Installation and Operation Manual

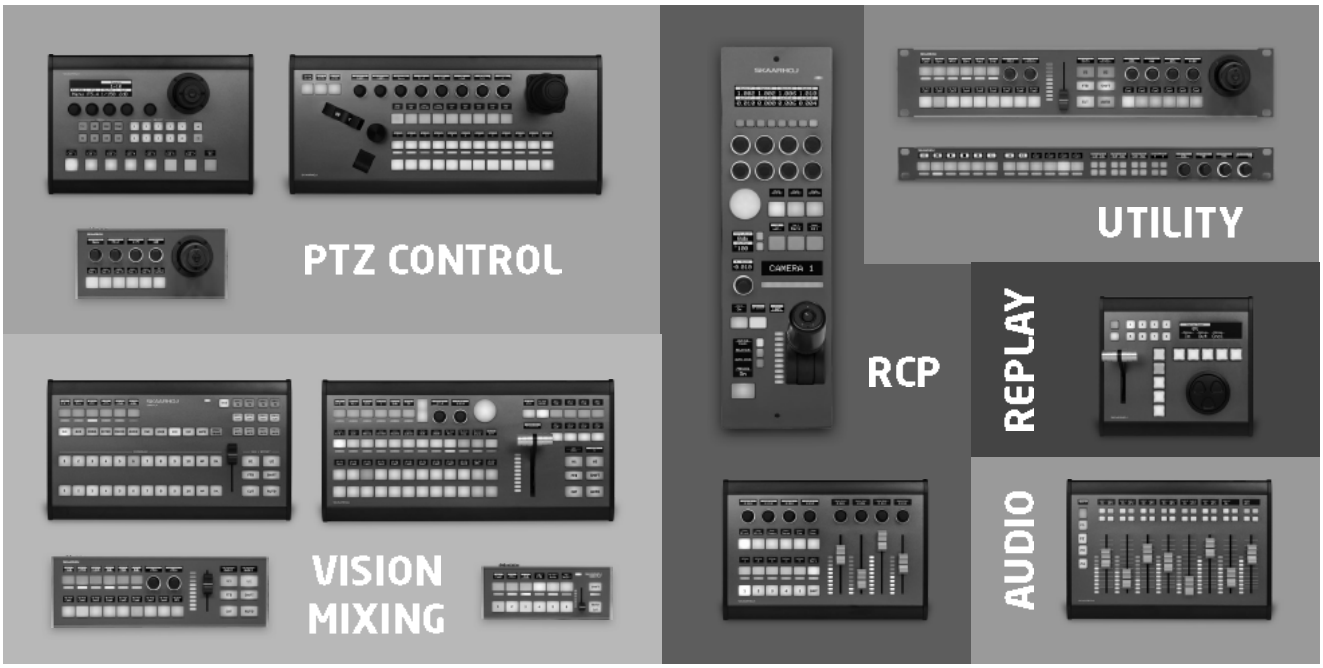
June 2019

Congratulations with your SKAARHOJ controller! Our mission is to ease the use of broadcast hardware for people making live video and doing so by means of awesome tactile industrial strength hardware controllers. We are really proud of how much we have been able to stuff into this device, and we hope you can see our love and passion for cool and helpful technology shine through when you browse this manual.

While we really want to make everything intuitive for you, we still need to document some not so obvious facts and conventions and we have tried to put everything you need to know into this document along with a few extra tips too.

Please notice this manual is aimed at UniSketch powered SKAARHOJ controllers. If you have a device not running UniSketch please see other manual at http://skaarhoj.com/support/manual/. In order to run UniSketch you need a device with the SKAARDUINO Due MCU.

Have fun!



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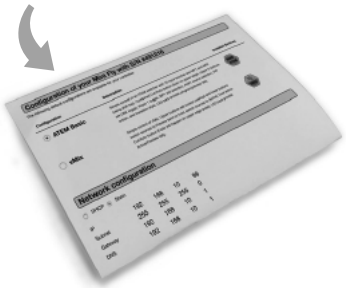
Getting Started

For UniSketch based controllers a config-slip is included in the package.

1 What configuration is installed?
Make sure this is the one you want. If not, read the next section on how to change it.

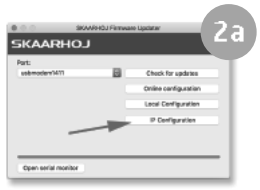


2 What IP addresses are used?
If the configuration is good, but the IP settings don't match your network, you'll have to change them.

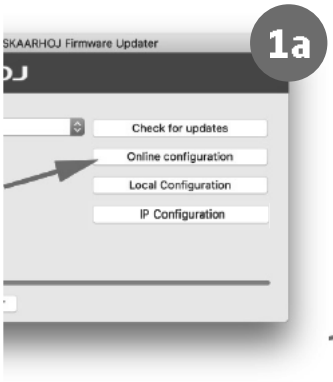
Change the controller IP adresses
To set up the IP addresses, click "IP Configuration" in the firmware application.

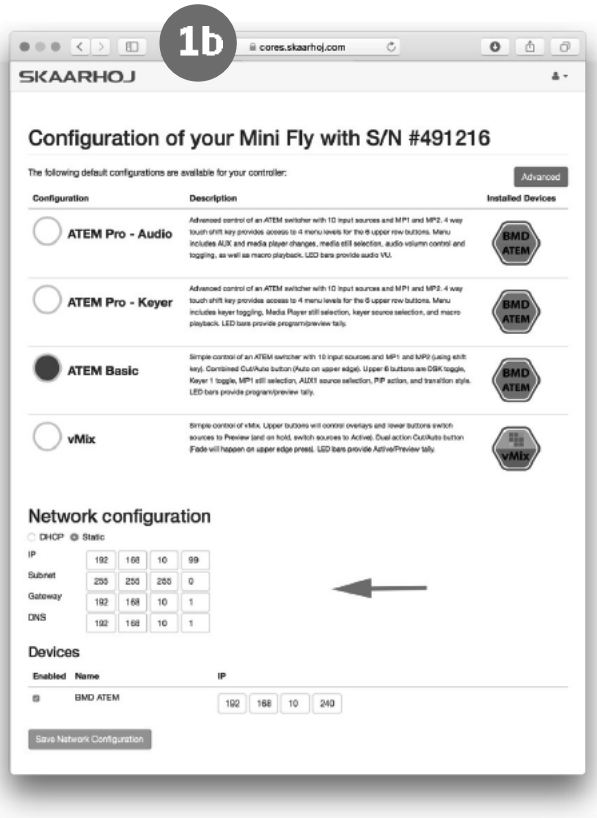
In the pop-up window, make the IP changes you need, save and power cycle the controller.

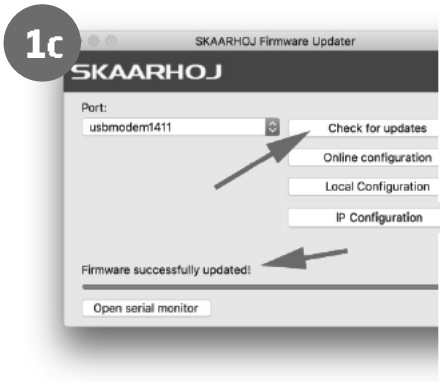
You're done!



1 Download an entirely different configuration







Press "Online Configuration" in the SKAARHOJ Firmware Updater application. A web browser will open.

You'll see the same page printed and included in this cover; Now, select a different configuration and set the corresponding IP addresses.

! Your computer must be connected to the Internet!

The final step to bliss is to go back to the SKAARHOJ Firmware Updater application and press "Check for updates". A new unique firmware with your selected configuration and IP settings is created, downloaded and installed on your controller.

You're done!

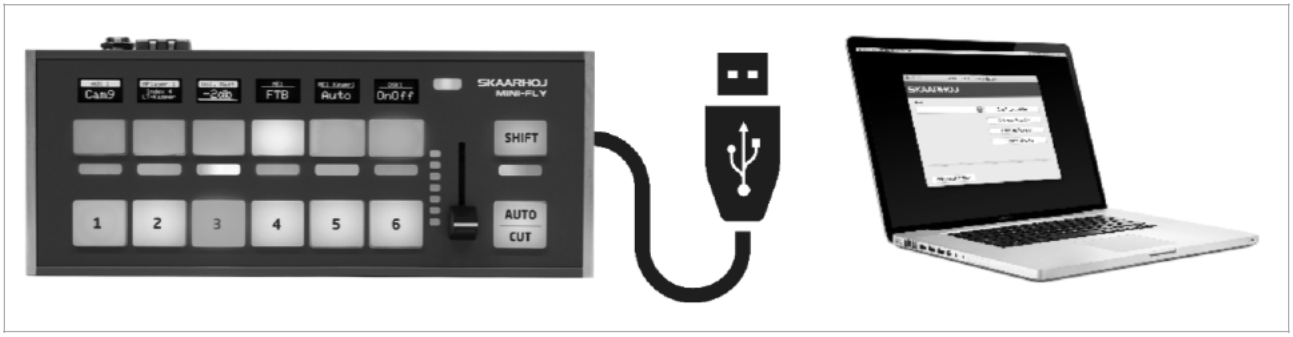
! Pro-tip: If you are up for some fun later, notice the "Advanced" button on the web page. Don't click it just yet - but go back there and explore when you have successfully worked with a default configuration.

Having trouble? Visit http://skaarhoj.com/support

Default IP configuration for a SKAARHOJ unit when shipping:
IP Address: 192.168.10.99 & **Subnet:** 255.255.255.00

Firmware Updater

You won't get far without the SKAARHOJ Firmware Updater application. Download it www.skaarhoj.com/support/firmware-updater/. Install, run it and connect your controller. Please notice the USB cable is only to be used for configuration and firmware upgrade. The USB plug is not designed to be connected during normal operation. More details are found in the "Firmware Updater Application" section of this manual.



Connect the SKAARHOJ controller to your Mac or PC with the included USB cable. The device shows up in the Port list (only connect one SKAARHOJ controller at a time).	

Connecting SKAARHOJ Controller with Clients

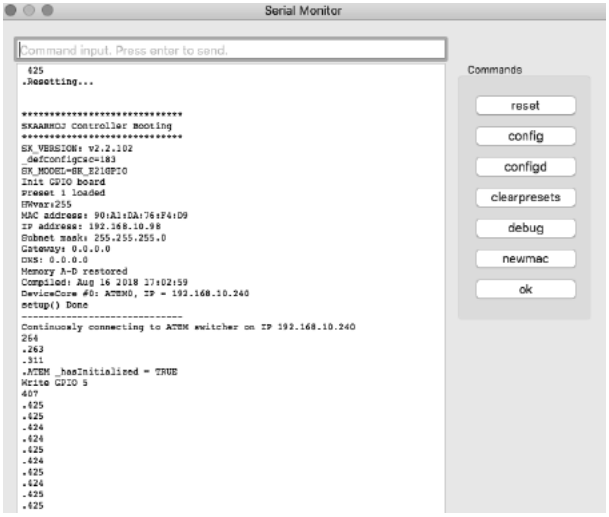
Almost all of our controllers are IP based. Below two examples are given for how to connect a SKAARHOJ controller with a client or multiple clients. Notice communication is ethernet based and not via USB. For control of multiple PTZ cameras please read the "PTZ Manual" at www.skaarhoj.com/support/manuals/

If you want to control for example an ATEM switcher you do *not* need a PC/Mac running the ATEM Software Control Panel for using the SKAARHOJ controller since it connects directly to the ATEM. But you can run both at the same time if you want, and the changes made in either the SKAARHOJ controller or in the ATEM Software Control panel will correlate with the other unit. This is the case for most device cores you can install on your controller, but for more information, consult the support pages for the individual device cores.

Troubleshooting

If you have followed the above instructions and still have issues here's some tips

- Check IP and network settings. If the Device Core IP address does not match the client(s) nothing will work
- Double check IP settings! Use the serial monitor to confirm IP address of the controller and clients.
- Consider pressing "clearpresets". This will remove any presets and IPs stored locally on the controller. Notice: IPs set via the "IP Configuration" will be removed + any local configuration will be removed by this command.
- Use the serial monitor in the Firmware Updater Application to check connection status. Depending on Client type you will get confirmation when clients are connected or not (see illustrations below)
- Avoid having Device Cores enabled if clients does not exist. The controller will use resources trying to connect to non-existing clients.
- SKAARHOJ controller and client must be on the same subnet.



Setting IP for non UniSketch Based Controllers

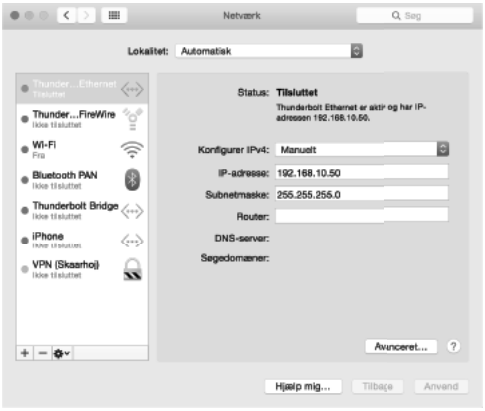
Some of our products such as the ETH-SDI Link does not run UniSketch OS and for these the procedure for setting IP address differs.

Set manual IP address for Mac/PC

We recommend connecting your SKAARHOJ controller directly to your PC/Mac with a ethernet cable in order to access the web interface.

Turn off your wifi and set your IP manually:

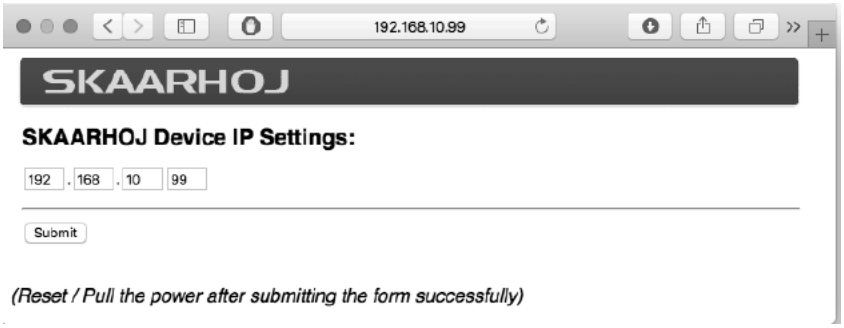
192.168.10.50 PC/Mac IP address
255.255.255.0 Netmask
192.168.10.1 Gateway/Router IP address if necessary



Enter Configuration Mode

- **Step 1** – Connect SKAARHOJ device to PC/Mac with ethernet cable and power up the unit. Let it boot up.
- **Step 2** – Press and hold the config button until the status LED starts to blink
- **Step 3** – Access web interface by entering http://192.168.10.99/ in your browser

Location of "Config" and "Status LED"



Example of web interface on ETH-SDI Link

Notice: The web interface IP is always set to http://192.168.10.99 even if you change the "SKAARHOJ Device IP Address" in the web interface.

Network Recommendations

Facts

- SKAARHOJ controllers have a 100 mbps network interface
- Network switch must have Auto-MDI/MDIX
- Network switch must support 100 mbps
- PoE: IEEE 802.3af

When connected to a network switch, the yellow LED (lower left) at the ethernet jack will be on. If the device in the other end supports TX/RX auto detection you may be able to connect the SKAARHOJ controller directly to your device, otherwise use a crossed cable or a network switch (the supported setup). Remember a SKAARHOJ controller and client must be on the same subnet (192.168.10.* or one you set up in the controller). If you have multiple SKAARHOJ units connected to the same network they need to have different IP addresses!

Power over Ethernet (PoE) Specifications

We use the PoE industry standard 48V IEEE 802.3af. If you want to power our controllers using PoE it is important your switch supports this standard. Please notice some manufactures such as Ubiquity have their own non-standard 24V type of PoE which is incompatible with our controllers. Especially pay attention to the standard if you use a PoE injector.

Troubleshooting

If you experience no network activity at all try one or more of the following suggestions:

- Use a managed network switch
- Force network switch port to 100 mbps
- Try a different network switch

1GB or 10 GB switches can have issues with our 100 mbps interface if not properly managed. The iMac Pro with 10 GB have issues if connected directly to our controller. Try with a USB to ethernet adapter in this case.

Connection Stability and NDI

Background: People are moving to NDI video on a large scale and while it's a fantastic technology, it can lead to frustrating network issues which may first appear as faults on specific and seemingly unrelated devices like a SKAARHOJ controller. In general, the problem is that NDI used on a poorly configured network that is not "NDI ready" will lead to flooding of NDI video data to devices that doesn't want it and can't handle it. For a SKAARHOJ controller this means that the essential control data connection is killed by all the irrelevant video data it receives. Even a single lost control package can lead to poor of connection stability or the use of a joystick. In the worst case the control won't even connect. These cases can be frustrating because they are tipping-point issues where a small change cascades into large consequences.

In general: For any network control system to work - and certainly for a SKAARHOJ controller - you need to consider that your network is configured so that neither the SKAARHOJ controller nor the devices it communicates with and no link in between are congested with network traffic that can result in predictably poor performance. No matter how much error correction we build into a controller, lost communication information will lead to poor performance. When NDI video data and other Multicast data is shared on a network it will congest the network unless propper guidance have been taken. Use proper managed network switches with something called IGMP snooping enabled so the lovely NDI data is only sent to the devices that wants to receive it. If not - and this is the default unfortunately - all devices including your SKAARHOJ controllers will receive it too and spend incredibly amount of resources to filter it out.

Below you will find our recommendations as this present time. Please be aware suggestions might get updated as we get to understand and test further.

If you use our controllers on a network with NDI sources (Multicast) it is absolutely imperative to configure your network properly to ensure a stable connection.

