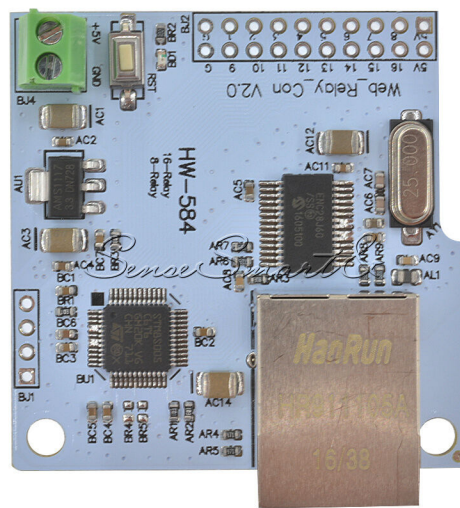


November 15, 2020

Introduction



- 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.

Code Rev 20201116 0256 and higher: Added support for MQTT.

The code is designed to compile into four different configurations:

- 1) 16 Outputs – You can control 16 Relays
- 2) 8 Outputs / 8 Inputs – You can control 8 Relays and monitor 8 digital inputs
- 3) 16 Inputs – You can monitor 16 digital inputs
- 4) 8 Outputs / 8 Inputs with MQTT support

NOTE 1: 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 2: 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.

NOTE 3: If you're looking to buy these modules the best source I've found is eBay. Best search term is “ENC28J60 Network Module”. I've also seen them on Amazon, Banggood, and Aliexpress. In some cases they show photos of both the V.1 and V2.0 versions, but don't provide a way of specifying which one you want. You may need to communicate with the seller to be sure you'll get the V2.0 device.

Thank You!

Many thanks to Carlos Ladeira for his help with user interface ideas, many hours of testing, and his patience during development of the MQTT version of this code. We've ended up with a much better project as a result.

Document License

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Change Log

June 20, 2020 – Initial Release

August 2, 2020 – Added descriptions of “8 Output / 8 Input” and “16 Input” configurations.

August 6, 2020 – Added a note to make sure people know they don’t need to set up a development environment unless they need to change the code.

August 20, 2020 – Added a note on editing the .stp file

November 16, 2020 – Major change: Added MQTT support

Other changes:

- Changed the GUI to have a Configuration page in place of the former Address Settings page
- Moved the device Name input field to the new Configuration page
- Moved the Relay Invert control to the new Configuration page
- Added an Input Invert control
- Added the ability to select whether all relays retain their state, are all forced off, or are all forced on when a power cycle occurs. This is in the “Config” settings added to the Configuration page.
- Added the ability to select whether the Ethernet interface operates in Half or Full Duplex.
- Added the ability to configure settings for MQTT Broker IP Address and Port.
- Added the ability to provide options MQTT ID and Password information.
- Added MQTT connection status indicators in the Configuration page.
- Fixed several corner case bugs in the web server code that were causing anomalous behavior in browsers.

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Screen Shots and Usage - 16 Output Configuration

IO Control

Name:	NetworkModule-186		Device name display. The name can be changed on the Configuration page.
		SET	
Relay01		<input type="radio"/> ON <input checked="" type="radio"/> OFF	Relays are turned on and off with radio buttons
Relay02		<input type="radio"/> ON <input checked="" type="radio"/> OFF	
Relay03		<input type="radio"/> ON <input checked="" type="radio"/> OFF	
Relay04		<input type="radio"/> ON <input checked="" type="radio"/> OFF	
Relay05		<input type="radio"/> ON <input checked="" type="radio"/> OFF	Color coded quick reference for Relay states
Relay06		<input type="radio"/> ON <input checked="" type="radio"/> OFF	
Relay07		<input type="radio"/> ON <input checked="" type="radio"/> OFF	
Relay08		<input type="radio"/> ON <input checked="" type="radio"/> OFF	
Relay09		<input type="radio"/> ON <input checked="" type="radio"/> OFF	Changes take effect when you click on Save You can Undo your changes before you save
Relay10		<input type="radio"/> ON <input checked="" type="radio"/> OFF	
Relay11		<input type="radio"/> ON <input checked="" type="radio"/> OFF	
Relay12		<input type="radio"/> ON <input checked="" type="radio"/> OFF	
Relay13		<input type="radio"/> ON <input checked="" type="radio"/> OFF	
Relay14		<input type="radio"/> ON <input checked="" type="radio"/> OFF	
Relay15		<input type="radio"/> ON <input checked="" type="radio"/> OFF	
Relay16		<input type="radio"/> ON <input checked="" type="radio"/> OFF	
Save	Undo All	Navigation to Configuration page Network Statistics Help	
Refresh	Configuration		

Screen Shots and Usage

16 Output Configuration

Configuration

Name:	NetworkModule-186					
Config	002000					
IP Addr	192	168	001	186		
Gateway	192	168	001	001		
Netmask	255	255	255	000		
Port	08080					
MAC Address	c2	4d	69	6b	65	06

Save Undo All

Enter a device name of your choosing so that you can easily tell which Network Module you are connected to

The Config fields allow you to invert the inputs, invert relay outputs, retain relay outputs through a power failure (or force them ON or OFF), and set Ethernet communication to Half or Full duplex. See the section "Notes on Config Settings".

Change IP Address, Gateway Address, Netmask, Port Number, MAC Address

Changes take effect when you click Save
You can Undo changes before you save them

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.

Code Revision 20201116 0256

Reboot NOTE: Reboot may cause the relays to cycle.

Refresh IO Control Network Statistics Help

Screen Shots and Usage

16 Output Configuration

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](#)

Screen Shots and Usage

16 Output Configuration

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

Config Field:

- 1st character: Output Invert 0 = off, 1 = on
- 2nd character: Input Invert 0 = off, 1 = on
- 3rd character: Output Retain Control:
 - 0 = Turn OFF all outputs on power cycle
 - 1 = Turn ON all outputs on power cycle
 - 2 = Retain previous state of all outputs on power cycle (default)
- 4th character: Full/Half Duplex Ethernet Control:
 - 0 = Half duplex (default)
 - 1 = Full duplex

IO Control

Screen Shots and Usage

16 Output Configuration

Network Statistics

Values shown are since last power on or reset

0000055767	Dropped packets at the IP layer
0000056015	Received packets at the IP layer
0000000212	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
0000000251	Received TCP segments
0000000215	Sent TCP segments
0000000000	TCP segments with a bad checksum
0000000000	TCP segments with a bad ACK number
0000000000	Received TCP RST (reset) segments
0000000000	Retransmitted TCP segments
0000000000	Dropped SYNs due to too few connections available
0000000000	SYNs for closed ports, triggering a RST
IO Control	Clear Statistics

Screen Shots and Usage

16 Output Configuration

111111011111011

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.

Screen Shots and Usage - 8 Output / 8 Input Configuration

IO Control

The screenshot shows the 'IO Control' interface for a device named 'NetworkModule-186'. It features a table for controlling 8 outputs and 8 inputs. Callouts provide additional context:

- Device name display:** The name 'NetworkModule-186' can be changed on the Configuration page.
- Relays are turned on and off with radio buttons:** Each output row has radio buttons for 'ON' and 'OFF'.
- Color coded quick reference for Relay states:** Red squares indicate the current state of the outputs.
- Shows the state of Input pins:** Green squares indicate high, and red squares indicate low.
- Changes take effect when you click on Save:** A 'Save' button is located at the bottom.
- You can Undo your changes before you save:** An 'Undo All' button is located next to the 'Save' button.
- Navigation to Configuration page, Network Statistics, Help:** Buttons for 'Refresh', 'Configuration', 'Network Statistics', and 'Help' are at the bottom.

Name:	NetworkModule-186	
		SET
Output01	<div></div>	<input type="radio"/> ON <input checked="" type="radio"/> OFF
Output02	<div></div>	<input type="radio"/> ON <input checked="" type="radio"/> OFF
Output03	<div></div>	<input type="radio"/> ON <input checked="" type="radio"/> OFF
Output04	<div></div>	<input type="radio"/> ON <input checked="" type="radio"/> OFF
Output05	<div></div>	<input type="radio"/> ON <input checked="" type="radio"/> OFF
Output06	<div></div>	<input type="radio"/> ON <input checked="" type="radio"/> OFF
Output07	<div></div>	<input type="radio"/> ON <input checked="" type="radio"/> OFF
Output08	<div></div>	<input type="radio"/> ON <input checked="" type="radio"/> OFF
Input01	<div></div>	
Input02	<div></div>	
Input03	<div></div>	
Input04	<div></div>	
Input05	<div></div>	
Input06	<div></div>	
Input07	<div></div>	
Input08	<div></div>	

Save Undo All

Refresh Configuration Network Statistics Help

Screen Shots and Usage

8 Output / 8 Input Configuration

Configuration

Name:	NetworkModule-186					
Config	002000					
IP Addr	192	168	001	186		
Gateway	192	168	001	001		
Netmask	255	255	255	000		
Port	08080					
MAC Address	c2	4d	69	6b	65	06

Save Undo All

Enter a device name of your choosing so that you can easily tell which Network Module you are connected to

The Config fields allow you to invert the inputs, invert relay outputs, retain relay outputs through a power failure (or force them ON or OFF), and set Ethernet communication to Half or Full duplex. See the section "Notes on Config Settings".

