# Furuno Radar Interfacing

Connecting to Furuno sub display analogue radar video output and appropriate software configuration

## Summary

*A number of popular Furuno radar models provide a common analogue radar video interface, specifically designed for use with external equipment. This interface, known variously as the "sub display", "slave display" or "remote display" interface, provides analogue video, trigger, ACP and ARP signals and is fully compatible with Cambridge Pixel's HPx radar interface cards.*

*Successful interfacing to a Furuno radar requires the correct physical connections to be made and also a number of corresponding software settings. This application note describes the physical connection to the radar, the appropriate jumper settings on HPx cards and the appropriate software settings.*

## Introduction

Many popular older Furuno radars, such as the FAR2XX7 and FR8XX2, provide an analogue interface which external equipment may receive polar radar video and corresponding control signals from. Typically there may be one or two of these "sub display" interfaces, each providing video, trigger, azimuth and azimuth reset signals.

Depending on the model of Furuno radar, these sub display interfaces can generally be found on the processor or the display board, within the radar transceiver unit, normally as 8-pin headers directly from the PCB.

The video signal itself is inverted, lying between 0V (no signal) and -4V (full signal), with an input impedance of 75 Ohms.

The trigger, azimuth and azimuth reset pulses are all single-ended signals, with a nominal amplitude of 12V into a high impedance load. The radars typically provide relatively few azimuth pulses per scan, either 360 or 450.

The sub display interface for a given Furuno radar will often be mentioned in the installation manual for that radar, rather than the user manual. In particular, the "interconnection diagrams" given at the rear of these manuals often show the connector location and pinout. The azimuth pulse will usually be referred to as a "bearing pulse" or simply "BP". Similarly the azimuth reset pulse will likely be called "heading pulse" or just "HD".

## Physical Interfacing

When connecting to the radar for the first time **it is important to look at the signals on an oscilloscope first**, to confirm that they are on the expected pins and have the anticipated amplitude.

An 8-pin sub display output will usually have the pinout given in the table below.

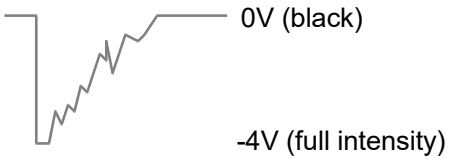
| Pin | Signal | Description |
|---|---|---|
| 1 | GND | Ground pin for "OP_HD" |
| 2 | OP_HD | Azimuth reset pulse (i.e. heading or ARP) |
| 3 | GND | Ground pin for "OP_BP" |
| 4 | OP_BP | Bearing pulse (i.e. ACP) |
| 5 | GND | Ground pin for "OP_TRIG" |
| 6 | OP_TRIG | Trigger pulse |
| 7 | GND | Ground pin for "OP_VIDEO" |
| 8 | OP_VIDEO | Analogue video |

The expected signals are described below.

### Video

Amplitude: 0V (black) to -4V (peak)

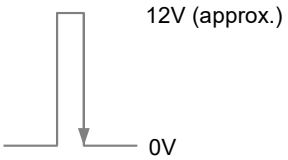
Input impedance: 75 Ohm




### Trigger

Amplitude: 12V (approximately)

Input impedance: >1 kOhm



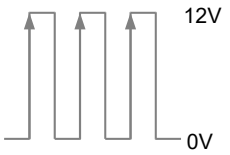

Notes: video zero range aligns with trailing edge of pulse. Pulse width ~10us.

## Bearing Pulse (BP)

Amplitude: 12V (approximately)

Input impedance: >1 kOhm

Notes: 360 or 450 pulses per scan.

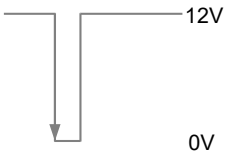



## Heading Pulse (HD)

Amplitude: 12V (approximately)

Input impedance: >1 kOhm

Notes: Negative-going pulse, i.e. active when low.  One pulse per radar scan.



## Cabling

Depending on the model of Furuno radar and potential fitted options, the sub display interface will usually be an 8-pin (male) header. The appropriate mating connector is a 2.5mm pitch, "NH" series female connector, as shown below.