Network Guidelines

Besides having taken propper network switch considerations such as Gigabit Ethernet on all network switch ports we recommend the following settings on your Managed Switch when possible:

- Enable IGMP Snooping (mDNS is automatically blocked by many switches when snooping is enabled – refer to documentation from your switch vendor)
- Enable Flow Control as Asymmetrical or simply as On
- Disable Quality of Service
- Disable Jumbo Frames
- CONFIGURE IGMP Querier and Query Interval for each switch in multi-switch networks when using multicast

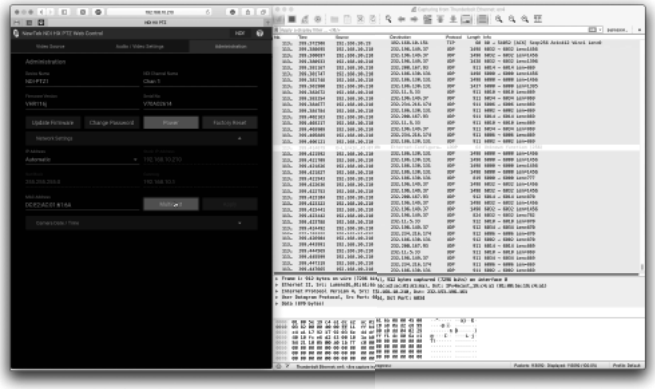
Additional Resources

- **NewTek:** NDI Network Guidelines
- **PTZOptics:** Setting up a Ubiquiti Network for use with PTZOptics Products
- **NewTek Network Settings:** https://support.newtek.com/hc/en-us/articles/115001705074-NETWORK-SETTINGS?mobile_site=true

Multicast Data on Network

If you are unsure if Multicast data is present on your network we recommend using a network protocol analyzer such as Wireshark. Many tutorials can be found online to filter to Multicast data on the network.

See a example here.



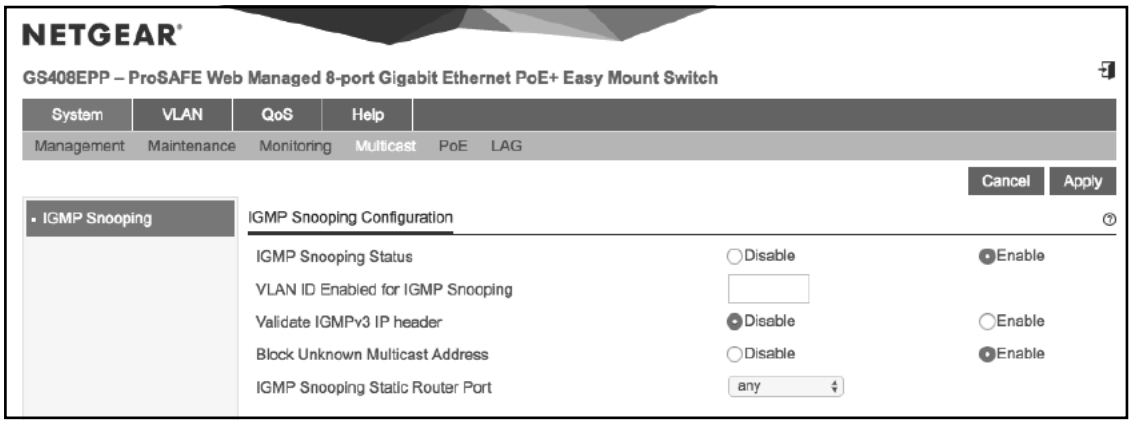
Recommend Managed Network Switches for NDI Network

We have tested 2 different managed network switches for a setup where multicast data is present. Below you will find a quick guide on how to configure these 2 devices to ensure stable connection on your network.

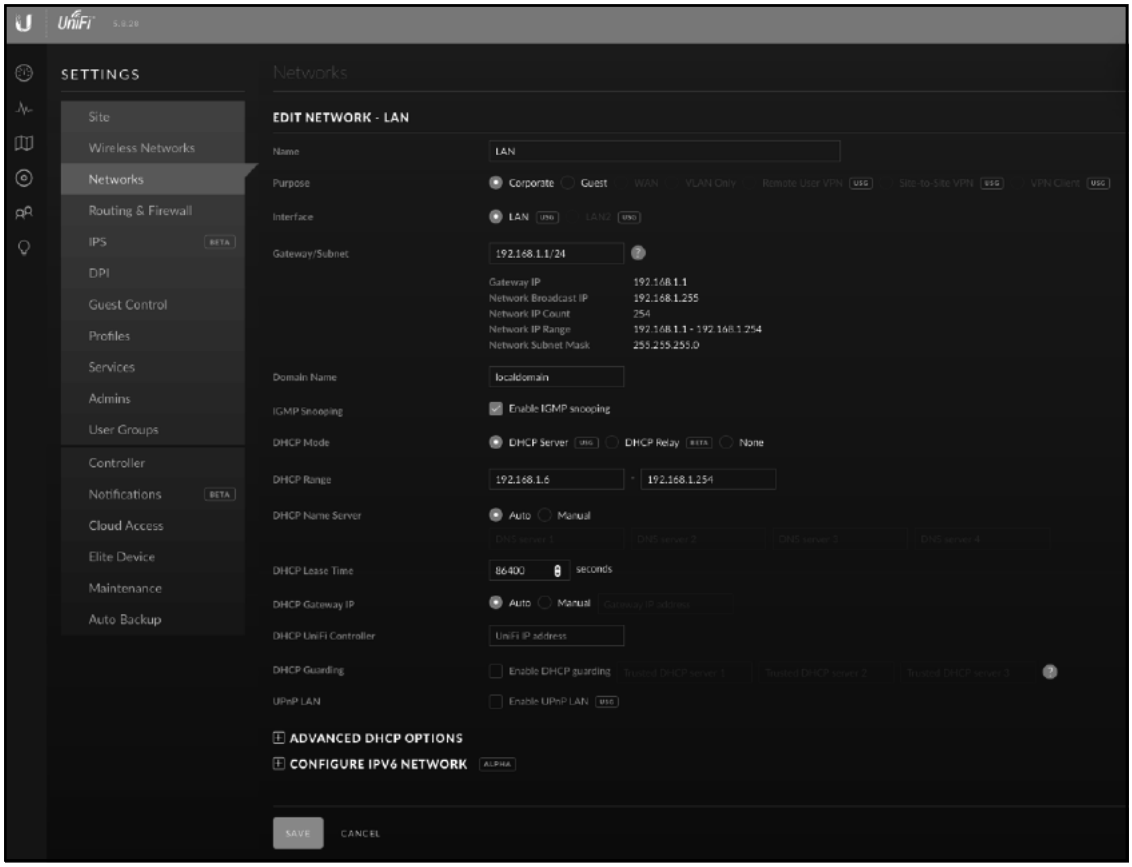
- Ubiquiti UniFi US-8-150W
- Netgear Click GS408EPP

At this current moment we advise against the **DGS-1100-08P** from D-link as we have experienced poor performance on this switcher. It can cause network devices to become unresponsive when a SKAARHOJ controller is connected. We are investigating…

Netgear Click GS408EPP

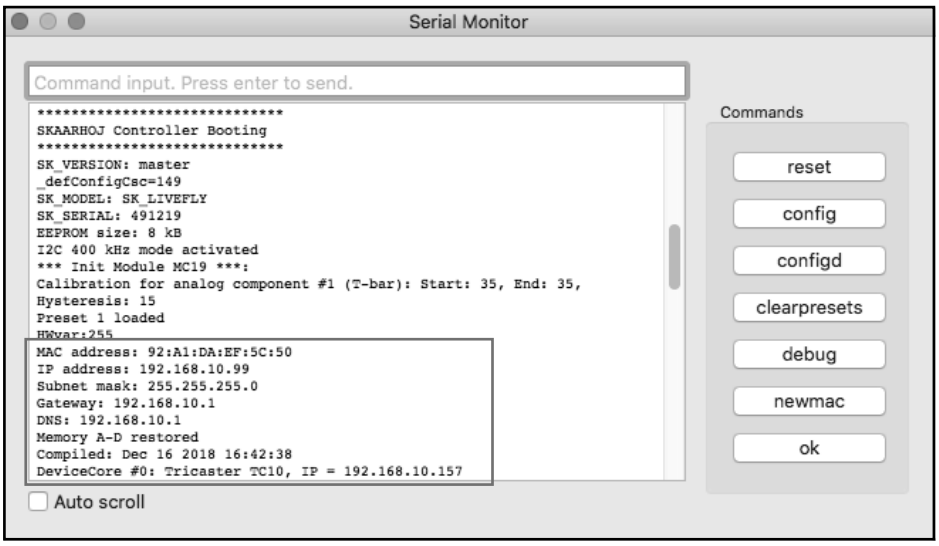


Ubiquiti UniFi US-8-150W

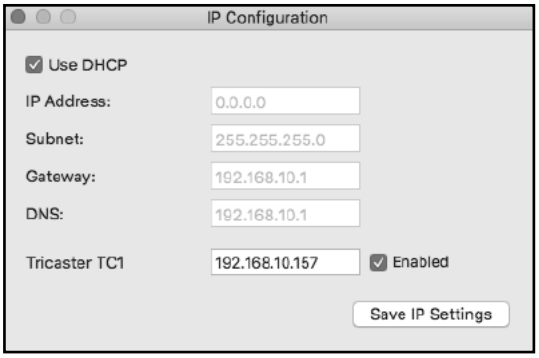


Static IP Address or DHCP

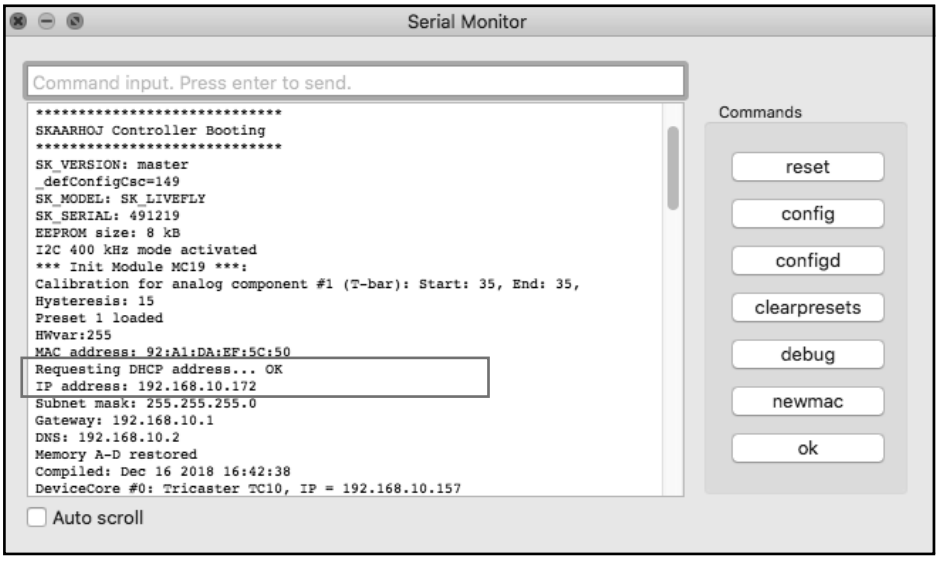
A SKAARHOJ controller running UniSketch will have the IP you set on the configuration page or via the "IP Configuration" from the Firmware Application. During you boot up process you can always confirm the IP settings on the controller and the Device Cores.



If the controllers IP is set to 0.0.0.0 (four zeros) or "Use DHCP" is activated in the IP Configuration window the controller will get a IP address from your DHCP server on your network.



A message with "Requesting DHCP address... OK" will appear in the serial monitor if the controller gets a IP address from the HDCP server.



If the controller is not assigned with a IP address from DHCP during boot up the serial monitor will report "Requesting DHCP address... failed" and the controller will fall back to IP address 0.0.0.0

```
Requesting DHCP address... failed
IP address: 0.0.0.0
Subnet mask: 0.0.0.0
Gateway: 0.0.0.0
DNS: 0.0.0.1
```

The controller will continuously try to get a IP address from the DHCP server. If it fails the message "DHCP renew failed" will appear.

```
DHCP renew failed
```

If successfully the message "DHCP Renewed: x.x.x.x" will appear.

```
DHCP Renewed: 192.168.10.172
```

Device Cores

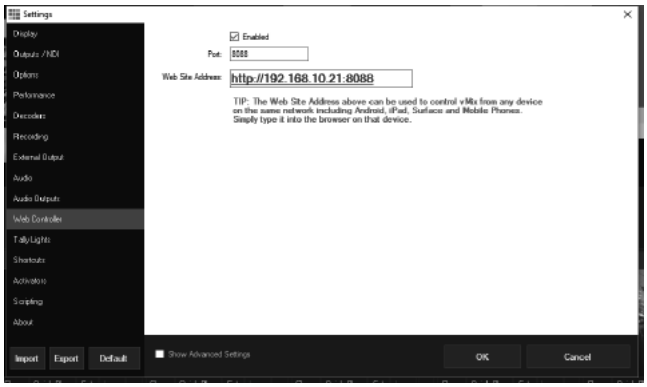
External hardware support is made available on your controller as what we call Device Cores. A device core is the driver - or akin to an "app" - installed on the your controller that enables communication support with a given piece of broadcast gear. Some are very mature and full featured, others still just basic, some are in beta versions and yet others are just planned at this stage

You can always see the latest status here www.skaarhoj.com/support/device-cores/ and find specific Device Core manuals www.skaarhoj.com/support/manuals if they exist.

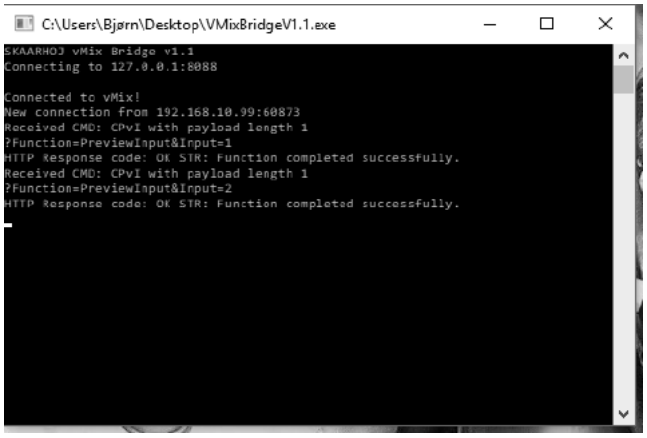
vMix Device Core

When using our controller together with vMix the application vMixBridge is necessary to run on your computer. This gabs communication between our controller and vMix - get it here: www.skaarhoj.com/support/device-cores/vmix/

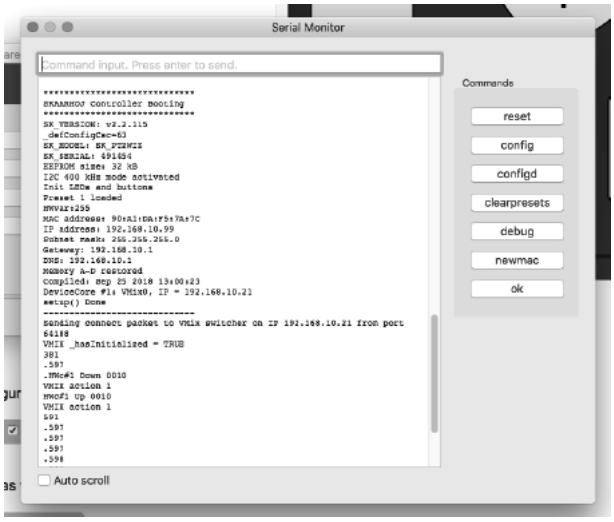
Set fixed IP on computer to match vMix Device Core IP address



You can check IP settings in vMix - Settings - Web Controller



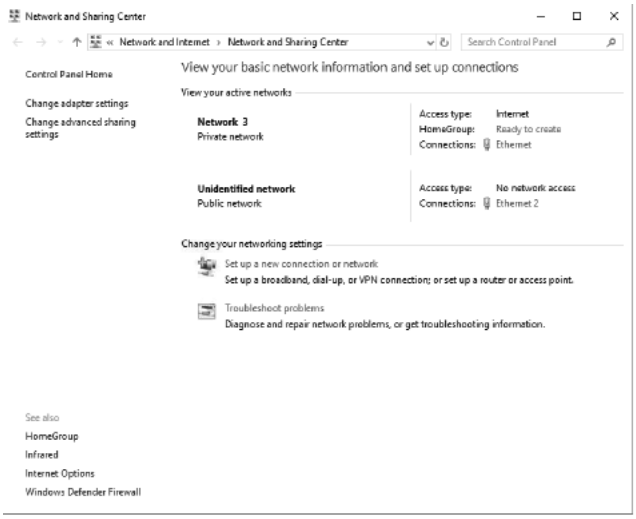
Open vMix and vMixBridge. When SKAARHOJ controller connects the vMixBridge will report "New connection from ..."

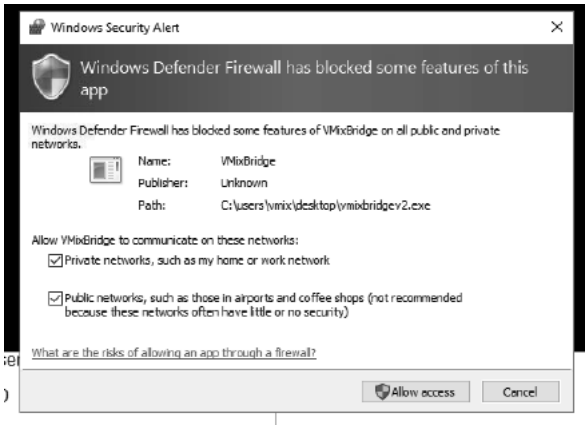


Check connection have been established in serial monitor. Connection is confirmed by "VMIX _hasInitialized = True"

A note on Windows Defender Firewall

In order for the vMixBridge application to work properly you need to make sure the application is granted access to either your Private Network or your Public Network dependent on which network the SKAARHOJ controller is connected to.

