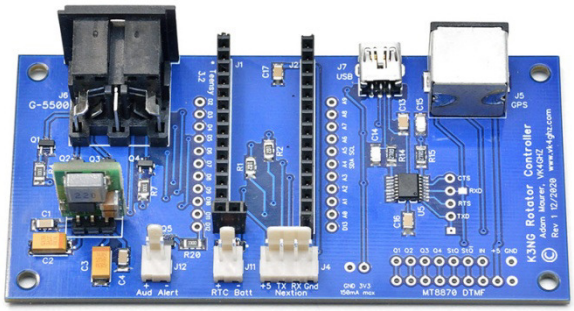
VK4GHZ G-5500 K3NG Rotator Controller Kit Notes

This K3NG based computer interface controller suits a Yaesu G-5500 type dual Az/El rotator controller for operators who want a practical and powerful interface, along with the ability to access spare MCU I/O ports for future experimentation.

Pre-assembled and tested (factory MCU removed after testing) and ready for you to complete the integration into your own system requirements.



Skill level required: Intermediate

- **Arduino IDE/Teensyduino familiarity**
- **Programming your own Teensy MCU via USB**
- **Programming your own Nextion via microSD card or USB/FTDI**
- **Soldering interface lead connectors & wires**
- **Mounting Nextion & board in your own enclosure**

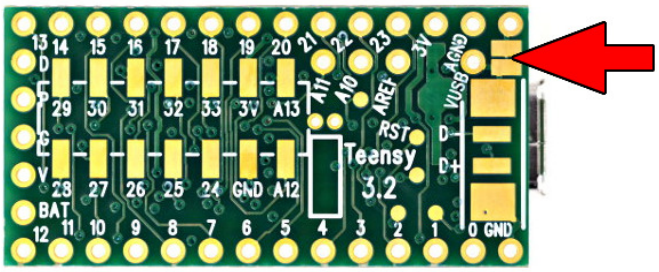
Free Nextion firmware available from vk4ghz.com

Cutting Teensy 3.2 V_{USB} Link

If the Teensy USB lead is connected to a PC and 5V is present (PC may even be 'off') and the V_{USB} link is not cut, Az and El meters on a G-5500 will deflect FSD when the controller board is off because voltage from the USB line is appearing on the controller's 5V rail.

The USB 5V line and the controller's 5V rail should be isolated by cutting the VUSB link on the under-side of the Teensy 3.2. Use a sharp utility knife the break the fine trace linking these two pads.

Verify with a DMM continuity check that link has been broken between both pads.



Cut track in here to isolate V_{USB} from V_{IN}

Once the V_{USB} link has been cut, the Teensy must be inserted into the controller board and powered up when programming via USB lead.

Also refer to page 9 - Fixing the TERRIBLE G-5500 +13V Supply Rail

VK4GHZ G-5500 K3NG Rotator Controller Kit Notes

Features

- Yaesu G-5500 compatible for CW/CCW/Up/Down external control
- PCB 100 x 50mm, M3 mounting holes
- Accommodates Teensy 3.2 MCU (not supplied)
- Computer interface via Teensy's USB-micro port
- Nextion (not supplied) touch screen HMI interface
- Az and El analogue potentiometer inputs
- Piezo audible alert output
- Teensy RTC battery connection
- 4 x N.O. generic push-button switch inputs with pull-ups
- GPS serial data pass-through (genuine FTDI chip) to USB Mini-B for simultaneous PC time-syncing ability
- High efficiency DC-DC Buck 7805 Regulator
- Powered from G-5500 Controller
- Accommodates MT8870 DTMF decoder module (not supplied) for remote DTMF control applications

What's in the Box?

1 x assembled and tested controller board (Factory Teensy removed after testing)
1 x 8-pin DIN connector (connects to G-5500)
1 x 4-pin min DIN connector (connects to GPS)
2 x Polarised 2-pin connectors (connects to audible alert piezo, RTC battery backup)

What's Needed to Finish This Off?

Teensy 3.2 MCU (requires programming)
Nextion HMI (requires programming)
Enclosure & mounting hardware to suit
Wires and cable to suit

VK4GHZ G-5500 K3NG Rotator Controller Kit Notes

MCU Selection Notes

Whilst many capable microcontroller modules are suitable, the powerful **Teensy 3.2** microcontroller from PJRC was chosen due to its small form factor (similar size Arduino Nano), and being a plug in solution.
PJRC MCUs are assembled in the USA, not China.

