# Application Note:

## Port – Starboard Crosstalk in Sidescan Sonars.

The sidescan sonar imagery has unavoidable image contamination in the near nadir region. This is due to unavoidable system design constraints, namely the requirement for good coverage right down to nadir, and some allowance for small roll variations during the survey, which allows some of the port side transmitted energy to enter the starboard receiver and vice versa. The origins of this , and its impact on the imagery is shown in this note.
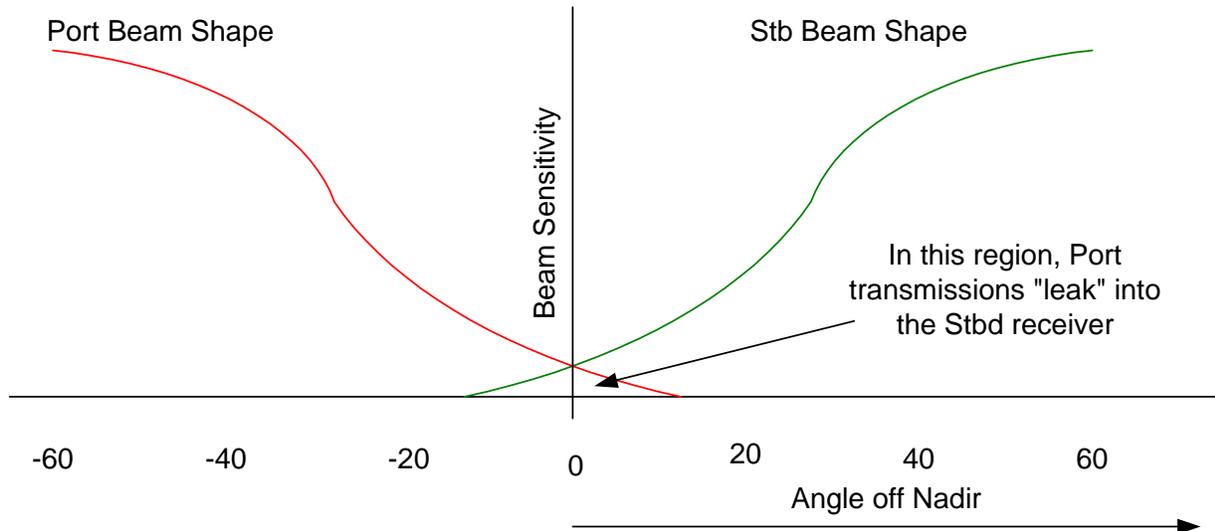
Sidescan Geometry:
The typical sidescan configuration is show below, as viewed from aft : (Note the horizontal and vertical scales are quite different)
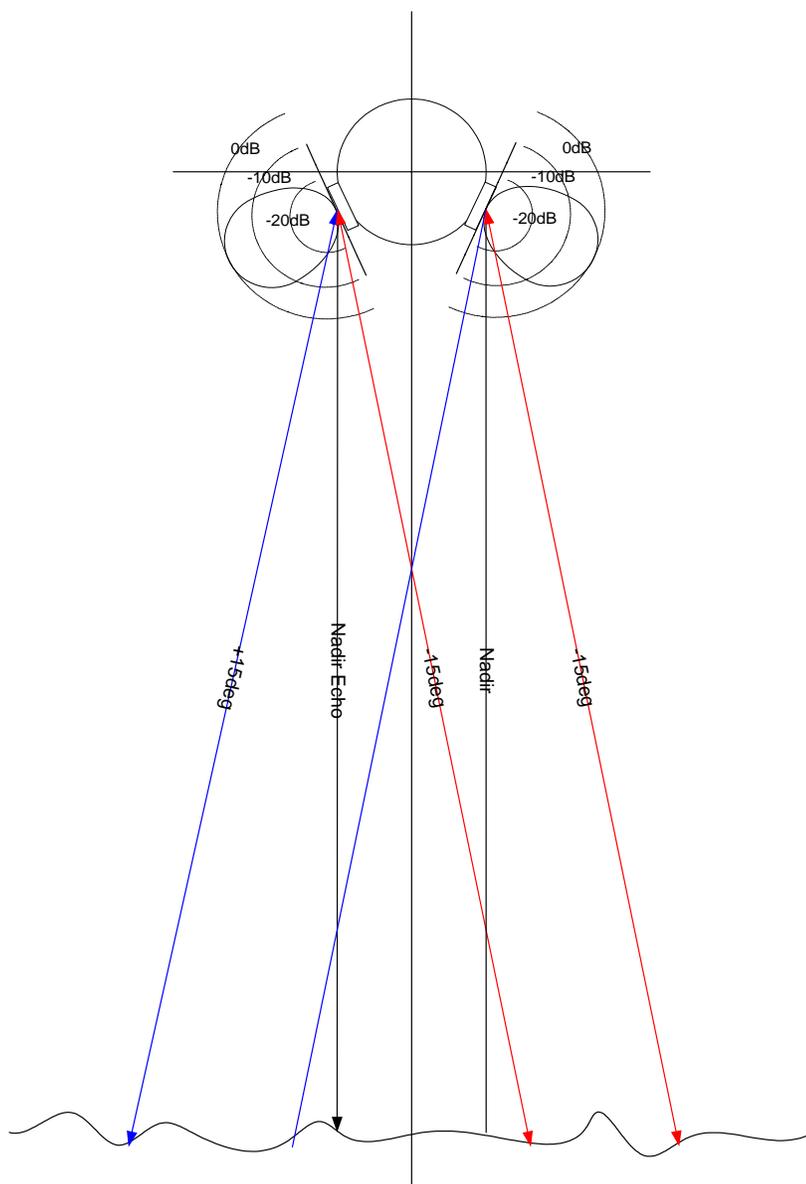