Change IP Address, Gateway Address, Netmask, Port Number, MAC Address

Changes take effect when you click Save
You can Undo changes before you save them

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.

Code Revision 20201116 0256

Reboot NOTE: Reboot may cause the relays to cycle.

Refresh IO Control Network Statistics Help

Screen Shots and Usage

8 Output / 8 Input Configuration

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
01 = Relay-01 ON	10 = Relay-05 ON
02 = Relay-02 OFF	11 = Relay-06 OFF
03 = Relay-02 ON	12 = Relay-06 ON
04 = Relay-03 OFF	13 = Relay-07 OFF
05 = Relay-03 ON	14 = Relay-07 ON
07 = Relay-04 OFF	15 = Relay-08 OFF
08 = Relay-04 ON	16 = Relay-08 ON
55 = All Relays ON	
56 = All Relays OFF	

The following are also available:

- 60 = Show IO Control page
- 61 = Show Address Settings page
- 63 = Show Help Page 1
- 64 = Show Help Page 2
- 65 = Flash LED
- 66 = Show Statistics
- 67 = Clear Statistics
- 91 = Reboot
- 99 = Show Short Form IO Status

[Next Help Page](#)

Screen Shots and Usage

8 Output / 8 Input Configuration

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

Config Field:

- 1st character: Output Invert 0 = off, 1 = on
- 2nd character: Input Invert 0 = off, 1 = on
- 3rd character: Output Retain Control:
 - 0 = Turn OFF all outputs on power cycle
 - 1 = Turn ON all outputs on power cycle
 - 2 = Retain previous state of all outputs on power cycle (default)
- 4th character: Full/Half Duplex Ethernet Control:
 - 0 = Half duplex (default)
 - 1 = Full duplex

IO Control

Screen Shots and Usage

8 Output / 8 Input Configuration

Network Statistics

Values shown are since last power on or reset

0000055767	Dropped packets at the IP layer
0000056015	Received packets at the IP layer
0000000212	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
0000000251	Received TCP segments
0000000215	Sent TCP segments
0000000000	TCP segments with a bad checksum
0000000000	TCP segments with a bad ACK number
0000000000	Received TCP RST (reset) segments
0000000000	Retransmitted TCP segments
0000000000	Dropped SYN's due to too few connections available
0000000000	SYNs for closed ports, triggering a RST
IO Control	Clear Statistics

Screen Shots and Usage

8 Output / 8 Input Configuration

1111110111111011

HTML output page with a short form representation of the Relay and Input states. Useful to app writers.

Relay states are Relay 1 on the left up to Relay 8, followed by Input 1 to Input 8 on the right.

Screen Shots and Usage - 16 Input Configuration

IO Control

The screenshot displays the 'IO Control' interface. At the top, a 'Name:' field shows 'NetworkModule-186'. Below this is a list of 16 inputs, each with a corresponding colored square indicating its state: Input01 through Input08 are red, and Input09 through Input16 are green. At the bottom, there are two rows of buttons: 'Save' and 'Undo All' in the first row, and 'Refresh', 'Configuration', 'Network Statistics', and 'Help' in the second row. Four callout boxes provide additional information: one points to the device name field, another explains the color coding for input pins (green for high, red for low), a third points to the 'Save' button, and a fourth points to the navigation buttons.

Name:	NetworkModule-186
Input01	Red
Input02	Red
Input03	Red
Input04	Red
Input05	Red
Input06	Red
Input07	Red
Input08	Red
Input09	Green
Input10	Green
Input11	Green
Input12	Green
Input13	Green
Input14	Green
Input15	Green
Input16	Green

Save Undo All

Refresh Configuration Network Statistics Help

Device name display. The name can be changed on the Configuration page.

Shows the state of Input pins
Green = high
Red = low

Changes take effect when you click on Save
You can Undo your changes before you save

Navigation to
Address Settings
Network Statistics
Help

Screen Shots and Usage

16 Input Configuration

Configuration

Name:	NetworkModule-186					
Config	002000					
IP Addr	192	168	001	186		
Gateway	192	168	001	001		
Netmask	255	255	255	000		
Port	08080					
MAC Address	c2	4d	69	6b	65	06

Save Undo All

Enter a device name of your choosing so that you can easily tell which Network Module you are connected to

The Config fields allow you to invert the inputs, invert relay outputs, retain relay outputs through a power failure (or force them ON or OFF), and set Ethernet communication to Half or Full duplex. See the section "Notes on Config Settings".

Change IP Address, Gateway Address, Netmask, Port Number, MAC Address

Changes take effect when you click Save
You can Undo changes before you save them

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.

Code Revision 20201116 0256

Reboot NOTE: Reboot may cause the relays to cycle.

Refresh IO Control Network Statistics Help

Screen Shots and Usage

16 Input Configuration

Help Page 1

REST 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:

60 = Show IO Control page

61 = Show Address Settings page

63 = Show Help Page 1

64 = Show Help Page 2

65 = Flash LED

66 = Show Statistics

67 = Clear Statistics

91 = Reboot

99 = Show Short Form IO Status

[Next Help Page](#)

Screen Shots and Usage

16 Input Configuration

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

Config Field:

- 1st character: Output Invert 0 = off, 1 = on
- 2nd character: Input Invert 0 = off, 1 = on
- 3rd character: Output Retain Control:
 - 0 = Turn OFF all outputs on power cycle
 - 1 = Turn ON all outputs on power cycle
 - 2 = Retain previous state of all outputs on power cycle (default)
- 4th character: Full/Half Duplex Ethernet Control:
 - 0 = Half duplex (default)
 - 1 = Full duplex

IO Control

Screen Shots and Usage

16 Input Configuration

Network Statistics

Values shown are since last power on or reset

0000055767	Dropped packets at the IP layer
0000056015	Received packets at the IP layer
0000000212	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
0000000251	Received TCP segments
0000000215	Sent TCP segments
0000000000	TCP segments with a bad checksum
0000000000	TCP segments with a bad ACK number
0000000000	Received TCP RST (reset) segments
0000000000	Retransmitted TCP segments
0000000000	Dropped SYN's due to too few connections available
0000000000	SYNs for closed ports, triggering a RST
IO Control	Clear Statistics

Screen Shots and Usage

16 Input Configuration

1111110111111011

HTML output page with a short form representation of the Input states. Useful to app writers.

Input states are Input 1 on the left up to Input 16 on the right.

Screen Shots and Usage – 8 Output 8 Input Configuration with MQTT

IO Control

The screenshot displays the 'IO Control' interface. At the top, a 'Name:' field shows 'NetworkModule-186'. Below this is a list of 16 input pins, labeled 'Input01' through 'Input16'. Each pin has a corresponding colored square indicating its state: red for low and green for high. The first 8 pins (Input01-Input08) are red, and the next 8 pins (Input09-Input16) are green. At the bottom, there are four buttons: 'Save', 'Undo All', 'Refresh', and a navigation bar with 'Configuration', 'Network Statistics', and 'Help'.

Device name display. The name can be changed on the Configuration page.