Teensy 3.2	Arduino MEGA 2560	Arduino Nano
Cortex M4 72MHz 32-bit MCU	ATmega 16 MHz 8-bit MCU	Seriously, Forget about it!
256 kB FLASH	256 kB FLASH	
64 kB RAM	8 kB RAM	
2 kB EEPROM	4 kB EEPROM	
ADC 12-bits used 787 uV / step resolution	ADC 10-bit 4.9 mV /step resolution	
3 Hardware Serials	4 Hardware Serials	
Small sub-board form factor	Large form factor	

⚠ **Teensy 3.2 EEPROM accommodates 16 Satellite TLEs for stand-alone satellite tracking**

Teensy 3.2 purchasing suggestions (some suppliers provide header connectors, but not soldered to board)

Direct from PJRC (USA)
https://www.pjrc.com/store/teensy32.html

Sparkfun (USA)
https://www.sparkfun.com/products/13736

Adafruit (USA)
https://www.adafruit.com/product/2756

Arduino.cc Store (USA)
https://store.arduino.cc/usa/teensy-3-2-usb-development-board

Core Electronics (Aus)
https://core-electronics.com.au/teensy-3-2.html

Robot Gear (Aus)
https://www.robotgear.com.au/Product.aspx/Details/1052-Teensy-3-2-32Bit-processor-with-USB

Little Bird (Aus)
https://www.littlebird.com.au/products/teensy-3-2-cb69a1de-a135-4b0d-a569-5f537f5e6c9c

Hobbytronics (UK)
https://www.hobbytronics.co.uk/teensy-v32

Nextion Enhanced purchasing suggestions

Direct from iTead (not always the cheapest)
https://www.itead.cc/display/nextion.html

Banggood
https://www.banggood.com/search/nextion.html?from=nav

AliExpress
https://www.aliexpress.com/wholesale?catId=0&initiative_id=SB_20210127215039&SearchText=nextion

VK4GHZ G-5500 K3NG Rotator Controller Kit Notes

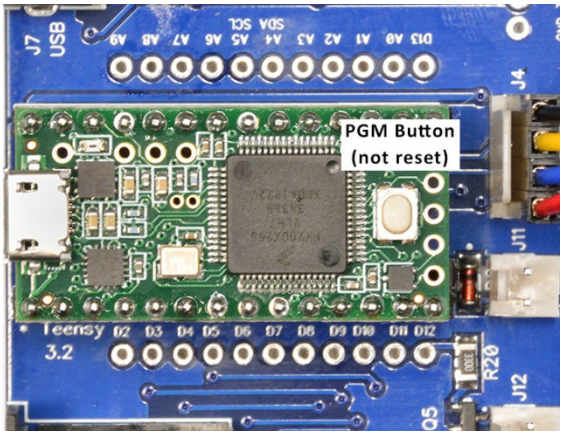
Teensy 3.2 Programming & Orientation

⚠ **USB connector is towards PCB rear edge**

Insert your Teensy 3.2 MCU module as follows;

Teensy USB port becomes main interface connection to computer for rotator control/tracking.

USB



Teensy can be programmed stand-alone before being inserted.

If programming after insertion, disconnect Nextion during programming, as your Teensy USB programming port may not be able to provide sufficient current for everything. (?)

Can I use another MCU?

No, this board is designed to use a Teensy 3.2.

Teensy 3.2 I/O Summary

Physical Pin	I/O Pin	K3NG Reference	Pin Function
5	D3	3	CW output to NPN open collector
6	D4	4	CCW output to NPN open collector
7	D5	5	Up output to NPN open collector
8	D6	6	Down output to NPN open collector
9	D7	7	RX3 (Serial 3) Data from Nextion
10	D8	8	TX3 (Serial 3) Data to Nextion
11	D9	9	RX2 (Serial 2) Data from GPS
14	D12	12	Audible Alert to Piezo (-ve side)
16	A0	A0	Azimuth Analogue Volts In (adjust your G-5500 for 3V3 max)
17	A1	A1	Elevation Analogue Volts In (adjust your G-5500 for 3V3 max)
18	D16/A2	16	Remote CW input (This pin is pulled up - take low to activate CW)
19	D17/A3	17	Remote CCW input (This pin is pulled up - take low to activate CW)
22	D20/A6	20	Remote Up input (This pin is pulled up - take low to activate Up)
23	D21/A7	21	Remote Down input (This pin is pulled up - take low to activate Down)

