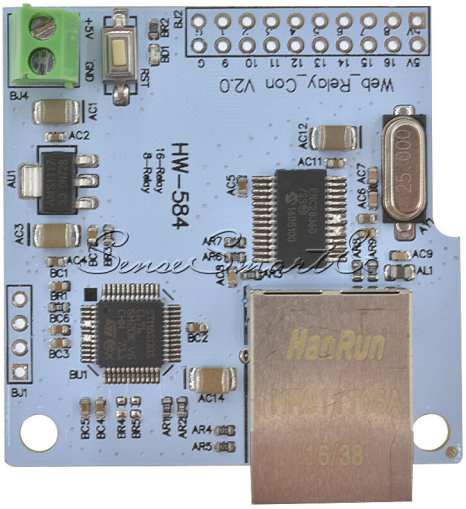
# Reprogramming the Web_Relay_Con V2.0 HW-584 Network Module

**June 20, 2020**

# Introduction




Did you buy one (or more) of these Network Modules and then find disappointment in the software on the board?

- All of the modules have the same MAC address. That's a problem if you want more than one on your network. And the supplier does not give you a way to change the MAC.
- If you change the IP Address the device returns to its default IP Address when it power cycles. That makes it pretty much useless even if you only put one on your network - unless you're OK with it always having IP Address 192.168.1.4.

I was disappointed enough that I decided to reprogram the device to provide a web server interface that let's you change the IP Address, Gateway (Default Router) Address, Netmask, Port number (a REAL port number), and MAC Address. I also added the ability for the device to remember all these settings through a power cycle. Any Relay settings you make are also saved through a power cycle.

IMPORTANT NOTE: The software provided in this project only works with the "Web_Relays_Con V2.0 HW-584" which is based on the STM8S-005 processor and ENC28J60 ethernet controller. I haven't tried it with any other version of the hardware. I think the V.1 FC-160 is based on a Nuvoton processor and this code and the tools are

incompatible. NOTE: I am not in any way associated with the manufacturer of this device. I only wrote code to run on it for my own hobby purposes, and I am making it available for other hobbyists.

# Document License

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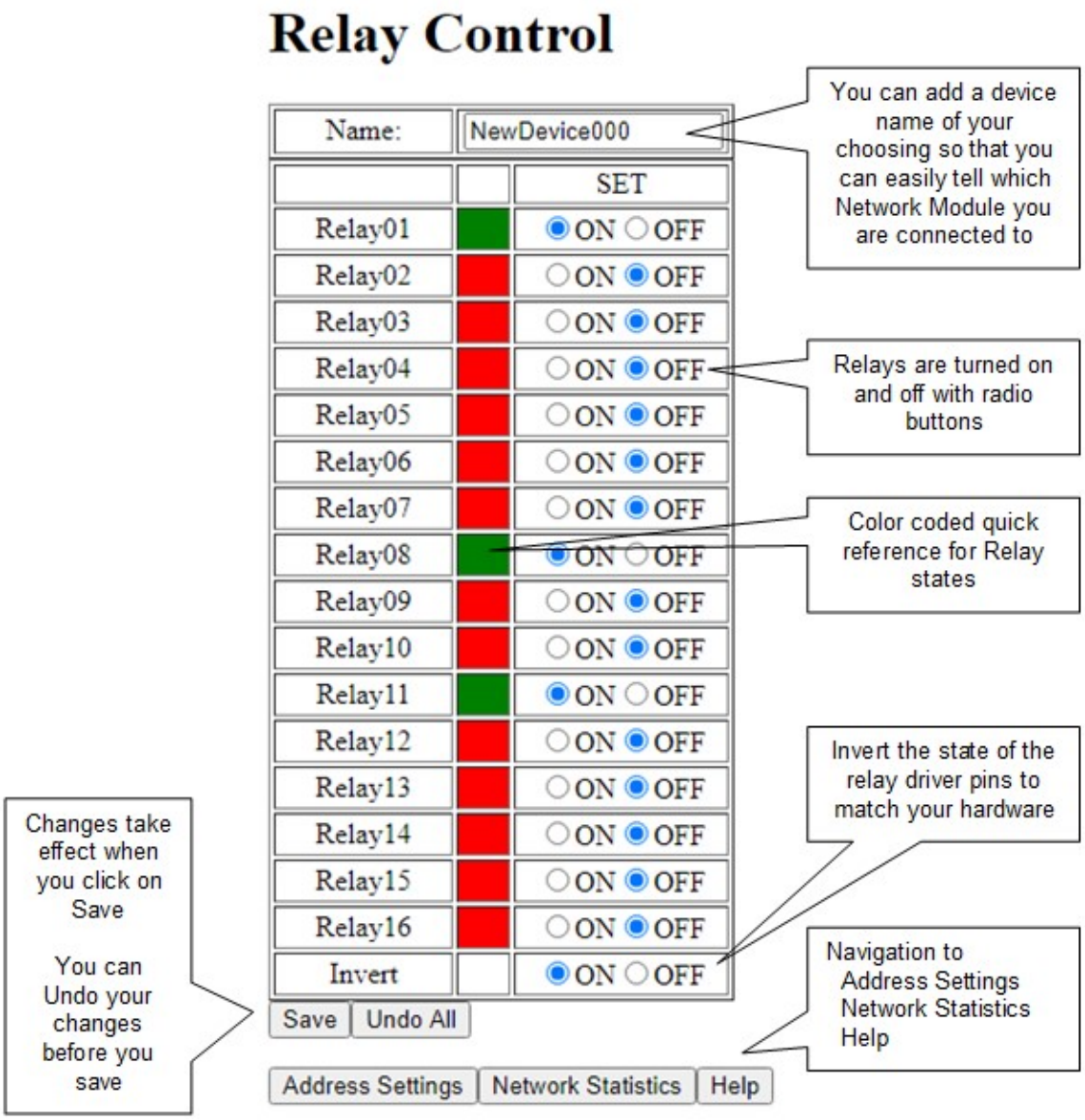
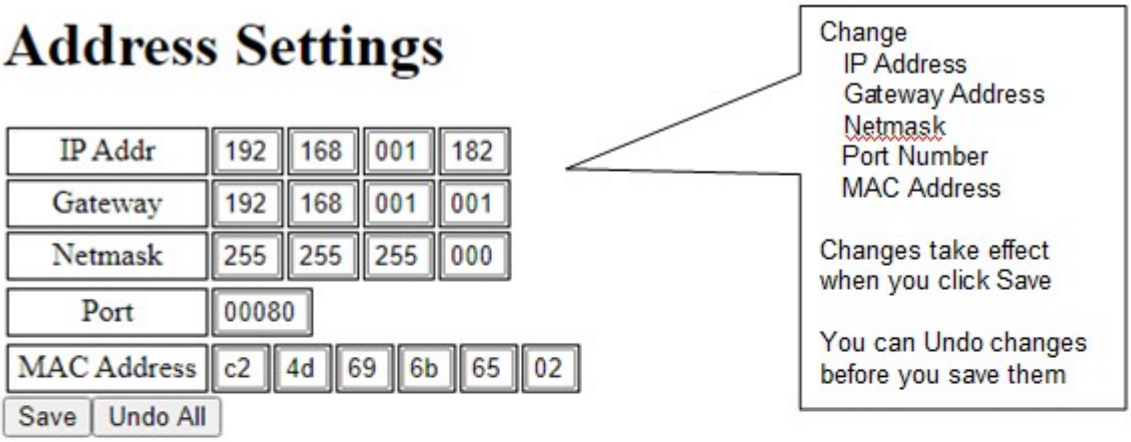
# Screen Shots and Usage



# Address Settings




Use caution when changing the above. If you make a mistake you may have to restore factory defaults by holding down the reset button for 10 seconds.