(Note that the pin inserts are not shown in this picture and often have to be purchased separately.)

Single-ended signals should be carried on coax, with the core used to carry the signal and the shield used for the corresponding return.

The mapping of Furuno sub display signals to HPx inputs is given below; please refer to the relevant HPx user manual for the actual connector pinout.

| **Furuno Signal** | **Description** | **HPx Input** |
|---|---|---|
| GND | Ground pin for azimuth | ARPL |
| HD | Azimuth reset pulse (i.e. heading or ARP) | ARPH |
| GND | Ground pin for "OP_BP" | ACPL |
| BP | Bearing pulse (i.e. ACP) | ACPH |
| GND | Ground pin for "OP_TRIG" | TRGL |
| TRIG | Trigger pulse | TRGH |
| GND | Ground pin for "OP_VIDEO" | AGND |
| VIDEO | Analogue video | VIDA |

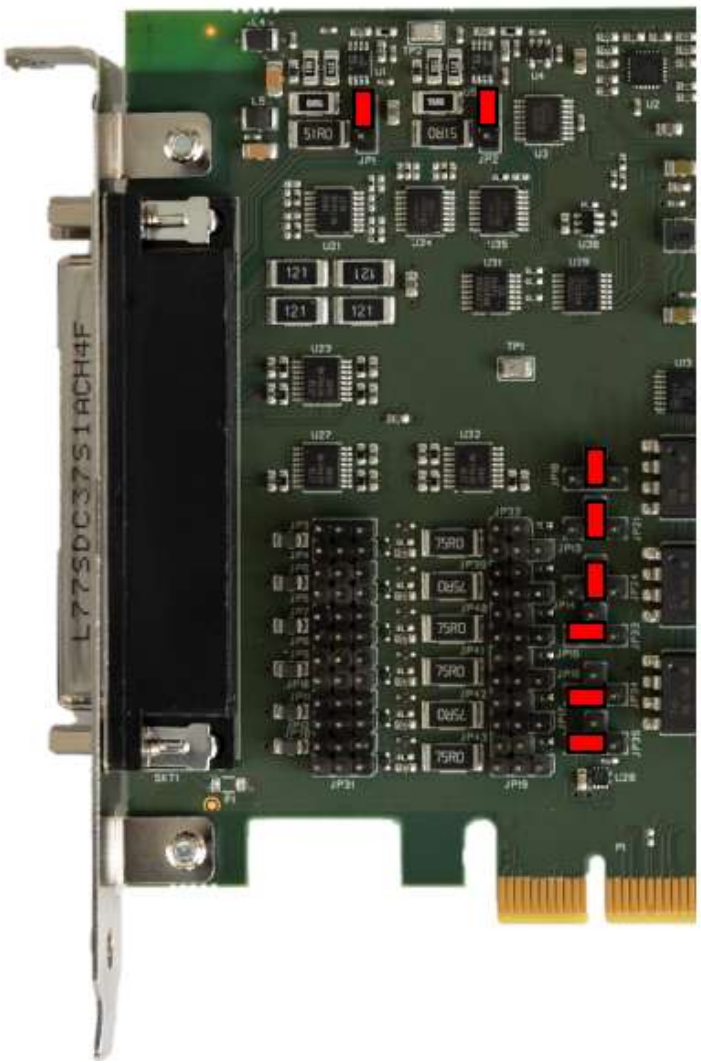
## HPx Jumper Settings

Assuming that the measured outputs from the radar match those described above, the HPx radar interface hardware should be configured for 75 Ohm impedance video and single-ended, "medium" voltage range, high impedance for the other three signals.

The following sections summarise the link settings for current HPx radar interface cards.

