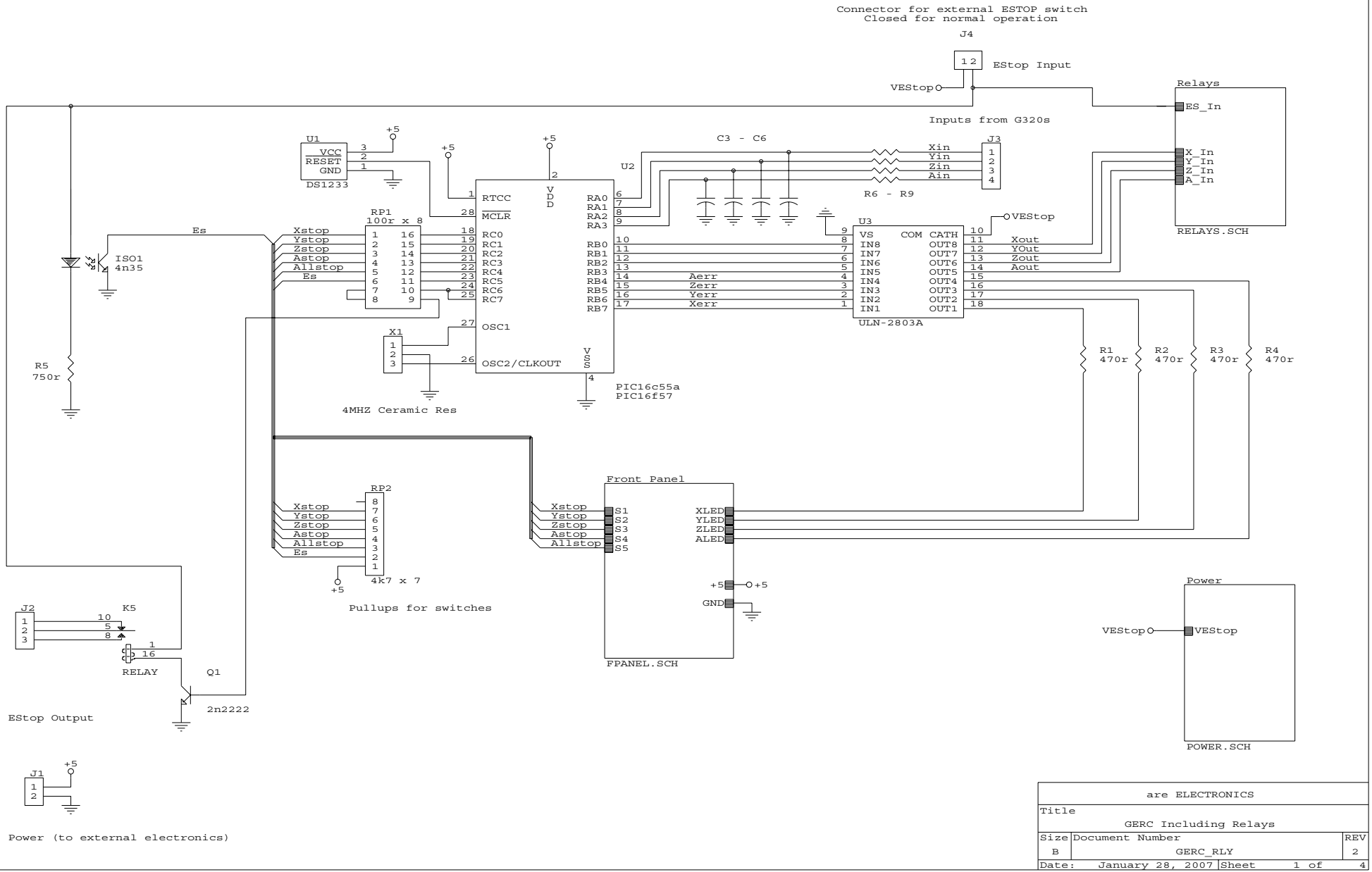
A motor power supply +

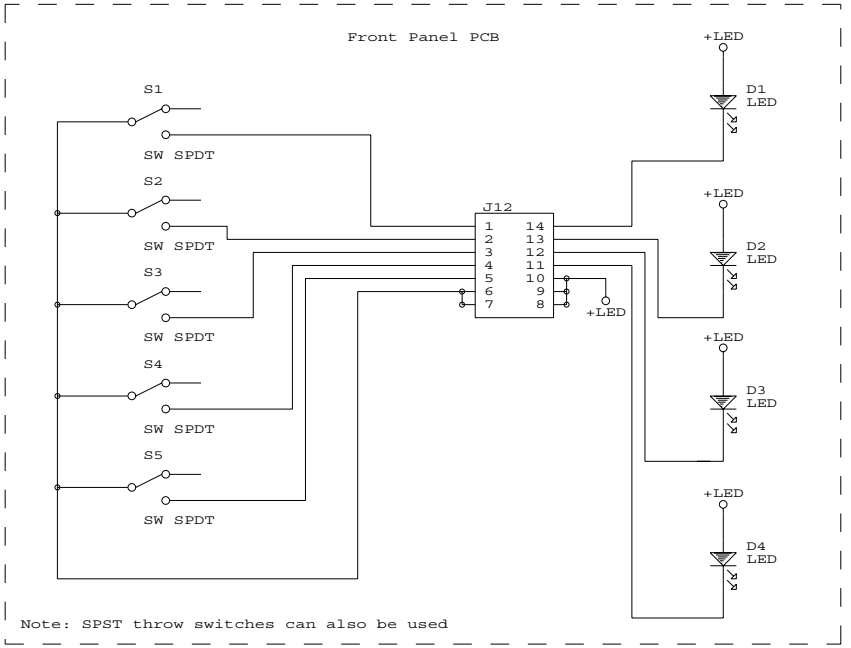
A Gecko Pin 2

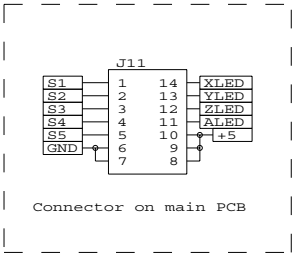
A motor power supply - (Gnd)



J4	EStop and limit switch(es)	Pin 1 Pin 2
J3	X Y Z A	To Gecko G3x0 drive(s)
J2	Estop Out	Pin 1 Pin 2 Pin 3
J1	+5 Gnd	Pin 1 Pin 2


Connector for external ESTOP switch
Closed for normal operation
J4
EStop Input
VEStop
Relays
ES_In
Inputs from G320s
X_In
Y_In
Z_In
A_In
RELAYS.SCH
U1
VCC
RESET
GND
DS1233
+5
RP1
100r x 8
Es
Xstop
Ystop
Zstop
Astop
Allstop
ISO1
4n35
R5
750r
U2
RTCC
MCLR
OSC1
OSC2/CLKOUT
VDD
VSS
RA0
RA1
RA2
RA3
RB0
RB1
RB2
RB3
RB4
RB5
RB6
RB7
RC0
RC1
RC2
RC3
RC4
RC5
RC6
RC7
X1
4MHZ Ceramic Res
PIC16c55a
PIC16f57
C3 - C6
R6 - R9
Xin
Yin
Zin
Ain
J3
U3
VS
IN8
IN7
IN6
IN5
IN4
IN3
IN2
IN1
COM
CATH
OUT8
OUT7
OUT6
OUT5
OUT4
OUT3
OUT2
OUT1
Xout
Yout
Zout
Aout
Aerr
Zerr
Yerr
Xerr
ULN-2803A
R1
470r
R2
470r
R3
470r
R4
470r
RP2
4k7 x 7
Pullups for switches
Front Panel
S1
S2
S3
S4
S5
XLED
YLED
ZLED
ALED
GND
FPANEL.SCH
Power
POWER.SCH
J2
K5
RELAY
Q1
2n2222
EStop Output
J1
Power (to external electronics)
are ELECTRONICS
Title
GERC Including Relays
Size
B
Document Number
GERC_RLY
REV
2
Date: January 28, 2007
Sheet 1 of 4