Make sure the MAC you assign is unique to your local network. Recommended is that you just increment the lowest octet and then label your devices for future reference.

If you change the highest octet of the MAC you MUST use an even number to form a unicast address. 00, 02, ... fc, fe etc work fine. 01, 03 ... fd, ff are for multicast and will not work.

Reboot NOTE: Reboot may cause the relays to cycle.

Relay Controls | Network Statistics | Help

# Help Page 1

An alternative to using the web interface for changing relay states is to send relay specific html commands. Enter http://IP:Port/xx where
- IP = the device IP Address, for example 192.168.1.4
- Port = the device Port number, for example 8080
- xx = one of the codes below:

| | | | |
|---|---|---|---|
| 00 = Relay-01 OFF | 09 = Relay-05 OFF | 17 = Relay-09 OFF | 25 = Relay-13 OFF |
| 01 = Relay-01 ON | 10 = Relay-05 ON | 18 = Relay-09 ON | 26 = Relay-13 ON |
| 02 = Relay-02 OFF | 11 = Relay-06 OFF | 19 = Relay-10 OFF | 27 = Relay-14 OFF |
| 03 = Relay-02 ON | 12 = Relay-06 ON | 20 = Relay-10 ON | 28 = Relay-14 ON |
| 04 = Relay-03 OFF | 13 = Relay-07 OFF | 21 = Relay-11 OFF | 29 = Relay-15 OFF |
| 05 = Relay-03 ON | 14 = Relay-07 ON | 22 = Relay-11 ON | 30 = Relay-15 ON |
| 07 = Relay-04 OFF | 15 = Relay-08 OFF | 23 = Relay-12 OFF | 31 = Relay-16 OFF |
| 08 = Relay-04 ON | 16 = Relay-08 ON | 24 = Relay-12 ON | 32 = Relay-16 ON |

55 = All Relays ON
56 = All Relays OFF

The following are also available:
60 = Show Relay Control page
61 = Show Address Settings page
63 = Show Help Page 1
64 = Show Help Page 2
65 = Flash LED
66 = Show Statistics
91 = Reboot
99 = Show Short Form Relay Settings

Next Help Page

# Help Page 2

IP Address, Gateway Address, Netmask, Port, and MAC Address can only be changed via the web interface. If the device becomes inaccessible you can reset to factory defaults by holding the reset button down for 10 seconds.
Defaults:
IP 192.168.1.4
Gateway 192.168.1.1
Netmask 255.255.255.0
Port 08080
MAC c2-4d-69-6b-65-00

Code Revision 20200619 1346

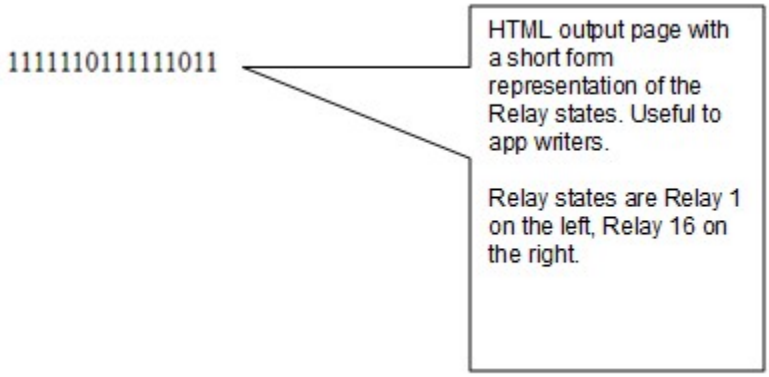
Relay Controls

# Network Statistics

Values shown are since last power on or reset

| | |
|---|---|
| 0000000048 | Dropped packets at the IP layer |
| 0000000281 | Received packets at the IP layer |
| 0000000190 | Sent packets at the IP layer |
| 0000000000 | Packets dropped due to wrong IP version or header length |
| 0000000000 | Packets dropped due to wrong IP length, high byte |
| 0000000000 | Packets dropped due to wrong IP length, low byte |
| 0000000000 | Packets dropped since they were IP fragments |
| 0000000000 | Packets dropped due to IP checksum errors |
| 0000000000 | Packets dropped since they were not ICMP or TCP |
| 0000000000 | Dropped ICMP packets |
| 0000000000 | Received ICMP packets |
| 0000000000 | Sent ICMP packets |
| 0000000000 | ICMP packets with a wrong type |
| 0000000000 | Dropped TCP segments |
| 0000000235 | Received TCP segments |
| 0000000193 | Sent TCP segments |
| 0000000000 | TCP segments with a bad checksum |
| 0000000000 | TCP segments with a bad ACK number |
| 0000000002 | Received TCP RST (reset) segments |
| 0000000000 | Retransmitted TCP segments |
| 0000000000 | Dropped SYNs due to too few connections avaliable |
| 0000000000 | SYNs for closed ports, triggering a RST |

Relay Controls

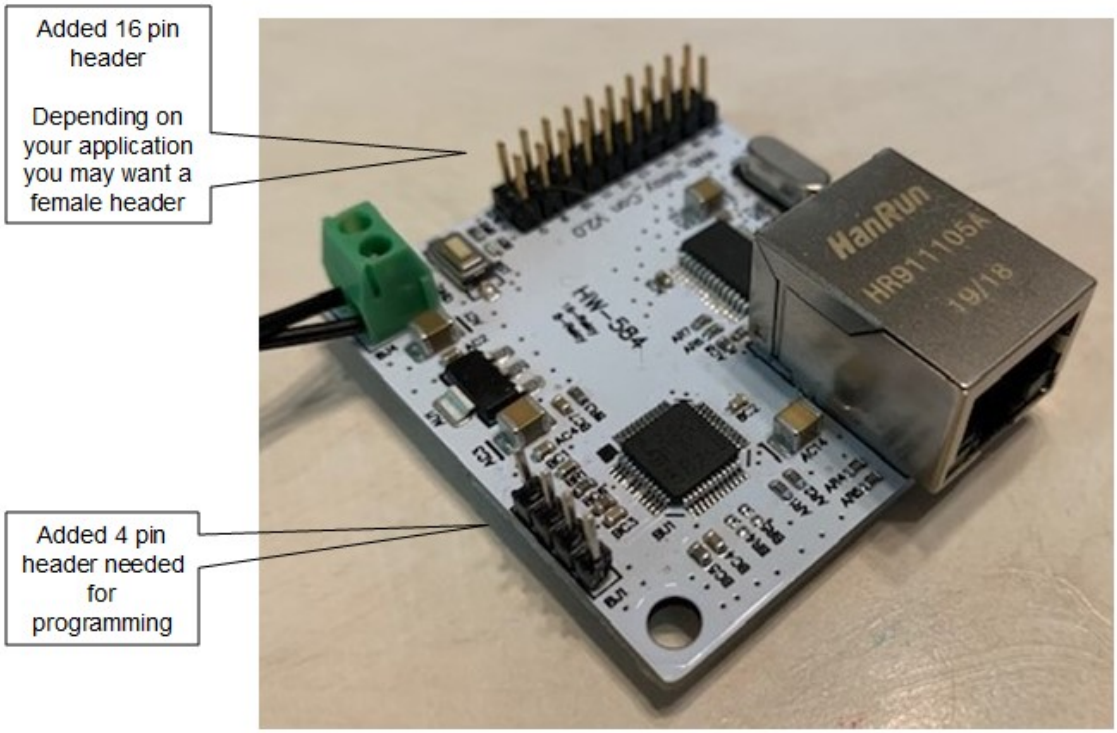

1111110111111011
HTML output page with a short form representation of the Relay states. Useful to app writers.
Relay states are Relay 1 on the left, Relay 16 on the right.