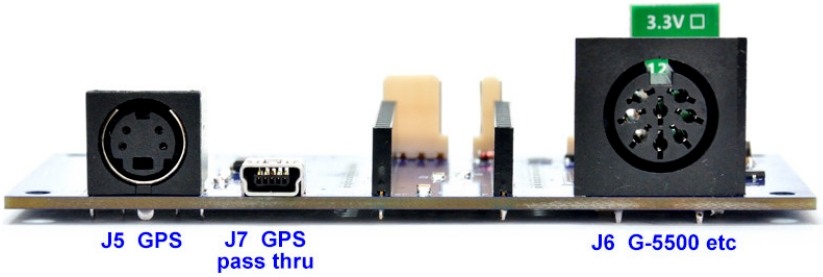
⚠ **If manually editing the standard rotator_pins.h file, configure as per above**

Pre-configured rotator_pins.h file available from

https://vk4ghz.com/product/g-5500-k3ng-rotator-controller/

VK4GHZ G-5500 K3NG Rotator Controller Kit Notes

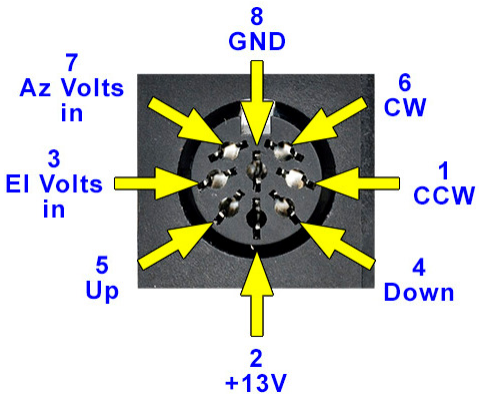
Rear Connections



J6 - G-5500 Port

CCW, CW, Up and Down outputs are open-collector NPN transistors switching to ground.

Use the supplied 8-pin DIN connecto to prepare a shielded multi-core lead to your Yaesu G-5500 controller as follows. For your own reference, note the wire colours in the chart below;



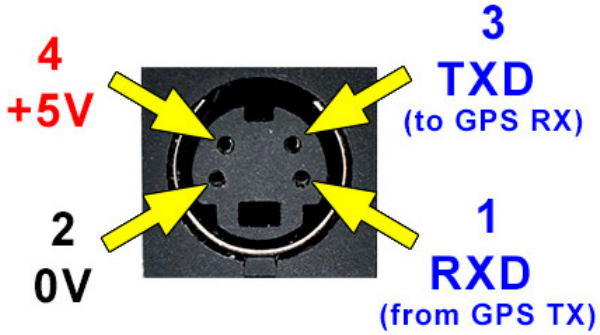
J6 <> Rotator Connection Chart

VK4GHZ J6 Pin	My wire colour	Function	Yaesu G-5500 Ext Control Pin
1		CCW	4
2		+13V	7
3		El volts	1
4		Down	5
5		Up	3
6		CW	2
7		Az volts	6
8		GND	8

⚠ **For other rotators, check your manual for connection details**

J5 - GPS Port

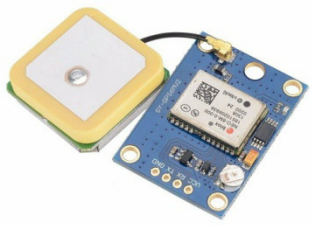
Using the supplied 4-pin mini DIN connector, prepare a lead to connect to your external GPS module as follows:



Ordinary 4-core alarm cable is ok for several metres.

GPS Suggestion

Low cost (AUD$18) UBlox NEO6M based modules available on ebay:



NEO6M modules are sensitive enough to use indoors, but not the basement!

VK4GHZ G-5500 K3NG Rotator Controller Kit Notes

Front Connections

J7 - GPS Pass thru

Use a standard USB Mini-B lead to connect to your PC.