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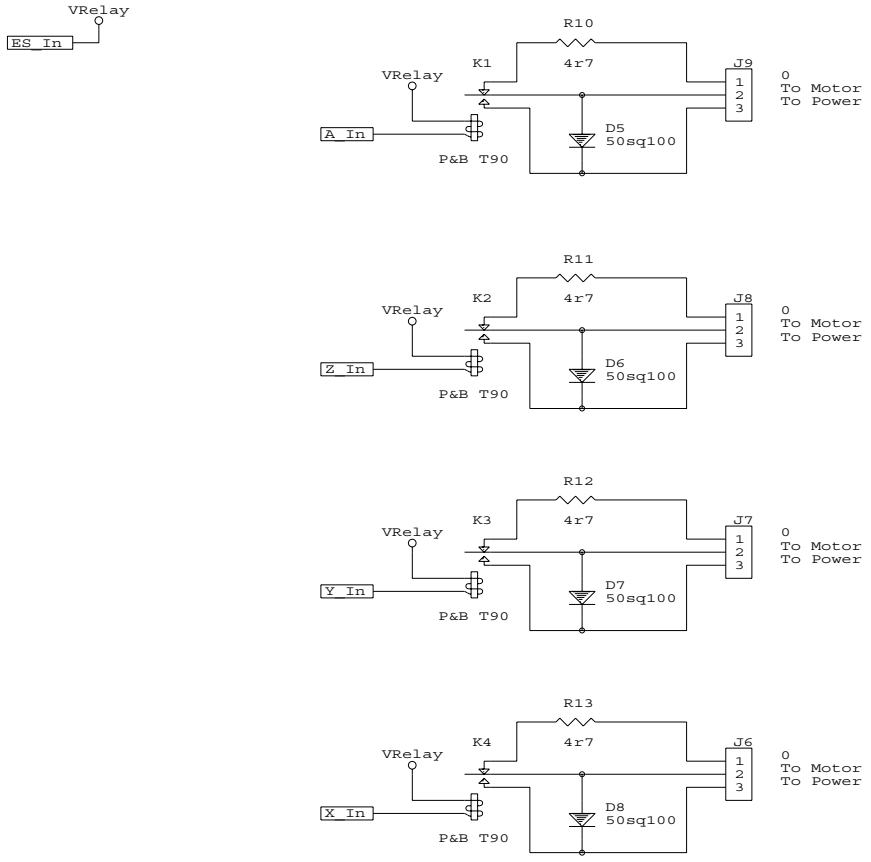
Date: January 28, 2007	Sheet 2 of 4	



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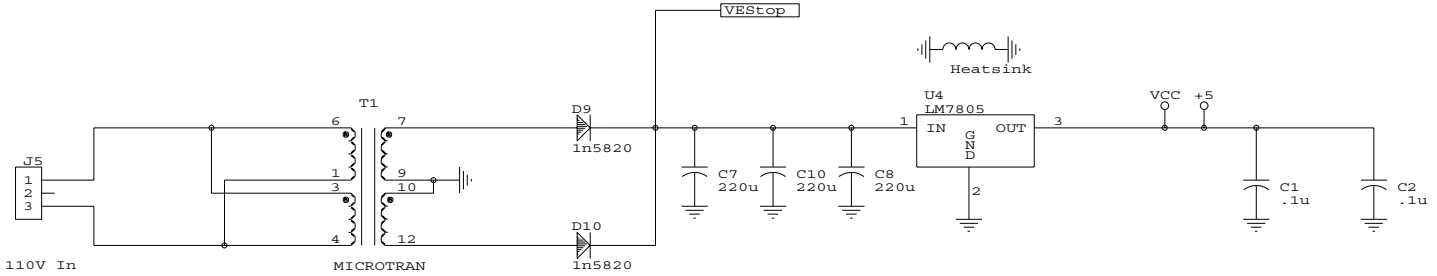
Date: January 28, 2007	Sheet 3 of 4	



