

Zodiac FX

USER GUIDE

Mar 2017

Important Information

Limited warranty:

Northbound Networks warrants that the Zodiac FX will be free from defects in material or workmanship for a period of 12 months from the date of shipment to you, the Customer. In the event of a defect covered by this limited warranty, Northbound Networks will, at its option and free of charge to Customer, repair, replace or refund the purchase price paid. Only the physical product is covered under this limited warranty and there is no cover, either expressed or implied, for any software or firmware that may be installed into the device either by Northbound Networks, the Customer or any other third party. NORTHBOUND NETWORKS MAKES NO OTHER EXPRESS WARRANTIES EXCEPT AS PROVIDED HEREIN, AND ANY AND ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSE SHALL ONLY BE IN EFFECT DURING THE 12 MONTH WARRANTY PERIOD PROVIDED HEREUNDER. NORTHBOUND NETWORKS'S LIABILITY ON ANY WARRANTY CLAIM SHALL BE LIMITED TO THE ACTUAL PURCHASE PRICE PAID. NORTHBOUND NETWORKS SHALL NOT BE RESPONSIBLE TO CUSTOMER OR ANY THIRD PARTY FOR ANY CONSEQUENTIAL, INCIDENTAL OR INDIRECT DAMAGES, INCLUDING BUT NOT LIMITED TO LOSS OF PROFITS, LOSS OF DATA, REVENUES, SALES, BUSINESS, GOODWILL OR USE. This limited warranty does not cover the cost of shipping the defective Zodiac FX to Northbound Networks for repair, however the cost of shipping the repaired or replacement Zodiac FX to you will be paid for by Northbound Networks in the event that the defect is covered under this limited warranty.



WARNING: This product, like all micro-controller products, uses semiconductors that can be damaged by electrostatic discharge (ESD). When handling, care must be taken so that the device is not damaged. Damage due to inappropriate handling is not covered by the limited warranty.

Compliance Information

FCC Compliance

This device has been tested and verified to comply with Part 15, Class B, of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

IC Compliance

This Class B device has been tested and verified to comply with **Industry Canada ICES-003**.

EU Conformity Statement



This product is labelled with the CE Mark in accordance with the related European Directives, Low Voltage Directive 2006/95/EC and EMC Directive 2004/108/EC. The product has been assessed against standards EMC: EN 55022 and EN 55024.

