



# Ultrasonic marine growth prevention for box coolers



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## INTRODUCTION

Shipsonic is a brand of Delta-sistems B.V., a Dutch cleantech company that provides innovative, effective, cost efficient & environment friendly antifouling solutions for professional marine, offshore, fishery and industry. As of January 2017 Delta-sistems B.V. has incorporated Shipsonic, since 2006 one of the market leaders in ultrasonic antifouling. Delta-sistems B.V. will continue the Shipsonic brand with recently developed and strongly improved series of heavy duty ultrasonic antifouling systems. All Shipsonic systems are developed and built in the Netherlands.

### **Permanent innovation**

The Netherlands has a rich maritime research and development tradition. At Shipsonic we have made a conscious decision to tap into this. To be able to do this, our systems are fully developed and built in the Netherlands. This allows us to partner with such institutions as the NIOZ (Netherlands Institute for Sea Research) and the HZ Vlissingen (University of Applied Sciences), amongst others. For a more detailed look into our present innovation agenda, go to our Research & Development section.

### **Installation consulting services**

Installing an ultrasonic antifouling system is very simple, and normally carried out by the ship's crew. The one decision to make is how many transducers are needed, and where to place them. To help clients with this, we offer an installation consultancy service. We let you do the installation, but help you decide which transducers to place where. This service can be hired online, using video conferencing etc. Or one of our consultants comes to visit you on the ship itself.

### **Permanent, structural client feedback**

We find client feedback so important, that any client willing to give us structural feedback on the functioning of his ultrasonic anti-fouling system, will get some benefits. As part of our feedback system, we are the only UAF supplier that hires professional divers to film the state of box coolers and sea chests protected by our systems.



## HOW IT WORKS

### GENERAL PRINCIPLES

The working of ultrasonic marine growth prevention is very simple: Any object, immersed in sea water, that vibrates in the ultrasonic frequency range (roughly 15kHz to 45kHz), and with enough sound pressure (SPL), will be significantly less fouled. The reason for this is explained in two steps:

1. All objects immersed in seawater will be covered with a bio film. This is the slippery surface on objects in the sea. This bio film consists of a mixture of proteins, bacteria and micro algae. On objects vibrating in the ultrasonic range, the forming of this bio film is largely prevented.
2. This bio film emits molecules into the surrounding water (excretiae, dead organisms etc). The presence of these molecules triggers larvae of larger fouling mechanisms (mussel etc) to settle.

### FREQUENCIES

An ultrasonic transducer (UT) is actually a spring-mass system, just like any loudspeaker.

Ordinary speakers have a wide frequency range, but cannot handle all frequencies. Woofers are especially for the low tones, tweeters for high tones, etc.

UTs only have 1 resonance frequency. This frequency is set at the factory (factors: mass of resonance element, mass of membrane, specs of the piezo elements, torque with which everything is assembled). UTs do have overtones, but these over tones have very little energy, resulting in little contribution to the final sound pressure level (SPL).

The resonance frequency of the UT is according to specs, when the UT is functioning as a proper ('free hanging') spring-mass system.

However, when a UT is installed, this changes. In theory, a new spring-mass system is constructed consisting of the UT and the object on which it is installed.

The mass of the system is greatly enhanced. This would normally result in a lower resonance frequency.

But the amplitude capability of the membrane is restricted, since the membrane is pressed against the object. Lesser amplitude results in a higher resonance frequency.

Two changes pointing in different directions. Our measurements have shown that the final outcome of these 2 is that the factory resonance frequency of an UT goes up with an average of 16 kHz. Only due to installation.

Resonance frequency not only changes with the torque with which the membrane is pressed against the object, but also with the temperature of the mass spring system.

Conclusion: the resulting resonance frequency of an installed ultrasonic transducer can never be exactly predicted, and is not constant (varies with temp).

Shipsonic has solved this by agitating each transducer in a wide range of frequencies, to make sure that each transducer, on whatever object it is installed, with whatever torque and whatever temperature, is always agitated in its resonance frequency.

We do this in a software loop, from 18 kHz to 45 kHz, with steps of only 20 Hz. Each frequency is activated during 20 milliseconds.

The result is that a 100 Watt peak power UT only consumes around 8 Watt. This is the consequence of the fact that a UT, when not agitated in its resonance frequency, hardly generates any noise at all. Note that a UT, which would be constantly agitated in its resonance frequency, would soon destroy itself.