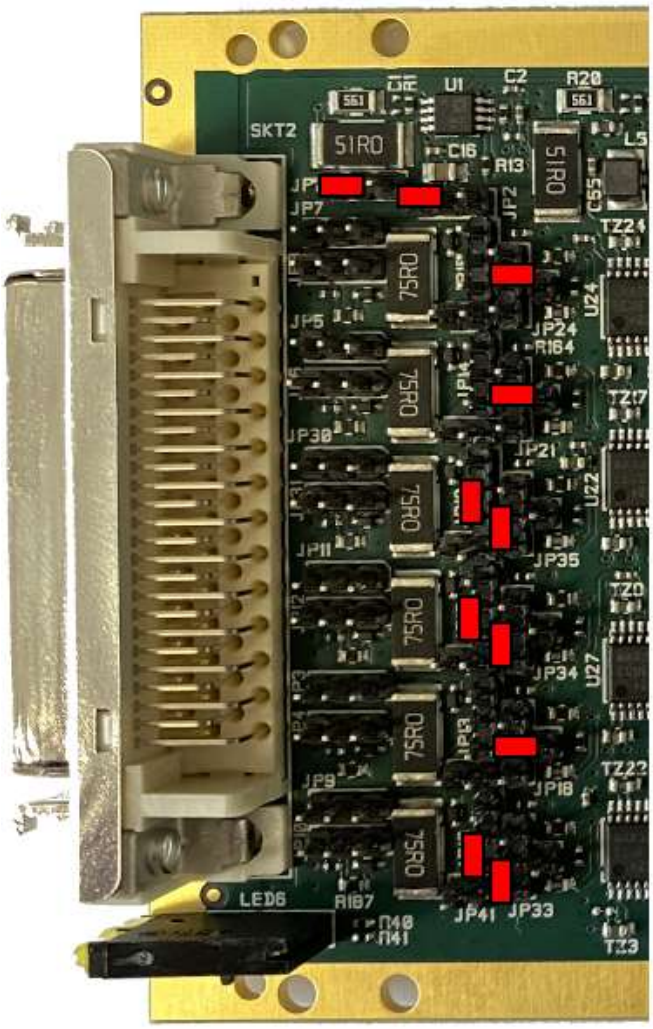
## HPx-410

| Signal | Link Configuration | Description |
|---|---|---|
| Video | Fit: 1 (top) | Analogue radar video input channel A set for 75 Ohm impedance input. |
| Trigger | Remove: 3, 4, 13<br>Fit: 18 (centre) | Single-ended, "medium" range input through opto-coupler. High impedance. |
| ACP (BP) | Remove: 5, 6, 14<br>Fit: 21 (centre) | Single-ended, "medium" range input through opto-coupler. High impedance. |
| ARP (HD) | Remove: 7, 8, 15<br>Fit: 24 (centre) | Single-ended, "medium" range input through opto-coupler. High impedance. |