Australia / New Zealand

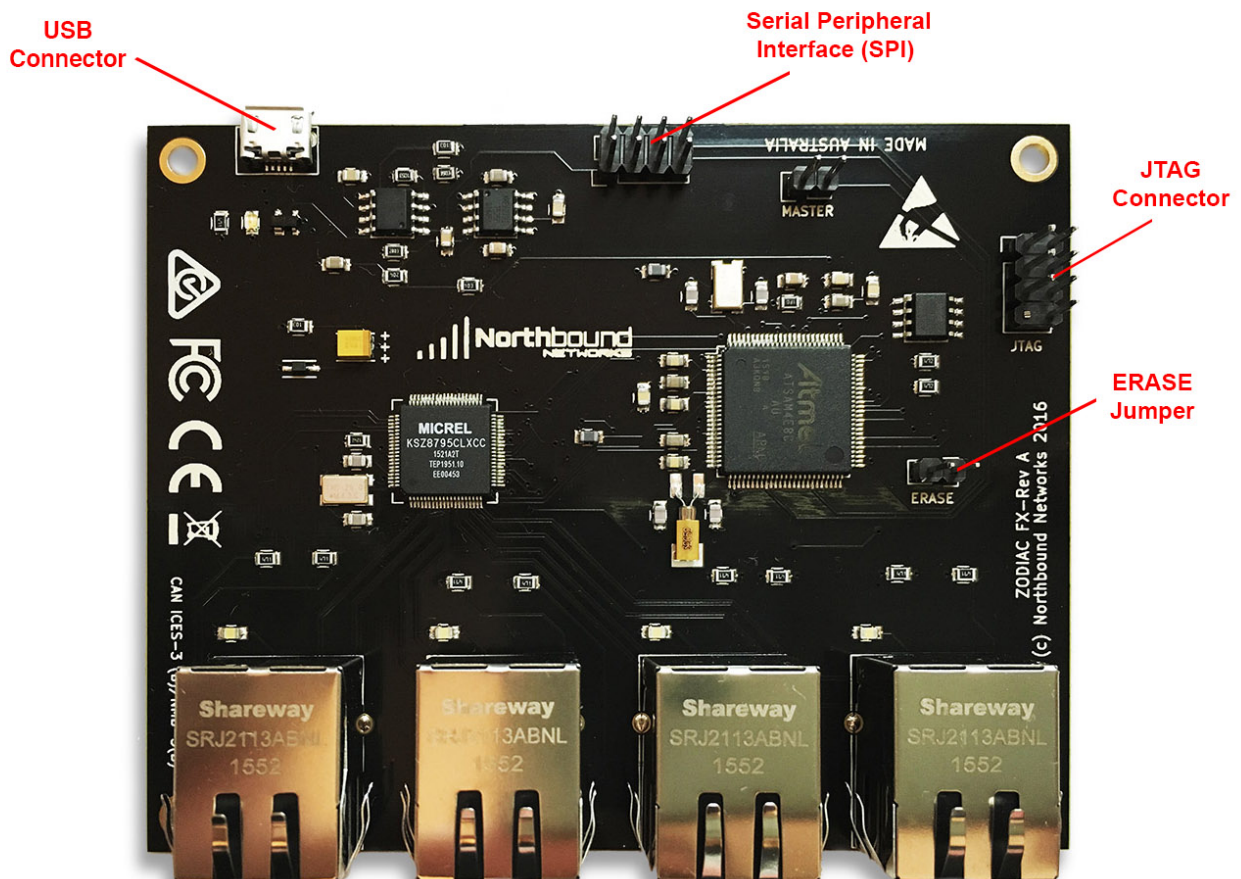


This device has been tested and verified to comply with **AS/NZS CISPR 22**.

1. Overview

The Zodiac FX is a 4 port network development board designed for hobbyists, students, researchers, embedded developers or anyone who requires a low cost network development platform. Even though it was initially designed to allow affordable access to OpenFlow enabled hardware, its open source firmware it can be used in any number of other applications. By providing the firmware source code, users are free to not only create their own versions but also use it as a basis for a completely different type of device. Some such applications may include:

- Router
- Bridge
- Load Balancer
- Web server
- VPN concentrator
- TOR client
- and many more



2. Updating Firmware

The Zodiac FX firmware is stored within the flash memory of the Atmel processor and is easily updated via the web interface or USB port.

Following firmware 0.80, a new update system is in place. To upgrade from earlier firmware, follow the instructions in **section 2.3. Base Firmware Update**.

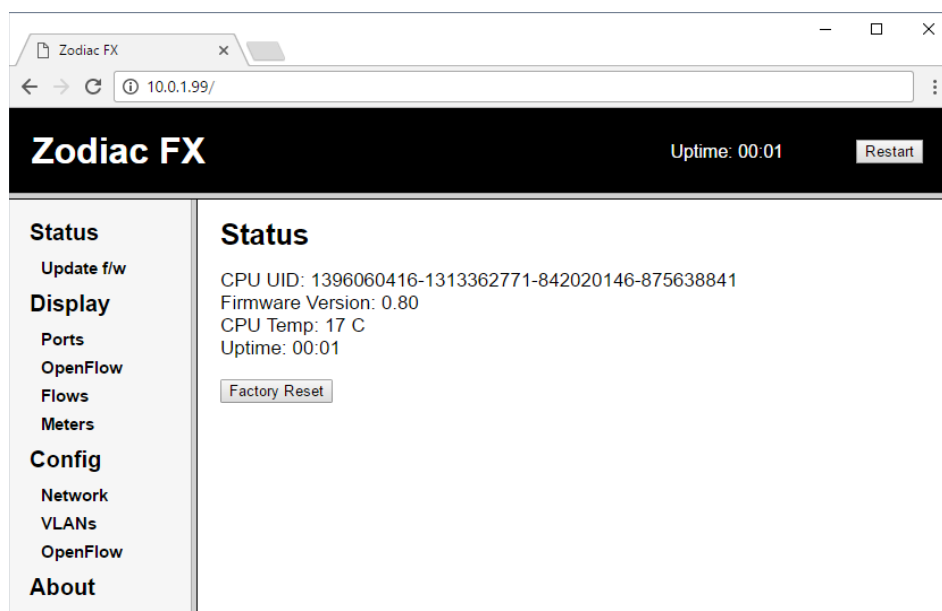
2.1 Updating via Web Interface

Note: updating via web interface is only supported on version 0.80+

Firmware updates via web interface is fully supported in **Google Chrome**. To ensure a successful firmware update, please perform updates through supported browsers.

Firmware updates can be performed directly from the Zodiac FX web interface. The update procedure is as follows:

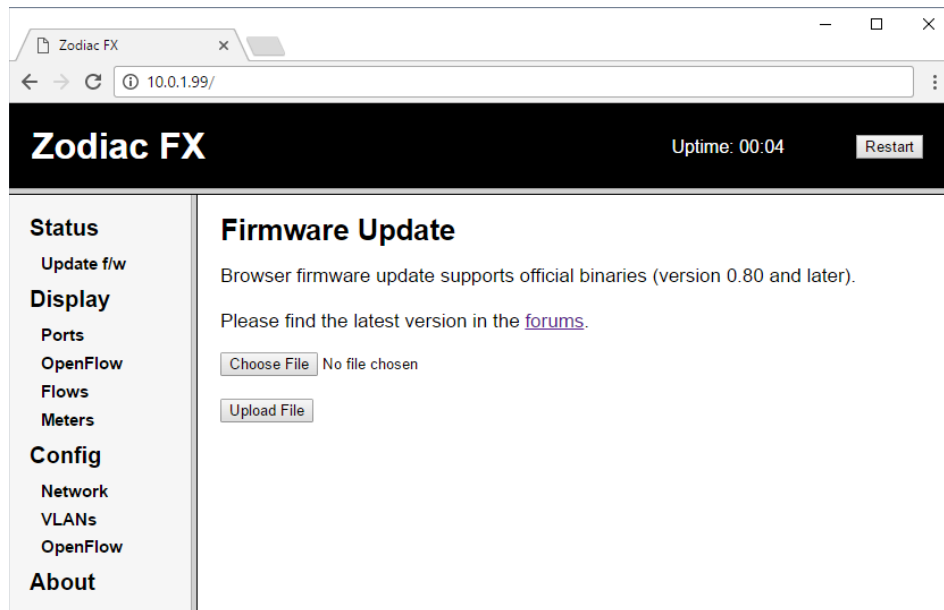
1. Download the **update firmware .bin** file ('Update Firmware (v0.xx) - ZodiacFX_vxx_update.bin') which is available from the Zodiac FX forums (see appendix B). Alternately you can build your own version from the source code using Atmel Studio.
2. Connect the Zodiac FX "Controller" Ethernet port (port 4 by default) to an OpenFlow controller.
3. Access the web interface by typing the Zodiac FX IP address into a web browser on the controller (default **10.0.1.99**). The status page will appear on successful connection.



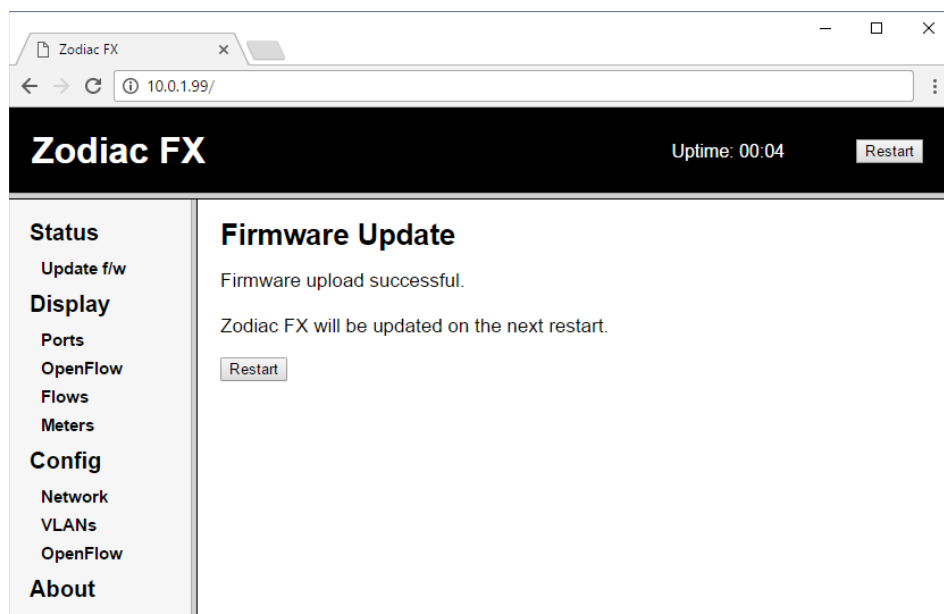
Note: depending on the network layout, the Zodiac FX configurations may need to be changed before the web interface can be accessed. A list of CLI commands are available in **section 3**.

4. Click on the 'Update f/w' button in the menu.

5. The 'Choose File' button will allow you to browse for the update .bin file. 'Upload File' will begin the file transfer process. Please verify that the selected version is the correct **update firmware** binary ('ZodiacFX_vxx_update.bin').



6. Allow up to 30 seconds for the firmware upload to complete. A response page will appear providing the status of the upload.



Note: if the upload page does not respond after 30 seconds, attempt to refresh the page to interrupt the upload. A new upload can then be started.

7. Click the 'Restart' button to complete the update process.

To verify that the firmware has successfully updated, check the version shown in the 'Status' page after restarting.

2.2 Updating via Command Line Interface

Note: *updating via command line is only supported on version 0.80+
Not all serial terminal applications support XMODEM file transfers. For a list of tested terminal applications, please visit the Zodiac FX forums (see appendix B).*

The Zodiac FX supports CLI updates via the XMODEM protocol. The update procedure is as follows:

1. Download the **update firmware** .bin file ('Update Firmware (v0.xx) - ZodiacFX_vxx_update.bin') which is available from the Zodiac FX forums (see appendix B).
2. Start a session in a supported serial terminal application.
3. Enter the **update** command in the base context of the CLI.
4. When prompted, start an XMODEM file transfer of the update .bin file through the terminal application. Please verify that the selected version is the correct **update firmware** binary ('ZodiacFX_vxx_update.bin').
5. On a successful update, the Zodiac FX will automatically restart.