Shows the state of Input pins
Green = high
Red = low

Changes take effect when you click on Save
You can Undo your changes before you save

Navigation to
Address Settings
Network Statistics
Help

Name:	NetworkModule-186
Input01	Red
Input02	Red
Input03	Red
Input04	Red
Input05	Red
Input06	Red
Input07	Red
Input08	Red
Input09	Green
Input10	Green
Input11	Green
Input12	Green
Input13	Green
Input14	Green
Input15	Green
Input16	Green

Save Undo All

Refresh Configuration Network Statistics Help

Screen Shots and Usage

8 Output / 8 Input Configuration with MQTT

Configuration

Name:	NetworkModule-186				Enter a device name of your choosing so that you can easily tell which Network Module you are connected to		
Config	002000				The <u>Config</u> fields allow you to invert the inputs, invert relay outputs, retain relay outputs through a power failure (or force them ON or OFF), and set Ethernet communication to Half or Full duplex. See the section "Notes on <u>Config</u> Settings"...		
IP Address	192	168	001	186	Change IP Address, Gateway Address, <u>Netmask</u> , Port Number, MAC Address		
Gateway	192	168	001	001			
Netmask	255	255	255	000			
Port	08080						
MAC Address	c2	4d	69	6b	65	06	
MQTT Server	192	168	001	020	Enter the IP Address and Port number of the MQTT Broker / Server		
MQTT Port	01883						
MQTT Username					Enter the MQTT Username and Password (optional – depends on how you set up the Broker)		
MQTT Password							
MQTT Status					Status of the MQTT connection. All boxes Green indicates a successful connection to the server and broker.		
Save	Undo All				Changes take effect when you click Save You can Undo changes before you save them		

See Documentation for help
Code Revision 20201116 0256

Reboot

Refresh IO Control

Screen Shots and Usage

8 Output 8 Input Configuration with MQTT

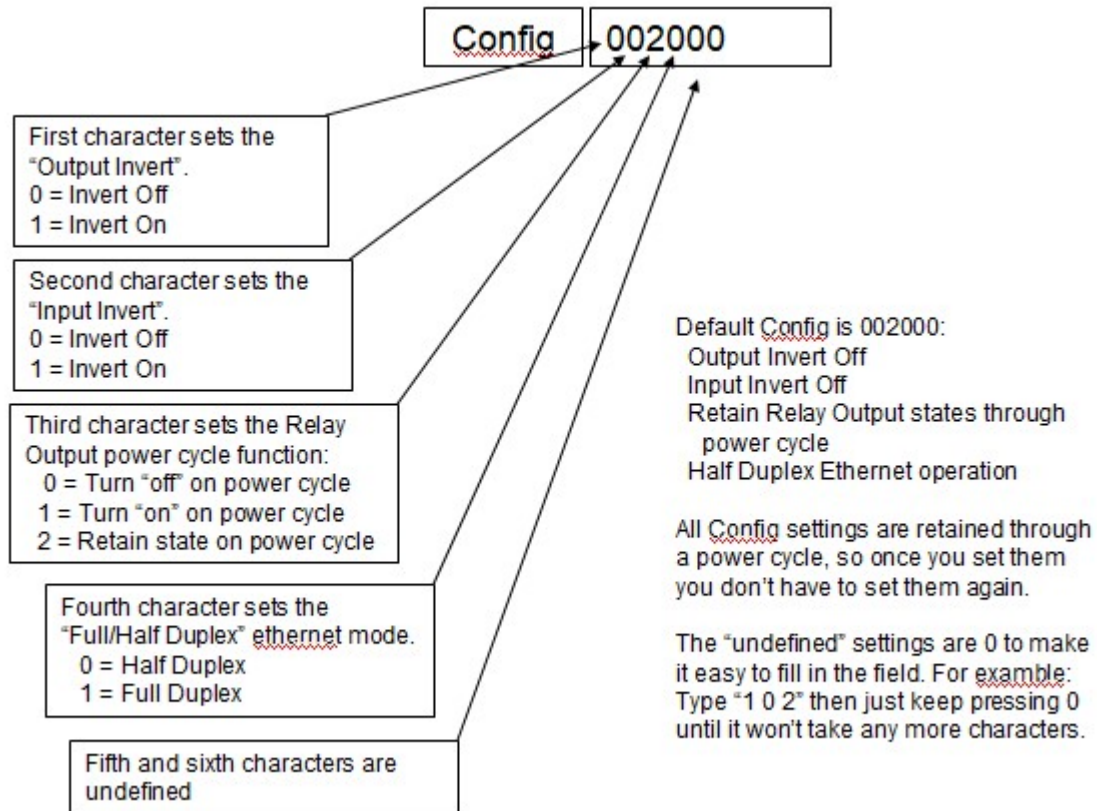
1111110111111011

HTML output page with a short form representation of the Input states. Useful to app writers.

Input states are Input 1 on the left up to Input 16 on the right.

Notes on Config Settings

The Config Settings field on the Configuration page lets you modify operation of the code as follows:



Output and Input Invert:

The Output and Input Invert settings let you accommodate logic reversals in your external circuitry.

Relay Output Power Cycle Setting:

The Relay Output power cycle setting lets you define how you want the relay output control pins handled in event of a power cycle. "0" will cause all pins to enter the "OFF" state in event of a power loss and restart. "1" will cause all pins to enter the "ON" state in

event of a power loss and restart. “2” will cause all pins to return to their state prior to the power loss. Actual logic level on the pins are as defined by the “Invert” setting.

IMPORTANT: Due to the limited number of times the EEPROM can be written you should set the ‘Retain’ (“2”) state only if you expect the relay outputs to change infrequently, such as in home lighting controls. If you expect the relays to change frequently, for example a holiday light display, you should select “0” or “1” as the power cycle setting.

Why? The EEPROM is rated for about 100,000 writes (although it can probably take many more than that). That sounds like a lot, but if it was written once every 10 seconds you would hit 100,000 writes in about 11 days. Using a “0” or “1” setting won’t perform any writes to the EEPROM (because there is no need to remember the relay state through a power cycle). But a “2” setting will write the EEPROM with every relay output change.

The “2” Retain setting is really meant to make sure the relay states are remembered for less frequent changes like home lamp controls, motor controls, and other similar “a few times a day” control activities. If relay states change infrequently (say, 10 times per day) the EEPROM will last at least 27 years with Retain turned on.

Full / Half Duplex Setting:

The Half / Full Duplex support setting lets you determine the Ethernet communication method. This setting defaults to Half Duplex because that is the most reliable setting for the ENC28J60 Ethernet chip used on the Network Module board. Since all the Ethernet transactions that will occur with the module are small and infrequent there is no real performance advantage to using Full Duplex.

During test it was found that Cisco business level switches exhibited Half Duplex timing that the ENC28J60 cannot handle, the symptom being a device disconnect (and automatic recovery) every few hours. This isn’t the fault of the Cisco switch, rather it appears to be the fault of errata in the ENC28J60. During test it was determined that we could get around this issue seen in the Cisco switch configuration by enabling Full Duplex mode in the ENC28J60. While there was concern that this would not work (due to chip spec notes and online discussion over the years), it seemed to run error free. There may be other switches which show the same issue. Again, the reason it Full Duplex works may be the very low messaging rate used with the Network Module which eliminates the need for flow control.

Note 1: The spec for the chip indicates that Full/Half Duplex auto-negotiation DOES NOT work. However, experimentation showed that both Full and Half Duplex worked with the limited number of unmanaged switches on hand. Problems were only found running Half Duplex with the Cisco managed switch.

Note 2: If you choose to use the Full Duplex setting note that the spec says the Switch port the device is connected to MUST be manually configured for Full Duplex operation ... even though our testing did not show that to be the case. Of course we had a limited number of switches and this might be an issue on some other switch.

Note3: Feel free to experiment with this setting at your own risk to see what works best in your network configuration. I recommend you use Half Duplex and only try Full Duplex if you have issues.

Notes on MQTT

This is not a tutorial on MQTT as there are a lot of great resources online to bring you up to speed if you are just getting started with this protocol. Here I am only including notes on the tools and methods used in test of the MQTT functionality on the Network Module.

Configuration Settings:

First a discussion of the Configuration page parameters associated with MQTT

MQTT Server	192	168	001	020
MQTT Port	01883			
MQTT Username	<input type="text"/>			
MQTT Password	<input type="password"/>			
MQTT Status	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

At this date the MQTT Broker Server must be specified in the form of an IP Address (as opposed to a URL). In future versions I may be able to allow use of a URL for the Broker Server.

The MQTT Port is self explanatory. The MQTT default value of 1883 automatically appears, but you can enter any port number you have assigned to MQTT on your Broker Server.

Security:

The MQTT Username and MQTT Password are optional and only required if you've set up your Broker to require them.

IMPORTANT: SSL/TSL are NOT implemented due to memory restrictions. I haven't found any implementations that are small enough to fit in the flash space available on the Network Module, so I don't expect this to ever be possible.

If security is really important due to the need to access MQTT on the device from the internet I suggest using access to your internal MQTT Broker Server in a secure way, then letting the Broker Server pass all messages on your internal network. You don't have to do it this way, but this is a suggestion for improving security rather than just exposing the device to the internet.

Tools and test methods:

Tools used in development and test of the MQTT functionality:

- The Mosquitto Broker was used on a Windows 10 laptop and worked very well with the Network Module.
- Chrome with MQTTLens was used at various points to provide a manual MQTT subscribe and publish interface.
- NodeRed was used to drive automated MQTT messages.
- Carlos Ladeira used Home Assistant in concert with NodeRed and the Mosquitto Broker in a Linux environment to perform extensive long run testing.

You aren't restricted to the above. Any tools and interfaces that are MQTT compliant should work just as well. But if you are just getting started I can recommend the above as a good place to start.