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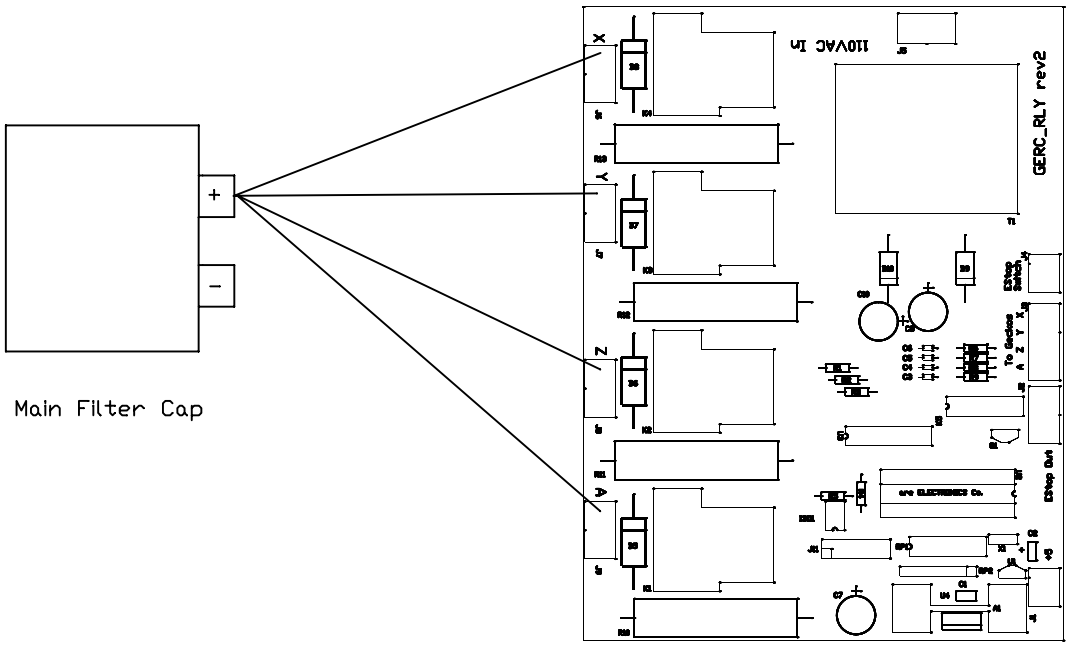
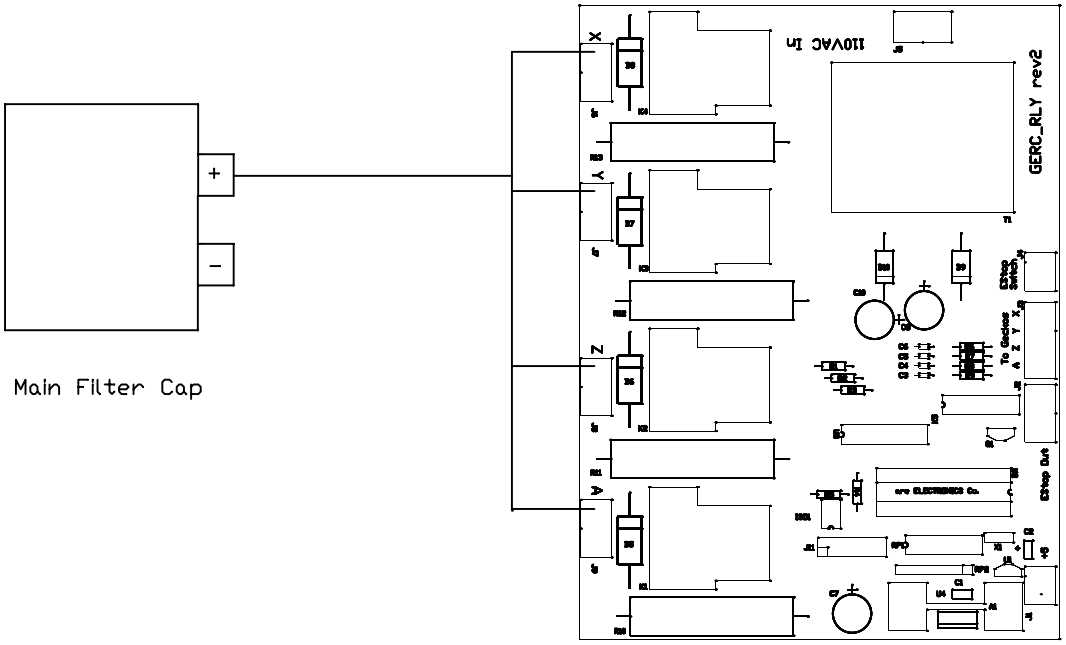
Date: January 28, 2007	Sheet 4 of 4	

GERC_RLY Controller power (+) wiring hints



Correct !