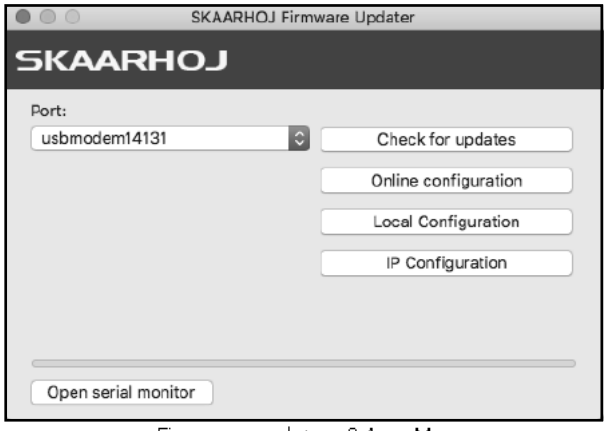




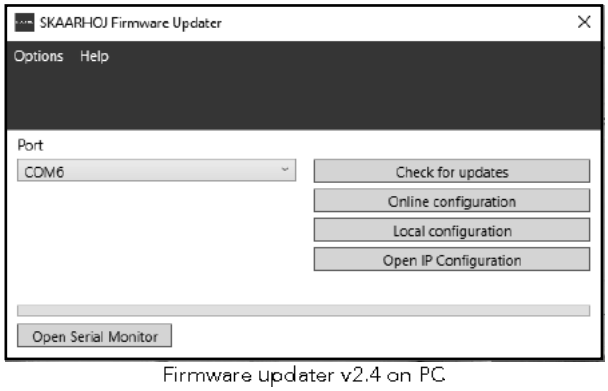
Firmware Updater Application

A quick introduction to the Firmware Updater Application is presented in the "Getting Started" section. Here we provide some more details. The applications can be downloaded for Mac and PC at: www.skaarhoj.com/support/firmware-updater/

When the application is installed and open, connect your controller with USB to the computer. It should now be displayed in the "Port" dropdown box. Please only connect *one* SKAARHOJ controller at a time.



Firmware updater v2.4 on Mac



Firmware updater v2.4 on PC

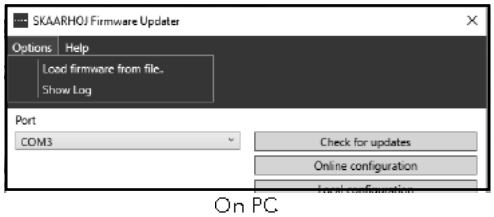
A number of options now exist.

- **Check for updates:** Generates a new firmware on our server and downloads it to the unit. The is required whenever a change to the configuration have been made from "Online Configuration", or we have updated UniSketch OS and Device Cores.
- **Online Configuration:** Opens a webbrowser and give you access to the online configuration page of your controller. Remember a change made here are not saved on the controller before "Check for updates" is pressed.
- **Local Configuration:** Starts a local webserver on the controller and open a webbrowser with a local configuration page. Please notice changes made in the local configuration will *not* be synced with your Online Configuration and whenever a "Check for Updates" command is executed the Local Configuration will be overwritten!
- **IP Configuration:** Opens a configuration window for IP settings on the controller and Device Cores.

Load Firmware from File

In addition you will find a "Load Firmware from File" and "Show Log" in the "Options" tab in the application.

On Mac



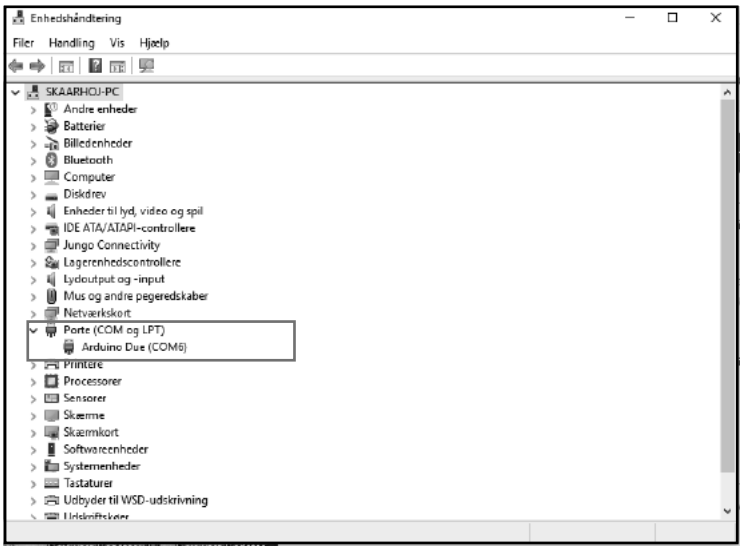
On PC

The "Load Firmware from file" is used if you have generated a firmware file from the Online Configuration page and want to upload it manually. Or if you want to update firmware on a unit not integrated in our UniSketch OS. Please notice firmwares are unique to each controller and paired with a hardware ID for the controller it have been generated from. Firmware files ***cannot*** be uploaded to a different controller than the one it have been generated from.

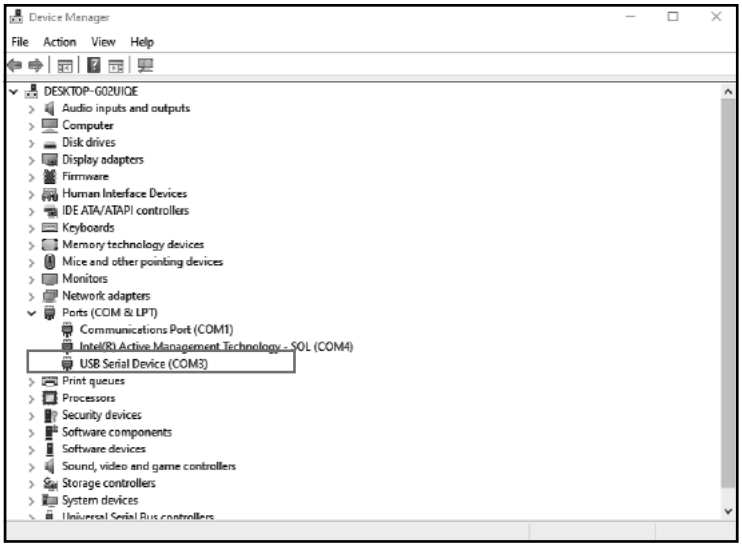
The "Show Log" will open a text document with a log from the application. Please included the relevant parts in a support case.

Port selection on Windows

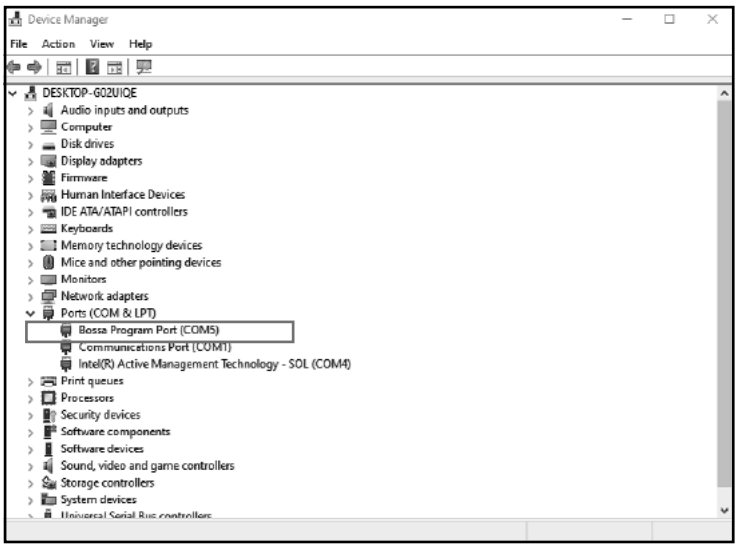
If multiple options are listed in the port selection on Windows you can use Device Manager to find the relevant COM port. If you have issues getting access to the controller when several COM port are listed in the application try and disable other COM ports or disconnect other hardware using COM ports. For UniSketch based units the controller should appear as "**Arduino Due**" but in some cases you will find the naming to be "**USB Serial Device**" or "**Bossa Program Port**" depending of the state of the controller.



Arduino Due

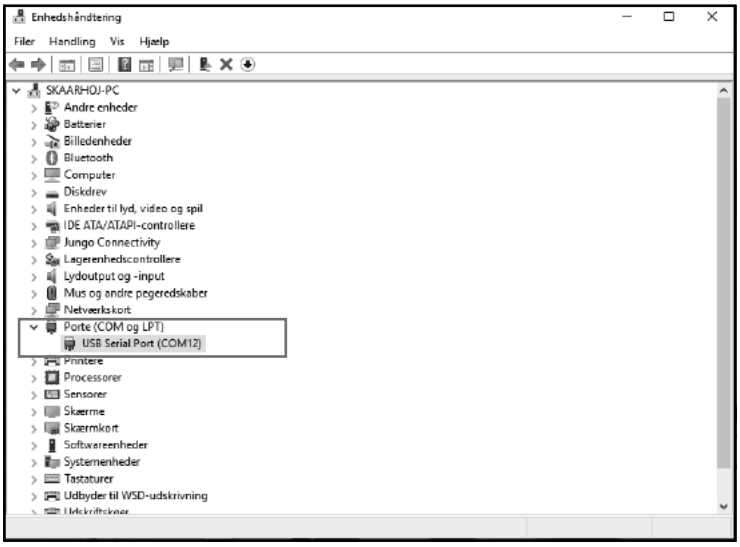


USB Serial Device



Bossa Program Port

If you have a unit not running UniSketch such as a ATEM-TCP Link it will typically be listed as a **"USB Serial Port"**



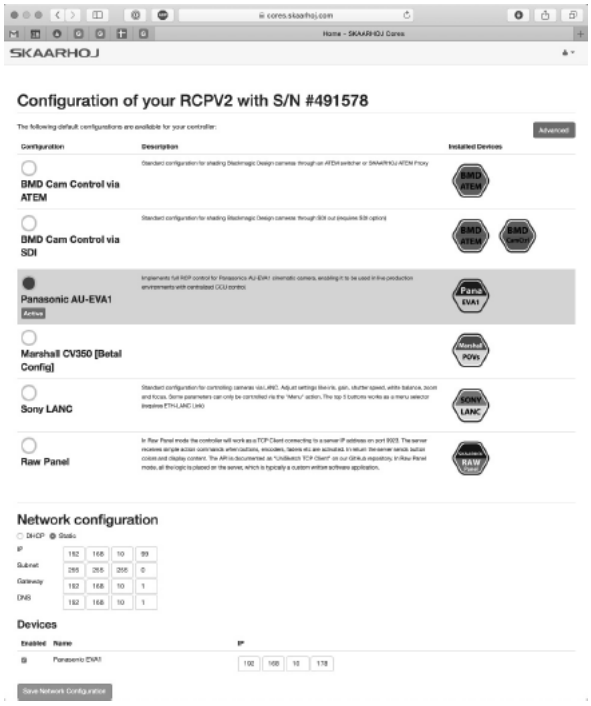
IP Settings

A couple of methods exist to set IP settings on the Device Cores and the controller itself.

- **Method 1:** Using "Online Configuration" and "Check for updates" in the Firmware Application

Setting IP for default Configurations

If no custom configurations have been made on a SKAARHOJ controller, a overview with default configurations will appear when pressing "Online Configuration"

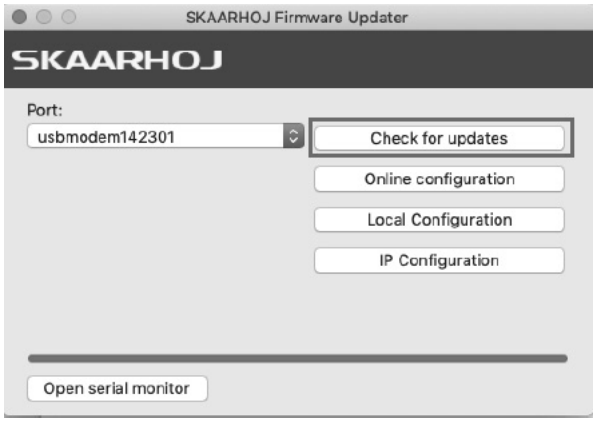


In the section "Network configuration" you can set the desired IP addresses. Press "Save Network Configuration" and *then* press "Check for updates" in the Firmware Application.

Setting IP for custom configurations

If custom configurations have been made on a SKAARHOJ controller a overview like below will appear when pressing "Online Configuration"

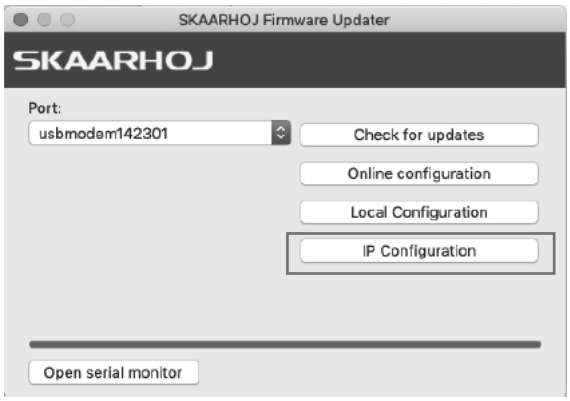
At the bottom of the config page you set IP settings. Remember to press "Save Settings" and *then* press "Check for updates in the Firmware Application.

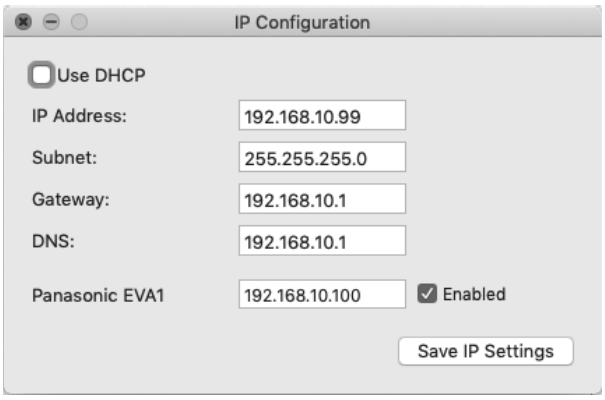


Notice on Windows the Port dropdown will display "COM" ports. Please see section "Port selection on Windows"

- **Method 2:** Using "IP Configuration" in the Firmware Application

A alternative way of setting IP addresses is using the "IP Configuration" option in the Firmware Application

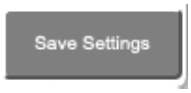




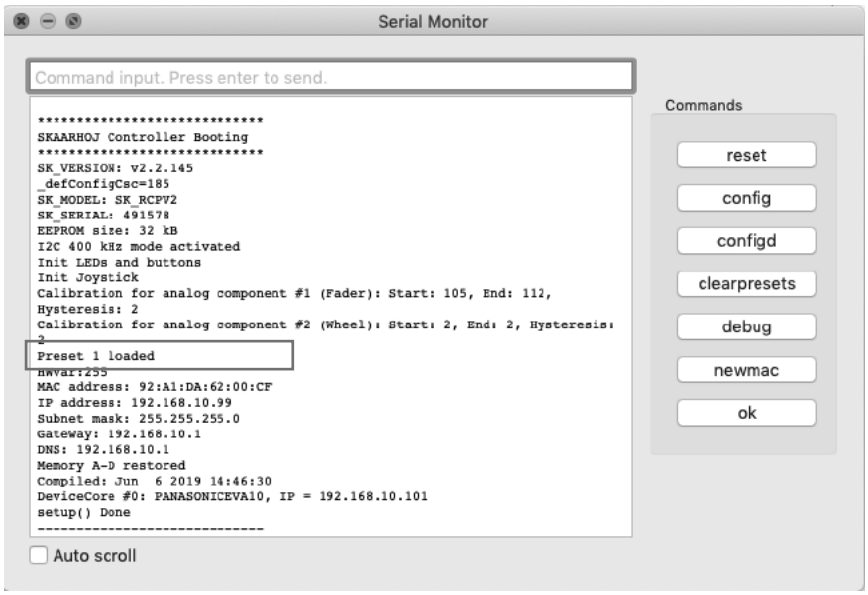
Please notice this will generate a local "preset" on the controller. This preset will ***overrule*** IP settings set in the "Network Configuration/Device Settings" on the Configuration page when pressing "Check for updates" **unless:**

- One have opened the config page with default configurations and pressed and then pressed "Check for updates"

- One have opened the config page with custom configurations and pressed and then pressed "Check for updates"



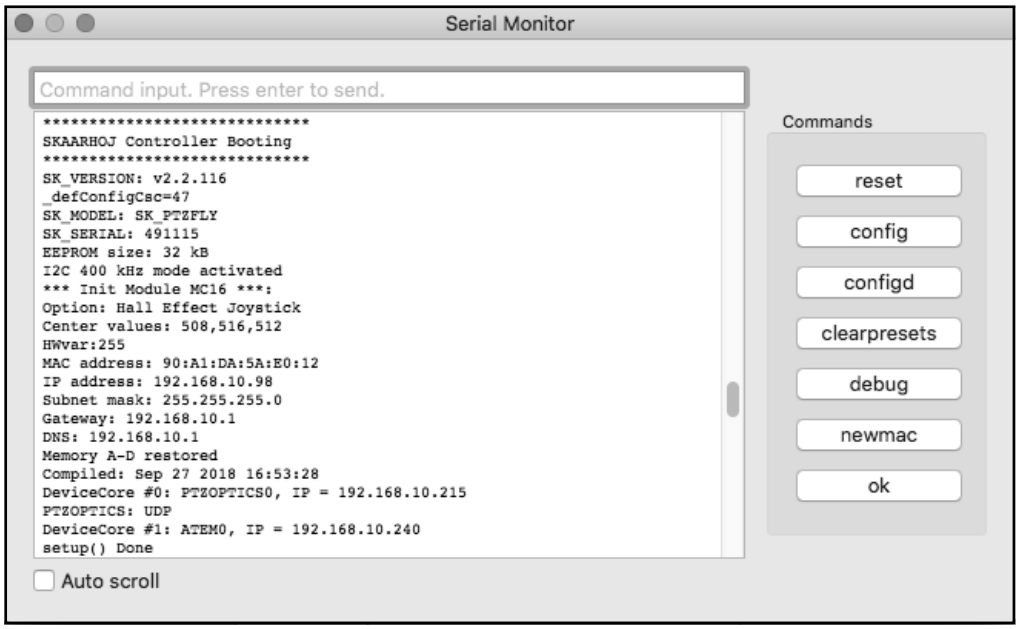
The Serial Monitor can be used to monitor if a "Preset" exist



A preset can be deleted by using the above methods (Save Network Configuration or Save Settings and then pressing "Check for updates). Alternatively press "clearpresets" in the Serial Monitor.

Serial Monitor

The serial monitor in the Firmware Application is an indispensable tool for bug fixing any problems with your SKAARHOJ controller. The serial monitor runs at 115200 baud and a typical output from the boot process looks like this:



This tells us the firmware version loaded, model name of the controller, serial number, how a number of hardware components have been initialized, which IP address, subnet mask and MAC address the controller has, which date the software was compiled.It also shows us which hardware devices it will try to connect to.During this process until the "setup() Done" message is output, the status LED will blink purple.