MQTT Status Indicators:



The MQTT Status indicators show connection progress with the MQTT Server and Broker:

Box 1 - Indicates that the MQTT Connection process has started.

Box 2 - Indicates a successful ARP reply from the Server.

Box 3 - Indicates a successful TCP connection with the Server.

Box 4 - Indicates the MQTT Broker has responded (Connect phase)

Box 5 - Indicates initial communications with the Broker has completed successfully (initial subscribe and publish messages completed).

Once all 5 boxes are green the Network Module is connected to the Broker and normal MQTT communications can proceed.

Reminder regarding the Relay Output power cycle setting:

A reminder regarding the relay output power cycle setting in the Config settings on the Configuration page: If you select 'Retain' (ie, "2" - retain the states if a power cycle occurs) then the Relay states are written to the EEPROM every time a relay changes state. If you anticipate a lot of relay state changes you may wear out the EEPROM with too many changes to the relay states.

Network Module Subscriptions:

Once the Network Module connects to the Broker it will Subscribe to the following topics:

“NetworkModule/<devicename>/on”

“NetworkModule/<devicename>/off”

“NetworkModule/<devicename>/state-req”

Where <devicename> is the Name you gave the module on the Configuration page.

Network Module Publish Status:

The Network Module will Publish the following topic messages:

“NetworkModule/<devicename>/status”

Payload: “online”

“NetworkModule/<devicename>/status”

Payload: “offline”

Any client using the Network Module can Subscribe to

“NetworkModule/<devicename>/status” to receive the Network module online / offline messages.

Network Module Pin State Publish Messages:

The Network Module will Publish the following topic messages to the Broker when any Input or Output pin changes state:

“NetworkModule/<devicename>/in-on

Payload: <input #>

Where <input #> = 01 to 08. The Publish occurs for any input pin that changes state from “off” to “on”.

“NetworkModule/<devicename>/in-off”

Payload: <input #>

Where <input #> = 01 to 08. The Publish occurs for any input pin that changes state from “on” to “off”.

“NetworkModule/<devicename>/out-on”

Payload: <output #>

Where <output #> = 01 to 08. The Publish occurs for any output pin that changes state from “off” to “on”.

“NetworkModule/<devicename>/out-off”

Payload: <output #>

Where <output #> = 01 to 08. The Publish occurs for any output pin that changes state from “on” to “off”.

“NetworkModule/<devicename>/state”

Payload: 2 byte binary pin values

This message is only published in response to a “state-req” topic message (see below in the “Client Publish Commands to the Network Module” section). The payload consists of two bytes with the bits organized as follows:

First byte:

Bit 7 = Pin 16 (Input 8) state
Bit 6 = Pin 15 (Input 7) state
Bit 5 = Pin 14 (Input 6) state
Bit 4 = Pin 13 (Input 5) state
Bit 3 = Pin 12 (Input 4) state
Bit 2 = Pin 11 (Input 3) state
Bit 1 = Pin 10 (Input 2) state
Bit 0 = Pin 9 (Input 1) state

Second byte:

Bit 7 = Pin 8 (Relay 8) state
Bit 6 = Pin 7 (Relay 7) state
Bit 5 = Pin 6 (Relay 6) state
Bit 4 = Pin 5 (Relay 5) state
Bit 3 = Pin 4 (Relay 4) state
Bit 2 = Pin 3 (Relay 3) state
Bit 1 = Pin 2 (Relay 2) state
Bit 0 = Pin 1 (Relay 1) state

A Client using the Network Module should Subscribe to the above topics to receive Input and Output pin state changes.

Client Publish Commands to the Network Module:

A client can send one of the following Publish messages to the Broker, and because the Network Module has Subscribed to these topics it will receive the messages from the Broker:

“NetworkModule/<devicename>/on”

Payload: <output #>

Where <output #> = 01 to 08. The result will be that the corresponding output (relay) will turn on.

“NetworkModule/<devicename>/off”

Payload: <output #>

Where <output #> = 01 to 08. The result will be that the corresponding output (relay) will turn off.

“NetworkModule/<devicename>/state-req”

Payload: none

The result of this Publish is that the Network Module will generate a “NetworkModule/<devicename>/state” response. See above in the “Network Module Pin State Publish Messages” section.

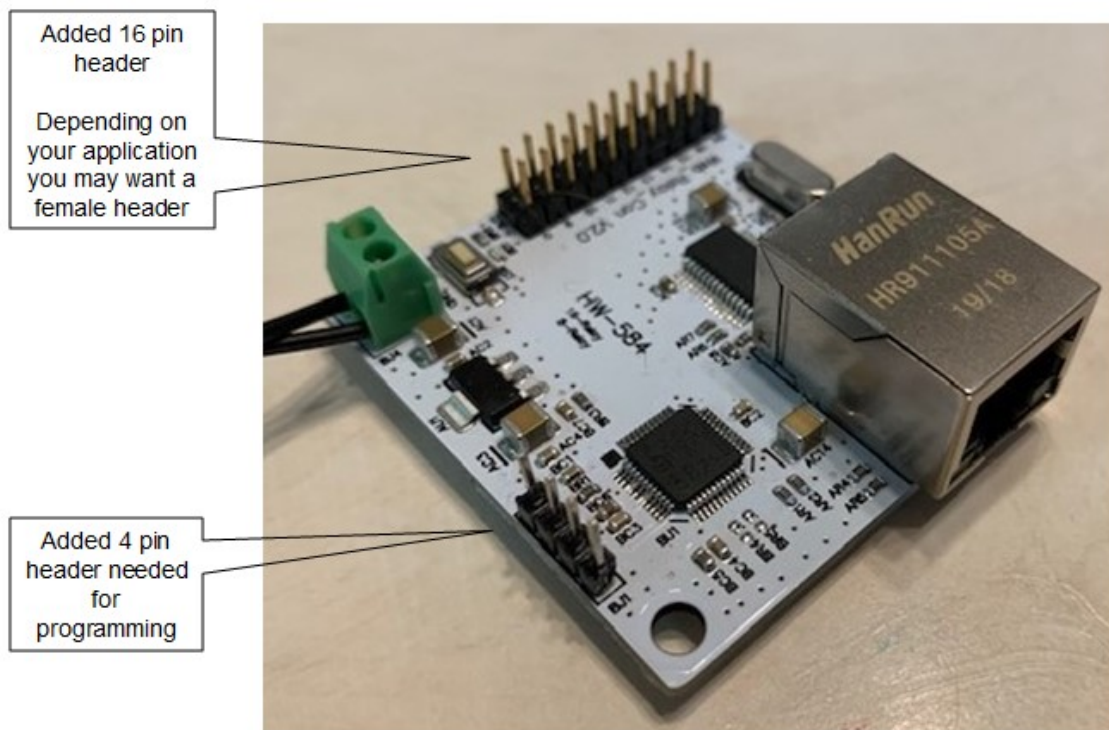
Programming the Module

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.

Remember there are 3 configurations of the firmware. When the appropriate step in the process comes up you'll need to pick the configuration you want.

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 STVP programmer needs a “.stp” and “.sx” file pair to program the Network Module. Depending on the functionality you are looking for you’ll need to copy one of the following pairs of files into your Documents directory. Or you can copy all of them and select the configuration you want in a later step.

16 Output Configuration:

NetworkModule-16Out.stp - The STVP project file

NetworkModule-16Out.sx - The NetworkModule binary file

8 Output / 8 Input Configuration:

NetworkModule-8Out.stp - The STVP project file

NetworkModule-8Out.sx - The NetworkModule binary file

16 Input Configuration:

NetworkModule-16In.stp - The STVP project file

NetworkModule-16In.sx - The NetworkModule binary file

8 Output / 8 Input Configuration with MQTT:

NetworkModule-8OutMQTT.stp - The STVP project file

NetworkModule-8OutMQTT.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.

IMPORTANT: Since the path to your “Documents” directory will be different than mine (if for no other reason than your user ID is different than “Mike), you may need to **edit the .stp file to match your directory path**. Open the .stp file with NotePad or NotePad++ and look for the following. Edit it to match the path to your .sz file.

```
30 File0=C:\Users\Mike\Documents\COSMIC\FSE_Compilers\CXSTM8\NetworkModule\NetworkModule.sxCRLF
```

I use NotePad++ and have it set to show the CR/LF at the end of the line. If you use NotePad as your text editor you won’t see that.