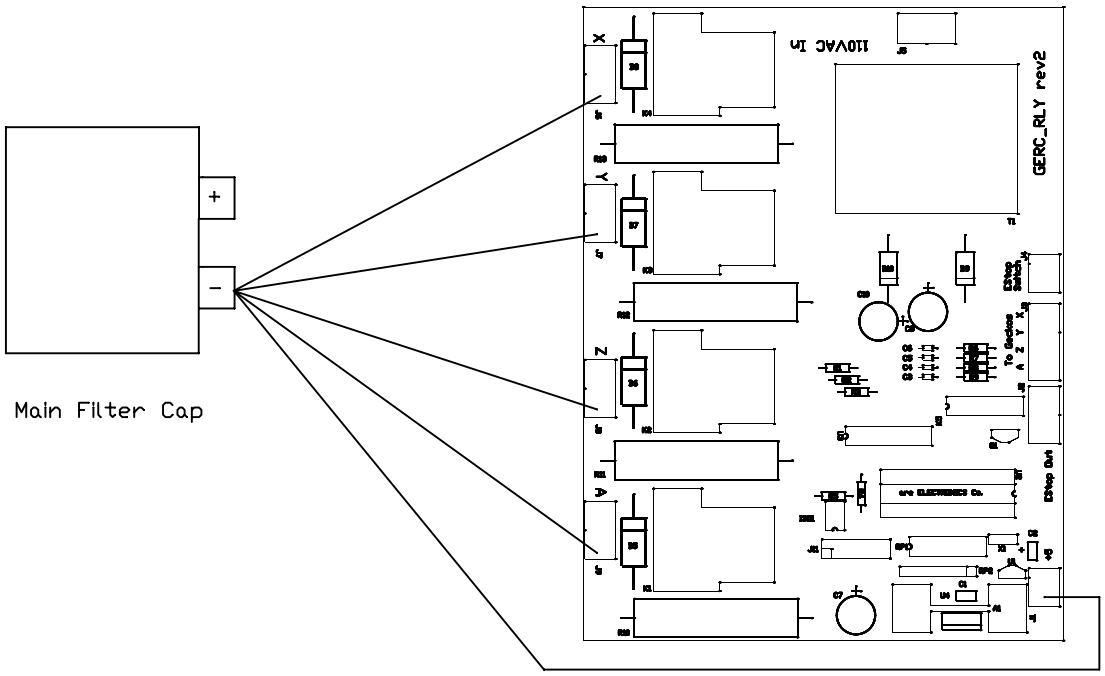
Single point ("star") connection



WRONG !

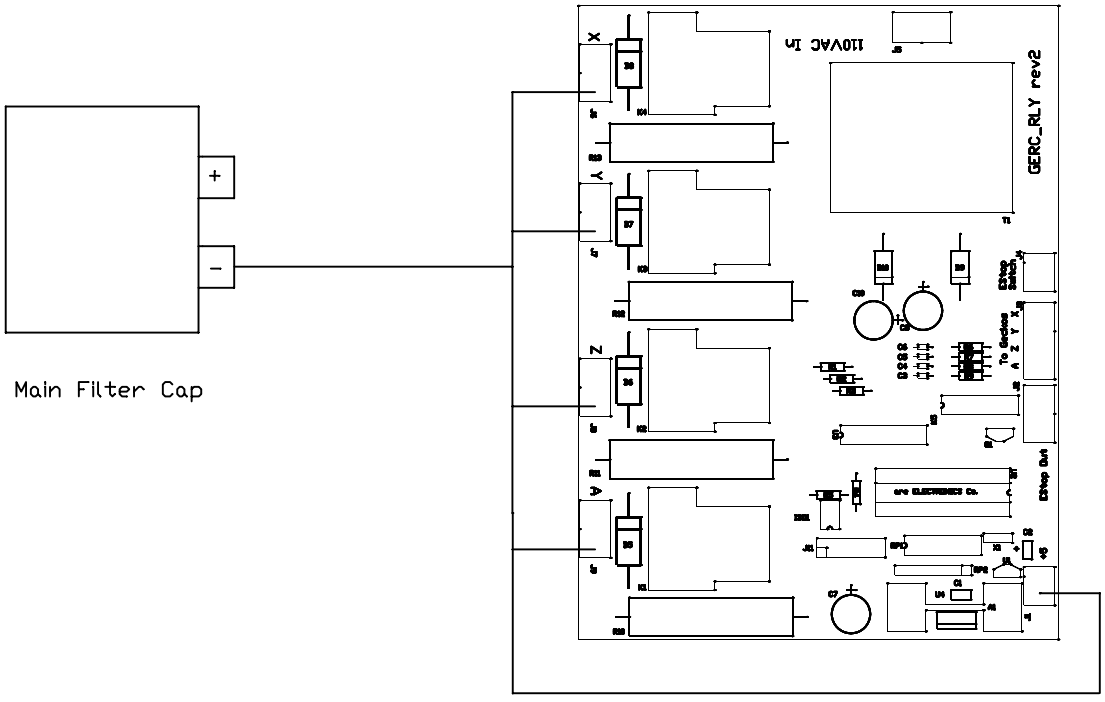
Daisy chain connection

GERC_RLY Controller ground (-) wiring hints



Correct !