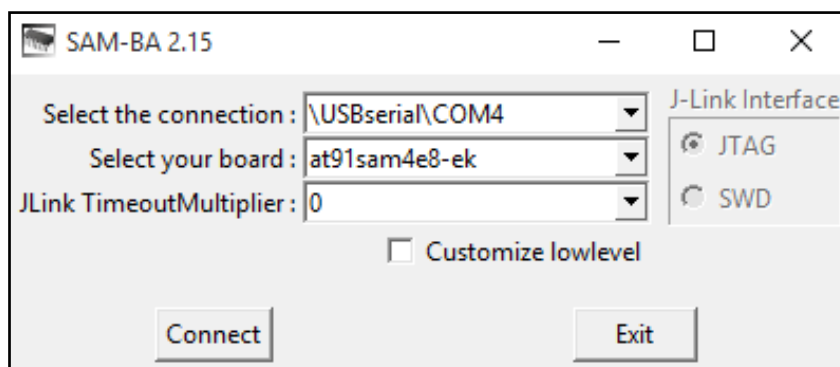
To verify that the firmware has successfully updated, enter the **show version** command in the base context of the CLI.

2.3 Base Firmware Update

Note: *if the firmware appears to be corrupted, performing a base firmware update may resolve the issues.*

To install the base firmware, the existing code must first be erased which will allow the CPU to boot in USB mode ready to receive the update. The flashing procedure is as follows:

1. Download the **full upgrade firmware** .bin file (Full Upgrade Firmware (v0.xx) - ZodiacFX_vxx_full_install.bin') which is available from the Zodiac FX forums (see appendix B).
2. Disconnect the USB cable from the device.
3. While the device is powered off, **CLOSE** the **ERASE** jumper.
4. Reconnect the USB power source, wait 5 seconds, and then disconnect it again. This will erase the firmware and reset the boot flag to allow the flash utility to communicate with the device.
5. Move the **ERASE** jumper back to the OPEN position. Be careful not to lose the jumper!
6. Connect the USB cable to power to the device again and open the SAM-BA utility (see list of links in appendix B).
7. Ensure the correct COM port is displayed and that the board type is "at91sam4e8-ek", see figure below. Press the connect button. If the "Select the Connection" is blank then the existing firmware was not erased correctly - repeat steps 2-6.



8. In the “Download / Upload File” section click the folder icon for the “Send File Name” field and select the appropriate bin file.
9. Click the “Send File” button to upload the firmware to the device.
10. When the “Lock region(s)” pop-up window appears select “No”.
11. Under the “Scripts” section, select “Boot from Flash (GPNVM1)” from the drop down list and press the “execute” button.
12. Disconnect and reconnect the USB cable again to restart the device. The device will now load the updated firmware.

3. Command Line Interface (CLI)

The Command Line Interface provides the ability to configure settings and monitor the operation of the Zodiac FX. To simplify operations the CLI uses the concept of a “context”, limiting the available commands to the currently selected context. There are currently 3 available contexts:

- Base
 - Config
 - OpenFlow
 - Debug

To enter the required context simply type the name of the context on the command line while at the base level. To return to the base level type “exit”. The current context is shown in brackets between the device name and the prompt. For example, the config context would show: `Zodiac_FX (config)#`

The following sections describe the commands available within each context. Please note that commands are case-sensitive (lowercase).

3.1. Base

config - Enter the “config” context.

openflow - Enter the “openflow” context.

debug - Enter the “debug” context.

show ports - Displays information about each ethernet port including state, VLAN membership and traffic statistics.

show status - Displays the current device status.

show version - Display the firmware version.

restart - Restarts the Zodiac FX.

help - Display a list of available commands.

3.2. Config

save - Saves the current configuration to non-volatile memory.

restart - Restarts the Zodiac FX. Any unsaved configurations will be lost.

show config - Display the current device configuration.

show vlans - Displays a list of the currently configured VLANs.

set name <name> - Sets the device name. Maximum of 16 characters, entries will be truncated.

set mac-address <mac address> - Sets the MAC address of the device. The MAC address assigned to the device is located on a label on the underside of the device.

set ip-address <ip address> - Sets the device IP address.

set netmask <netmask> - Set the device netmask.

set gateway <ip address> - Sets the default gateway of the device.

set of-controller <ip address> - Sets the IP address the OpenFlow controller.

set of-port <tcp port> - Sets the TCP port of the OpenFlow Controller.

set failstate <secure | safe> - Sets the failstate of the Zodiac FX. When set to 'secure', all traffic is blocked when contact with the controller is lost. When set to 'safe', existing flows will be processed until they time out. The default configuration is 'secure'.

add vlan <vlan id> <vlan name> - Creates a new VLAN. Valid IDs are 1-4096 and names must be less than 16 characters.

delete vlan <vlan id> - Deletes an existing VLAN.