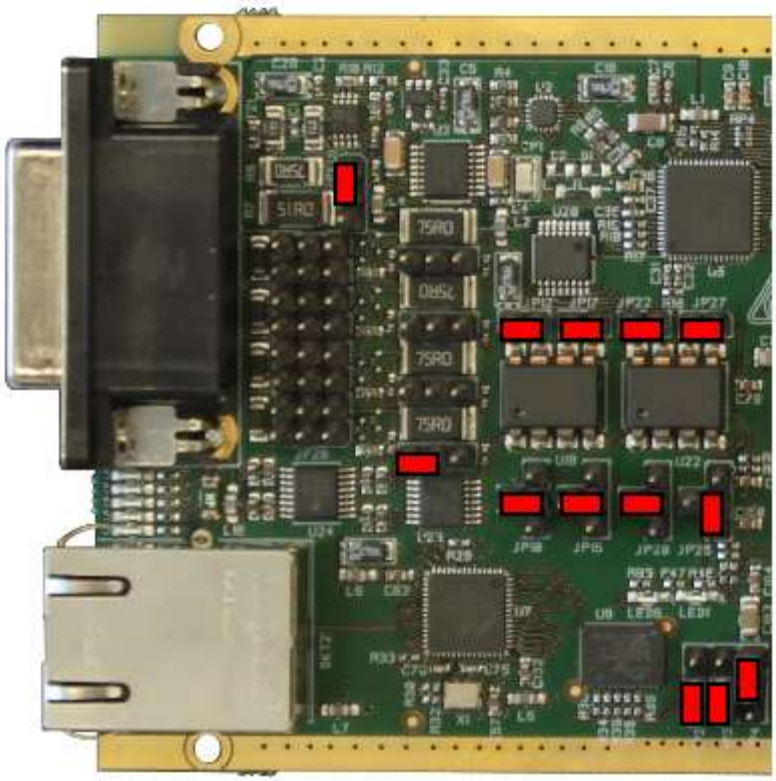
## HPx-450

| Signal | Link Configuration | Description |
|---|---|---|
| Video | Fit: 1 (left) | Analogue radar video input channel A set for 75 Ohm impedance input. |
| Trigger | Remove: 3, 4, 13<br>Fit: 24 (centre) | Single-ended, "medium" range input through opto-coupler. High impedance. |
| ACP (BP) | Remove: 5, 6, 14<br>Fit: 21 (centre) | Single-ended, "medium" range input through opto-coupler. High impedance. |
| ARP (HD) | Remove: 7, 8, 15<br>Fit: 18 (centre) | Single-ended, "medium" range input through opto-coupler. High impedance. |



## HPx-346

| Signal | Link Configuration | Description |
|---|---|---|
| Video | Fit: 1 (top) | Analogue radar video input channel A set for 75 Ohm impedance input. |
| Trigger | Remove: 8, 11<br>Fit: 12, 10 (centre) | Single-ended, "medium" range input through opto-coupler. High impedance. |
| ACP (BP) | Remove: 13, 16<br>Fit: 17, 15 (centre) | Single-ended, "medium" range input through opto-coupler. High impedance. |
| ARP (HD) | Remove: 18, 21<br>Fit: 22, 20 (centre) | Single-ended, "medium" range input through opto-coupler. High impedance. |



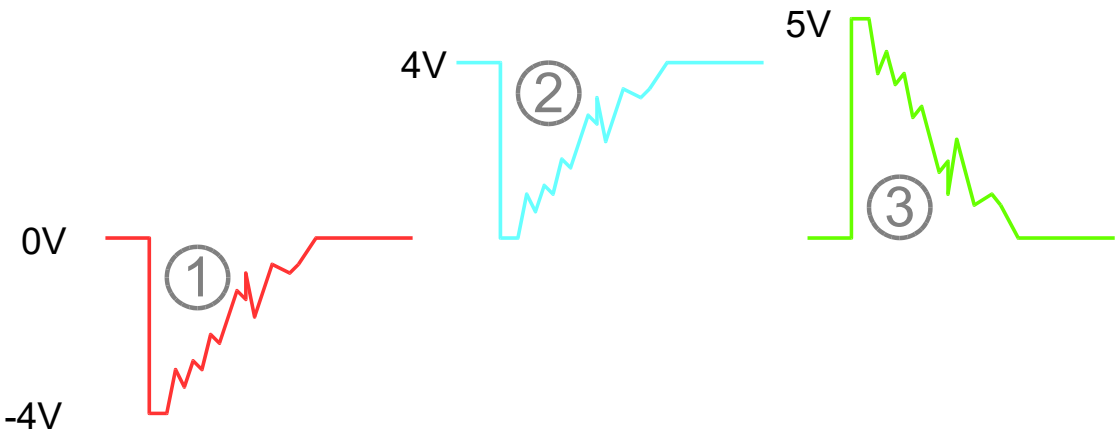
## Corresponding Software Settings

Setting the links on the HPx card correctly allows the signals to be received by the card. A number of accompanying software settings are also required, in order to get the video correctly processed by the card. In the case of the HPx-346 card these settings are made through the firmware (e.g. via the web interface). For PCIe or PMC/XMC cards the controlling software may be a ready-made Cambridge Pixel application, such as SPx Server, or a custom developed application that uses the SPxHPx100Source class.

Each of the trigger, ACP and ARP inputs on the card should be set to the single-ended (opto-coupler) option. Furthermore, the ARP input should have its "inverted" option set.