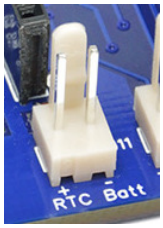
J12 – Audible Alert

Connect your external piezo buzzer using supplied 2-pin polarised connector.

⚠ **Observe polarity**

J11 – Teensy 3.2 Real Time Clock (RTC) Battery

Use supplied 2-pin polarised connector for an external 3V battery RTC power backup.



⚠ **Observe polarity**

Note:
As of this documentation date, Teensy RTC firmware support is not currently implemented, but this hardware will accommodate if/when this happens.

J4 – Nextion HMI

Connect your own enhanced Nextion as follows.

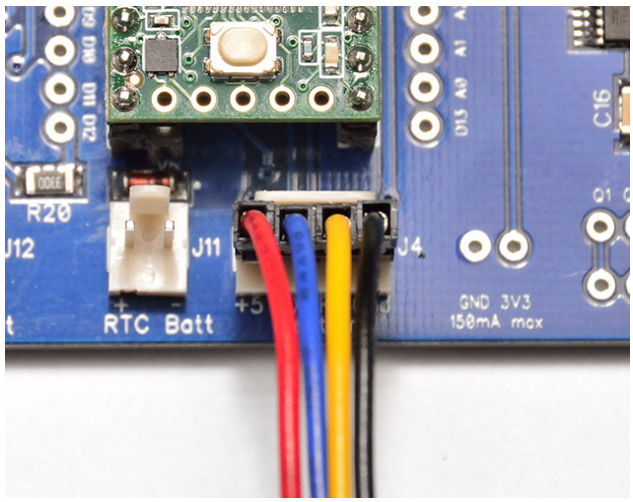
⚠ **Wires connect in the same order as they connect to the Nextion**

Red = +5V

Blue = Nextion TX

Yellow = Nextion RX

Black = GND

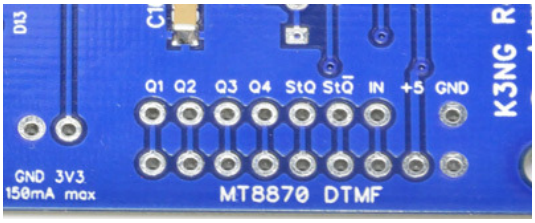


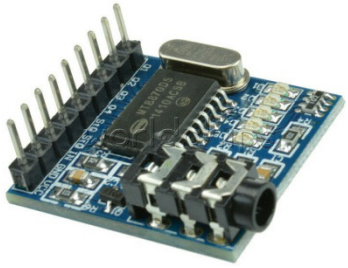
VK4GHZ G-5500 K3NG Rotator Controller Kit Notes

MT8870 DTMF Module Interface

For experimenters, this accommodates an MT8870 DTMF module (eBay) for DTMF remote control purposes.

Jumper Q1, Q2 etc pads to suit your own requirements.





⚠ **Be aware that +5 and GND pads may differ to your module – check & wire accordingly**

Teensy 3.2 Firmware

K3NG provides free official firmware from Github

https://github.com/k3ng/k3ng_rotator_controller

Use the IDE of your choice to configure the settings, pins, and features and program the Teensy 3.2

For casual users, the free Arduino IDE is suggested

https://www.arduino.cc/en/software

Advanced MCU enthusiasts may prefer the free Microsoft Visual Studio (Community Edition)

https://visualstudio.microsoft.com/downloads/

Either IDE will require Teensyduino from Teensy manufacturer PJRC be installed

https://www.pjrc.com/teensy/td_download.html

Nextion Firmware

VK4GHZ provides free firmware for both the 3.5" **NX4832K035** and 5.0" **NX8048K050 Enhanced** HMIs

https://vk4ghz.com/vk4ghz-k3ng-rotator-controller-system/

⚠ **VK4GHZ firmware requires enhanced HMIs, not the cheaper basic HMI variant**

You are free to modify the Nextion firmware provided by VK4GHZ to suit your own requirements, however no support may be provided due to unforseen situations you may create – you need to know what you are doing!