# Programming the Module

Assuming you have the Web_Relays_Con V2.0 HW-584 and all you want to do is apply this firmware the following describes the process.

> **IMPORTANT NOTE: In the steps below you'll turn off the Read Out Protection bit on the Network Module. This will ERASE the program currently in the device. It will only work again after you successfully reprogram it. DO THIS AT YOUR OWN RISK.**

**1) Prepare your Network Module:** Install a 4 pin header on the board (see photo)



**2) Buy the Programmer:** Purchase a ST-Link V2 (see photo). If you are patient you can get one from China in about a month for about $3.50. Or in less than a week from within the US for about $6.00 (assuming you are in North America). Price estimates are as of June 2020. Search on Google, Amazon, eBay, etc.

The ST-Link V2 is required to reprogram the Network Module. It is a USB to SWIM interface module supported by free software from STMicroelectronics. You'll need a four wire Dupont cable if you don't already have one. Some sellers ship the module with a cable. The Dupont cable is just a simple four wire cable with female push connectors on each end (as shown in the photo below).

The ST-Link V2 modules come in several colors so pick the color you like.

**3) Obtain and Install Free Software:** All of my development work was on the Windows 10 OS. If you are using Linux you will have a little more homework to do on your own, but I don't think there is much difference. For Windows you'll need to download and install the following files:

en.stsw-link009.zip
You'll find the above at https://www.st.com/en/development-tools/stsw-link009.html

en.stvp-stm8.zip
You'll find the above at https://www.st.com/en/development-tools/stvp-stm8.html

You'll need to create an account at st.com to get the above software. It's free but they want an email address to contact you. When you try to download the software you'll be asked for your account credentials and given the option to create an account. By providing my email address I've gotten some invitations to online programming seminars but otherwise no spam. Not much hassle.

The stsw-link009 software is the driver to operate the ST-Link V2.

The stvp-stm8 software is a development utility and the programmer specific to the STM8 processor. When you install en.stvp-stm8 you'll get two programs:

1) ST Visual Develop
2) ST Visual Programmer (STVP)

I only used STVP even when developing the code. And if you are only reprogramming your devices STVP is the only tool you'll need.

**4) Copy the Program:** Now that you've installed the necessary software you need to copy the STVP project file and the Binary file from GitHub that will be programmed into the Network Module.

On my Windows 10 machine the project was located in the following directory:

C:/Users/Mike/Documents/COSMIC/FSE_Compilers/CXSTM8/NetworkModule

If you locate your copy of the project files in a similar Documents file location this should minimize the tinkering you have to do. And should you decide to modify the program you'll already have an appropriate directory set up.

The only two files STVP is looking for are:

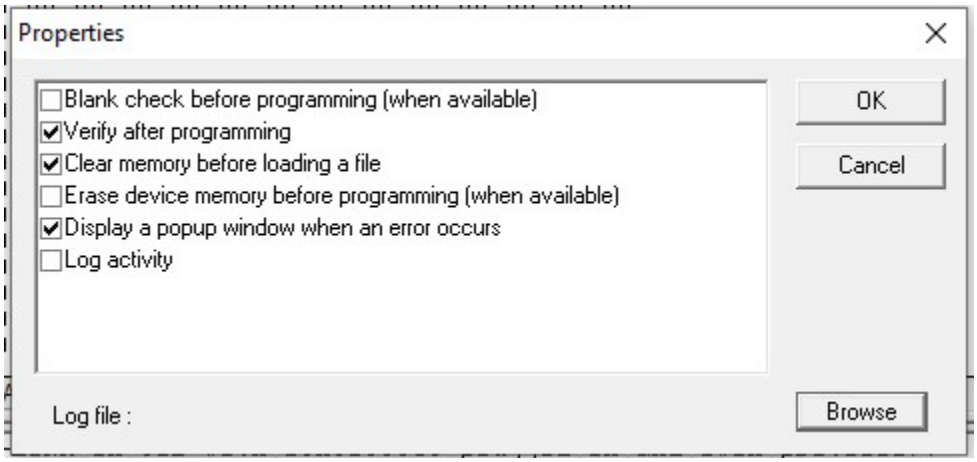
**NetworkModule.stp** - The STVP project file
**NetworkModule.sx** - The NetworkModule binary file

These are the only files you need to copy from the GitHub project account if you only want to program your module and you are not jumping right into code modifications.

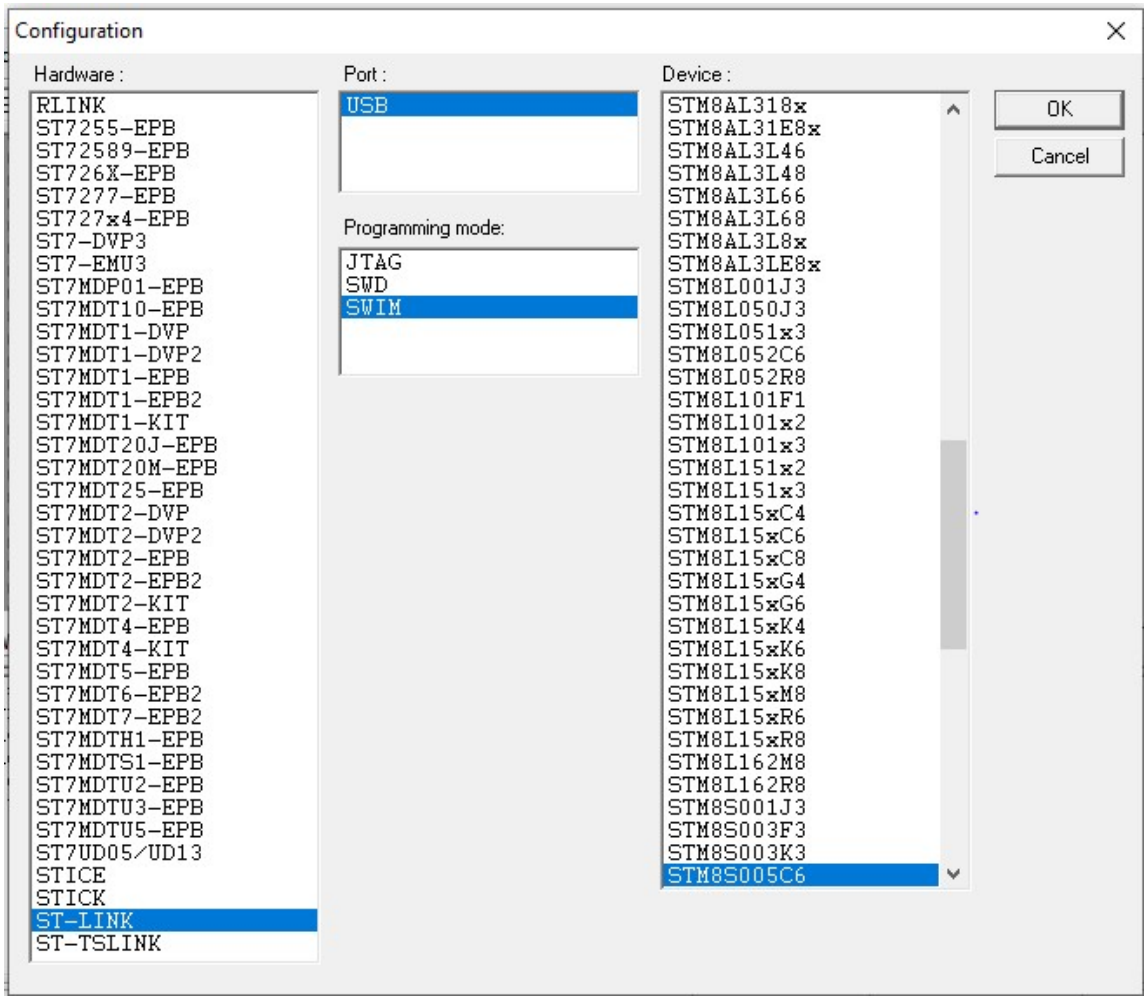
Since your User name on your Windows machine is probably not "Mike" you'll need to start STVP, click on "**Project/Open**", and browse for the .stp file that you copied to your **Documents/…** directory. Once you open the project file STVP should automatically load the .sx file from that same directory.