Single point ("star") connection

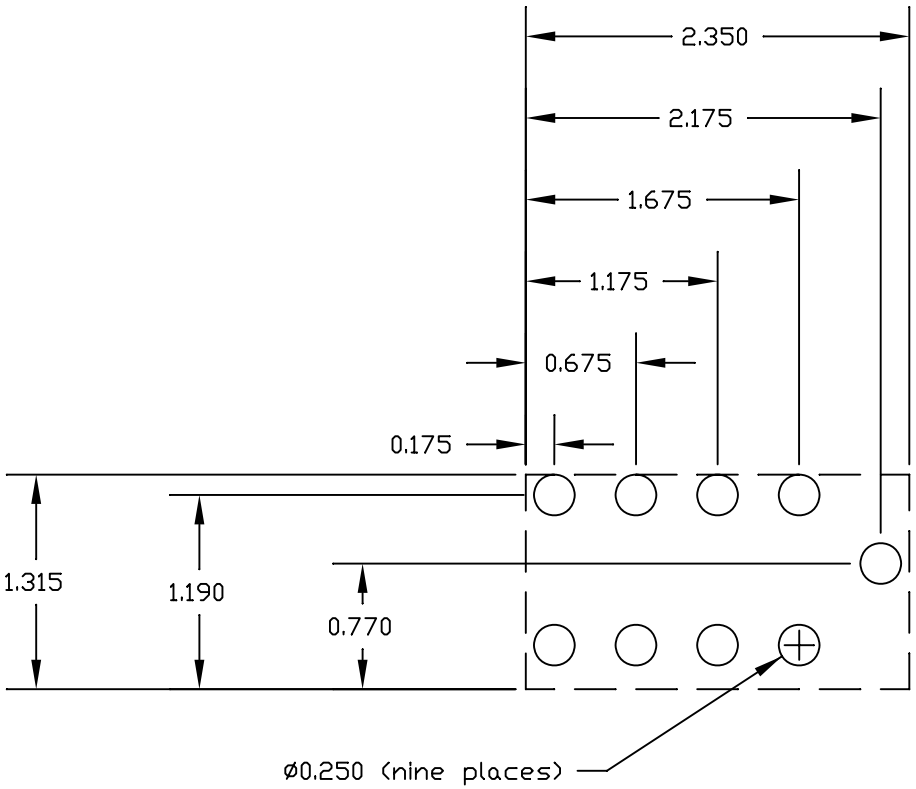


WRONG !

Daisy chain connection

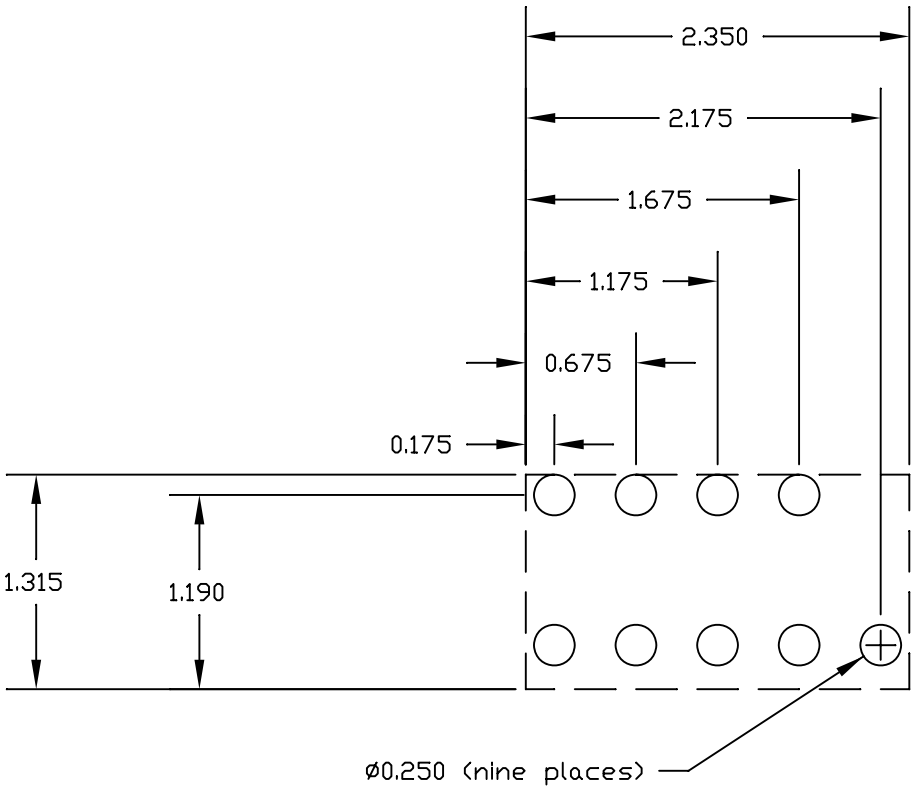
Recommended drilling pattern for front panel LED display