After the setup, the controller enters normal operational state. You see that it tries to connect to the devices and that it succeeds in this. During this process, the status LED blinks yellow and eventually it will blink green.

The serial monitor will continuously output a small dot and a number every second. If this is not the case permanently, it indicates a crash of the controller. The number indicates the number of times a second the controller manages to check all device connections and hardware components. It should be higher than 25. The higher the better. This number may/will drop if there are problems, if something slows down the controller, if devices are not connected properly or in the process of being connected, if a lot of displays needs to be updated etc. The lower this value, the less responsive the interface will feel. This value will also be impacted by the number and type of actions configured for interface components in the web interface. Network problems may also impact this value. If this value is too low, the controller may further loose connections to devices and may seem unresponsive to interface operations.

Commands in the Serial Monitor

You can enter commands in the serial monitor to do certain things with the controller. This is particularly useful for developers and also for bug-fixing and calibration. If you are using the Arduino IDE Enable CR/LF on the serial monitor dropdown menu in order to send the commands.

List of Commands

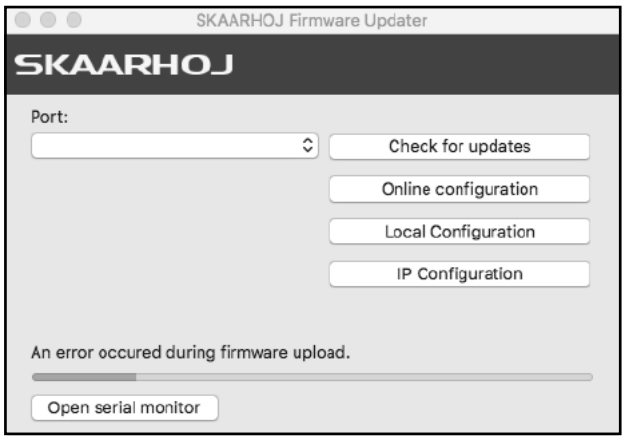
"config"	Reboots the device into config mode with its current IP. Similar to holding the config button until the LED becomes blue.
"configd"	Reboots the device into config default mode (IP always 192.168.10.99). Similar to holding the config button until the LED becomes white.

"debug"	Reboots and enables debug output to serial monitor
"sockets"	Lists the 8 available sockets and their status. (If "debug" mode is enabled - see above - whenever a change happens to a socket you will see it printed in the serial monitor on the same form)
"newmac"	Generates a new random MAC address to EEPROM. Power cycle both your controller and network switch after this operation. Useful if you have network problems.
"clearpresets"	Clears the preset memory completely (flushes all!). Useful/necessary after a firmware upgrade. Similar to holding the config button until the LED becomes red.
"reset"	Reboots the controller
"HWvar=XXX"	Set Hardware Variant (byte). This value shouldn't be changed by users. It's significance is to inform the UniSketch software about which hardware revision it's running on in order to take certain specifics into account. Bit 0: Determines model of status LED on SKAARDUINO-AVR models.
"list analog"	Lists analog hardware components on the controller with number, description and three calibration values (start/end/tolerance)
"show analog X"	Shows readings from analog component X where X is the number given by "list analog". The readings indicate the value and noise level for the read out. This is useful for debugging. If you move the analog component you should see values change. Write "hide analog" to stop the display.
"hide analog"	Stops the display of "show analog"
"calibrate analog X"	Starts calibration of analog component X. Instructions will be posted in the serial monitor. The steps involve moving the analog component to various positions.
"clear analog X"	Resets calibration data for analog component X to default. If X is not given it resets calibration data for all components.
"set analog X=start,end,tolerance"	Forces calibration data "start", "end", and "tolerance" for component X
"exportPresets"	Will dump a large amount of data representing the entire configuration with presets in the controller. Last two bytes is a checksum
"importPresets"	Will import configuration into the internal EEPROM memory. After sending the command, the controller will instruct to paste configuration into the serial monitor. It must be formated like the output from "exportPresets"
"preset X"	Will select the given preset number X if it exists and reboot the controller
"ip=A.B.C.D"	Sets the controller IP address (for the current preset)
"ipDeviceX=A.B.C.D"	Sets the IP address for device index X (see boot up output) for the current preset.
"enableDeviceX=[0/1]"	Enable or disable device X for the current preset.
"clearusermemory"	Clears user memory space (used for various types of device setting presets).
"getVersion"	Shows the current version of UniSketch
"getCID"	Returns the controllers unique ID, which is used to access the configuration pages on cores.skaarhoj.com. Since this ID gives access to the online configuration, do not share it publicly.

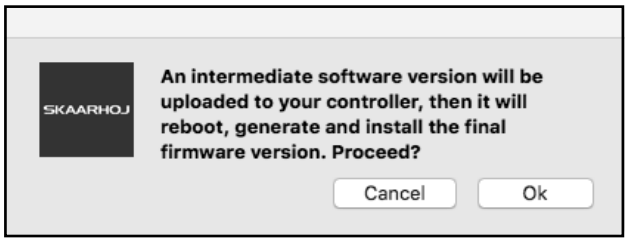
Technical Notice: Any operation from the serial monitor that reboots the controller, does so with a "soft" reset and the Ethernet chip in the controller may still hold old settings. In most cases this is no problem, but at other times it may lead to strange behaviours and connection problems. In that case; power cycle the unit, press the reset button shortly or close down and reopen the serial monitor which will also act as a hardware reset.

Error Occurred during Firmware Upload

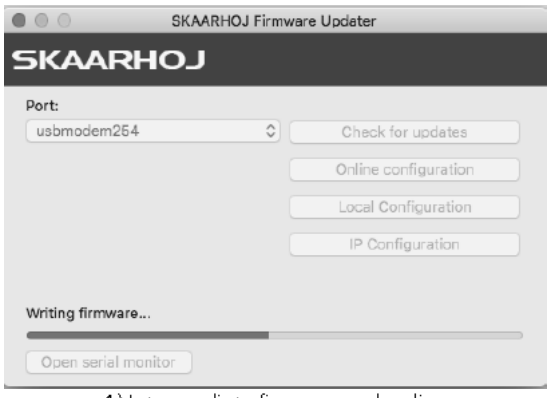
If the update process for whatever reason is interrupted (e.g. power is lost) the firmware will be rendered useless on your device. A new firmware have to be uploaded to the unit.



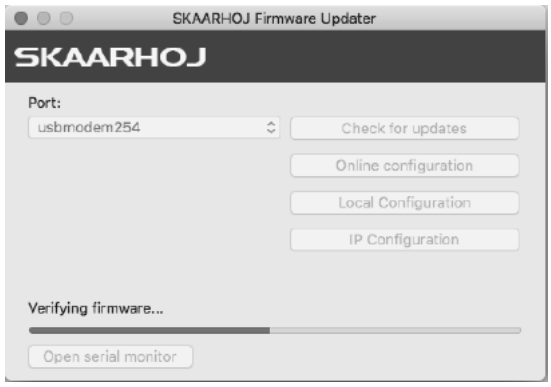
Press "Check for updates" - you will be presented with a message about a "intermediate software version...". Press "OK" to proceed. A intermediate firmware will be loaded on your unit, and subsequently the final firmware.



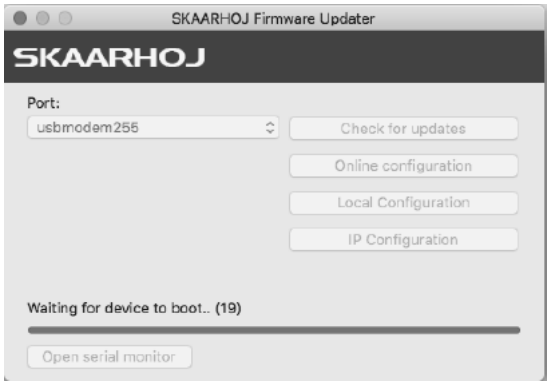
Process for updating firmware with intermediate software version



1) Intermediate firmware uploading



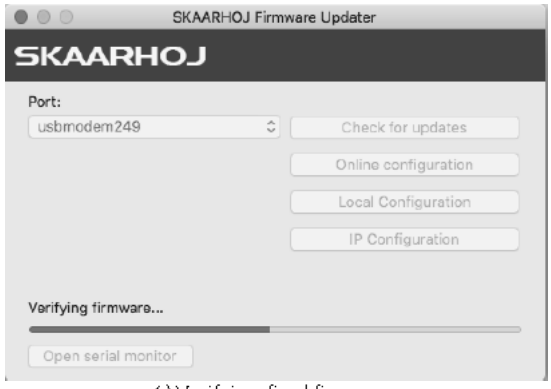
2) Verifying intermediate firmware



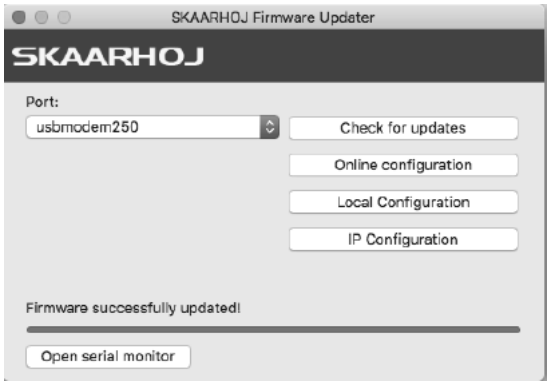
3) Waiting for device to boot

4) Generating and downloading final firmware

5) Writing final firmware



6) Verifying final firmware



7) Status

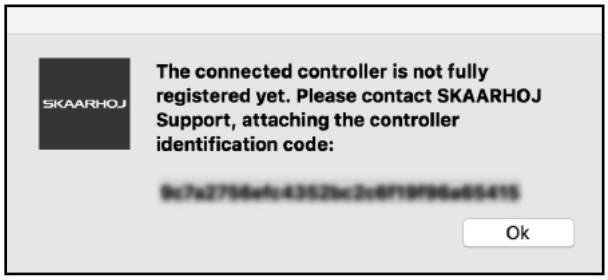
The Connected Controller is not Fully Registered yet

In rare cases you might experience a message from the Firmware Updater stating that the connected controller is not fully registered yet. This happens if the unique hardware ID of your controller does not match the record in our database.

In order to solve this issue please send the following information to support@skaarhoj.com

- Identification code from the Firmware Application.
- Serial number of the unit. The serial number is found on a small silver sticker with 6 digits.

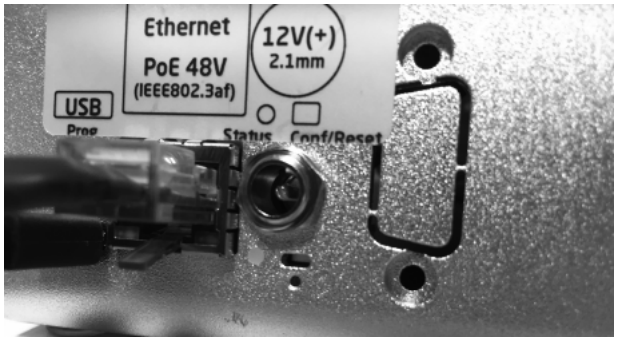
After we have confirmed the registration by email press "Check for updates" in the Firmware Application. This will render a new valid firmware for your device.



The Controller Appears Bricked/Non Responsive

If a firmware update fails or is interrupted (i.e powerloss, Application crash, missed connection from USB cable) the controller can end up in "**Programming Mode**". In this mode *no* hardware components (buttons, displays etc will light up) and *no* lights will be seen on the SKAARDUINO Due - so no lights in the status LED, no lights on the ethernet port even though the controller is powered via PoE or PSU. The controller still appear in the Port list in the Firmware Application.

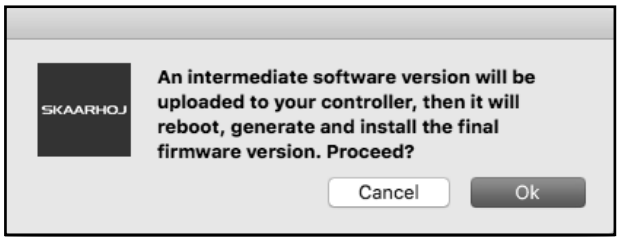
To check if a controller is in Programming mode write # in the serial monitor. The serial monitor should respond with a > as seen below.



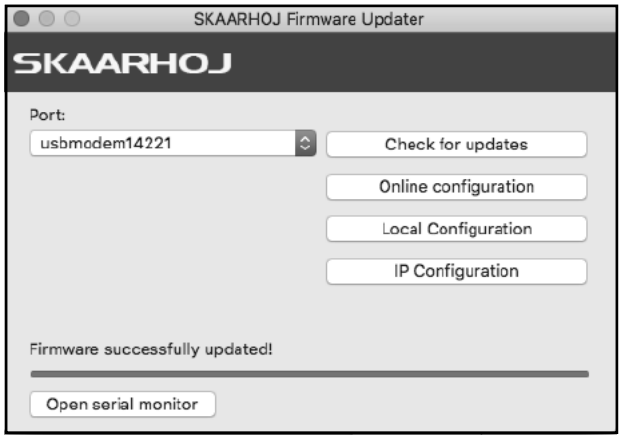
No lights from the SKAARDUINO Due. No lights in the status LED and no activity on the Ethernet port.

Respond from the serial monitor to determine if the controller is in "Programming mode. Write # in the command input and the controller respond with >

In order to get the controller out of programming mode press "Check for Updates" in the Firmware Application. You will be prompted with a message about "An intermediate software version will be..." like illustrated below. Press "OK" to proceed.



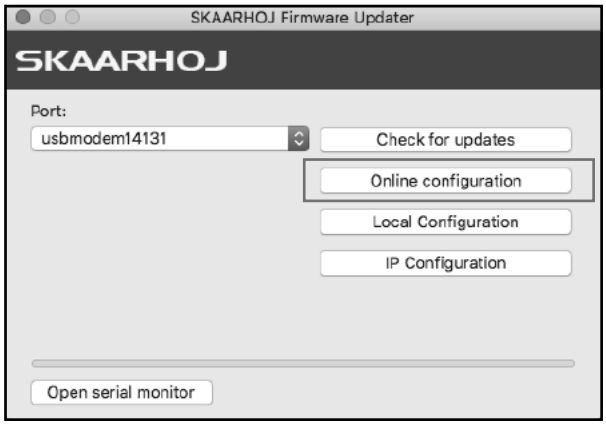
The steps from the Firmware application illustrated in the "Error Occurred during Firmware Upload" section will follow and the controllers firmware will be uploaded and the application states "Firmware successfully updated!



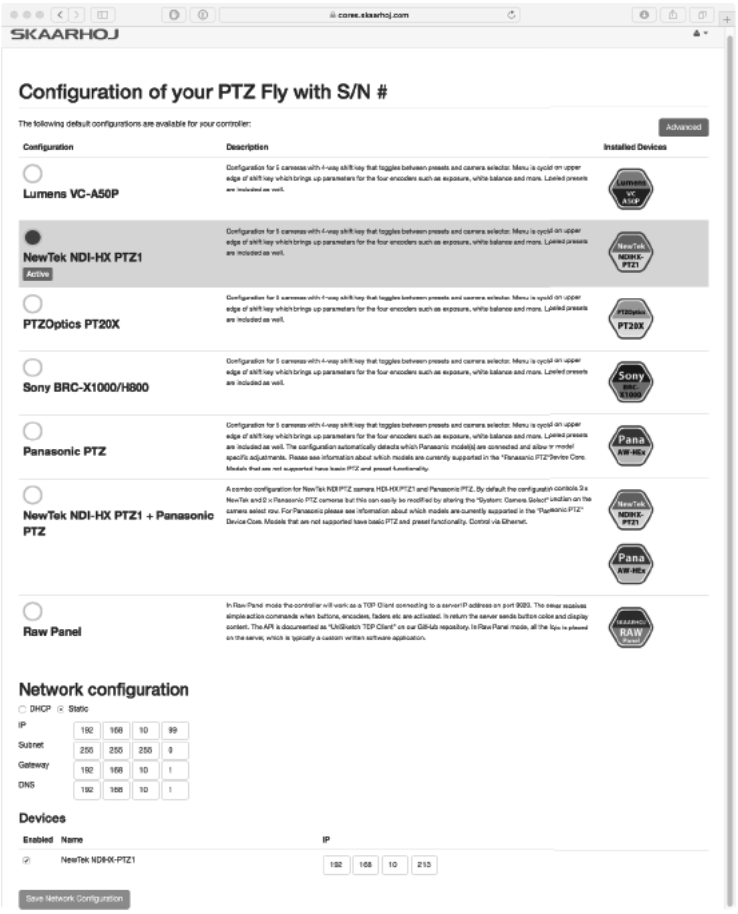
cores.skaarhoj.com

A SKAARHOJ controller running UniSketch OS has a license profile in our online repo at cores.skaarhoj.com. This is where its software (firmware) came from that was programmed onto the unit when it was delivered. Whenever you need a firmware upgrade for whatever reason, this is where the firmware will be downloaded from by the firmware application. But this is only the most basic case. cores.skaarhoj.com provides you a fantastic way to expand the features of your controller; you can select between different pre-made configurations, install new device cores (support for more broadcast hardware), change configuration of the controllers behaviour, add media strings and graphics, add modules and manage multiple configurations for your controller.

To access the Configuration Page for your controller, simply connect it by USB to your computer and start the SKAARHOJ Firmware Application, then press "Online Configuration". If the controller correctly reboots and returns its unique ID, a web browser will open and take you to the configuration page on cores.skaarhoj.com. Whenever you are done changing the configuration online, return to the SKAARHOJ Firmware App and press "Check for updates". A new firmware reflecting the changes will be created and downloaded to your controller.