Since the radars only give relatively few bearing (ACP) pulses per scan (360 or 450) it is highly recommended to enable the azimuth interpolation feature on the HPx card. This feature will interpolate the azimuth between successive bearing pulses, thereby improving the azimuth resolution of the video.

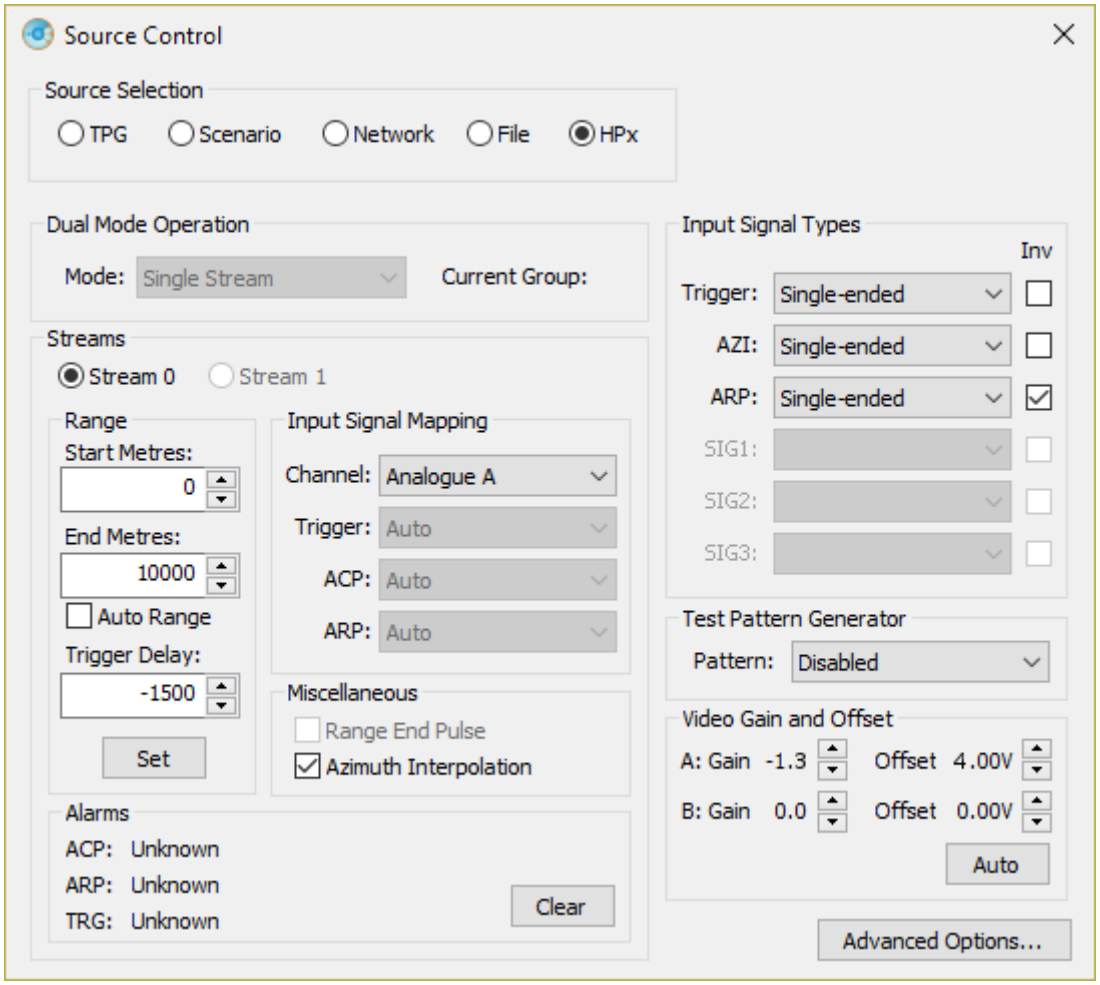
Since the radar video signal is negative, between 0V and -4V, it is necessary to invert it on the HPx card. This is simply a matter of setting appropriate offset and gain values, as depicted below.