The project file contains various settings that enable the ST-Link V2 to communicate with your target board. They should already be set for you, but just in case the following is how I had them set:

Under "**Edit/Preferences**":

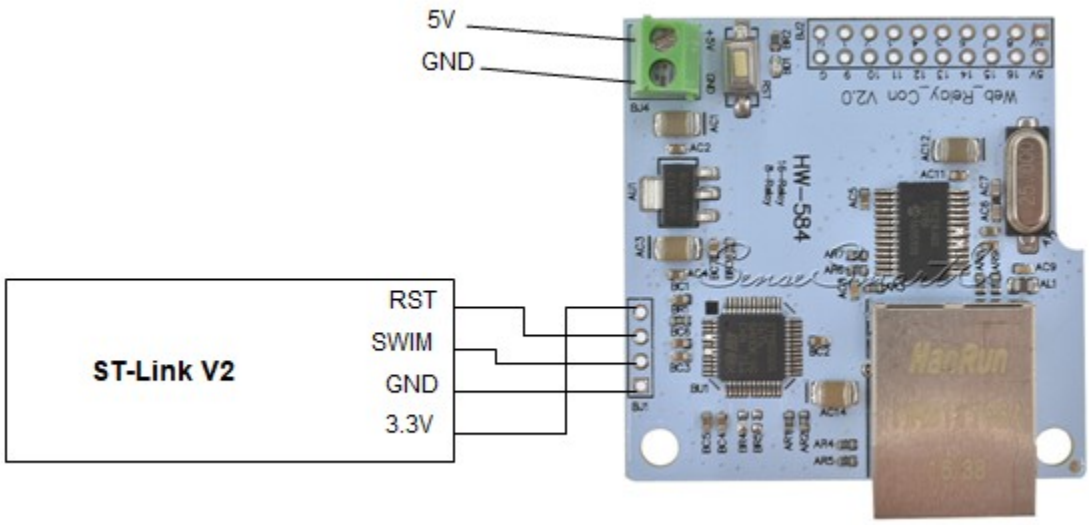


Under “**Configure/Configure ST Visual Programmer**”




If the above looks OK you are ready to program the Network Module.

First, attach the ST-Link V2 to your Network Module as follows:




Apply power to your Network Module. You should be using a 5V power supply connected to the power pins on the Network Module.

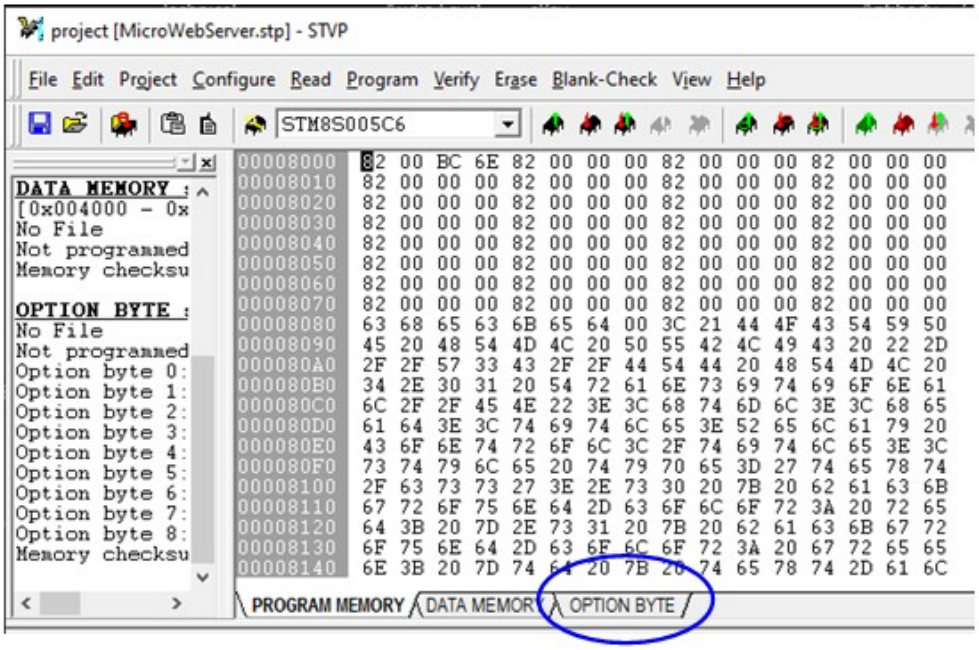
Plug the ST-Link V2 into your PC USB port.

If STVP is not already running, start it now.

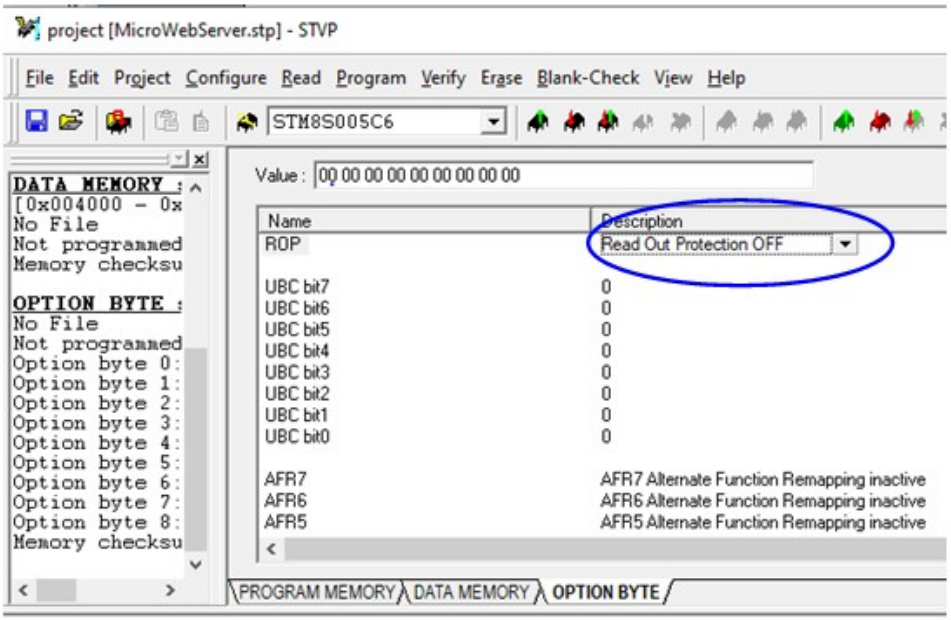
If the NetworkModule.stp project is not already loaded, load it now (click on **"Project/Open"**, and browse for the .stp file that you copied to your **Documents/…** directory). Give it 10 or 20 seconds to load the .sx file.