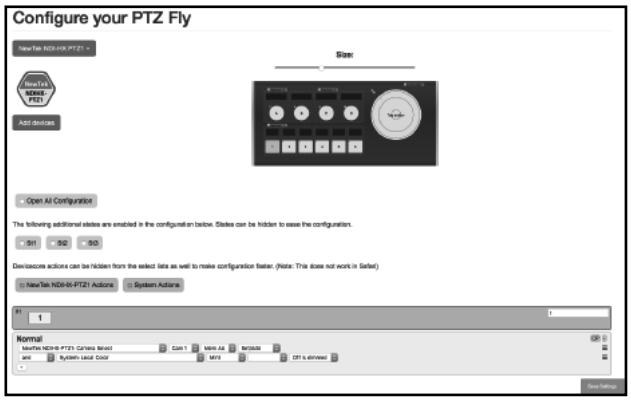


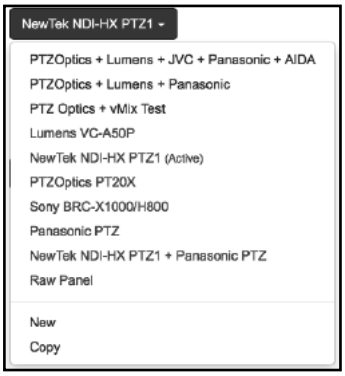
By default the configuration page will look something like this. Here you can select between different pre-made configurations and read a short description. You can also change Network settings and set IP address for Device Cores. If you press the red "Advanced" button you will access a configuration page where you can tweak a existing configuration or build one for yourself!



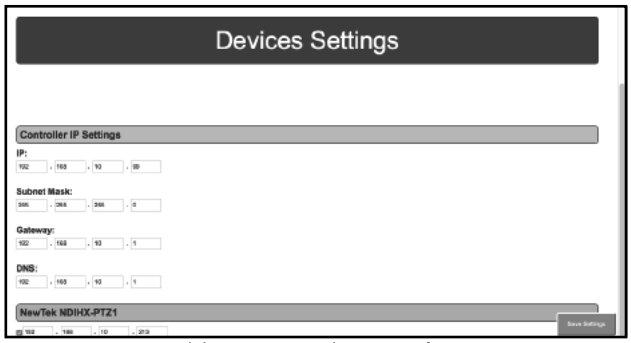
Controller Configuration

This is where the fun begins! On the advanced configuration page on Cores" (cores.skaarhoj.com) the configuration of your controller shares the same interface as the one documented in this manual in the UniSketch section. The configuration you set up on "Cores" will become the default configuration of your controller with the next firmware download. When pressing a hardware interface component the configuration will jump to that component and you can modify or change the actions.





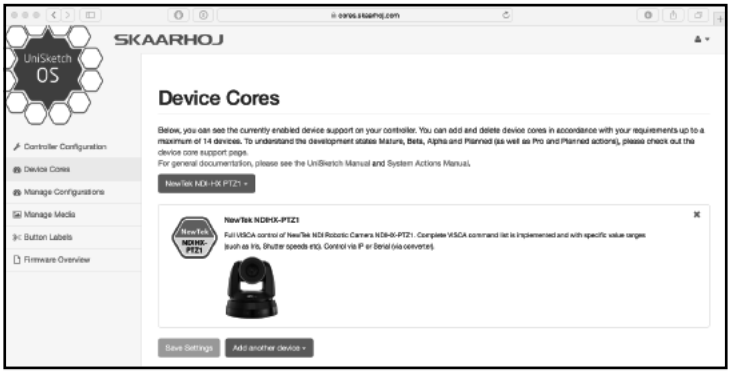
Chose a configuration from the drop down menu, copy or start with a clean slate



Set IP addresses at the bottom of the page

Device Cores

Add or remove Device Cores on the "Device Core" tab.

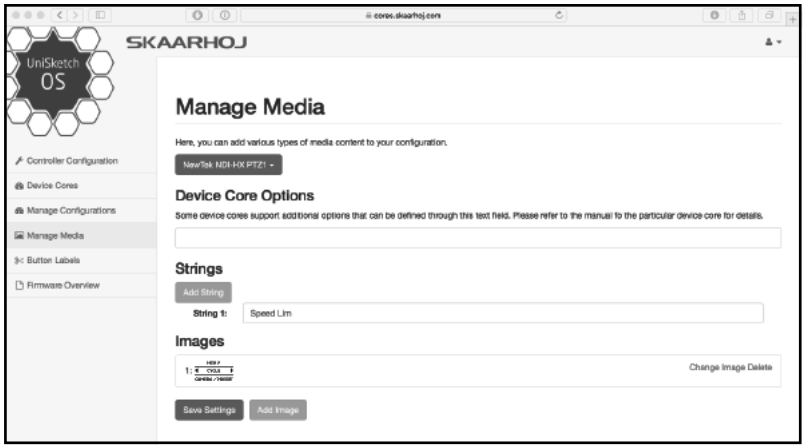


Manage Configurations

Select either SKAARHOJ official configuration from this tab or manage your User Configurations by assigning names, descriptions or delete. You can even Share a configuration to another controller with the "Share Button". This creates a ID number which you subscribe to in the "Configuration Subscriptions" section.

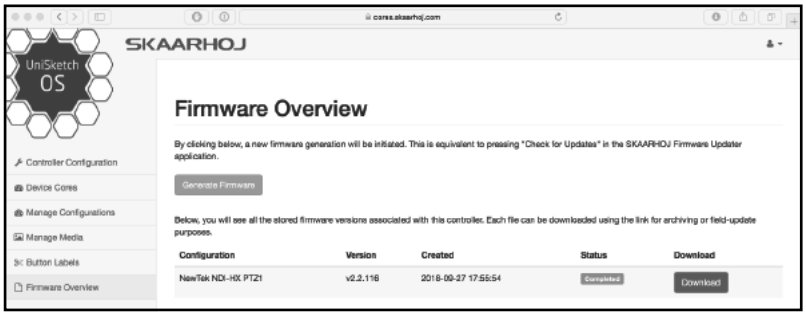
Manage Media

Add strings or images to your configuration. Device Core options are also set on this tab.



Firmware Overview

Download or generate a new firmware file - use it for archiving or field-update purposes.



Device Core Options

For some Device Cores a "Device Core Options" can be found. See the specific Device Core manuals for instructions on how to set these.

Notice if you want to set Device Core options for several Device Cores the structure is as following

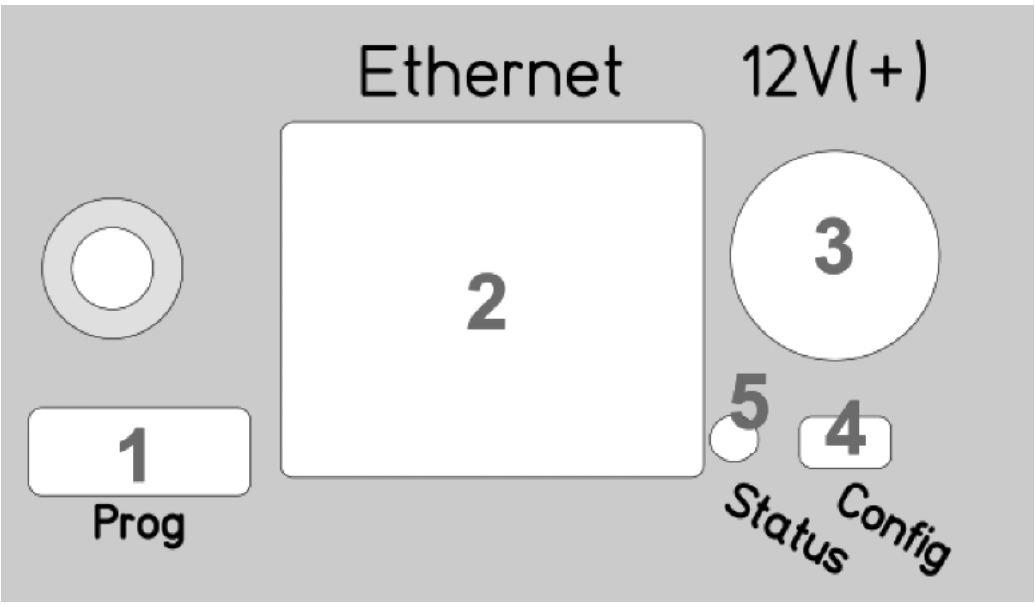
Dx:y=z ;Dx:y=z

Setting several Device Core Option indexes for the same Device Core is as following

Dx:y=z,y=z

Where the general form would be "Dx:y=z" where "x" is the number of the device cores installed on the controller (starting with zero for the first device core), "y" the index number and "z" the value for that index.

Back Connections and Config Mode



1. **Micro USB plug.** Used for service monitoring and programming new software into the unit ("firmware upgrades"). For some device cores this may also be used for controlling equipment. See "Programming"
2. **Ethernet Jack.** Connect this to your ethernet switch. This jack may also support PoE (Power over Ethernet) if your SKAARHOJ controller was delivered with that option. When connected to a network switch, the yellow LED (lower left) will be on. When data is sent to/from the controller, the green LED (lower right) will blink. If the device in the other end supports TX/RX auto detection you may be able to connect the SKAARHOJ controller directly to your device, otherwise use a crossed cable or a network switch (the supported setup).
3. **DC input.** Use a standard 2.1mm center pin plug (center = "+"). Allowed voltage range is 7-18V. We test controllers will work at 12V. The device uses max 1A at 12V. Units with BlackMagic 3G-SDI Arduino Shields needs 12V.
4. **Configuration/Reset button.** Use a pencil or tooth pick to press the button. When you press the button shortly, the controller will reset (same as pulling the power plug). If you press and hold the button, you can reset the controller into configuration mode:
    1. Press and hold the button until the status LED becomes blue after a few seconds. Release the button and the controller is in *config* mode. You can access the controller web interface with a web browser on "http://[CONTROLLER IP]/" where CONTROLLER IP is the IP address used for the currently loaded preset. The controller will run a diagnostics mode after 2 minutes where displays and buttons will light up.
    2. Press and hold the button longer until the status LED becomes white (which is 2 seconds after becoming blue). Release the button and the controller is in config default mode. You can access the controller web interface with a web browser on "http://192.168.10.99/". The controller will immediately run a diagnostics mode where displays and buttons will light up.
    3. Press and hold the button even longer until the status LED becomes red (which is 10 seconds after becoming blue and 8 seconds after becoming white). This will clear all presets in memory thereby resetting all configuration made in the controllers own web interface (this corresponds to the serial monitor command "clearpresets" and should only be necessary in case a firmware update requires it or if there is another tricky error state present).

In rare cases you cannot rely on the reset button but have to turn of the power to the controller instead ("cold start").

5. **Status LED:** When the controller is just powered up, you will see the status LED blink purple during the boot process. In this process, the hardware is initialized. Eventually the LED should end up blinking slowly (2 sec period) steady green (or blue or white if in config modes). If the LED blinks yellow quickly it indicates that connection to one or more devices is not established. This is perfectly normal for a few seconds between the boot up process (purple blinks) and the operational state (green blinks) when the controller connects to all devices. The status LED should never be permanently on or off, this indicates a potential freeze in the system. In fact, in normal healthy operation the LED should blink with a steady 2 sec period, otherwise it could indicate trouble with connections or hardware. The LED will also light up red for a split second whenever an analog hardware component (such as a T-bar) is operated (this feature is helpful to determine if calibration is needed).

Status LED Overview

Purple blinks, uneven durations	The controller is booting up (and for each blink a given step has been completed).
Yellow blinks, quickly	The controller hasn't established necessary connection to one or more devices. At the end of the boot process this is natural for a few seconds as the controller connects to devices for the first time. If you unplug the network cable or turn off an external device the controller is connected to, you will also see this state. Just turn on the external device again or re-insert the cable and the error state should restore itself to normal operation (green, steady blinking) after some time. If this happens during normal operation and without obvious explanations (like removal of a network cable or shutting down an external device), it's an error state you need to pay attention to and bug-fix further. If the controller boots up and never stops blinking yellow, you may want to check if you have configured devices for the controller which are not currently present in the network set up. Go to config mode, enter the web interface and check which devices are enabled and their IP addresses.
Green blinks, steady, period of 2 seconds	Normal mode, everything is connected and working properly. Just bliss
Blue or white blinks, steady, period of 2 seconds	Config mode (white: "config default") where you can access the controller web interface.
Red blinks (interrupting green or yellow blinks)	This happens if you move an analog hardware interface component like a T-bar or knob and is totally normal in that case. However if such blinks happen without you touching any analog components it indicates the need for calibration.
Quick red blinks and no response from controller	A problem with the preset memory checksum indicates that the preset memory may be corrupt. However, in most cases a "cold start" by removing the power supply, waiting 10 seconds and connecting the power supply will solve the problem. If after 2-3 attemps with this solution it still remains a problem, you must clear the preset memory. This is done by holding the config button pressed, then apply power to the controller and wait for around 15 seconds until the status LED becoems solid red (before that state, the LED should be first purple, then blue, then white for 8 seconds and finally solid red). When the LED is red, release the button and the status LED should start blinking again and the controller should boot up. Notice that your controller will be reset to factory settings in this case and you may need to reload or recreate your configuration.

Connection Troubleshooting

When you have a "blinking-yellow-quickly" situation, you need to figure out which device is not connected. Try some or all of these things:

- You should bring the controller into config mode and access the web interface in order to check which devices are enabled and what their IP addresses are.
- Make sure the SKAARHOJ controller itself has the expected IP address and subnet mask.
- Make sure the devices you have setup actually are on the network, can be ping'ed and responds to their respective other types of software connecting over IP.
- Unpower all devices and your network switch for 10 seconds and power them up again.
- Connect a computer to the USB port of the SKAARHOJ controller and open the serial monitor using the firmware application to see the output from that. This provides the most direct information about which devices are not answering and at which IP. You can also see the controller IP and Mac address here. See "Serial Monitor" section.

Configuration Mode/Accessing Web Interface

In Configuration Mode all device communication is disabled and instead the controller provides a **web interface** for configuration of the interface component behaviors. The IP address of the controller in configuration mode (or "config" mode) depends on how config mode was entered. There are two options: "config" mode or "config default" mode. You can enter either mode using

A. The Config/Reset button on the controller

B. Using the serial monitor command "config" or "configd".

- **"config" mode:** The controller IP address is the "last used" IP address; the one set up for the currently loaded preset. This is convenient most of the time since you probably know your controller IP and just need to boot in config mode and access the web interface with a browser. After 2 minutes in config mode, the controller will run cyclic test programs on the hardware interface components, typically a lot of blinking.
- **"config default"** mode changes the IP address to 192.168.10.99 and this is useful if for some reason you forgot the controller IP or otherwise want to make absolutely sure you know the right IP address for the controller. The controller will run cyclic test programs on the hardware interface components immediately as it has booted up.

Notice that the IP address of your SKAARHOJ controller can be different for each preset you have! This makes it easy to have presets for completely different network and device configurations.

We recommend connecting your SKAARHOJ controller directly to your PC/Mac with a ethernet cable in order to access the web interface

Turn off your Wi-Fi and set your IP manually: (these numbers are only valid if you are using the default IP address configuration from the factory)
192.168.10.50 PC/Mac IP address
255.255.255.0 Netmask
192.168.10.1 Gateway/Router IP address if necessary

Enter configuration mode

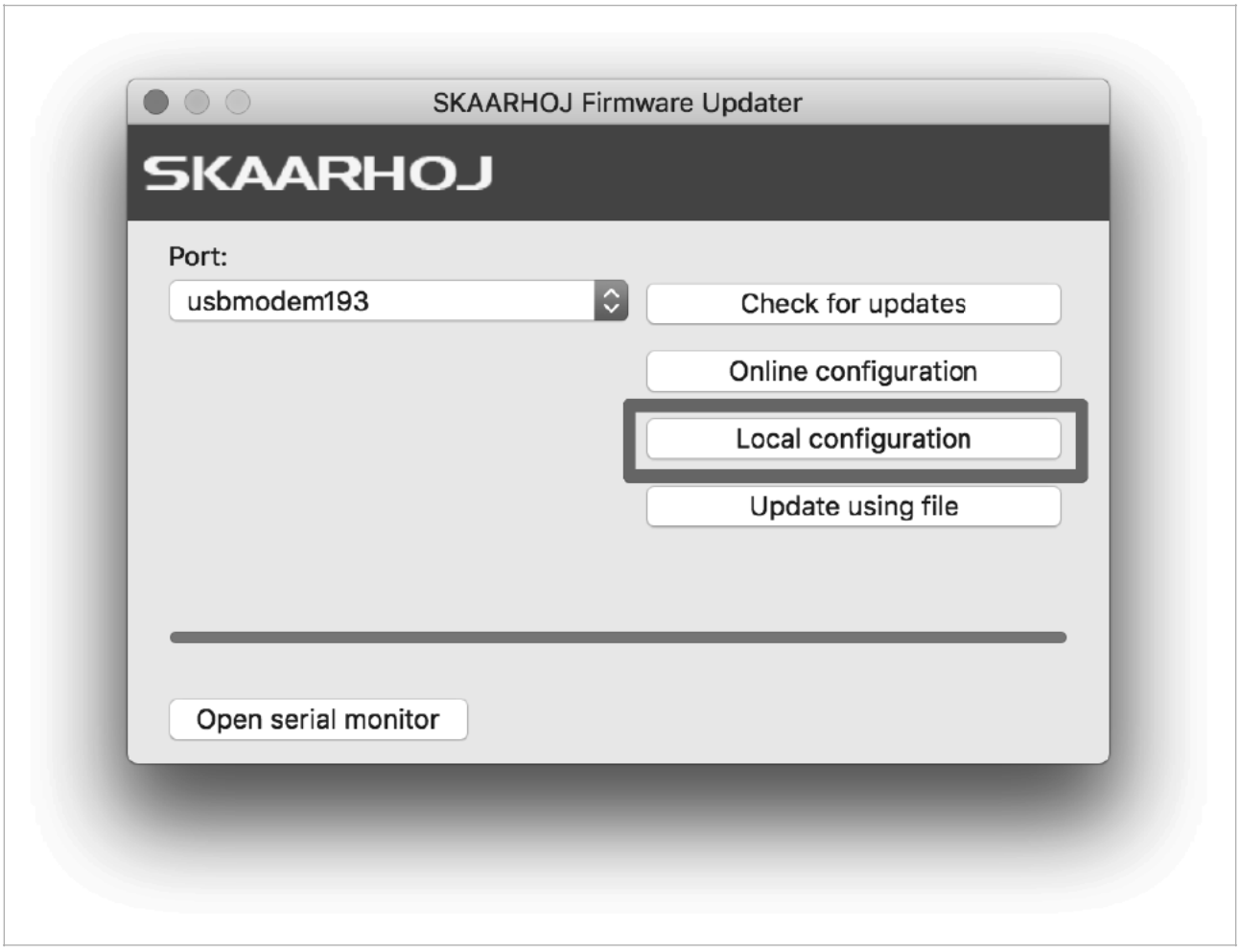
- **Step 1** - Connect the SKAARHOJ controller to PC/Mac with ethernet cable and power up the unit. Let it boot up.
- **Step 2** - Press and hold the config button until the status LED becomes blue. Release the button.
- **Step 3** - Access web interface by entering http://[CONTROLLER IP]/" where CONTROLLER IP is the IP address used for the currently loaded preset in your browser.