The typical port and starboard beam shapes are shown as polar plots of response in dB versus angle, for a 30dB range. These are somewhat idealized as strong sidelobe behavior is not shown.

If the angular response or sensitivity for each side is plotted against angle off nadir,  the following diagram is obtained.

Port Beam Shape                                          Stb Beam Shape

Beam Sensitivity

In this region, Port
transmissions "leak" into
the Stbd receiver

-60          -40          -20          0          20          40          60

Angle off Nadir

In the small regions shown above,  where the port and starboard beam patterns overlap, energy from each side is free to "leak" into the other.  This results in contamination of the port imagery, by a small amount of data from the starboard pulse echoes, and vice versa.  This contamination is often referred to as **port - stdb crosstalk,** in terminology borrowed from the telecommunications industry.

Note : It is impossible to design a set of transducers where this does not happen to some extent, so this effect is present in ALL sidescan sonar systems.

The visibility of this effect in the imagery will differ between  various implementations of the echo processing.

Non Coded Pulse system (Typical CW type transmissions):

When non coded transmit signals are used (as is common for most CW type systems), the signal processing in the receiver cannot discriminate between the Port and Starboard transmitted pulses (or echoes from them),  since they have the same frequency  content and detailed shape.  In this case the unwanted energy from the other side simply adds to the final receive signal  and contaminates the image in the near nadir region.

Note: This contamination can only be seen by detailed analysis of the port and starboard records in this region, and is in most cases never detected.

This process is shown in the following diagram.
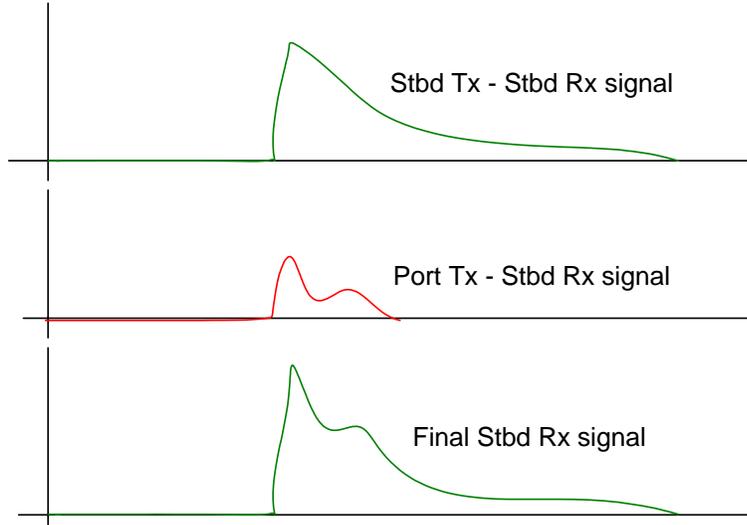
Port- Stdb crosstalk for non coded pulses