If this is the first time you are programming your Network Module you will need to clear the Read Out Protection (ROP) bit. If you don't clear the ROP any attempt to program the Network Module will give you a "This device is protected" message. How to clear the ROP bit:

In the STVP main window click on the "**Option Byte**" tab

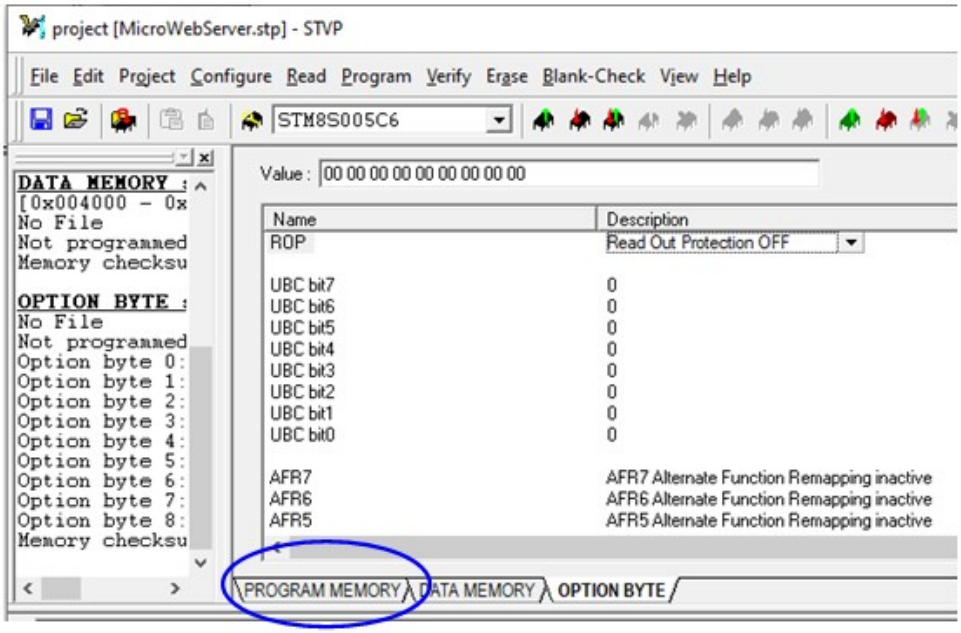



Make sure "**Read Out Protection OFF**" is selected in this drop down.



Next click on **"Program / Current Tab"**. This will clear the ROP bit and allow you to reprogram the device. **IMPORTANT: CLEARING THE ROP BIT ERASES THE CODE IN THE NETWORK MODULE. After you clear the ROP bit you MUST reprogram the Network Module to make it useful again.**

To program the device:
Select the Program Memory tab




Next select **"Program / Current Tab"**

If you got an error message while attempting to program the Network Module:

a) Make sure the RST connection is in place.
b) Make sure the power supply connected to the Network Module is providing 5V.
c) Make sure you have good connections from the ST-Link V2 to the Network Module.
d) You might have to unplug the ST-Link V2 from the USB port on your PC and plug it back in again.
e) You might have to stop the STVP program, unplug and replug the ST-Link V2, then restart the STVP program.

Generally I haven't had to do any of the above as I seldom got an error. But on occasion I got an error message that the link was not working, and the above tinkering got it working again.

If you got a message indicating programming success you are ready to attempt to connect to the Network Module via the Ethernet connector.

a) Disconnect the RST wire between the ST-Link V2 and the Network Module. You can leave the others connected for the time being.
b) Connect the Ethernet cable. I suggest you do this the first time without using your network. Make a direct Ethernet cable connection from the Network Module to your PC and attempt to access it at 192.168.1.4:8080. If the connection does not work check your IPV4 Ethernet settings on the PC and set it to use IP address 192.168.1.100 (not DHCP). If you don't know how to do this Google it. Here's a helpful link: https://stevessmarthomeguide.com/setting-up-static-ip-address-windows-10/

While the device is directly connected to your PC you can use your browser to make address setting changes on the Network Module that are appropriate to your network. Then you can connect the device to your network, return your PC to its original Ethernet settings, and attempt to access the device.

# Setting Up a Programming Environment

If you want to change the code for your own use I assume you have some experience with programming and the tools typically involved. I used the tools described in the previous sections for actual programming of the device, and used the Cosmic tools for the development environment. To duplicate this you'll want the following:

1) **Download and install the Cosmic Compiler:** Use the one that is specifically for the STM8 devices. Start at this website
   https://www.st.com/en/development-tools/cxstm8.html#product-details
   Click on Product Details and follow the link to the "partner website". From there you can download the compiler. The compiler is free. They will send you a 1-year license, but I think you can renew over and over. Note that the license is specific to the machine you install it on.
   As an FYI, even though my PC is x64, the tools installed in this directory:
   C:/Program Files (x86)/COSMIC/FSE_Compilers/

2) **Download and install the following library from st.com:**
   en.stsw-stm8069.zip You'll find it at
   https://www.st.com/en/embedded-software/stsw-stm8069.html
   NOTE: I included this library in the files included with the project so you may not need this step if you copy all the files from GitHub. This is the STM8S_StdPeriph_Driver directory.

3) **Copy the Program:** With the above installed the next step is to copy the entire project from GitHub into your Documents directory. On my Windows 10 machine the project was located in the following directory:
   C:/Users/Mike/Documents/COSMIC/FSE_Compilers/CXSTM8/NetworkModule
   Of course you will likely have a different user ID.

Start the Cosmic tools by double clicking on the NetworkModule.prjsm8 file. You should be on your way.

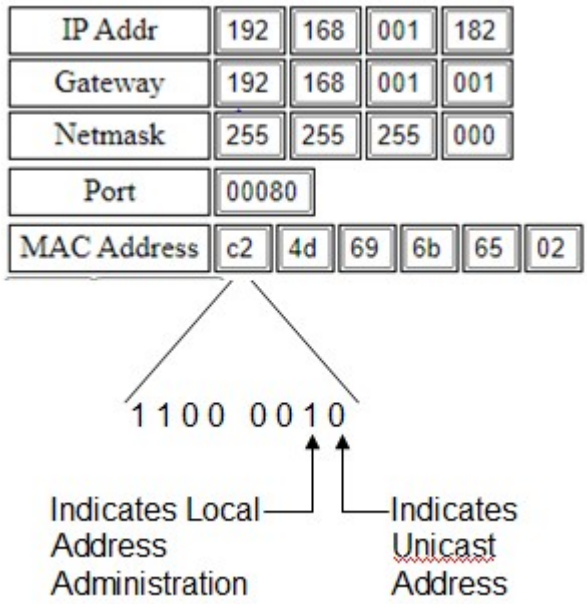
My programming note: My coding is not particularly esoteric or convoluted. I try to keep it simple to read and understand even if that is less efficient. And I put a lot of comments in, particularly if I had to do things to make the code work that didn't fully make sense to me. Sometimes that stuff happens and my intention is to come back and look at it again later. So, feel free to modify and "do it your way". I'm not proud as long as it works.

# Notes on the MAC Address

When new the Network Modules all have the same MAC address. This obviously doesn't work when you try to put more than one on a network.