Access to web interface if SKAARHOJ controller is connected via network router

We always recommend a direct ethernet connection with manual IP in order to gain access to the web interface. But depending on your network router settings you might be able to connect to the web interface without setting a manual IP address on your PC/Mac.

Access via the Firmware Application

The firmware application is always a great help to work with your controller. Connect it by USB and press the button "Local Configuration". After the controller reboots, the firmware application will read its IP address for you and open a web browser to that address. Assuming your computer and the controller are on the same network, this will work great!



DHCP

If you set the IP address to "0.0.0.0" instead of the default "192.168.10.99" then the controller will ask for a DHCP address. If it can't retrieve a DHCP lease, it will fall back to 192.168.10.99.

Web Interface Troubleshooting

If you are having problems connecting to the web interface there are numerous things that can trick you:

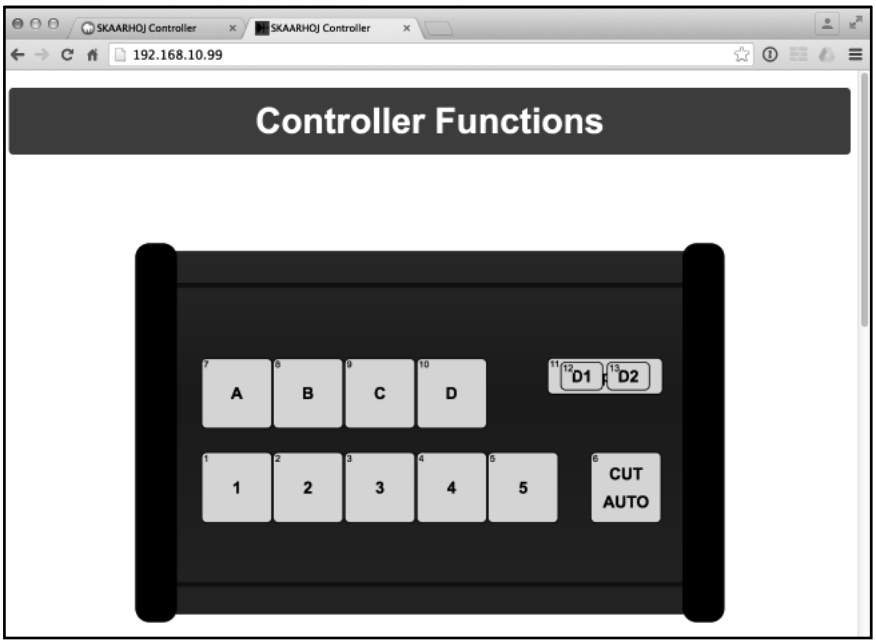
- Reboot your SKAARHOJ controller completely (disconnect for 10 seconds, re-power)
- Reboot your network switch. Sometimes it may hold old information about the controller IP and MAC addresses and to clear this out, reboot it (disconnect for 10 seconds, re-power)
- Check connection to the assumed SKAARHOJ controller IP from your computer with the "ping" command. You computer IP settings must be correct too.

UniSketch OS Explained

Web Interface

When your controller is in **configuration mode**, you will be able to access it's **web interface** with a web browser. We recommend using the Chrome browser because it's faster, but we have successfully tested it with other modern browsers such as Firefox, Safari and Internet Explorer in the latests version.

Notice that the web interface heavily depends on modern JavaScript and may malfunction with older browsers!



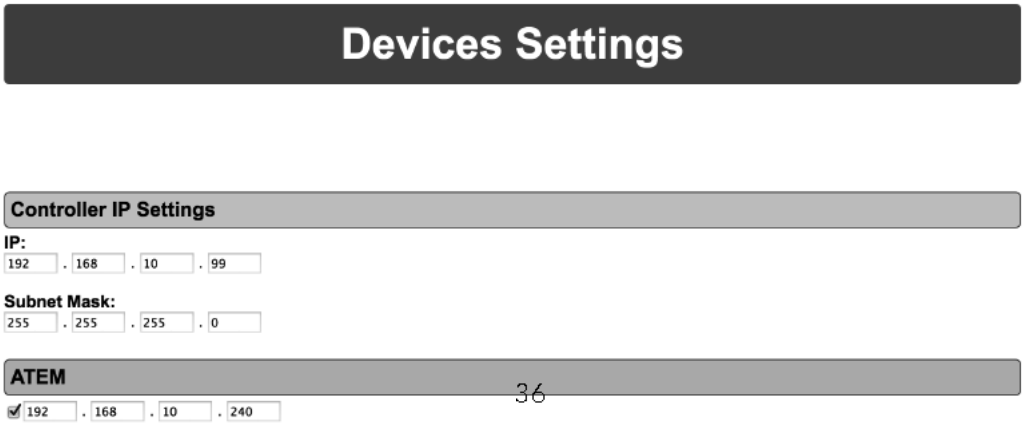
Example of web interface for SKAARHOJ controller.

Device Settings

You set up the IP address, Subnet mask, Gateway and DNS of your SKAARHOJ controller in the web interface. Likewise any external IP device your controller is configured to work with is listed here. Any device you want to be active must be enabled here and have a valid IP address set up.

Notice that all these IP settings will be saved with each preset in the controller. This is quite awesome because different presets allows you different IP configurations so a controller can easily move between different hardware contexts.

The number and type of external devices listed is compiled into your controller when it is delivered. The list may vary from controller to controller and can potentially be expanded or change to include other hardware by time. The "default" configuration for your controller is determined by the settings for it made on cores.skaarhoj.com.



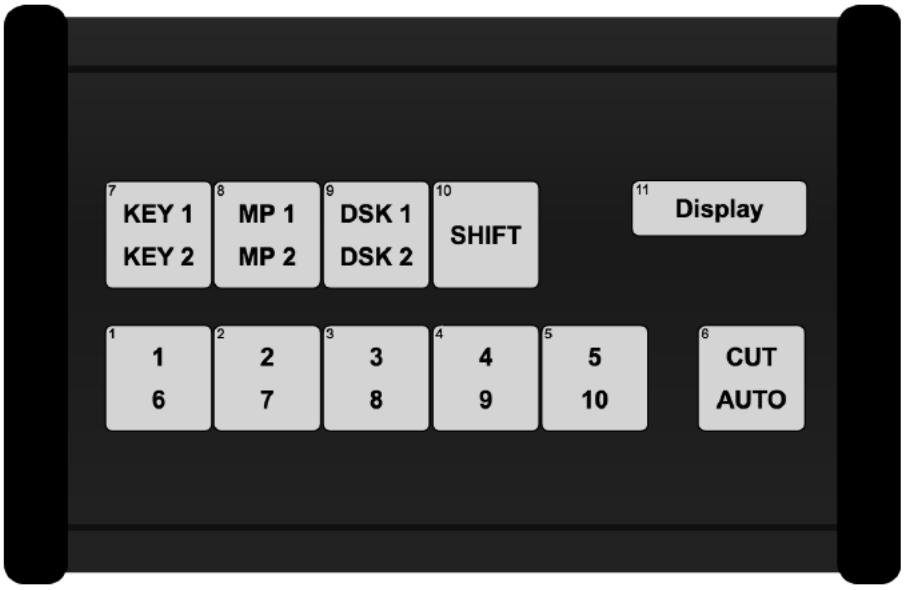
Hardware Interface Components (HWC)

Your SKAARHOJ controller consists of a number of hardware interface components such as buttons, knobs, dials, levers, displays, LEDs, joysticks, plugs, etc. They generally fall into broad categories such as inputs (eg. buttons and knobs, GPI) or outputs (eg. displays, LEDs, relay). Sometimes they can be both (most buttons have an illumination color, some even have a display on them). Input elements can be sub categorized as:

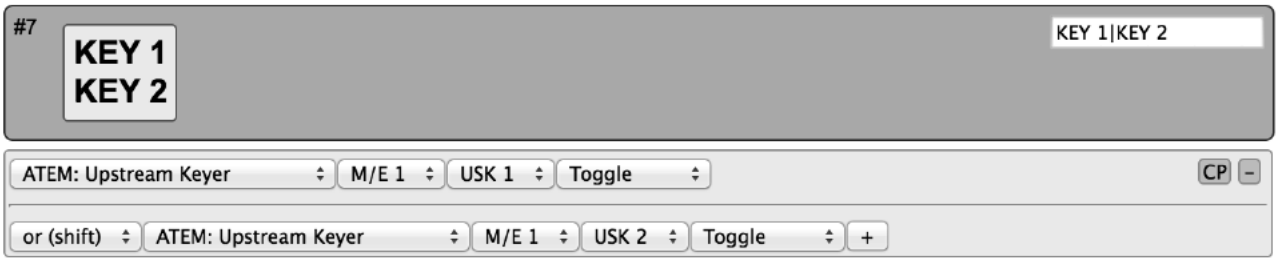
- "binary" such as a button or GPI trigger which is either pushed/triggered or not. Sometimes holding down a binary input has a special function.
- pulse-generators such as encoders which are knobs that can rotate indefinitely in both directions and sends a corresponding number of pulses. Encoders typically has a fine/coarse adjustment mode which is toggled by pressing it. Pressing and holding an encoder down for 1 second will typically send a binary "button down" signal to the interface component. Often this can function as a "reset" feature.
- analog signals such as T-bars or joysticks which provides a free value within some range.

Outputs range from a simple binary output like a relay to red/green LEDs, an array of LEDs (like a VU meter) or a graphical or text based display.

Hardware Interface Components are configured with actions which is what give them their function. This is described in the next sections.



An example of the schematic drawing of a controller as found in the controllers web interface which is available when booted in configuration mode.



This is how the button "KEY1 / KEY2" is configured in the web interface. As it appears, this button will toggle upstream keyer 1 or 2 on an ATEM switcher depending on whether the controller is in shift-state or not.

Graphical Displays

Displays are found in many configurations on SKAARHOJ controllers. One of them is Smart Switches which are buttons with a display on. Otherwise displays are typically stand alone but can be configured to reflect a certain button on the controller (through the "Tie to HWC#" system action). An important convention with

displays is whether it works as a label or displays a current status. Take the picture below as an example. Here there are two SmartSwitch buttons apparently showing the same thing:

- **A label:** The button to the left is configured to set the frame rate of Mix transitions to a fixed "24f". This can be seen from the fact that the button has a non-solid header bar. This is a *label* that simply tells us what will happen if you push the button: You will set a 24 frame mix transition rate.
- **A status:** The button to the right is configured to also set the frame rate of transitions but is configured to act in "Cycle" mode so when you press the button you will cycle through transition types and values by some scheme. The important thing is that the button shows the current value for Mix transitions - 24 frames. And if we change the value to 30 frames, the button will show 30 frames. This is a *status* that informs you about the current value of this ATEM feature and this can be seen from the fact that the button has a *solid* header bar.

This convention works throughout all displays on your SKAARHOJ controller. Generally, a display will show the value status unless it has been tied to a button-type interface component in which case a label is typically shown - unless the particular button operates in some sort of cyclic mode where a status makes more sense to display.

Devices

You configure your controller by assigning actions to interface components. An action is most typically a command sent to an external device, such as a video switcher, router, recording deck, monitor etc. External hardware support is made available on your controller as what we call *device cores*. A device core is the driver - or akin to an "app" - installed on the your controller that enables communication support with a given piece of broadcast gear.

Some actions may also relate to internal registers or "system functions". For instance you can have a button set or clear a "shift" value which the rest of the interface components will adapt itself to.

Since interface components can be inputs and/or outputs and of various types, the way they affect any given device via an action is a fixed interpretation coded into the system.

An excerpt of the list of ATEM switcher related actions.

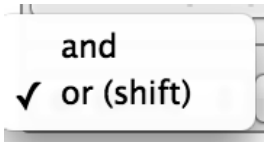
Multiple Actions

You can assign multiple actions - even on different devices - to any interface component. This is done by simply pressing the "+" button and setting up the new action:

In this case, the media player 1 (MP1) is brought on Preview on an ATEM switcher and right after the still number 5 is selected for the media player 1.

The return values, including those driving a display, will always come from the first action in the list (of the current shift level).

Notice that multiple actions are separated by an "operator" which is either "and" or "or (shift)":



This is explained in the following.

Shift

You can assign a button to set a shift state on your controller. Even though a shift state sounds like an either/or option, we have implemented the possibility to have multiple *shift-levels*. However, in the simple case, a shift button would be configured as shown below:

This will set the shift-level "1" in the system as long as the button is held down, otherwise it will be "0" (normal)

This means another button on the same controller could be configured like this now:

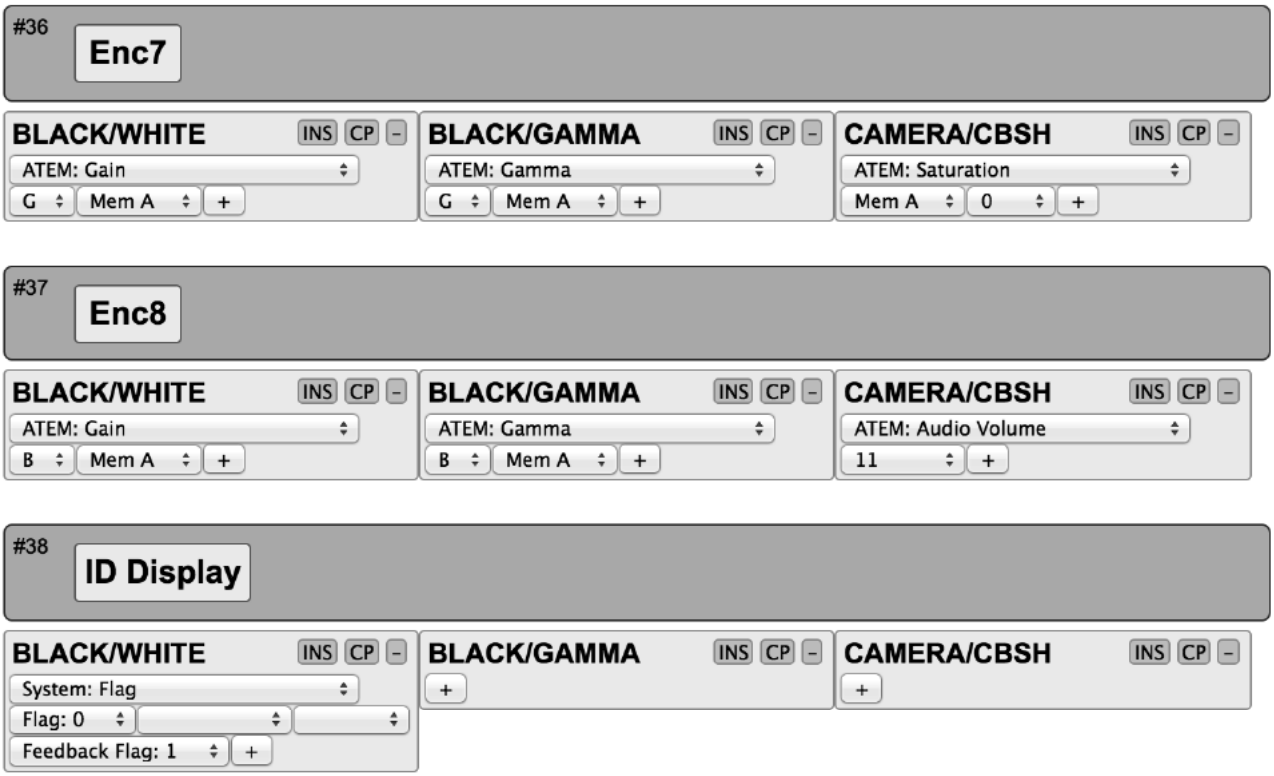
And because the divider between them is "or (shift)", the second action is only active when the shift button is held down.

If no specific action is defined for a shift level, the interface component will use the default list of actions.

If you insert additional "or (shift)" dividers, it will define how shift levels 2 and beyond will act. Within each shift level you can have multiple actions (see previous section).

States

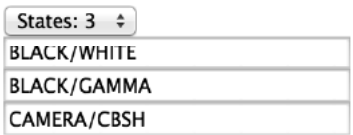
Similar to shift levels you can put your controller in various states. States are mainly different from shift levels by the way the interface lets you set them up. With three states you see three columns of actions for each interface component:



Like with shift levels you can assign other interface components to change the state of the controller. If actions are not defined in any given state, they will fall back to the action list in the first column (Normal state).

States and shift levels can be combined of course; you can have unique shift levels inside each state.

States can also be named. In the above example, they are named "BLACK/WHITE", "BLACK/GAMMA", "CAMERA/CBSH". This is done in the controller web interface as well:



This is where you select how many states the controller should support.

Copy / Paste

Often you will find yourself needing to set up almost the same function on multiple interface components (such as a row of buttons, all sending inputs to an AUX channel). To make this easy, make sure to use the Insert / Copy / Delete functions:

As soon as you make any change to a given interface components action list, this will be copied to memory so you just need to go to the next interface component and press "INS" for insert.

Presets

At the bottom of the web interface you can load, save and reset your presets. Your controller can theoretically hold any number of presets only subject to the memory usage related to storing them. Pressing the save button in the web interface will save the configuration to the currently selected preset, but you can also select a new or different preset to save to using the selector box.

Load the "(Default)" preset to get back to the factory configuration.

If your presets seems to be messed up for some reason (could be memory overflow which there is currently no protection against) you may need to clear the entire memory by using the serial monitor command "clearpresets" (see later).

Presets are a very powerful way to make use of your controller in multiple places since it can change the entire behavior of the controller including which devices to connect to and which IPs they are on.

There is a nifty way to load presets on most controllers if you have created more than 1 preset: When you boot your controller, you may see that a number of buttons (corresponding to the number of available presets) light up for a few seconds and one of them being highlighted. The highlighted button indicate the currently loaded preset and the other buttons represent other presets. If at this moment you press and hold any of the other buttons down until that button light up, you will then change the preset of the device (corresponding to selecting it in the web interface and press the "Load" button).