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



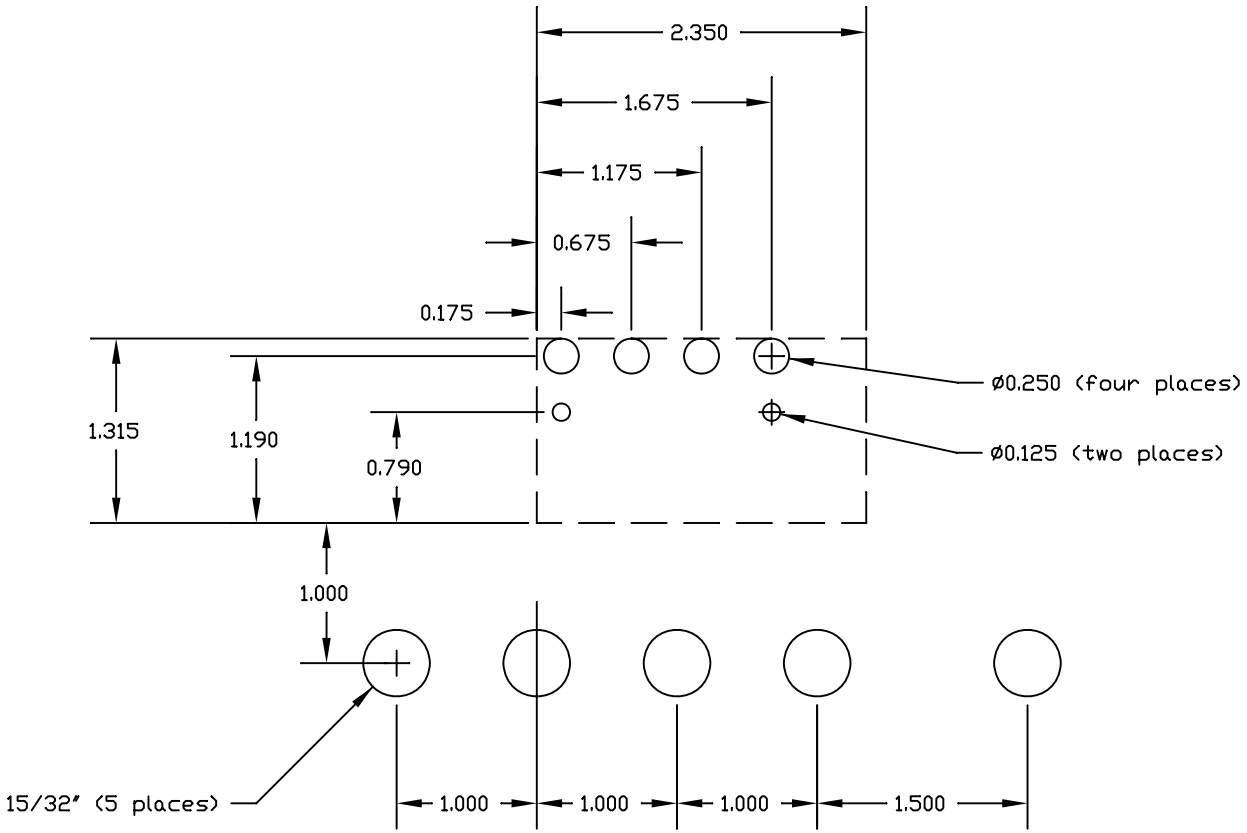
Optional drilling pattern for front panel LED display