set vlan-type <type> - Set the VAN to either 'openflow' or 'native'

add vlan-port <vlan id> <port> - Assigns a ethernet port to the designated VLAN. A port can only be a member of one VLAN.

delete vlan-port <port> - Remove the named Ethernet port from a VLAN.

factory reset - Configures and saves the configuration back to the factory test configuration, see appendix A for details. *Note: the MAC address is not reset and will remain at it's current value and a restart is required to apply the changes.*

set of-version <version(0 | 1 | 4)> - Sets the device to only connect to an controller using the OpenFlow version specified. A value of 0 disables this function and allows the device to negotiate the version.

set ethertype-filter <enable | disable> - Enable or disable Ethertype filter functionality. When enabled, Zodiac FX will ignore packets of a non-standard Ethertype.

exit - Return the context back to the base level.

3.3. OpenFlow

show status - Displays the OpenFlow status.

show flows - Displays a list of the currently installed flows.

show meters - Displays a list of the currently configured meters and associated meter bands.

enable - Enables the Openflow functionality.

disable - Disables the OpenFlow functionality.

clear flows - Clears the flow tables.

exit - Return the context back to the base level.

3.4. Debug

read <register> - Display the value of the KSZ8795 register.

write <register> <value> - Writes the value into the defined KSZ8795 register.

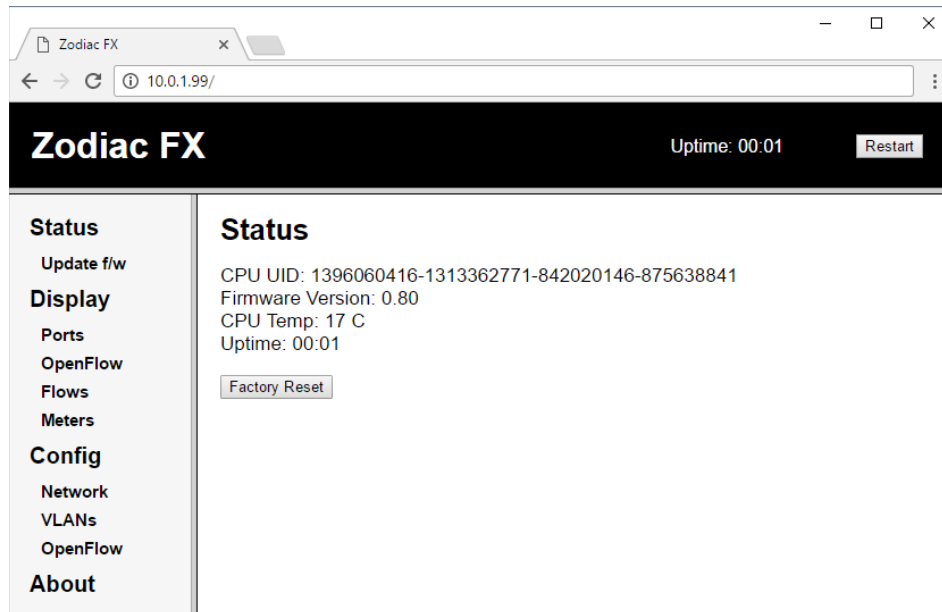
exit - Return the context back to the base level.

4. Web Interface

The web interface provides the ability to configure settings and monitor the operation of the Zodiac FX. The configuration can be changed through the 'Config' menu items, and monitoring can be performed in the 'Display' menu items.

4.1. Status

The status page shows hardware and firmware information of the Zodiac FX. The factory reset button reverts the Zodiac FX to the factory test configuration (see appendix A).



A restart can be performed at any time through the button in the header.

4.2. 'Display' Pages

These pages provide information and statistics about various aspects of the Zodiac FX.

4.2.1. Ports

The status of each of the Zodiac FX ports can be viewed on this page. Port statistics can also be monitored.

Zodiac FX Uptime: 00:04 [Restart](#)

Status
Update f/w

Display
Ports
OpenFlow
Flows
Meters

Config
Network
VLANs
OpenFlow

About

Port Information

Ports

	Port 1	Port 2	Port 3	Port 4
Status:	DOWN	DOWN	DOWN	UP
VLAN Type:	OpenFlow	OpenFlow	OpenFlow	Native
VLAN ID:	100 ▼	100 ▼	100 ▼	200 ▼
RX Bytes:	0	0	0	0
TX Bytes:	0	0	0	0
RX Packets:	0	0	0	0
TX Packets:	0	0	0	0
RX Dropped Packets:	0	0	0	0
TX Dropped Packets:	0	0	0	0
RX CRC Errors:	0	0	0	0

[Save](#) [Cancel](#)

Ports can also be assigned to VLANs configured in the Config - VLANs page (see **section 4.3.2**).