The corruption of the shape of the received signal just after the sea floor return is evident, **but is NOT noticeable to the user unless the true shape is known.**

Coded Pulse systems (Typical FM type transmissions):

In systems employing  coded  transmissions such as Linear FM or Chirp pulses, this crosstalk signal may be quite attenuated, but shows up in other ways.   These pulses typically using a changing frequency sweep during the transmission of the pulse. These pulses are much longer (by a factor of 10 or so) than CW pulses, and the final high resolution is achieved by correct processing of the echo data.

In these type of systems it is quite common to transmit pulses  which sweep UP on the one side and DOWN on the other, in order to provide some discrimination between the port and stbd echoes.

To understand the result , it is necessary to examine the pulse response of  a Chirp system to a matching chirp, and to a non matching chirp signal.



Compressed Pulse
response, Matching Tx
and Rx

Compressed Pulse
response, Non-Matching
Tx and Rx
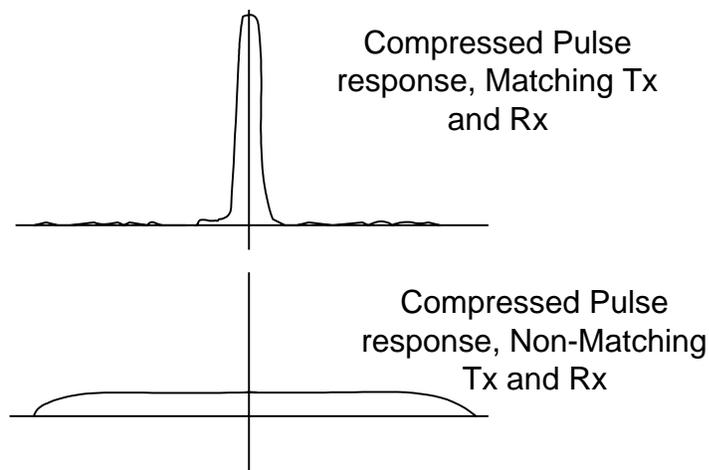
For the echo data that matches the transmit pulse (Port-Port, or Stdb to Stbd) , the result is a high amplitude, short duration signal with good resolution.
Where the echo data does NOT match (Port – Stbd or Stbd – Port) the result is a lower amplitude (typically $1/10^{th}$ or less compared to the compressed matching pulse ) , wide duration signal.
The signal duration is about twice the transmitted pulse length.

These two cases are shown in the diagram above, with exaggerated vertical scale for the unmatched case.

The resulting waveforms are sketched below.

Stbd Tx - Stbd Rx signal

Port Tx - Stbd Rx signal

Final Stbd Rx signal
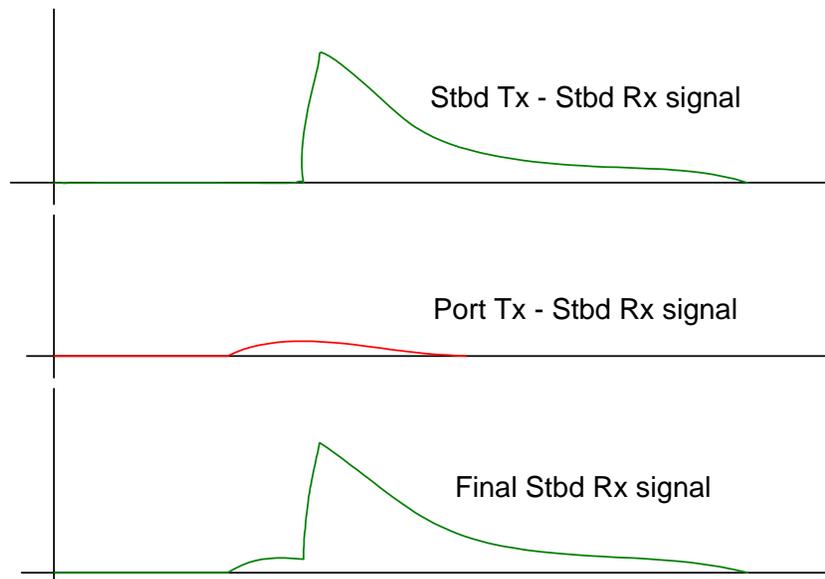
Here the port-stdb crosstalk is evident by inspection as low amplitude returns extending into the water column BEFORE the sea floor return.  Some small level of contamination follows this but is very small as compared to the main compressed echo data.  The primary echo data remains relatively uncorrupted by this effect.