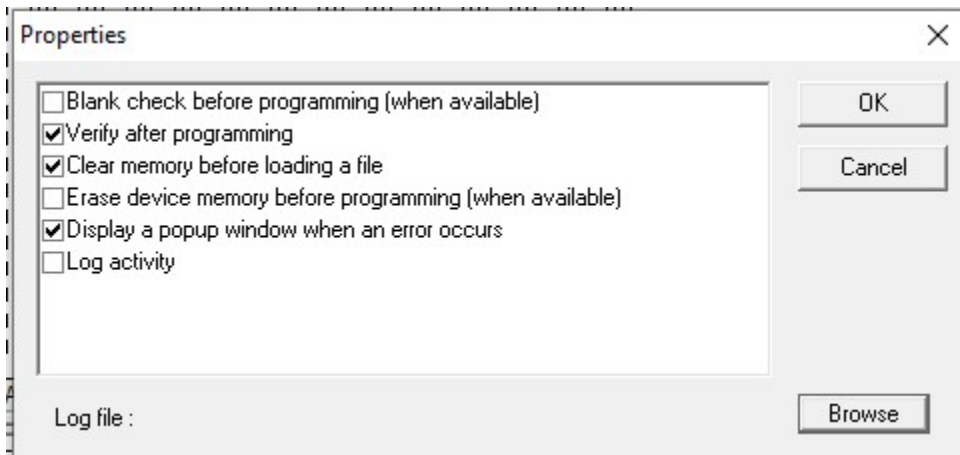
Telling STVP where your files are:

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.

Setting up ST-Link Communication:

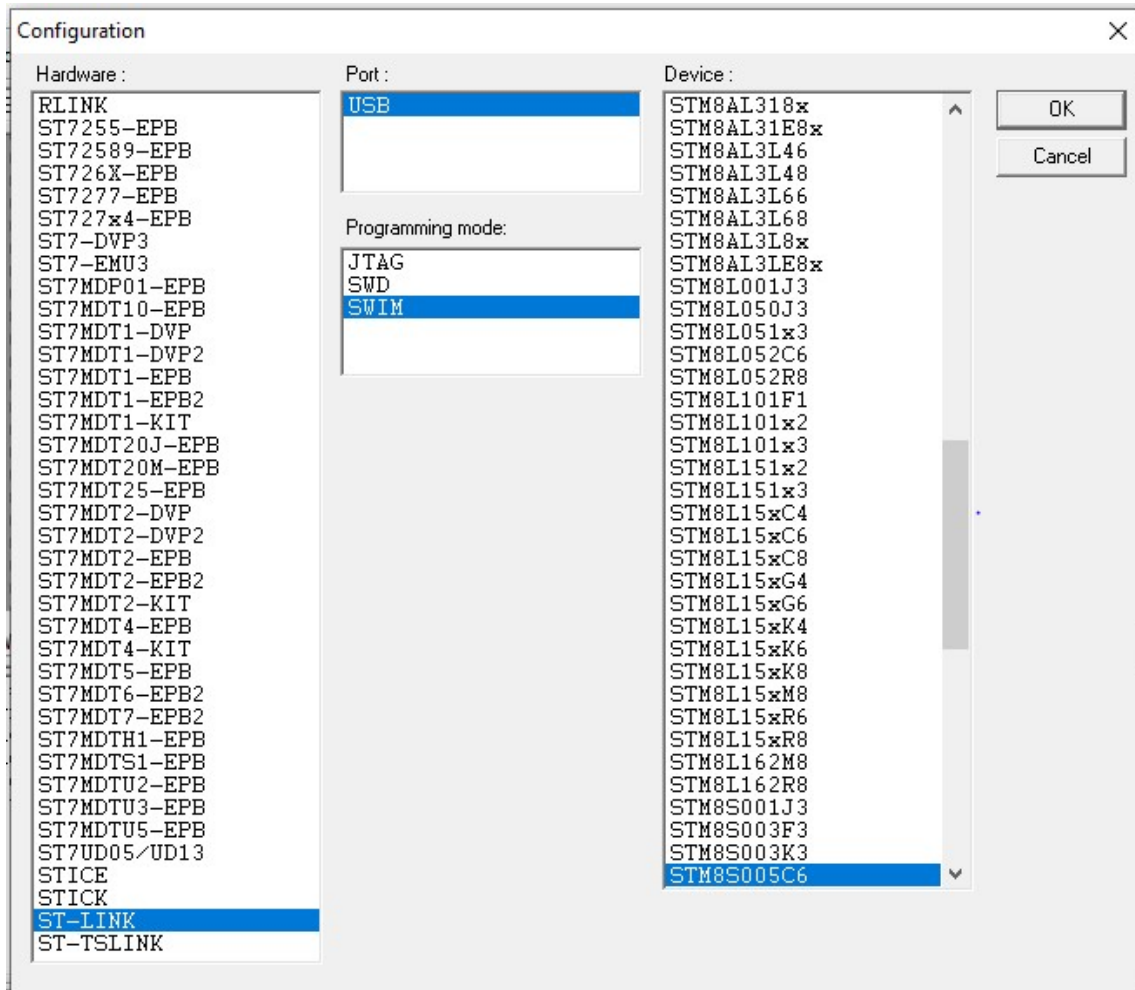
The project file contains various settings that enable the ST-Link V2 to communicate with your target board. They should already be set for you, but just in case the following is how I had them set:

Under "**Edit/Preferences**":



(Continued)

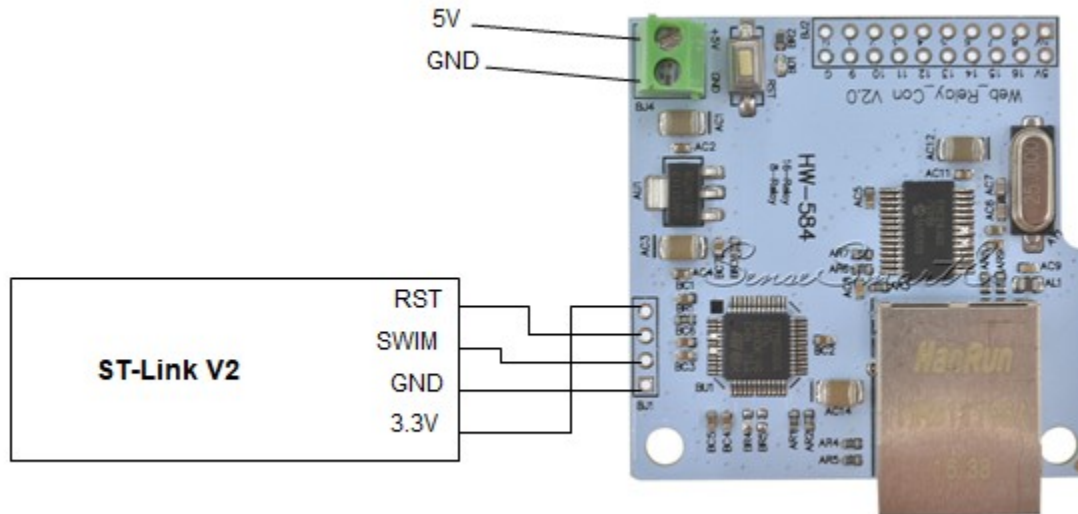
Under “Configure/Configure ST Visual Programmer”



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

Setting up the Hardware to allow programming:

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 you see “out of range” messages like the following this is NOT an error. It would have been nice if the messages were more informative, but they are just telling you that the indicated addresses are in non-programmable areas of the chip during program load. The addresses shown are typically in EEPROM and RAM.

```
> Loading file C:\Users\Mike\Documents\COSMIC\FSE_Compilers\CXSTM8\MQTT-Network
FILE : line 961: Address 0x4000 is out of range and is ignored!
FILE : line 961: Address 0x4001 is out of range and is ignored!
FILE : line 961: Address 0x4002 is out of range and is ignored!
FILE : line 961: Address 0x4003 is out of range and is ignored!
FILE : line 961: Address 0x4004 is out of range and is ignored!
FILE : line 961: Address 0x4005 is out of range and is ignored!
FILE : line 961: Address 0x4006 is out of range and is ignored!
```