Zodiac FX Uptime: 00:05 [Restart](#)

Status
Update f/w

Display
Ports
OpenFlow
Flows
Meters

Config
Network
VLANs
OpenFlow

About

Port Information

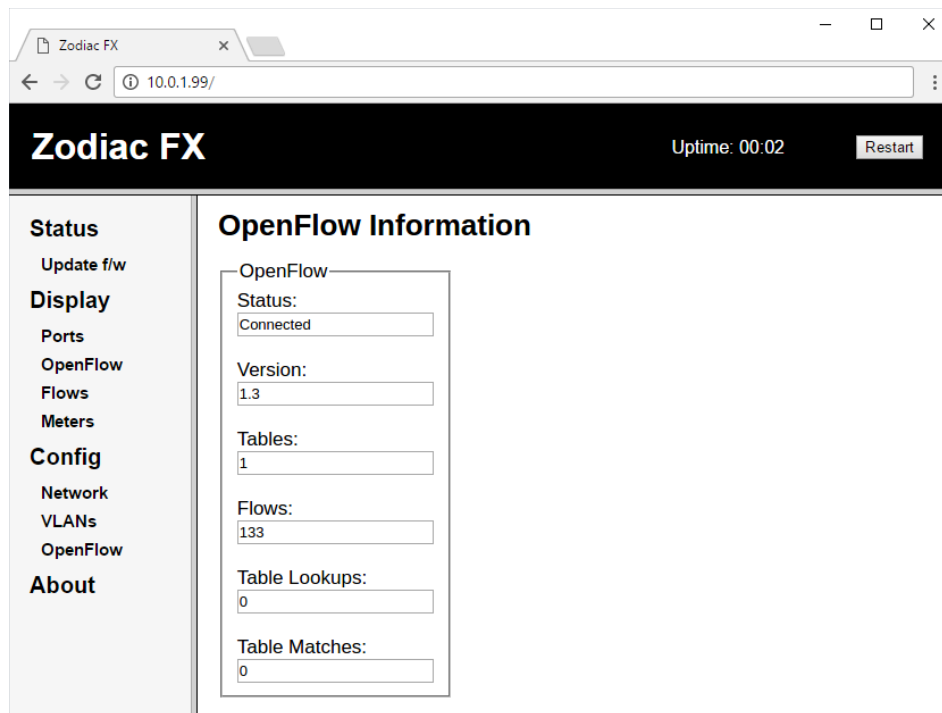
Ports

	Port 1	Port 2	Port 3	Port 4
Status:	DOWN	DOWN	DOWN	UP
VLAN Type:	OpenFlow	OpenFlow	OpenFlow	Native
VLAN ID:	100 ▼	100 ▼	100 ▼	200 ▼
RX Bytes:	0	0	0	0
TX Bytes:	0	0	0	0
RX Packets:	0	0	0	0
TX Packets:	0	0	0	0
RX Dropped Packets:	0	0	0	0
TX Dropped Packets:	0	0	0	0
RX CRC Errors:	0	0	0	0

[Save](#) [Cancel](#)

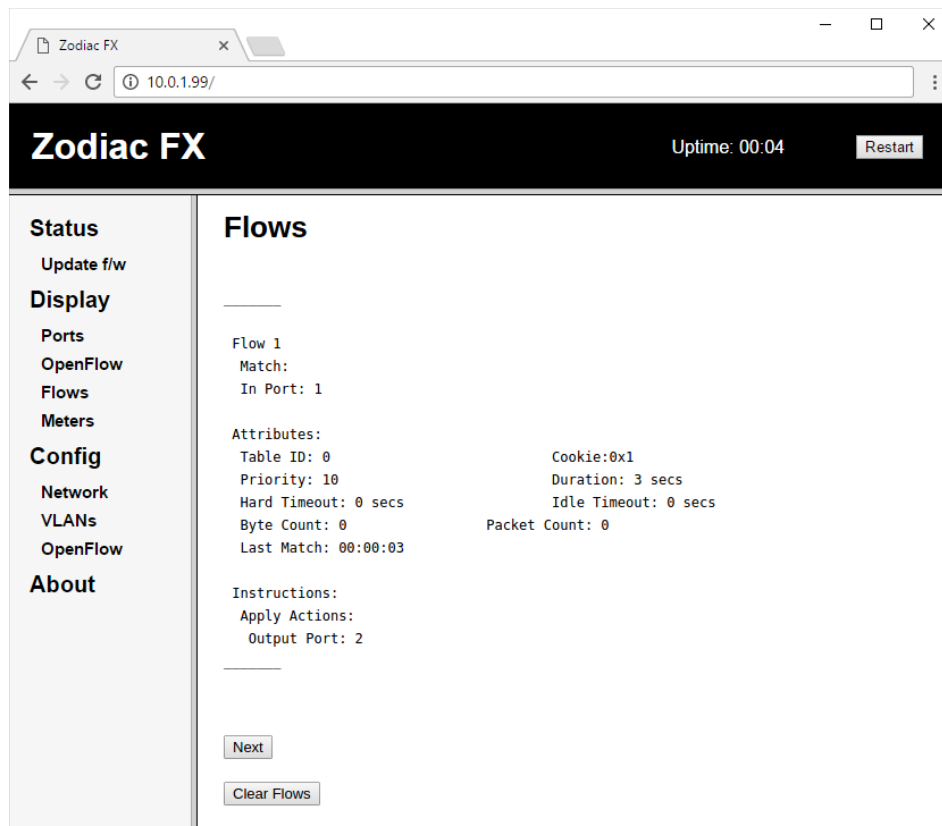
4.2.2. OpenFlow

This page shows the current OpenFlow status, as well as flow table statistics.