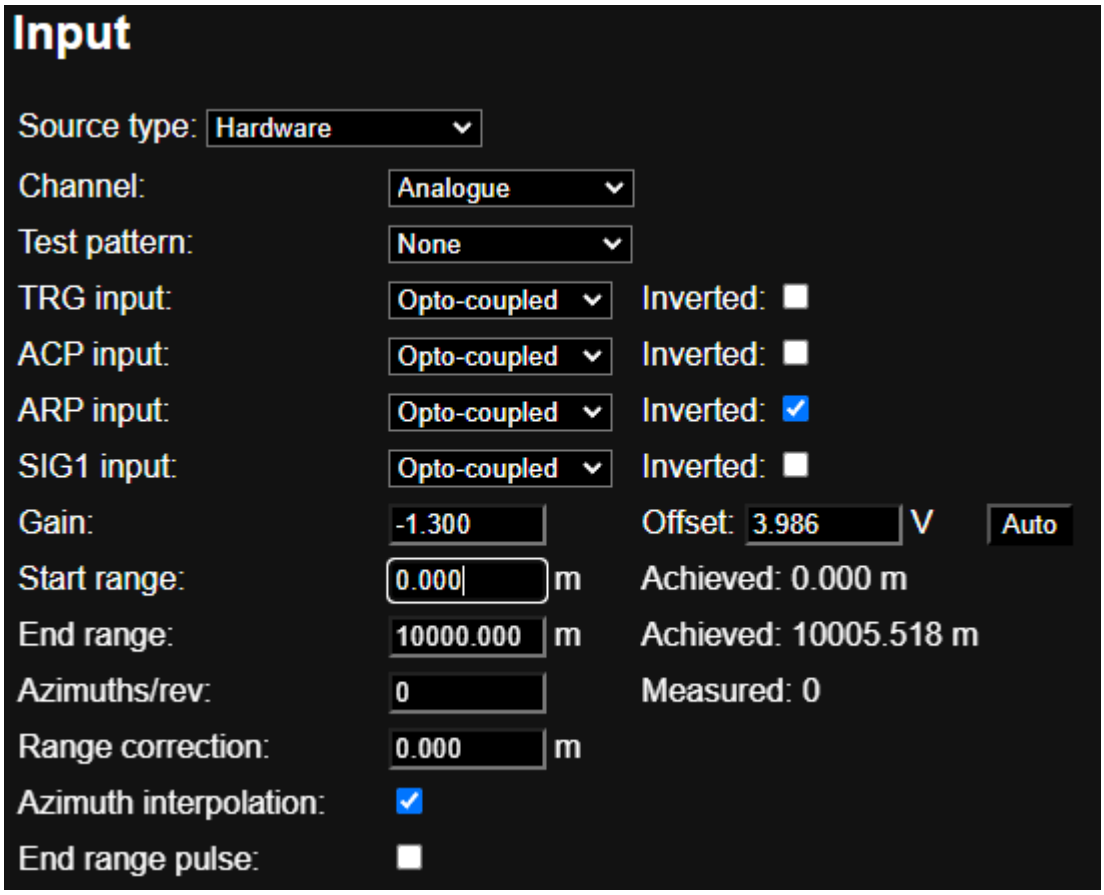

1. **The video signal coming from the radar ranges from 0V (no signal / black level) to -4V peak.**
2. **Applying an offset of +4V on the HPx card shifts the whole signal up into the range 0V to +4V. At this stage the video is still inverted, 4V is black and 0V is peak signal.**
3. **Applying a gain of -1.25 has the effect of scaling the video to fill the 0 to +5V digitisation range and inverting it so that 0V is black and +5V is peak.**

A range offset (trigger delay) will often be required too, since it is the trailing edge of the trigger pulse that marks the video zero range. Since the trigger pulse could be up to 10µs long, this equates to a possible range offset of -1500m being necessary.

As an example, the following image shows the configuration discussed above set in the HPx source control dialog in SPx Server.



The following image shows the equivalent configuration in the HPx-346 web UI.

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