Presets are a great way to manage multiple configurations in off-line situations. However, using cores.skaarhoj.com and the firmware application to manage multiple configurations for your controller is more powerful in the sense that you can include changes to installed device cores, string and image media and also have the latest software updates installed.

Notice: Presets will be automatically cleared if a firmware update indicates that the online configuration has changed. In other words: Always be cautious with firmware upgrades and make sure you "print out" important local configuration so you can recreate it if necessary.

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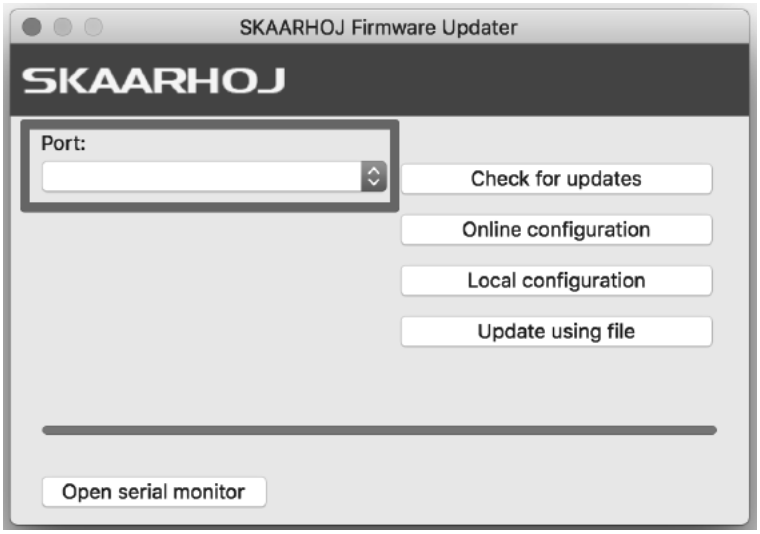
Troubleshooting

Controller doesn't show up under "Port"

If your controller doesn't show up under ports, try these things first:



- Make sure you have attached your controller with a micro USB cable to your computer and installed propper drivers (see www.skaarhoj.com/support/firmware-updater/)
- Is the controller turned on?
- Reboot you computer
- Change the USB cable for another one
- Boot the controller in config mode: Disconnect the controllers power, then hold the config button under the power plug down with a pen tip, power on the controller and hold the button until it lights blue, then release.

If none of the above brings up the USB port, you may try this procedure **but only after clearing it with the SKAARHOJ support team**!:

- Locate the small hole just below the config button
- Power on the controller and press this tiny button for a second and release. You may repeat this. (Pressing this button while the controller is on should reset it completely).
- Turn off the controller, then turn it on again. Now you should see the USB port in the firmware application and be able to perform a "Check for updates" (which at first will ask to install an intermediate firmware which you agree to).

Old method if no hole below config button are present:

- Open the controller carefully and locate the SKAARDUINO main board (the one with the ethernet plug)
- Locate the flatcable connector in the corner of this board. Next to this connector you will see a tiny button.
- Power on the controller and press this tiny button for a second and release. You may repeat this. (Pressing this button while the controller is on should reset it completely).
- Turn off the controller, then turn it on again. Now you should see the USB port in the firmware application and be able to perform a "Check for updates" (which at first will ask to install an intermediate firmware which you agree to).

Contact Support

You are always welcome to contact us for support questions - write an email to support@skaarhoj.com and we will do our best to accommodate your request.

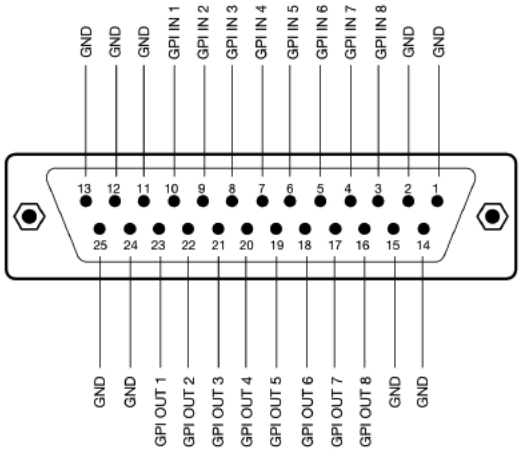
In order for us to provide the best support please state:

- Which SKAARHOJ unit it is about
- The serial number of your device (small silver label with 6 digits)
- The nature of the problem
- Which hardware device(s) you are controlling and their firmware version
- If you have successfully installed the Firmware Updater Application and made contact with your device though the Serial Monitor (you need the USB programming cable)
- Your operating system

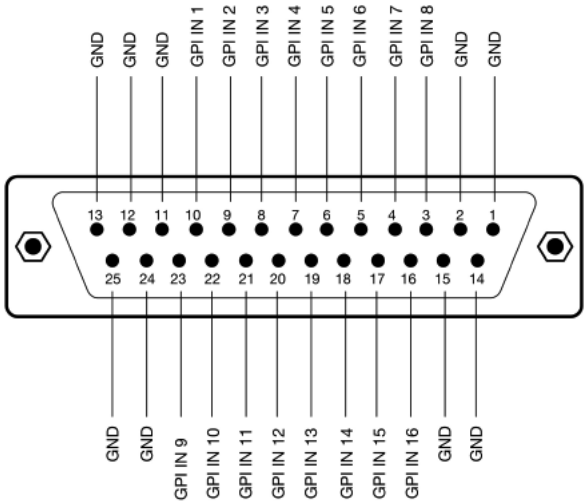
Hardware Notes:

DB-25 Connector Configuration for GPI

This is the pinout for the DB25 Connector we use as a GPI module:



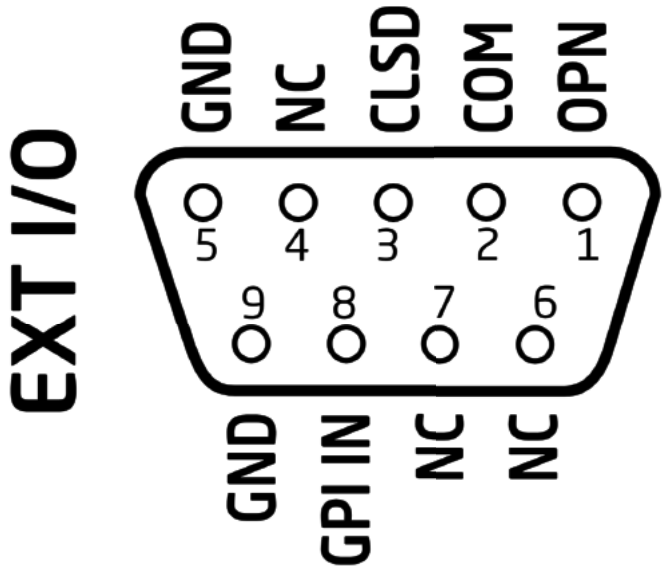
This is the pinout for the DB25 Connector we use on the SDI-GPI Link:



DB-9 Connector Configuration for RCP units (EXT I/O)

This is the pinout for the DB9 we use on our RCP units. Often a default RCP configuration will be configured so:

- When the joystick top button or the "Prev" button is pressed, a relay is shorting pin 1 and 2
- If pin 8 is shorted to GND (pin 5 or 9) the display backlight will change from white to red



Pinout for Tally Box

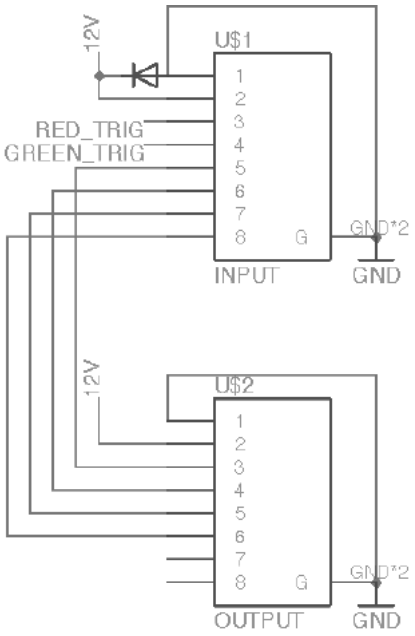
The pinout of the RJ-45 connector is as follows:

1. GND
2. 12V
3. 5V control signal for red tally 1
4. 5V control signal for green tally 1

The next four are for daisy-chaining tally lamps:

5. 5V control signal for red tally 2
6. 5V control signal for green tally 2
7. 5V control signal for red tally 3
8. 5V control signal for green tally 3

Our tally lamps need 12V power in order to light up the LEDs. The control signals are 5V so whenever you apply 5V on one of the pins the corresponding LEDs will illuminate.



1=O/ (GND)
2=O (12V)
3=G/ (Red, Lamp 1)
4=BL (Green, Lamp 1)
5=BL/ (Red, Lamp 2)
6=G (Green, Lamp 2)
7=BR/ (Red, Lamp 3)
8=BR (Green, Lamp 3)

Various Examples:

Triggering Actions from Binary Inputs

Some of our products such as the ETH-GPI Link have an option to interpret binary inputs. This is used in cases where one would like to have routing control or the like from a device such as the Panasonic AW-RP50 or the AW-RP120 PTZ controller.

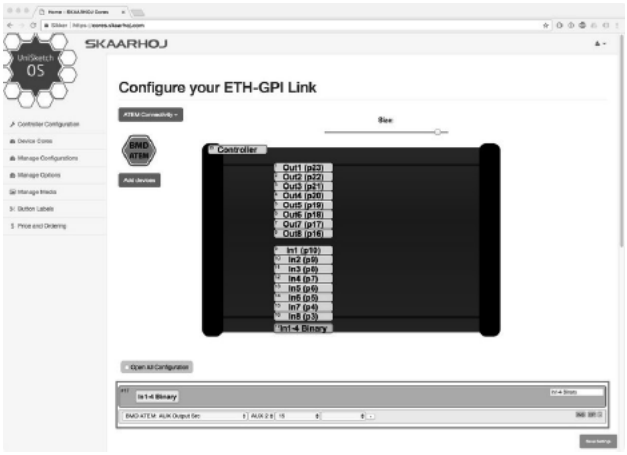
<Output states of GPI OUT1 to GPI OUT4 when the camera number registered to CAM OUT is selected>

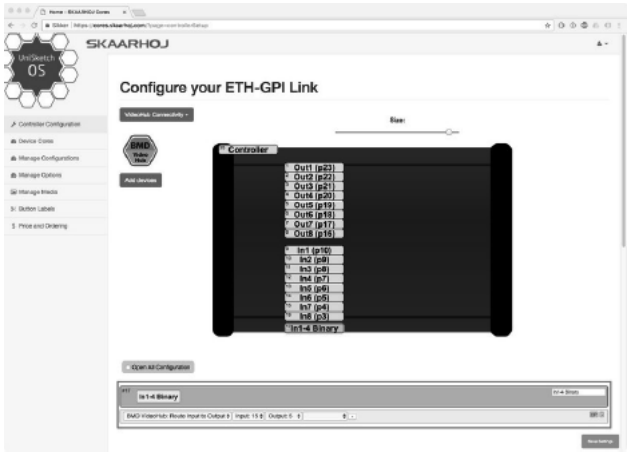
	Output of GPI OUT1 to GPI OUT4			
	GPI OUT1	GPI OUT2	GPI OUT3	GPI OUT4
CAM OUT1	On	Off	Off	Off
CAM OUT2	Off	On	Off	Off
CAM OUT3	On	On	Off	Off
CAM OUT4	Off	Off	On	Off
CAM OUT5	On	Off	On	Off
CAM OUT6	Off	On	On	Off
CAM OUT7	On	On	On	Off
CAM OUT8	Off	Off	Off	On
CAM OUT9	On	Off	Off	On
CAM OUT10	Off	On	Off	On

Example of Tally output from the manual of the Panasonic AW-RP120

Fixed Routing

The two below examples shows how a configuration should be made to trigger ATEM AUX routing our Blackmagic Design VideoHub routing. In these cases the routing is fixed so CAM1 from the AW-RPx will *always* correspond to CAM1 in the ATEM and Input1 in the VideoHub.

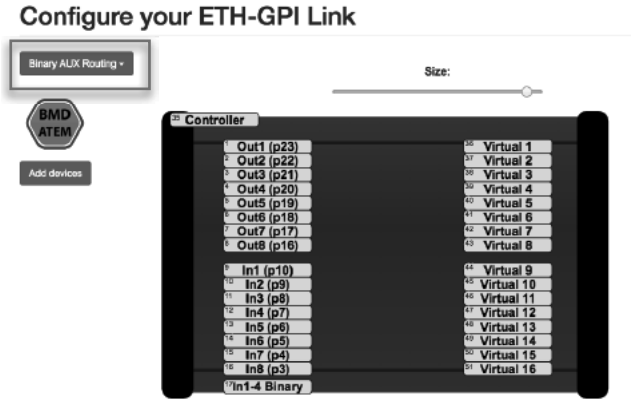




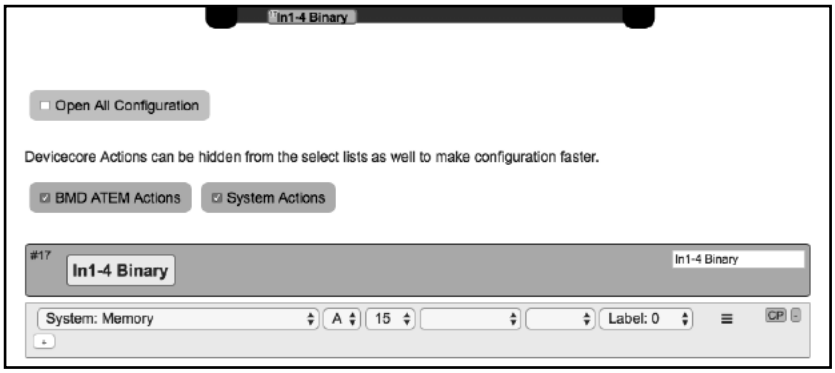
Flexible Routing

In some cases it is not desired to have the fixed coloration between CAM1 on the AW-RPx and CAM1/Input1 on the ATEM/VideoHub. The guide below explains how you achieve your desired routing.

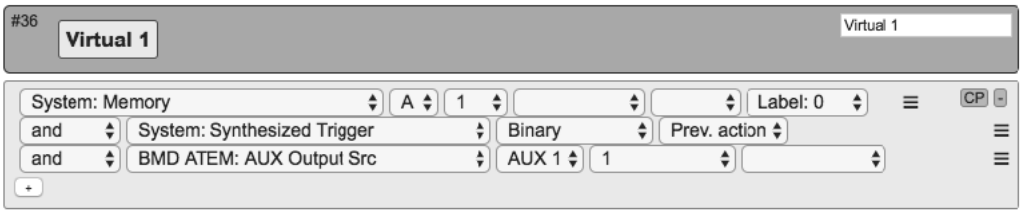
Use the default configuration “Binary AUX Routing”



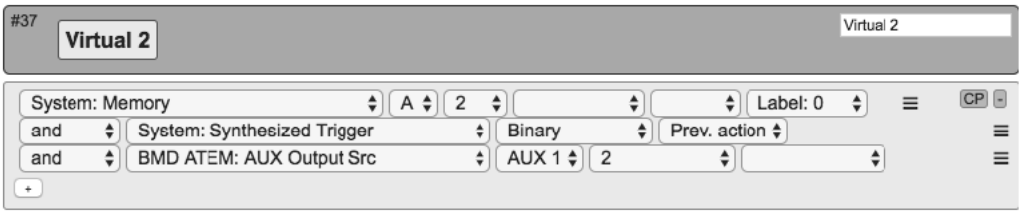
The "In1-4 Binary" is set to "System: Memory A". This will generate a memory parameter, A, in UniSketch which we will use to do our routing. If CAM1 is selected on the AW-RPx the memory parameter will be A=1, if CAM2 is selected it is A=2 and so forth.



Now we will utilise the Virtual Hardware Components called "Virtual 1" and use the command "System: Synthesized Trigger" to trigger a action. In this case we set it to source 1 for AUX 1 on the ATEM. But you could as well do it for a different source or a entirely different action such as routing on a Blackmagic VideoHub or a AJA Kumo Router.

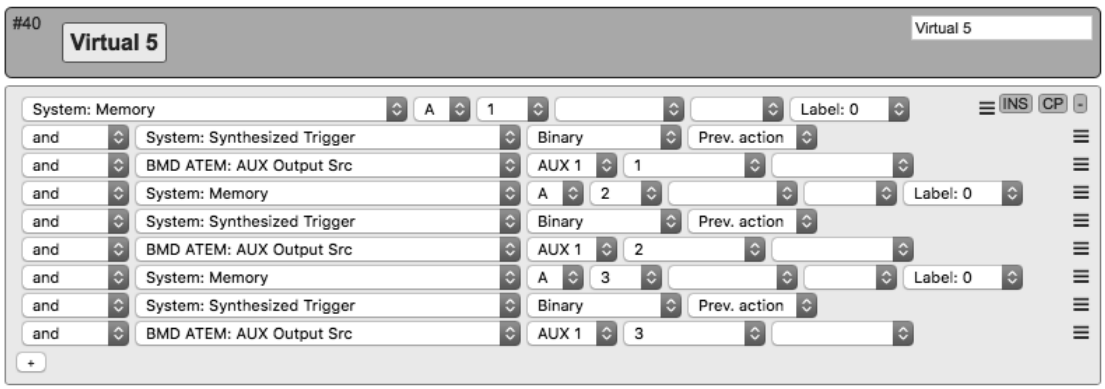


The same procedure is followed for "Virtual 2. Again you can leave the routing as it is, or you can alter the AUX routing or select a entirely different action.