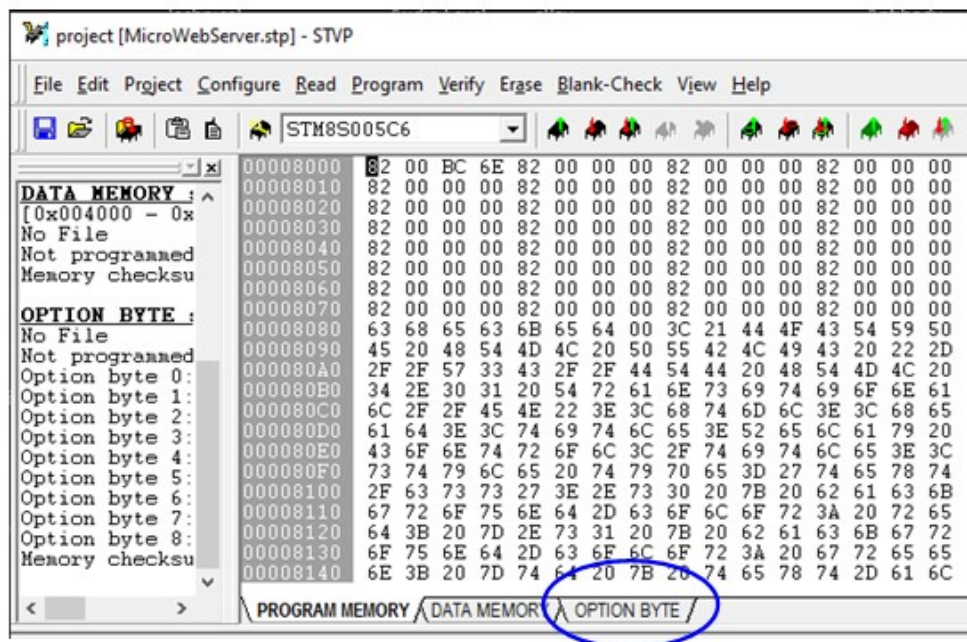
Once the program is successfully loaded in the programmer you will see a message like this (although the checksum will likely be different than what you see here).

```
FILE : line 964: Address 0xD is out of range and is ignored!
FILE : line 964: Address 0xE is out of range and is ignored!
FILE : line 964: Address 0xF is out of range and is ignored!
< File successfully loaded. File Checksum 0x297EE9
```

Clear the ROP Bit:

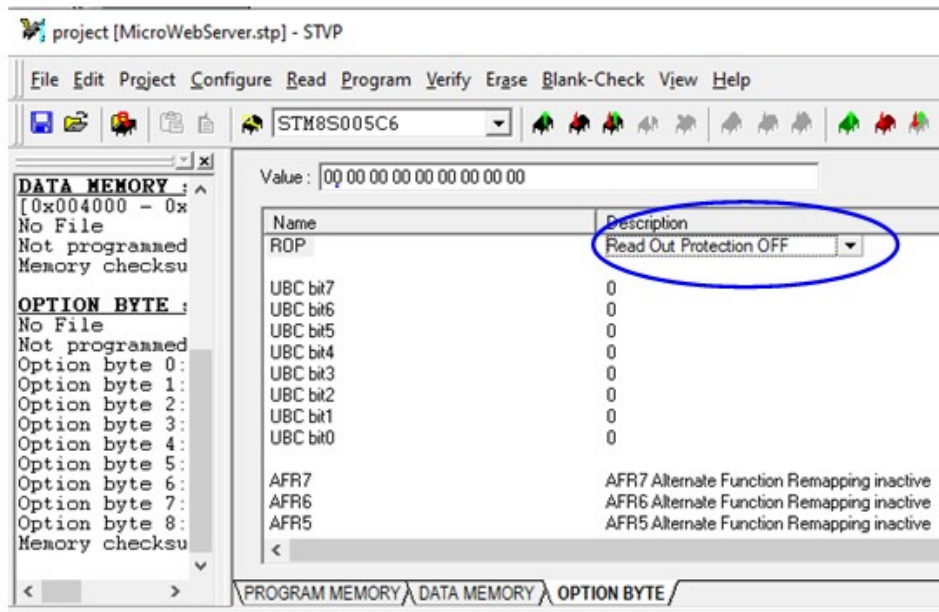
If this is the first time you are programming your Network Module you will need to clear the Read Out Protection (ROP) bit. If you don't clear the ROP any attempt to program the Network Module will give you a "This device is protected" message. How to clear the ROP bit:

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



(Continued)

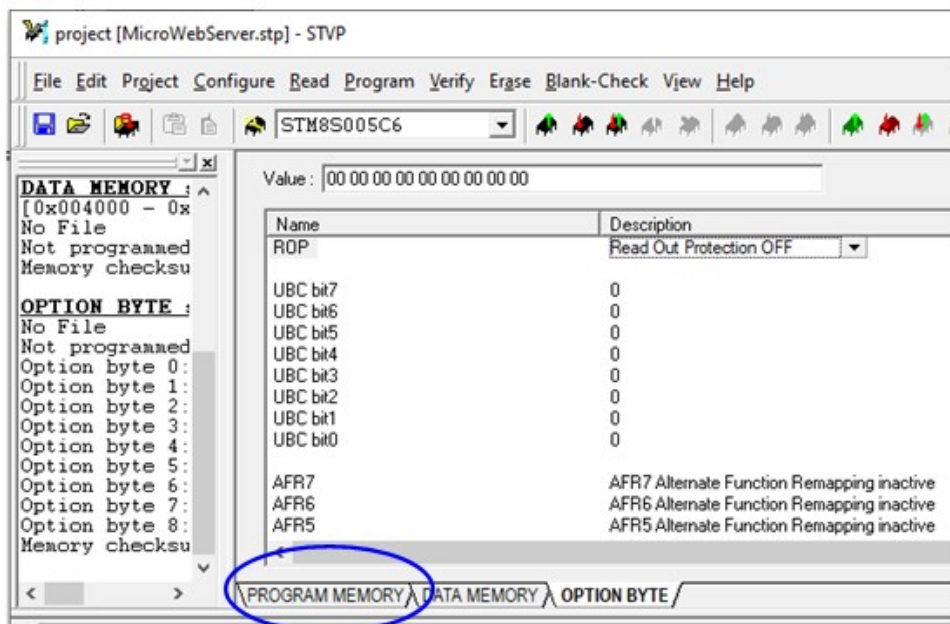
Make sure “Read Out Protection OFF” is selected in this drop down.



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.

Programming 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:

- Make sure the RST connection is in place.
- Make sure the power supply connected to the Network Module is providing 5V.
- Make sure you have good connections from the ST-Link V2 to the Network Module.
- You might have to unplug the ST-Link V2 from the USB port on your PC and plug it back in again.
- You might have to stop the STVP program, unplug and replug the ST-Link V2, then restart the STVP program.
- If you have 16 relays connected to your Network Module I suggest disconnecting them while reprogramming. If you have a very robust power supply it may be possible to leave them connected. The Network Module will be reset a couple of times during programming, and this may cause the relays to simultaneously turn on and off. Whether this interferes with programming depends on whether your power supply can handle the surge caused by the relay coils.

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

(Continued)

If you see 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 also disconnect the other wires, or leave them 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://steve-smarhomeguide.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 Development Environment

NOTE: You don't need to do this if you are going to use the binaries (.stp and .sx files) I already created.

If you want to change the code for your own use I assume you have some experience with coding 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.

A note about my coding style: 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 Compiling Different Configurations

NOTE: You don't need to do this if you are going to use the binaries (.stp and .sx files) I already created.

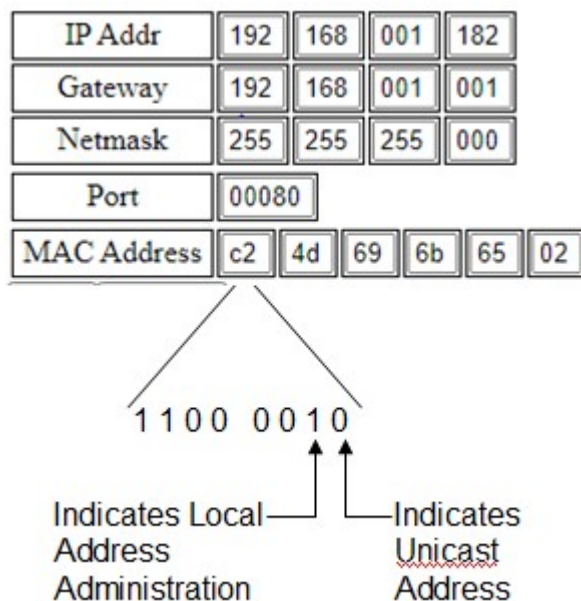
- 1) Compilation of the different configurations of the code (16 Out, 8Out/8In, 16In) is selected with the "GPIO_SUPPORT" define in the uiopot.h file. You also need to set the MQTT option if wanted. Read the notes in the uiopot.h file carefully to make sure the options you select are compatible. For instance, if you compile MQTT you can only use GPIO_SUPPORT2 and you must not include UIP_STATISTICS or HELP_SUPPORT 0 – there isn't enough memory in the device for those options with MQTT.
- 2) Compilation of any particular version will result in .stp and .sx files named "NetworkModule.stp" and "NetworkModule.sx". Rename those as appropriate to "NetworkModule -16Out", "NetworkModule -8Out", "NetworkModule -16In" or "NetworkModule – 8OutMQTT" depending on what you compiled.

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 four octets something you fancy.