4.2.3. Flows

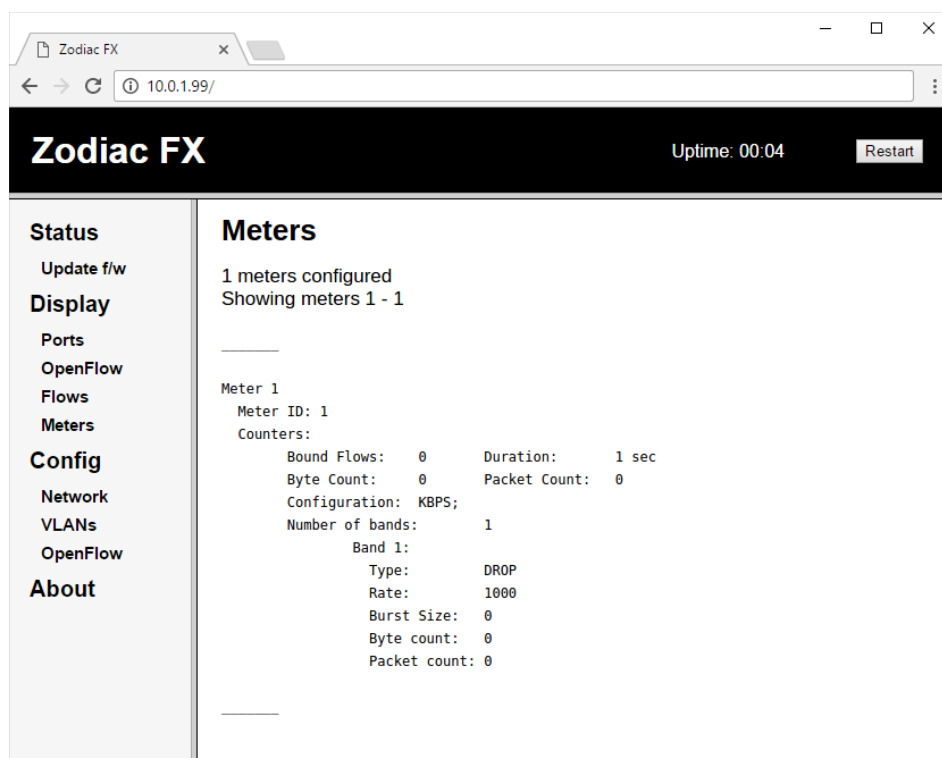
The flows page displays the current flows in the flow table, along with their configurations. Flows can be manually cleared using the 'Clear Flows' button.



Note: several flows will be displayed per page. Total flow count is listed in the Display - OpenFlow page.

4.2.4. Meters

Configured meters can be viewed on this page. Currently, up to 8 meters can be configured, with up to 3 meter bands on each. Up-to-date meter statistics are also shown, allowing meters to be monitored.



4.3. 'Config' Pages

These pages show the current configuration of various features of the Zodiac FX. Many of these configurations can be changed directly from their respective pages.

4.3.1. Network

The Zodiac FX network configuration settings can be changed directly from the web interface. After saving configuration changes, a restart is required for the new settings to take effect.

Warning: *improperly changing the network configuration may cause the web interface to become inaccessible. Connecting to the Zodiac FX via CLI will allow you to revert the changes.*

Zodiac FX Uptime: 00:02 [Restart](#)

Status
 Update f/w
Display
 Ports
 OpenFlow
 Flows
 Meters
Config
 Network
 VLANs
 OpenFlow
About

Network Configuration

Connection

Name:

MAC Address:

IP Address:

Netmask:

Gateway:

[Save](#) [Cancel](#)

4.3.2. VLANs

VLANs can be added or removed as required. By default, two VLANs are configured - one for OpenFlow ports (to connect to the network), and one for the connection to the OpenFlow controller.

Zodiac FX Uptime: 00:03 [Restart](#)

Status
 Update f/w
Display
 Ports
 OpenFlow
 Flows
 Meters
Config
 Network
 VLANs
 OpenFlow
About

Virtual LAN Configuration

VLANs

ID	Name	Type	Options
100	OpenFlow	OpenFlow	Delete
200	Controller	Native	Delete
<input type="text"/>	<input type="text"/>	OpenFlow ▾	Add

Valid VLAN IDs are 1-4096 and VLAN names must be less than 16 characters.

Ports can be assigned to new VLANs in the Display - Ports page (see **section 4.2.1**).