Cross talk suppression

These low amplitude signals preceding the sea floor return look like "hairs" growing off the sea floor in the waterfall imagery.  They can be suppressed to some extent by correctly setting the screen gain so as to not hard clip the sea floor echo. Very high levels of gain applied in this region will make the "hairs" quite evident, as they start to occupy the display's dynamic range.

These hairs can be completely eliminated by transmitting the same chirp signal on both sides (at the expense of image contamination)  OR

they may be suppressed or even completely eliminated if the port and starboard pulses of the system are individually frequency shifted, one up a few percent of center frequency (2-5%) and the other down by a similar amount. In this way the echoes from port and stbd  are put into separate bands and as a result do not interfere at all.   All Edgetech Chirp sonars have this capability.  Please contact Edgetech Customer Support for details on how to achieve this in your system.

NOTE: Multi Pulse modes of the 4200 and 4300 Sonars cannot be frequency shifted in this manner.

Independent Pulse Frequency Shifting.

This section describes how the transmit and receive frequencies for the port and stbd channels may be shifted to reduce or eliminate the cross talk.

Use Remote Desktop application  (part of the Windows XP OS ) to access the PC (IP address shipped as 192.9.0.101) running in the sonar.
Using Explorer, locate the file :

D:\Edgetech\SSSSonar\Sonar\PulseCal.pcf

Use Wordpad or Notepad to open and edit the  file.

Typical file:

```
;=indicates a comment line
;<> indicates optional parameter
;=================
;Pulse Calibration
;=================
;This file is used to customize pulses for customer specific transducer characteristics
;Every time a pulse is loaded, calibration values are read from this file (if present).
;
;Two sections are searched, namely:
; Sub<N>Pulse<F> : Where <N> is the subsystem number and <F> is the pulse file name
; DefaultSub<N>  : If above is not found.
;
;The following keywords can be provided.  Each may be appended by an OPTIONAL channel number <n>
;if the parameter is to be channel specific.
;
;FreqShift<n>=XXX : Frequency shift of pulse in hertz
;GainADC<n>=XXX   : Calibration constant in tenths of a DB
;GainDAC<n>=XXX   : Pulse power modifier where 1000 is unity gain

[DefaultSub0]
FreqShift=0

[DefaultSub20]
FreqShift=0

[DefaultSub21]
FreqShift=15000

[Serial0]
PressureCalValue=6955

;++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++EOF
```

The entries under section Sub20 apply to Sidescan Low, and Sub21 to Sidescan high.
Create two entries in the desired sub system section as follows;
FreqShift0=xxxx
FreqShift1=yyyy
and comment out the orginal FreqShift=zzzz entry.
Where xxxx = the desired frequency shift in hertz for port side and yyyy for  Starboard side.

xxxx and yyyy should be the original value specified by FreqShift=zzzz, shifted by 2 to 5% of the subsystem's center frequency.

EXAMPLE:

Sidescan Low, Center Freq nominally = 120Khz
Desire to reduce port /stdb cross talk to suppress interference

Original PCF file entries

[DefaultSub20]
FreqShift=-5000

[DefaultSub21]
FreqShift=15000


Shift each  frequency by 3 %,    3% of 120khz = 3600hz

Revised Contents

[DefaultSub20]
;FreqShift=-5000
FreqShift0=-8600
FreqShift1=1400

[DefaultSub21]
FreqShift=15000

;++++++++++++++++++++++++++++++++++++++++++++++++++++++++

SAVE THE FILE and then cycle power on the system to make the changes take effect