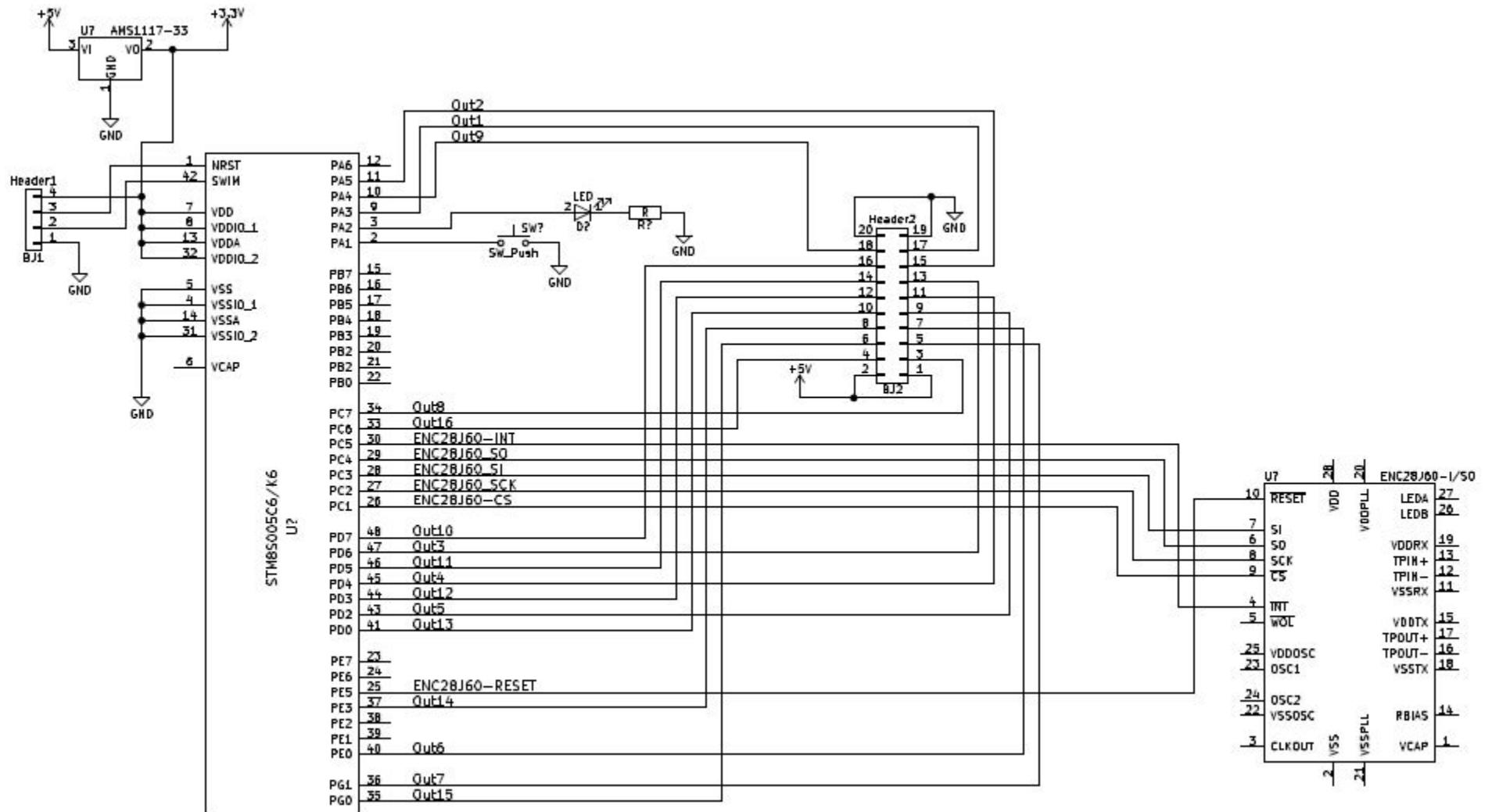
A good reference for MAC address explanations is here:

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.
 - o 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:
 - o 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.
 - o The -WOL pin does not appear to be connected.
 - o 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.

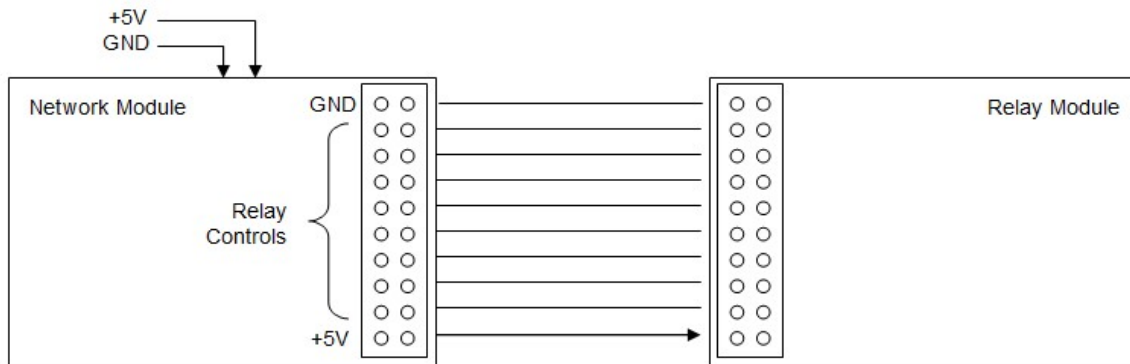


Notes on Interfacing to Relay Modules

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

Power Distribution

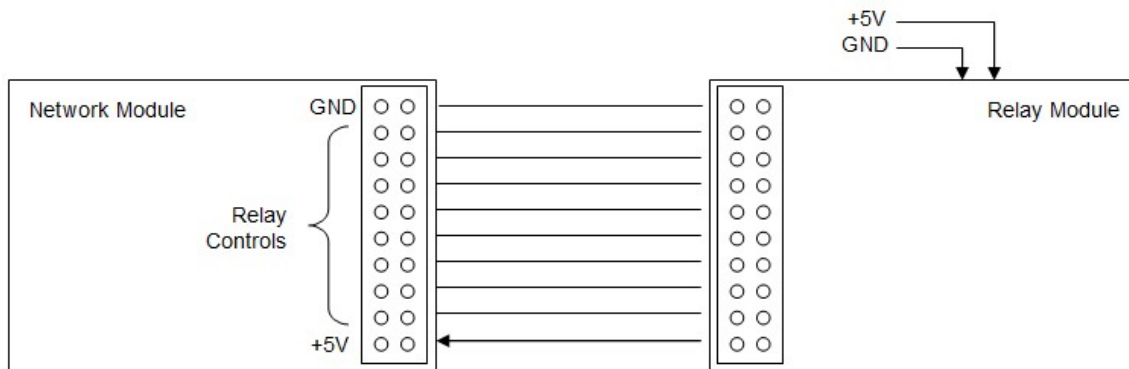
The first thing to consider is supplying power to the relay modules. The basic design of the Network Module is intended to provide +5V power to the relay modules via the pin header that also provides the relay control signals. This works well for just a few relays (up to 3 or 4). This connection method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



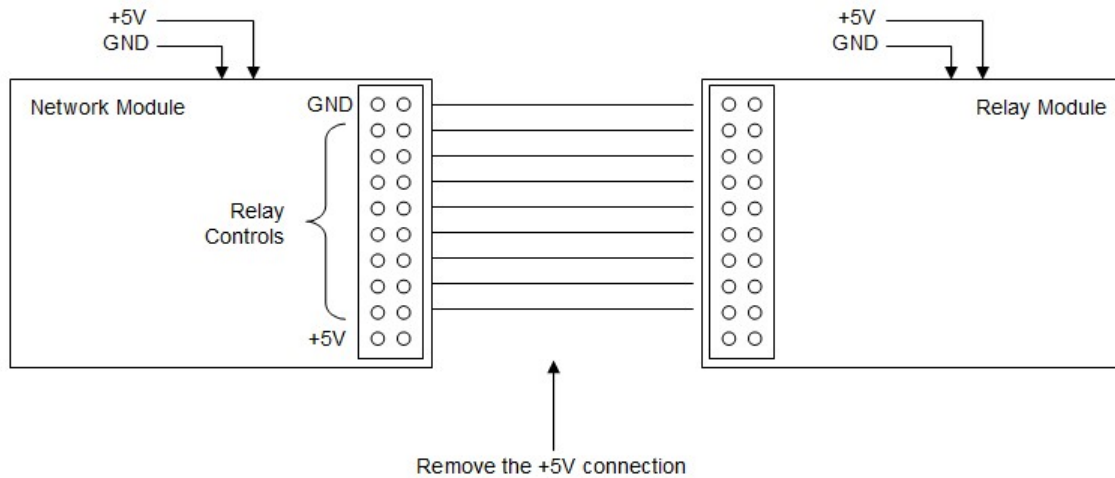
If you attach more relays you need to make sure that there is sufficient current supplied by your +5V power supply attached to the Network Module AND you need to make sure the method used to send power to the relay modules is adequate. This is particularly important if you are transferring power via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