A MAC address is only used within your network. Your router(s) and switch(es) use the MAC address as the means of uniquely addressing all the hardware in your network. The MAC address does not appear outside your network so it only needs to be unique to YOUR network, not to the entire world. This being the case, you only need to make sure that any MAC address you put in the Network Module does not conflict with any other hardware in your local network.

The default MAC address value in the code provided is just a random value with the exception that it has the two least significant bits of the most significant octet arranged to make it a "Unicast" and "Locally Administered Address (LAA)" as illustrated here:




All other bits and octets in the MAC address can be anything you want as long as you set the two bits above as shown.

Despite this being a LAA MAC address there is still some very remote possibility it will conflict with some other hardware you have on your network. You can search on Google to find methods of finding all MAC addresses on your network – the method you choose will depend on your level of expertise. Generally this is not required, and if you suspect a conflict you may just find it easier to try a different MAC address on the Network Module. Maybe make the middle fours octets something you fancy.

A good reference for MAC address explanations is here:

https://en.wikipedia.org/wiki/MAC_address

# Network Module Schematic

I traced out the parts of the Network Module that are pertinent to developing the new software. I did not trace ALL connections as my intention was not to reverse engineer the hardware design. My intention was only to fix the inadequate function of the software. The schematic may be useful should you decide to improve on the software I've provided. Some notes:

- There are a number of capacitors connecting power and ground. These are left out of the schematic.

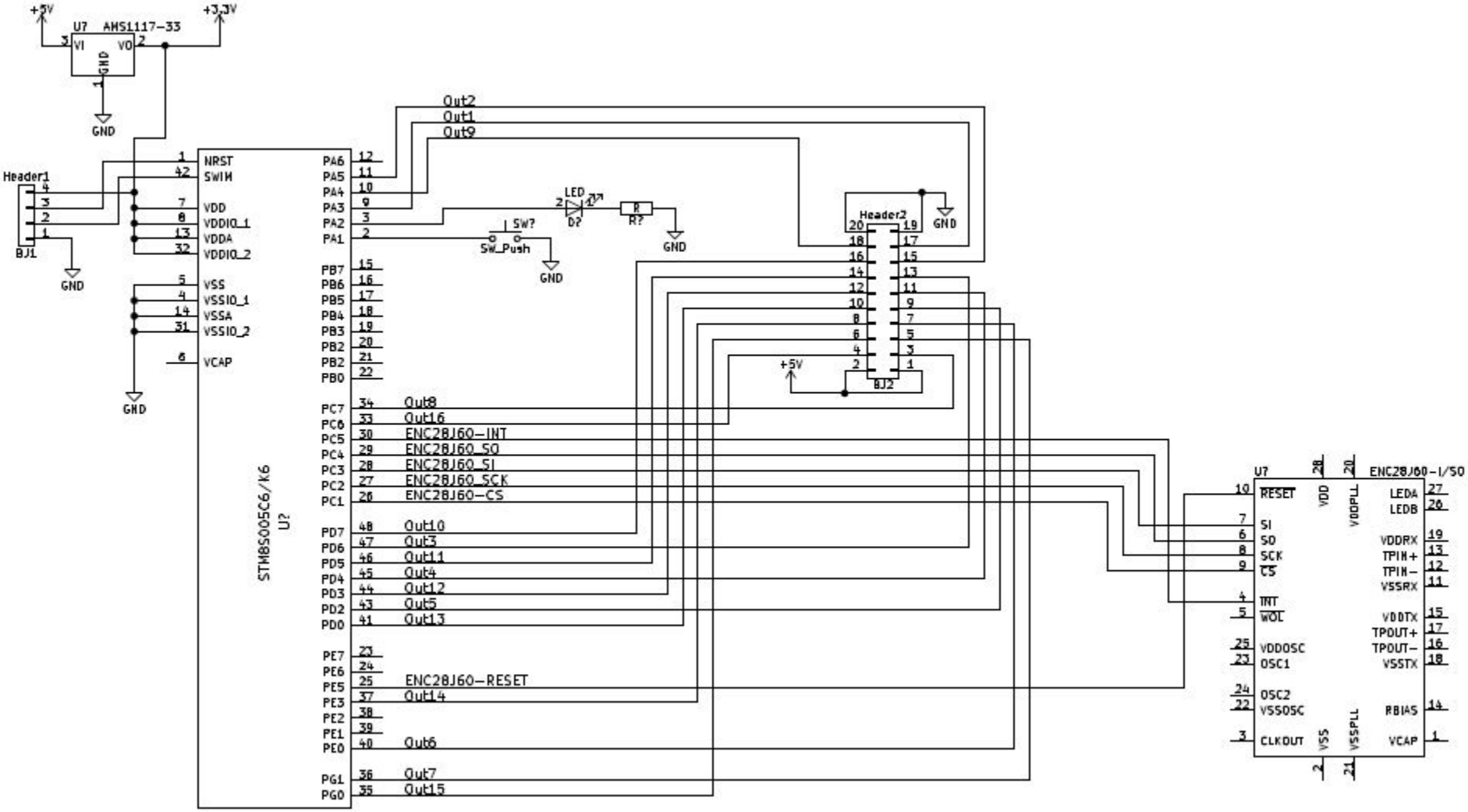
- The VCAP pin on the processor was not traced.

- Unused pins or pins that did not appear to be a necessary part of the functionality were programmed to be inputs with pull-ups. These are shown as disconnected on the schematic even if there was a component attached.
    - There are some components connected to the Port B pins. I suspect the original code used these to identify if the board was "8 port" or "16 port".

- I didn't trace out most of the pins on the ENC28J60, as I knew the design worked and did not need to do any modifications. Some notes:
    - The SPI interface on the ENC28J60 is not connected to the SPI interface on the STM8S005. Ordinary port pins on the STM8S005 are used to "bit bang" the SPI interface. Not very fast, but this is not an Ethernet performance design so it works just fine.
    - The –WOL pin does not appear to be connected.
    - The CLKOUT pin is not connected.

- If you dig into the STM8S005 specification you'll find that most pins that I show simply as "port pins" can be defined for other uses. I didn't include all that information in the component drawing as it just creates confusion in this context. The Network Module uses all the pins as "port pins", so that is all I show.

- The STM8S005 operates on its internal 16MHz clock. It does not have an external crystal or clock source.