Warning: *incorrectly configuring VLANs may cause the web interface to be unresponsive. Connecting to the Zodiac FX via CLI will allow you to revert the changes.*

4.3.3. OpenFlow

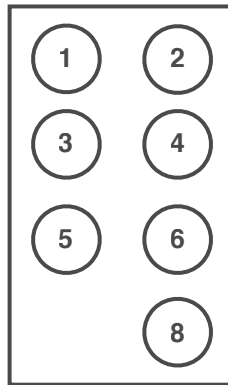
OpenFlow connection configurations can be modified on this page.

- OpenFlow functionality can be disabled altogether (turning the Zodiac FX into a simple network switch).
- Controller IP & port can be adjusted to allow communication between the switch and the controller.
- The **failstate** determines the Zodiac FX behaviour when connection with the OpenFlow controller is lost. When set to 'safe', existing flows will be processed until they time out. The default configuration is 'secure', which blocks all traffic instead.
- The OpenFlow version can be forced to version 1.0 or version 1.3. The default setting is 'Auto', which allows the Zodiac FX to determine the version by negotiating with the controller.

The screenshot shows a web browser window with the address bar displaying '10.0.1.99/'. The page title is 'Zodiac FX'. In the top right corner, it shows 'Uptime: 00:02' and a 'Restart' button. On the left side, there is a navigation menu with the following items: Status, Update f/w, Display, Ports, OpenFlow, Flows, Meters, Config, Network, VLANs, OpenFlow, and About. The 'OpenFlow' item is selected. The main content area is titled 'OpenFlow Configuration'. It contains a form with the following fields: 'OpenFlow Status' (set to 'Enabled'), 'Controller IP' (set to '10.0.1.8'), 'Controller Port' (set to '6633'), 'Failstate' (set to 'Secure'), and 'OpenFlow Version' (set to 'Auto'). At the bottom of the form are 'Save' and 'Cancel' buttons.

5. JTAG Debugger

The following table describe the pin-outs of the Zodiac FX JTAG header and the ATMEL-ICE debugger SAM connector. If using the 10 pin squid cable that comes with the full ATMEL-ICE kit then the wires can be connected to the pins as shown below. Alternatively a Zodiac FX Developer kit can be purchased from the Northbound Networks store which includes the debugger and a specifically designed cable.



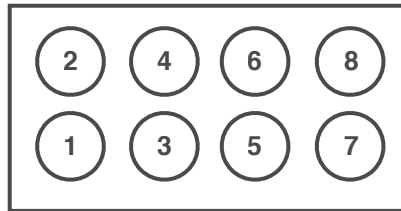
JTAG Pinouts

***NOTE: If using the Atmel ICE 10 pin squid cable then the pins highlighted in the table (7,9,10) are not required.**

Zodiac JTAG PIN	Function	ATMEL-ICE SAM JTAG PIN	Function
1	+3.3v	1	VCC
2	TMS	2	TMS
3	GND	3	GND
4	TCK	4	TCK
5	GND	5	GND
6	TDO	6	TDO
7	-	7*	KEY
8	TDI	8	TDI
-	-	9*	GND
-	-	10*	nReset

6. SPI Connector

The SPI connector allows the Zodiac FX to connect to other devices using the industry standard Serial Peripheral Interface (SPI). Information on the SPI standard can be found at https://en.wikipedia.org/wiki/Serial_Peripheral_Interface_Bus



SPI Pinouts

Zodiac SPI PIN	Function
1	+5.0v (200mA MAX)
2	-
3	IRQ 1*
4	GND
5	MISO
6	NPCS0
7	SCK
8	MOSI

****IRQ 1 is connected to a GPIO pin on the MCU to allow for a SLAVE devices to request access to the bus.***

Appendix A.

The factory configuration set the following values:

Device Name: Zodiac_FX
IP Address: 10.0.1.99
Netmask: 255.255.255.0
Default Gateway: 10.0.1.1
OpenFlow Controller: 10.0.1.8
OpenFlow port: 6633

VLANs

ID	Name	Type	Ports
100	"OpenFlow"	openflow	1,2,3
200	"Controller"	native	4

Appendix B.

The following is a list of links the relevant web pages and utilities:

Northbound Networks / Zodiac FX Support Forum: forums.northboundnetworks.com

SAM-BA programming utility: <http://www.atmel.com/tools/ATMELSAM-BAIN-SYSTEMPROGRAMMER.aspx>

ATMEL-ICE Debugger: <http://www.atmel.com/tools/ATATMEL-ICE.aspx>

Atmel SAM4E MCU information: <http://www.atmel.com/products/microcontrollers/arm/sam4e.aspx>

Micrel KSZ 8795 Ethernet Switch chip: <http://www.micrel.com/index.php/products/lan-solutions/switches/article/1-ksz8795clx.html>

OpenFlow Specification: <https://www.opennetworking.org/sdn-resources/technical-library>