Since it is impossible to predict the resonance frequency of a UT installed on an object, and this resonance frequency is not constant (temperature differences), it is not possible to claim that a particular system has the specific resonance frequencies against specific fouling organisms.

Shipsonic transducers are always, irrespective of installation parameters, agitated in the prevailing resonance frequencies.

## SOUND PRESSURE LEVELS

Shipsonic biological research<sup>1</sup> has shown that the main factor determining effectiveness of ultrasonic antifouling is sound pressure level (SPL). The more noise, the better. We noted no differences in effectiveness related to frequency differences. Thus, Shipsonic aims at maximum sound pressure level (SPL) in the hull plating, sea water intake piping or box-coolers.

Ultrasonic transducers (U) only have 1 main resonance frequency. UTs do have overtones, but these overtones have very little energy, resulting in little contribution to the final sound pressure level (SPL).

Resonance frequencies depend on transducer type and installation parameters<sup>2</sup>.

To get to maximum SPL, Shipsonic combines different types of UT on 1 single object, to get multiple resonance frequencies in the object.

Example: UT A has a resonance frequency of 20 kHz, after installation on box-cooler Z the resulting resonance frequency =  $20 + 16 = 36$  kHz.

UT B has a resonance frequency of 18 kHz, after installation on the same box-cooler Z, the resulting resonance frequency =  $18 + 16 = 34$  kHz.

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<sup>1</sup> Reporting on biological research findings in cooperation with Wageningen Research University, Royal Dutch Oceanographic Institute NIOZ, University of Applied Sciences Zeeland, Marine laboratory de Zeeschelp.

<sup>2</sup> See the Shipsonic brief 'A short note on the frequency behaviour of ultrasonic transducers' on [www.shipsonic.com](http://www.shipsonic.com).

Thus, box-cooler Z functions as 2 spring-mass systems, 1 with 36 kHz resonance and 1 with 34 kHz resonance. Therefore the resulting SPL in box-cooler Z will be significantly higher as compared to installing 2 x UT A or 2 x UT B.

In short, to get maximum SPL, Shipsonic

- builds powerful amplifiers and uses heavy loudspeakers (80, 100 and 120 Watt peak power)
- assures that resonance frequencies are always agitated
- generates multiple resonance frequencies in 1 object



## KEY FEATURES & SPECIFICATIONS

### **Robust system design**

Shipsonic™ has chosen for a robust, industrial approach of its systems designs. Ships are 24-7 on the move. In the engine rooms, humidity and temperatures can be very high for extended periods of time. At the high seas, you can not call a service engineer to check on problems with one of your ship's systems. Therefore Shipsonic™ systems are purely functional, no frills such as digital displays or wireless system monitoring. All such frivolities may look nice on a trade show, but they tend to break down, making your system vulnerable. We are not concerned with cosmetics, but with reliability.

### **High power (Wattage)**

We are one of the few, if not the only ones, who work with 80, 100 or even 120Watt transducers. This not only results in more ultrasonic energy in the object you want to protect, but the heavier transducers also have a lower resonance frequency. It is known that the lower frequencies of the ultrasonic spectrum are more efficient.

### **Correct frequency**

Resonant frequencies (the resulting frequency after installation) fluctuate with kind of object and method of installation. Our design features a standalone software module for each transducer, running through all relevant frequencies, which enables us to ensure that each transducer is optimally powered. This means every transducer always receives pulses in its own, specific resonance frequency.

### **Failsafe electronics design**

The Shipsonic electronics engineer has made a deliberate design effort to guarantee that the transducers in our systems can be powered continuously without excessive heat generation. The life cycle of electronics is severely shortened by excessive heat or fluctuating temperatures. Our system design ensures that all electronics always stay at least 25% below its maximum temperature specifications. All control units are equipped with 2 cooling fans, one blowing inward and one blowing outward to guarantee proper air circulation inside.

### **Plug and play**

In the Shipsonic design, each transducer is a stand-alone module, with separate power supply, separate power circuit board (PCB) and separate software module. This means that if one transducer fails, all other transducers of the same control unit will continue to function. In case of a short circuit in the transducer cable, the electronics can be damaged. But since the PCB's in the control unit are plug-and-play; replacing a PCB requires no special knowledge and requires 5 minutes, even at the high seas!