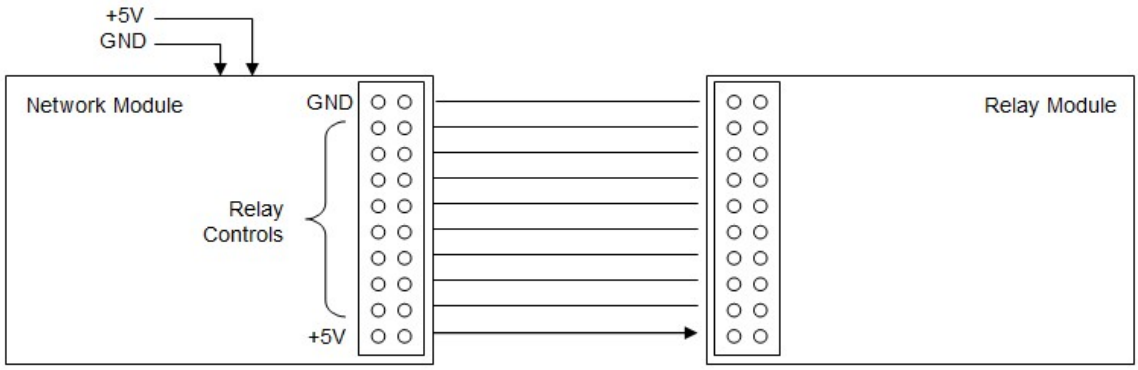

+5V
U7 AMS1117-33
VI
VO
GND
+3.3V
GND
Header1
BJ1
GND
NRST
SWIM
VDD
VDDIO_1
VDDA
VDDIO_2
VSS
VSSIO_1
VSSA
VSSIO_2
VCAP
GND
STM8S005C6/K6
U?
PA6
PA5
PA4
PA3
PA2
PA1
PB7
PB6
PB5
PB4
PB3
PB2
PB2
PB0
PC7
PC6
PC5
PC4
PC3
PC2
PC1
PD7
PD6
PD5
PD4
PD3
PD2
PD0
PE7
PE6
PE5
PE3
PE2
PE1
PE0
PG1
PG0
Out2
Out1
Out9
LED
D?
R
R?
SW?
SW_Push
GND
GND
Out8
Out16
ENC28J60-INT
ENC28J60_SO
ENC28J60_SI
ENC28J60_SCK
ENC28J60-CS
Out10
Out3
Out11
Out4
Out12
Out5
Out13
ENC28J60-RESET
Out14
Out6
Out7
Out15
Header2
BJ2
+5V
GND
U7
ENC28J60-I/SO
RESET
SI
SO
SCK
CS
INT
WOL
VDDOSC
OSC1
OSC2
VSSOSC
CLKOUT
VDD
VDDPLL
VSS
VSSPLL
LEDA
LEDB
VDDRX
TPIN+
TPIN-
VSSRX
VDDTX
TPOUT+
TPOUT-
VSSTX
RBIAS
VCAP

# Notes on the Relay Module Interface

There are two things to be cautious of when attaching relay modules to the Network Module.

**Power Distribution**

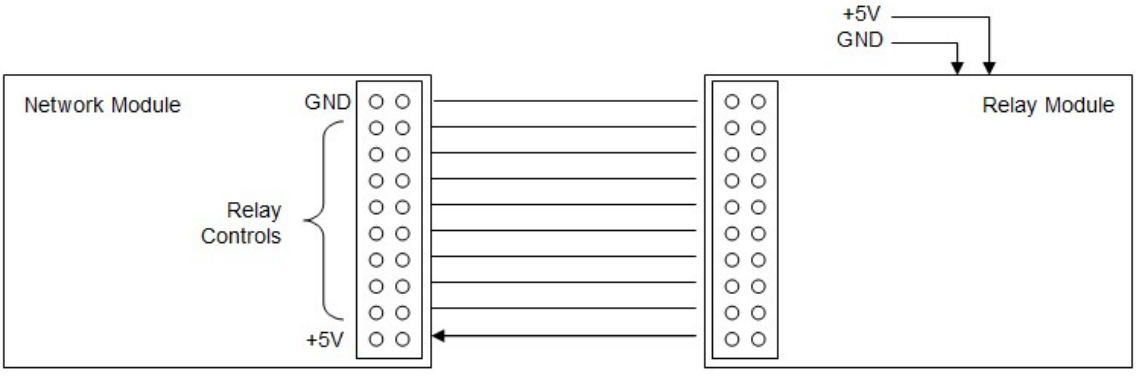
The first thing to consider is supplying power to the relay modules. The basic design of the Network Module is intended to provide +5V power to the relay modules via the pin header that also provides the relay control signals. This works well for just a few relays (up to 3 or 4). This connection method is illustrated here:



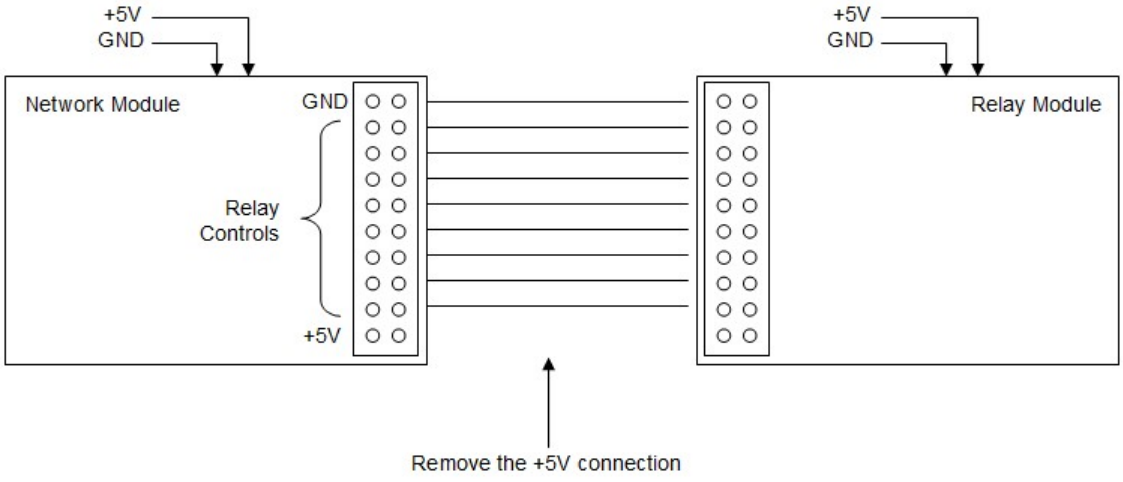

If you attach more relays you need to make sure that there is sufficient current supplied by your +5V power supply attached to the Network Module AND you need to make sure the method used to send power to the relay modules is adequate. This is particularly important if you are transferring power via a ribbon cable.

If you don't think you can provide adequate power to the relay modules via the Network Module relay header you can consider a couple of options:

1) Connect +5V power only at the Relays, and let the power/signal header send +5V back to the Network module.

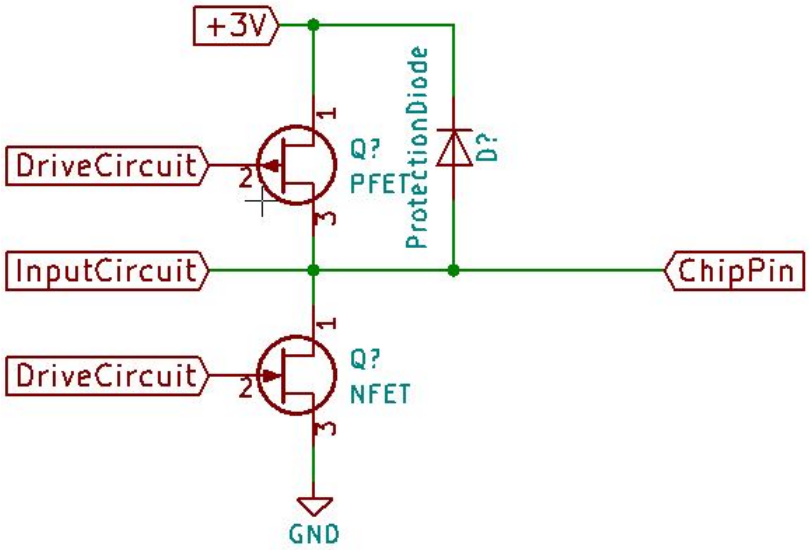


2) Use separate +5V power supplies on the Network Module and Relay Modules. If you do this you'll need to disconnect the +5V power connection between the headers.