Enclosure Mounting Suggestion

YouTube video where VK4GHZ mounts his 5.0" Nextion and Universal controller board (slightly larger than this G-5500 variant) inside an $8 ABS box

https://www.youtube.com/watch?v=aY0UyPOcEHY

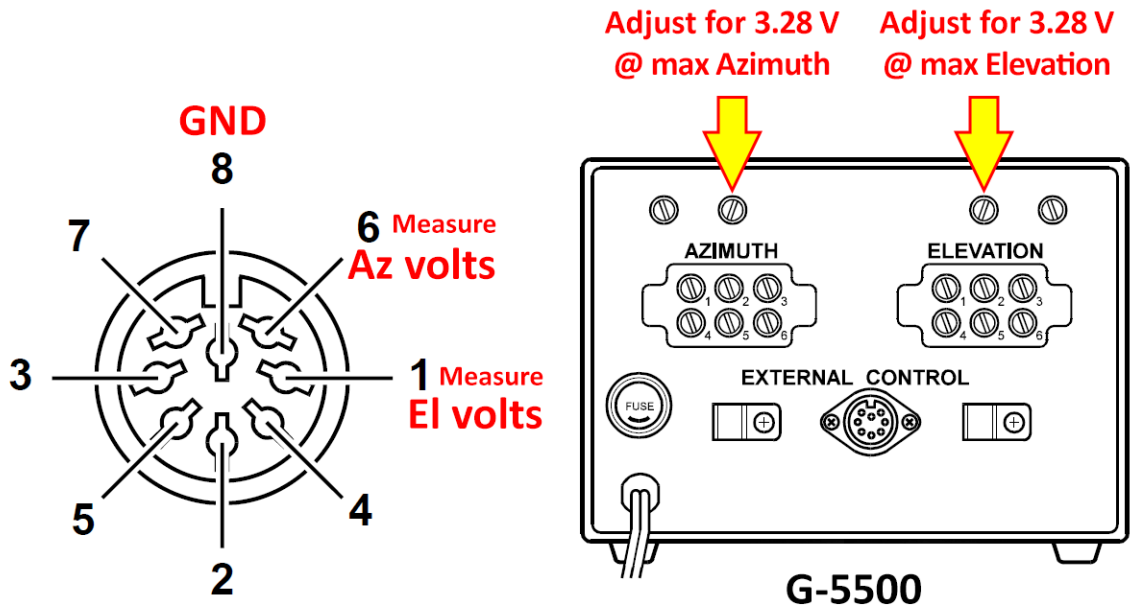
⚠ Before First Use – Potentiometer Feedback Voltage Adjustment

Whilst most Teensy 3.2 inputs are 5 volt tolerant, your rotator azimuth and elevation potentiometer outputs need to be trimmed for 3.3 volts absolute maximum output to suit the Teensy's 3.3 V environment.

Analogue to Digital Converters (ADCs) will saturate at 3.3 V, therefore potentiometer feedback voltages exceeding 3.300 V will not register and incorrect Az and El readings will result.

Hint: Set outputs to a maximum of 3.28 V (slightly under 3.3 V) to allow for +/- system variations.

Yaesu G-5500 Controller Adjustments



K3NG Firmware Calibration

Once Yaesu controller maximum voltages have been set to just under 3.3 V, K3NG controller firmware calibration can be performed via the Arduino serial terminal (or terminal program of your choice, eg; Putty) or via the VK4GHZ Nextion 'RotorCalibration' screen.

K3NG Command Reference Wiki

https://github.com/k3ng/k3ng_rotator_controller/wiki/820-Command-Reference

Satellite TLE Uploading to Teensy via USB

Remember, you cannot use the Arduino serial terminal to upload TLE data – it will NOT work!

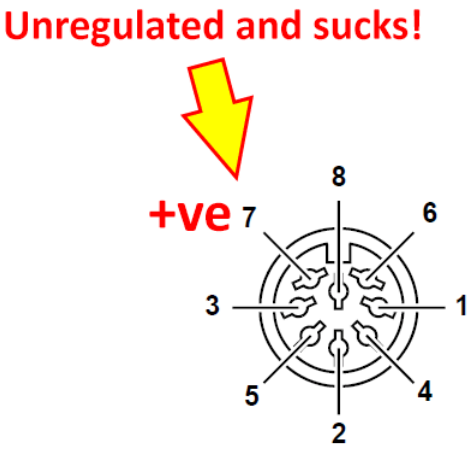
Terminal program Putty is suggested, as seen here https://www.youtube.com/watch?v=oFZq4j7RhY8

⚠ Before First Use – Fixing the TERRIBLE G-5500 +13V Supply Rail

The +13V rail going to pin 7 of the External Control connector (that supplies this interface board) is unregulated, and drops significantly when motors are energised. This is largely due to Yaesu fitting a 20 ohm 5W wire-wound resistor (R1010) in line with this supply rail.