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



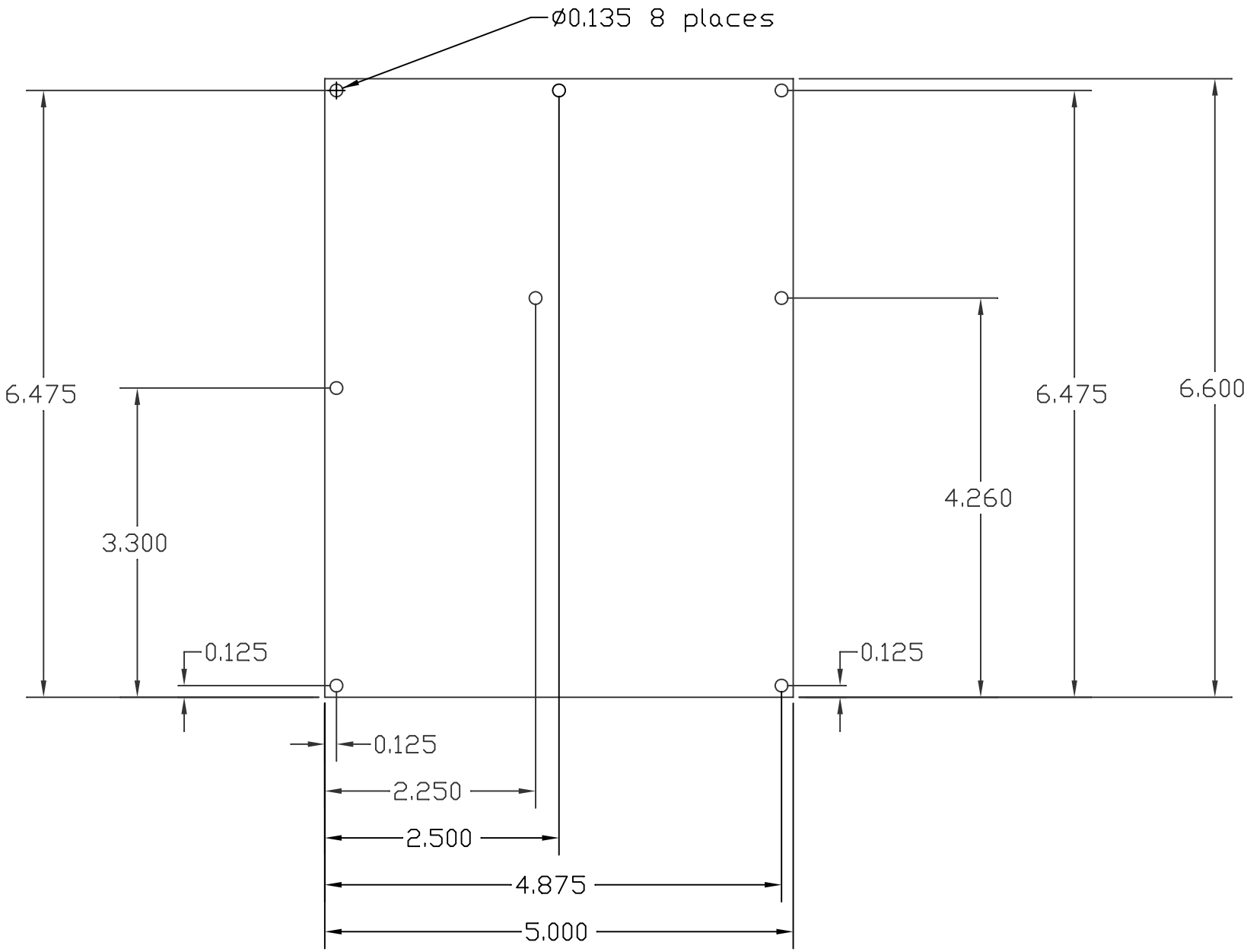
Drilling pattern for front panel LED display

(when used with large switches)



15/32" holes may be adjusted to personal taste

within the limits of lead wire length


Ø0.135 8 places
6.475
3.300
0.125
0.125
0.125
2.250
2.500
4.875
5.000
4.260
6.475
6.600