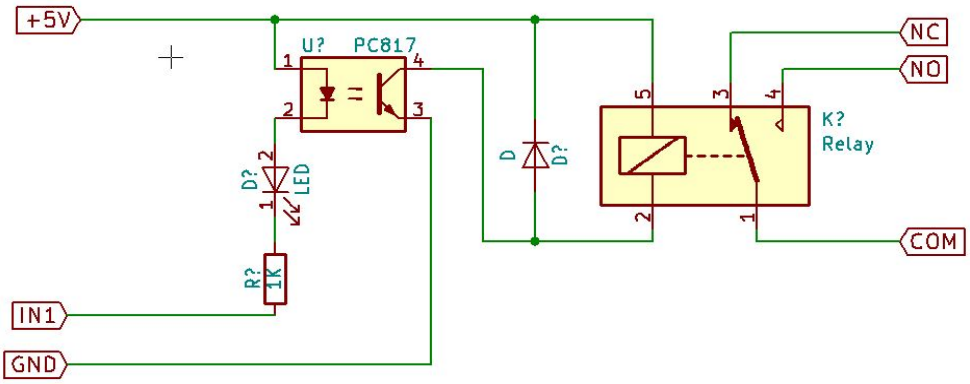

**Type of Relay Module**

The second consideration is the type of relay modules you attach. The SM8S processor on the Network Module operates at 3V and its outputs are connected directly to the relay control header. So, you need to avoid inadvertently causing +5V feedback from the relay modules to the 3V output pins of the processor that exceed the processor specifications (check the spec, but the short version is: Max 3.3V and/or limit to 4mA per pin, AND limit to 20mA across all pins). The reason this is a concern is because the SM8S output pins have overvoltage protection diodes that can provide a current path if a voltage higher than 3.3V appears on the pin when it is not in an active pull-down state. To visualize this here is a drawing illustrating the output pin:




Focus on the Protection Diode. There is also a protection diode to ground, but it is not a concern in this discussion so I left it out. If any of the relay modules can provide a current path from a higher voltage through the chip pin (when the pin is not pulling down) then there is the potential for damage. Knowing this let's look at typical relay module designs.

a) **Opto-isolated relay boards:** If you use opto-isolated relay boards there should not be a concern as long as the relay boards are designed to operate at a voltage no higher than 5V. The typical design of these relay modules looks like this:



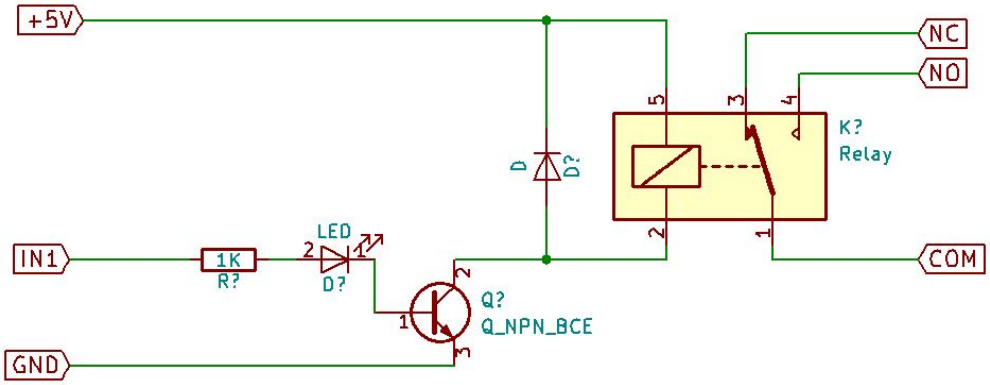

Note that in fact this relay module can provide a current path from +5V, through the photo emitter diode of the opto-isolator, through the visible LED, through the 1K resistor, then to the SM8S output pin via the "IN1" connection. But this will still work and here is why:

- The difference in voltage from the 5V supply to the SM8S output pin is 5V – 3V. But about 0.7V is dropped across the photo emitter diode. Then another 0.7V is dropped across the LED. And about 0.3V is dropped across the protection diode in the SM8S. The result is that there is only 5 – 3 – 0.7 - 0.7 - 0.3 = 0.3V potential across the 1K resistor. This will result in about 300 uA of current flowing through the path. This is not enough current to damage the SM8S and not enough current to cause the relay module to operate. So while not ideal it works.

- If your relay module does not have the LED in the trigger signal path as shown in the drawing above it might still work, but you'll have to test it to verify. The difference is that the 0.7 volt drop across the LED is missing from the equation so about 1mA will flow into the output pin of the SM8S. That won't hurt the SM8S, but it might cause the opto-isolator to operate in turn preventing the relay from releasing or causing the relay to release intermittently.

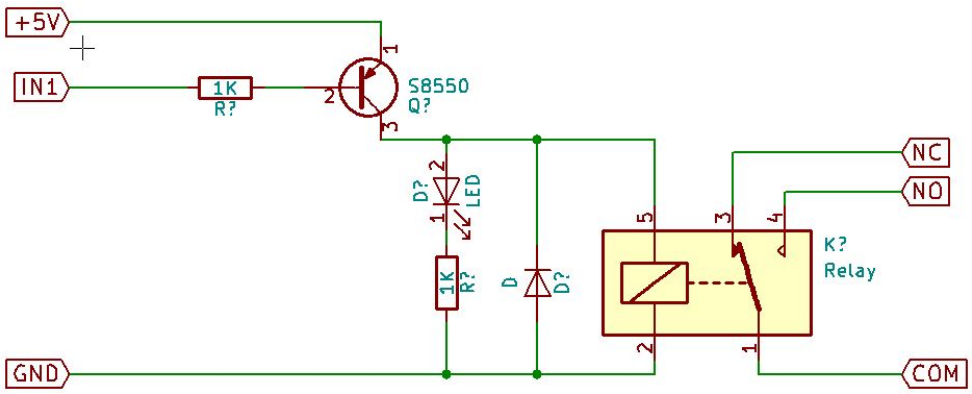
b) **Non-isolated relay module, Active HIGH trigger signal:** Some relay modules do not have opto-isolators. If they are of a design that has an active high trigger signal then the typical design has a 1K ohm resistor feeding the base of a NPN transistor. This type of relay module should operate just fine when connected directly to the Network Module, although you'll find that the logic seems reversed and you may have to set or clear the "Invert" function in the Relay Control page of the GUI.

A typical active-high relay module circuit design:




The reason this module works with the Network Module is because it has no path from +5V back to the SM8S output pin..

c) **Non-isolated relay module, Active LOW trigger signal:** This is another relay module design that does not have opto-isolators. This design typically has an active low trigger signal, and the typical design has a 1K ohm resistor feeding the base of a PNP transistor. A typical relay module design looks like this:




This design is problematic in that the PNP transistor is connected to 5V, and when the Network Module control signal goes to a high state a reverse current flow (also known as an injected current flow) will travel from +5V through the PNP transistor, through the 1K resistor, and into the SM8S output pin. Analyzing this path:

- The difference in voltage from the 5V power supply to the SM8S output pin is 5V – 3V. About 0.7V is dropped across the PNP transistor, and about 0.3V is dropped across the protection diode in the SM8S. The result is that there is 5 – 3 – 0.7 - 0.3 = 1V potential across the 1K resistor. This will result in about 1mA of current flowing through the path. This is not enough current to damage the SM8S, but it is in the active region of the PNP transistor. This may not allow the relay to turn off – or the relay may operate intermittently. If this is the case and you are unable to get a more compatible relay module you will need to provide a voltage shifting buffer between the Network Module and the Relay Module.

- If the relay module you have places the LED in series with the PNP transistor the module may work better due to the voltage drop across the LED. However, there may still be enough current to cause the PNP transistor and the relay to operate intermittently. All you can do is give it a try.

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