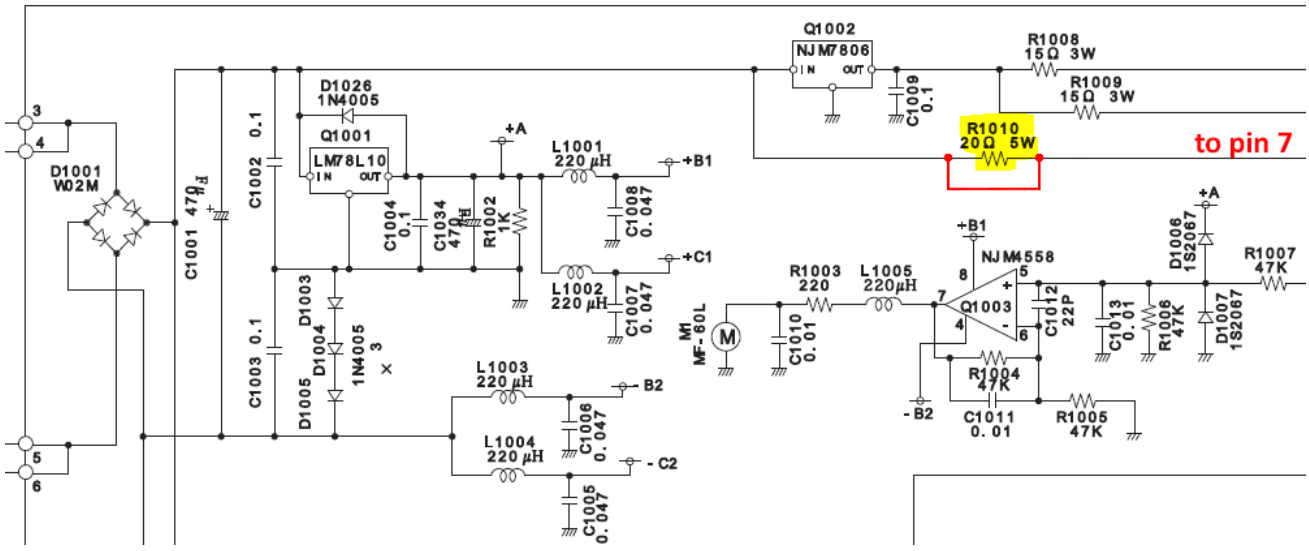
Voltage drop is noticeable when using a 5.0" Nextion, and the system might repeatedly reboot over and over, especially when a motor command is given. You may be OK if using a 3.5" Nextion that has a lower backlight current requirement.

Pin	Function
6	Provides 2 to 4.5 VDC corresponding to 0 to 450 °
1	Provides 2 to 4.5 VDC corresponding to 0 to 180 °
4	Connect to Pin 8 to rotate left (counterclockwise)
2	Connect to Pin 8 to rotate right (clockwise)
5	Connect to Pin 8 to rotate down
3	Connect to Pin 8 to rotate up
7	Provides DC 13 V to 6 V at up to 200 mA
8	Common ground



G-5500 External Control

In order to supply a reliable voltage rail for external equipment R1010 should be removed from circuit.