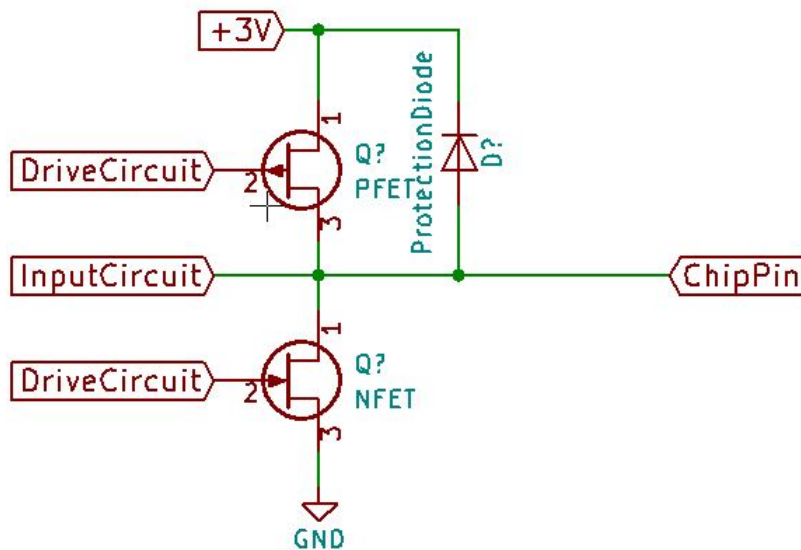


- 2) Use separate +5V power supplies on the Network Module and Relay Modules. If you do this you'll need to disconnect the +5V power connection between the headers.



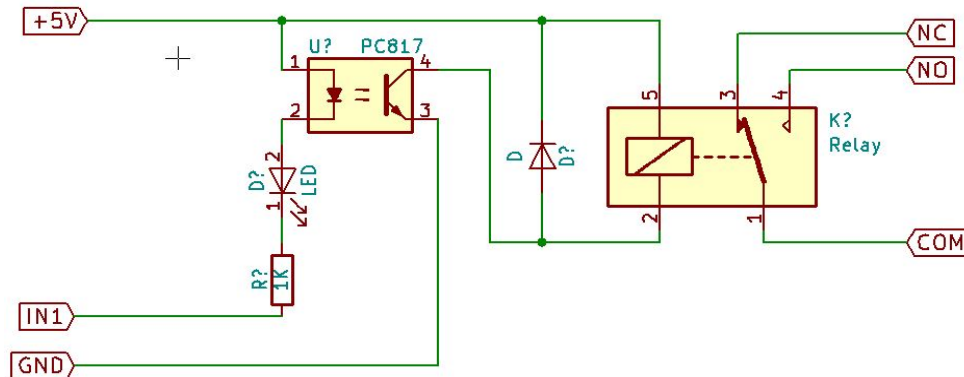
Type of Relay Module

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:

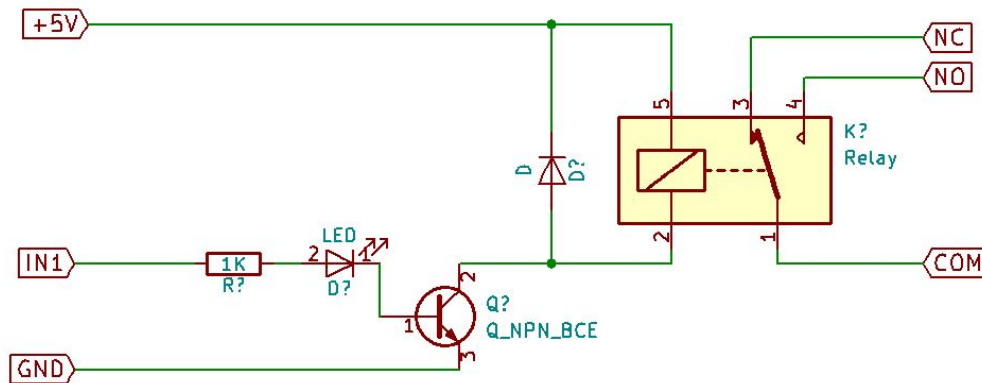


Note that in fact this relay module can provide a current path from +5V, through the photo emitter diode of the opto-isolator, through the visible LED, through the 1K resistor, then to the SM8S output pin via the “IN1” connection. But this will still work and here is why:

- 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.

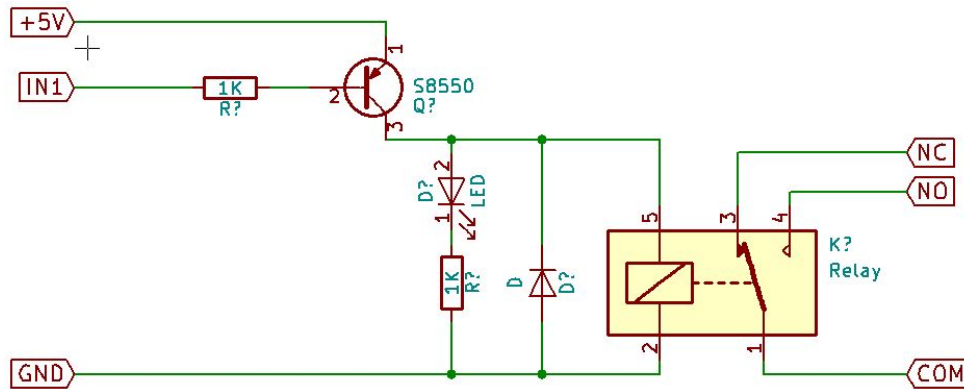
- b) **Non-isolated relay module, Active HIGH trigger signal:** Some relay modules do not have opto-isolators. If they are of a design that has an active high trigger signal then the typical design has a 1K ohm resistor feeding the base of a NPN transistor. This type of relay module should operate just 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.

Notes on Inputs

If you use the code configurations that provide digital inputs you'll need to be careful about the voltage you put on the input pin. The pins are directly connected to the SM8S processor. The processor operates at 3V, so you'll need to limit the high level voltage applied to the pin to 3V, or limit the current to no more than 1 mA.

Each input pin has a weak pull-up applied internal to the SM8S processor. The pull-up has a typical resistance equivalent of 60Kohm, but can range from 30Kohm to 80Kohm.

Some recommendations:

- 1) If you are using 3V logic to drive the input pin you should be able to directly connect it.
- 2) If your driver circuitry might place more than 3V on the input pin you can do one of the following:
 - a) Use open collector devices or level translators to prevent putting more than 3V on the input pin.
 - b) Use relay contacts to ground the input pin, relying on the SM8S pull-up to take the pin high. This might not be adequate if the wiring to the input pin is long or is subject to electrical interference.
 - c) Put a 1Kohm resistor between the driver logic and the input pin, but be sure the driver cannot exceed 5V. This isn't ideal, but should limit any current driven into the SM8S to an acceptable level and still achieve adequate logic levels at the SM8S input.

Pinouts of the Configurations

Following are the pin definitions for the three firmware configurations.

16 Output Configuration

Silkscreen on BJ2

	GND	○	○	GND	
Relay 9	9	○	○	1	Relay 1
Relay 10	10	○	○	2	Relay 2
Relay 11	11	○	○	3	Relay 3
Relay 12	12	○	○	4	Relay 4
Relay 13	13	○	○	5	Relay 5
Relay 14	14	○	○	6	Relay 6
Relay 15	15	○	○	7	Relay 7
Relay 16	16	○	○	8	Relay 8
	5V	○	○	5V	

8 Output / 8 Input Configuration

Silkscreen on BJ2

	GND	○	○	GND	
Input 1	9	○	○	1	Relay 1
Input 2	10	○	○	2	Relay 2
Input 3	11	○	○	3	Relay 3
Input 4	12	○	○	4	Relay 4
Input 5	13	○	○	5	Relay 5
Input 6	14	○	○	6	Relay 6
Input 7	15	○	○	7	Relay 7
Input 8	16	○	○	8	Relay 8
	5V	○	○	5V	

16 Input Configuration

Silkscreen on BJ2

	GND	○	○	GND	
Input 9	9	○	○	1	Input 1
Input 10	10	○	○	2	Input 2
Input 11	11	○	○	3	Input 3
Input 12	12	○	○	4	Input 4
Input 13	13	○	○	5	Input 5
Input 14	14	○	○	6	Input 6
Input 15	15	○	○	7	Input 7
Input 16	16	○	○	8	Input 8
	5V	○	○	5V	

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- * Author: Simon Kueppers
- * Email: simon.kueppers@web.de
- * Homepage: <http://klinkerstein.m-faq.de>
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