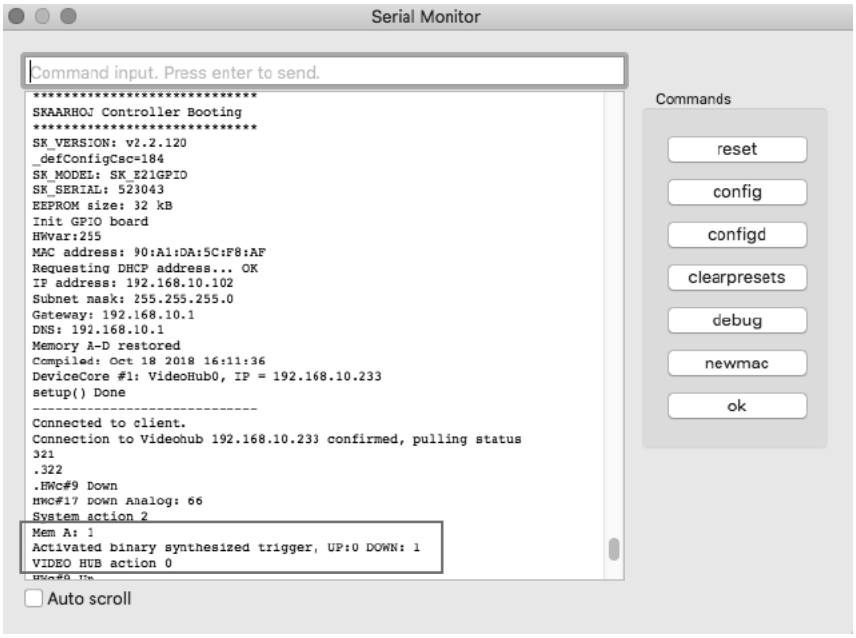
And then you continue to configure the routing you would like.

You do not need to configure different Virtual Hardware Components - more commands can be assigned to just one like illustrated below. However for the sake of overview and to avoid making mistakes using individual Virtual Hardware Components can be recommended.



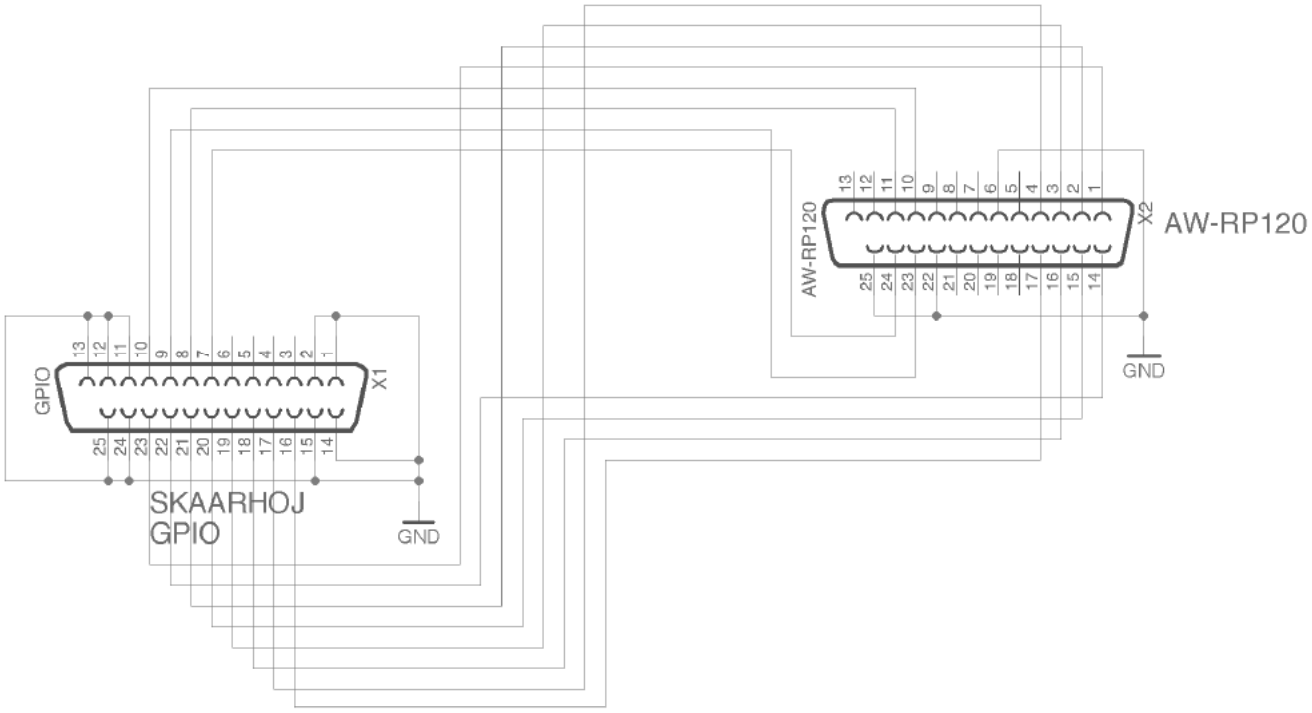
Example

Here is a readout from the Serial Monitor for a ETH-GPI Link connecting to a VideoHub and GPI1 being triggered. Notice that memory A is set to 1 which entails a binary trigger and finally the VideoHub action.



Cable and AW-RPx setup

Make sure the cable between the AW-RPx and the ETH-GPI Link is correct. Pin 10, 11, 23, 24 + GND on the AW-RP120 should be connected to pin 10, 9, 8, 7 + GND on the ETH-GPI Link.



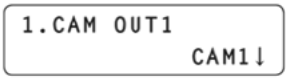
In the menu of the AW-RPx there should be a GPI Out menu. Go into this and make sure everything looks correct.

Registering camera numbers to CAM OUT1 to CAM OUT10

1. **Press the MENU button.**

2. **Open GPI OUT menu [45].**

3. **Turn the F1 dial to display the "1. CAM OUT1" item.**



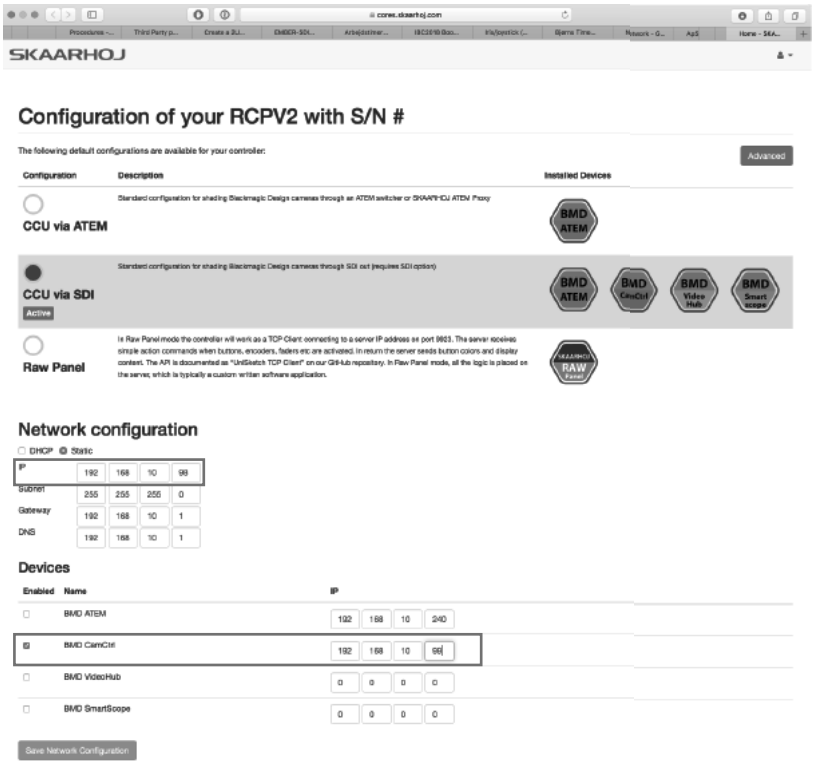
4. **Turn the F2 dial to select the camera number to set for CAM OUT1, and then press the F2 dial to confirm the selection.**

   Camera number : Select from CAM1 to CAM100.

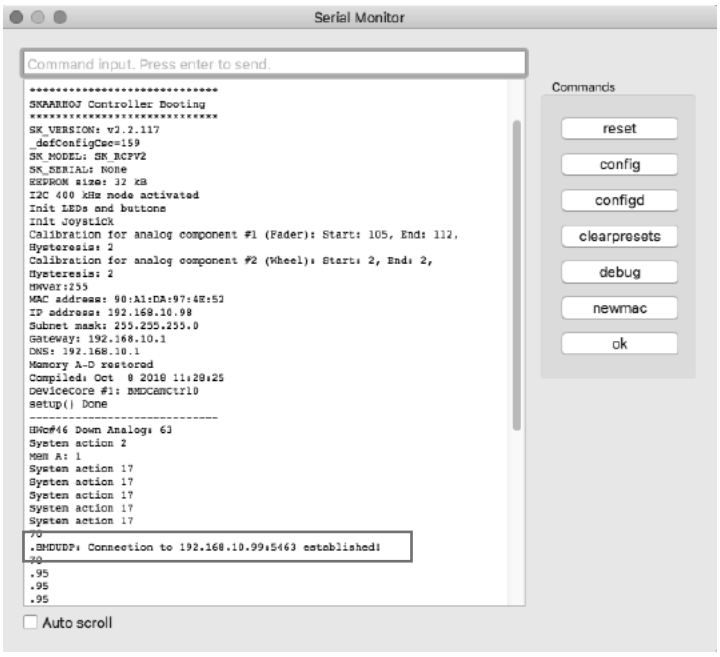
5. **Turn the F1 dial to display any of the "2. CAM OUT2" to "10. CAM OUT10" items and then register a camera number.**
   - Repeat steps 3 to 4.

Connection between RCP and ETH-SDI Link using ETH2SDI Firmware

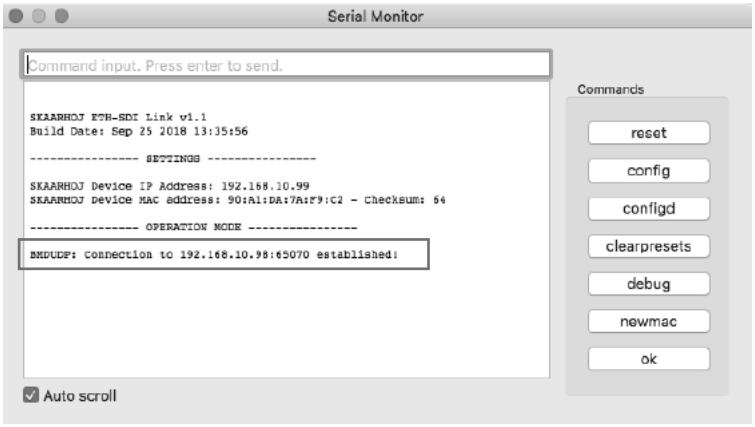
A SKAARHOJ controller such as a RCP should be configured with the "BMD CamCtrl" Device Core. In order for the device to send commands to a ETH-SDI Link the BMD CamCtrl Device Core IP should be changed from the default 0.0.0.0 to the IP address set on the ETH-SDI Link. Remember the IP address on the ETH-SDI Link and the RCP or other main controller should differ.



On the main controller sending commands to the ETH-SDI Link, connection can be confirmed from the serial monitor with the message *".BMDUDP: Connection to 192.168.10.99:5463 established!"* if the IP on the ETH-SDI Link have been set to 192.168.10.99



Connection can also be confirmed from the serial monitor on the "ETH-SDI Link" with the message



"BMDUDP: Connection to 192.168.10.98:65070 established!" if the IP on the RCP or main unit have been set to 192.168.10.98.

The ETH-SDI Link listens on port 5463 UDP. The RCP (or any UniSketch OS based controller) listens on return data on a random port between 50100 - 65300.

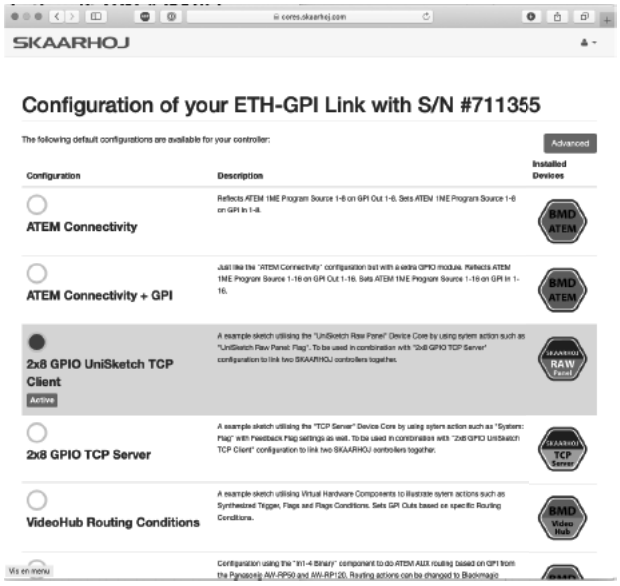
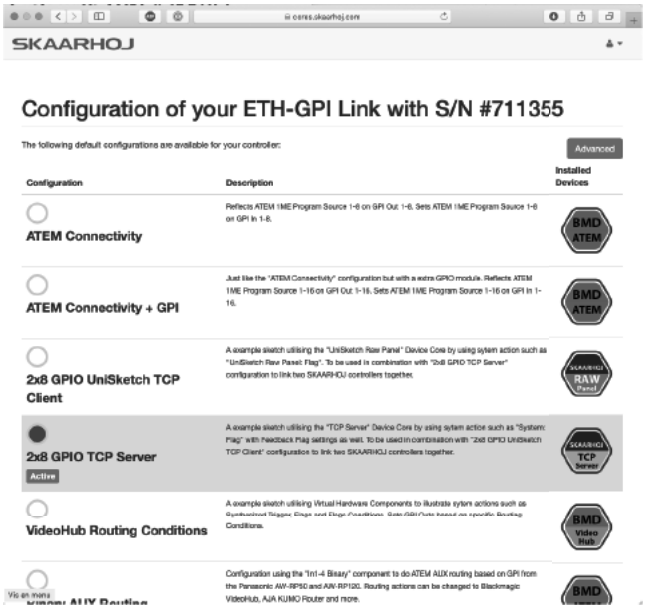
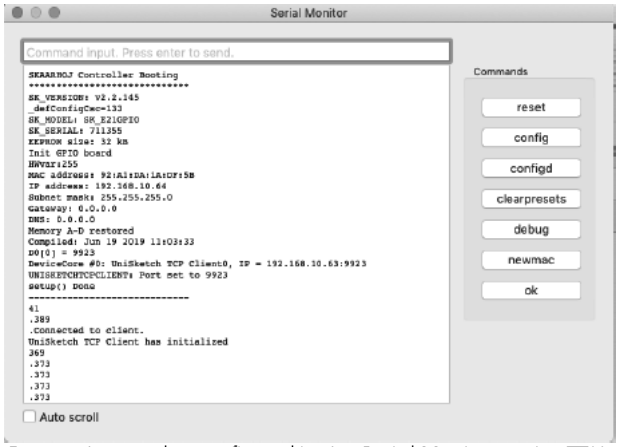
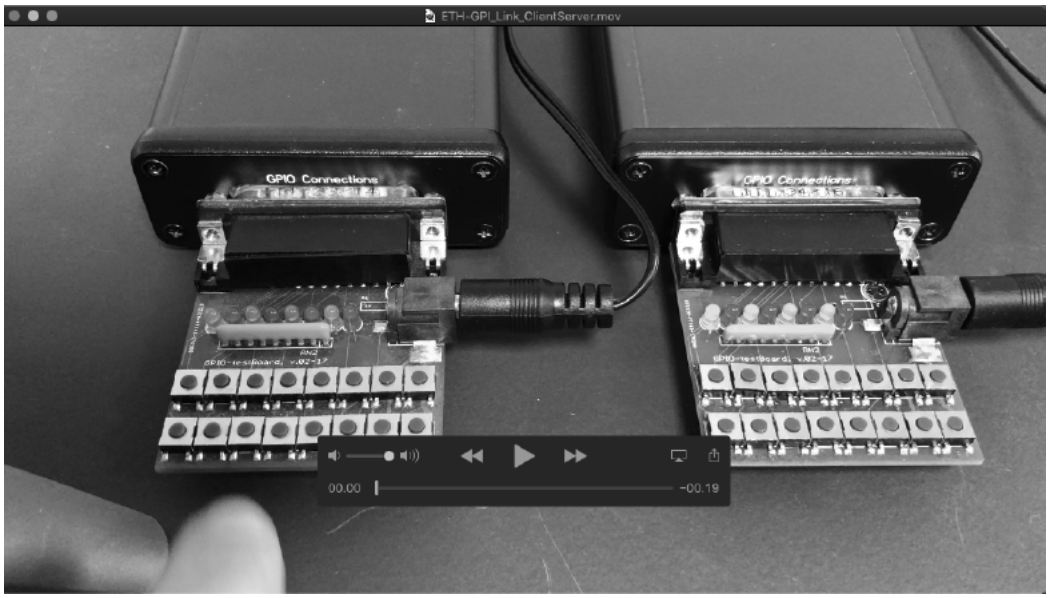
Connection between RCP and WIFI-B4 Link

The procedure have similarities with the above instruction. A SKAARHOJ controller such as a RCP should be configured with the "BMD CamCtrl" Device Core. In order for the device to send commands to a WIFI-B4 Link the BMD CamCtrl Device Core IP should be changed from the default 0.0.0.0 to the IP address set on the WIFI-B4 Link. Remember the IP address on the WIFI-B4 Link and the RCP or other main controller should differ.

Linking two ETH-GPI Links Together

This will explain the details from the first part of the video "Sending GPI over Ethernet - and much more!". Basically this setup will allow two ETH-GPI Links to be connected together for transporting GPIO over Ethernet. The configuration utilities the Device Cores:

- **UniSketch Raw Panel** - will works as a client
- **TCP Server** - will work as a server

ETH-GPI Link #1 (Client)	ETH-GPI Link #2 (Server)
• Press Online Configuration • Select "**2x8 GPIO UniSketch TCP Client**" • Press "Check for Updates" in Firmware Updater	• Press Online Configuration • Select "**2x8 GPIO TCP Server**" • Press "Check for Updates" in Firmware Updater
	
 Notice that the IP for the Device Core "UniSketch Raw Panel" matches the IP address of ETH-GPI Link #2	
 Connection can be confirmed in the Serial Monitor to the ETH-GPI Link #2 via the message ".Connected to client. UniSketch TCP Client has initialized"	

See a demonstration of the setup in action here: https://github.com/kasperskaarhoj/SKAARHOJ-Open-Engineering/raw/master/Manuals/Files/ETH-GPI_Link_ClientServer.mov