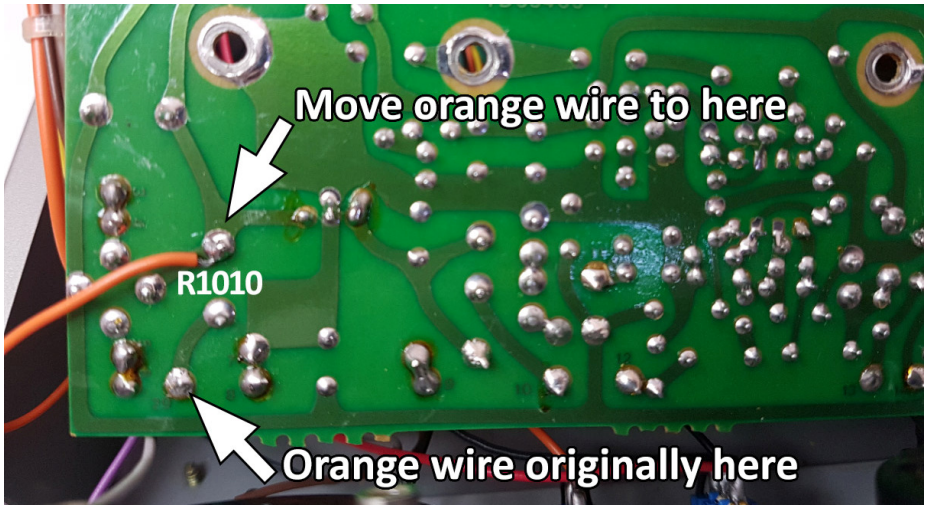
Three options:

You can either move the orange wire going to pin 7, **or** replace R1010 with a wire link, **or** bypass R1010 with a wire link.

⚠ Before First Use – Fixing the TERRIBLE G-5500 +13V Supply Rail

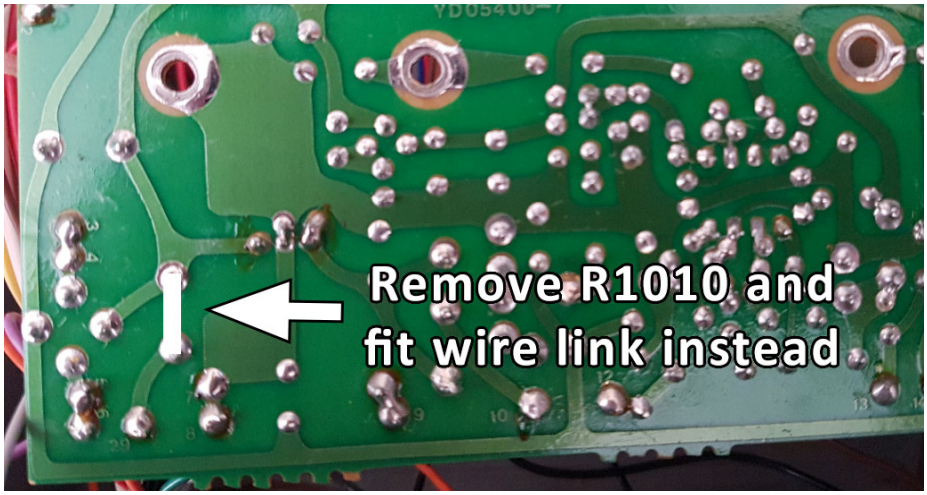
Option 1 – Solder Side Access Required

Relocate the orange wire (goes to Ext Control connector pin 7) from after R1010, to before R1010, as follows;



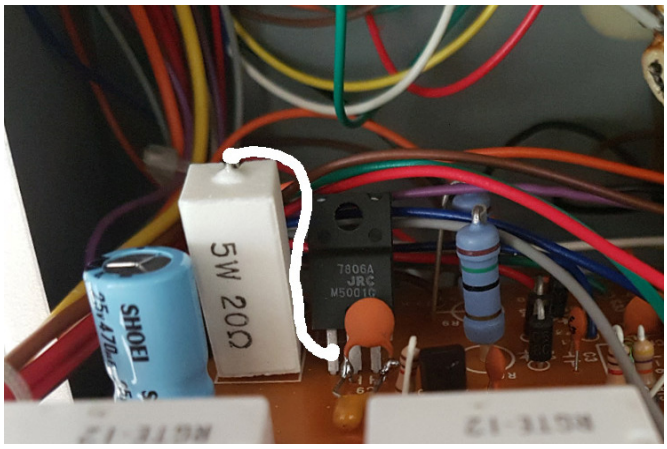
Option 2 – Solder Side Access Required

Remove R1010 and fit a wire link in its place on the components side.



Option 3 –From Component Side

Carefully bypass R1010 with a wire Link. Output side of R1010 is wired to the input pin of Q1002 regulator;



Check you do not short-circuit any pins of Q1002.

The middle pin of Q1002 is GND.