## CONTROL UNITS

Shipsonic's MDP series contains so many innovations that we say it is a new generation of ultrasonic antifouling! With its modular design, a single control cabinet can power up to 20 transducers. Additional transducer channels can be added very easily without any tools. And the system has also become smart. It continuously analyses itself and triggers an alarm if something goes wrong.

Where the fault occurred is displayed on the video screen inside the cabinet, or on the Shipsonic proprietary software on your console in the engine control room. Maintenance thus becomes very easy and, in many cases, can be carried out by yourself. And what makes the system so powerful? Each channel generates a whopping 125 Watt peak power!

### SPECIFICATIONS

- **HS code:** 8479.89.97
- **CE certified**
- **Wall mounted Rittal cabinet**
- **nVent Schroff board rack**
- **Modular design: powers from 1 to 20 transducers**
- **IP63**
- **Forced 2 fan cooling**
- **Over-temperature protection, fully functional up to 50 degrees ambient**
- **Frequency range:** 18,5 – 48 kHz
- **Programmable output frequency range to avoid interference with other ultrasonic systems**
- **No-tools board replacement**
- **Power supply:**
  - External: 240AC power supply  
2 circuit breakers, the system can be powered from 2 different electricity groups
  - Internal: 2 x 24 VDC power supply  
(redundant, 1 power supply suffices for the entire unit)
- **Monitoring on/In the control unit:**
  1. On-cabinet (door LED)
    - green: all OK
    - red: issue; open door and check
  2. In-cabinet (TFT video screen and board LEDs)
    - TFT video screen;
    - Power supplies voltage
    - Temp
    - Config
    - RTC
    - Individual transducer status (OK, open, short)
    - Board LEDs;
    - Board status
    - Channel configuration
- **Monitoring in the engine control room**
  1. RS-485 to USB connection
    - Dedicated Shipsonic Windows application;
    - Detailed system and transducer monitoring and data logging (7 years max)
  2. Contact Closure (normally closed dry contact)  
alarm output for PLC/SCADA system



## TRANSDUCERS

### A powerful protection of your ship

The sound pressure of our transducers is so high that they cannot be glued in the conventional way. Shipsonic developed an indestructible method that allows the transducers to be bolted onto welded rings, a method that is now patented.

### 3 Models

Shipsonic offers a range of 3 models: 80W - 100W - 120W. Depending on the size of your vessel, your box coolers and the available space, you will be offered a tailor-made plan based on calculations and past experience. Help needed with the installation? Shipsonic operates worldwide and can serve you in practically any port in the world.

### Especially for box-coolers

Shipsonic has gone a long way to develop the ideal, multipurpose transducer. We arrived at a set of relatively small, yet high powered, low frequency models. These are especially apt for installation on box-coolers, where installation space is often confined. Also, combining different transducer types results in a wider range of resonance frequencies, which means better protection.

### Patented method

The sound pressure of these models is so high, that they cannot be glued. Shipsonic developed an alternative installation method that ensures optimal transmission of the ultrasonic signal. At the same time, this construction is so solid that coming loose due to the vibrations and corrosion under the transducer foot do not stand a chance. This principle is patented, so exclusively obtainable from Shipsonic.

All transducers can be installed on both flat and curved surfaces. All transducers are IP67. 80W transducers can be furnished in IP68.

## SPECIFICATIONS

- Patented, double ring welding installation
- 80Watt / 100Watt / 120Watt peak power
- Power consumption: 8-10 Watts continuous
- Enclosure: POM
- Connector: Techno 381, IP68
- IP rating: IP67, 80W available in IP68
- Welding ring: steel S355
- (CuNiFe, marine brass, alu 6082 upon request)
- Nuts/threaded rods: M8
- Resonance frequencies:
  - 80W:  $22 \pm 0.5$  kHz;
  - 100W:  $28 \pm 0.5$  kHz
  - 120W:  $20 \pm 0.5$  kHz
- 80Watt transducers and corresponding welding rings can be machined to required radius for pipe installation



## TRANSDUCER POSITIONS

Shipsonic offers clients a detailed technical proposal for their required box cooler protection. This technical offer includes:

- Exact location of the different types of transducers on each individual cooler lid. (We install different types of transducers on 1 cooler for enhanced resonance frequency response)
- Configuration of the control units, given the location of the sea chests/ box coolers in the vessel. (Our control units are modular; each unit can power 1 to 20 transducers)

Below an example of a transducer location drawing:

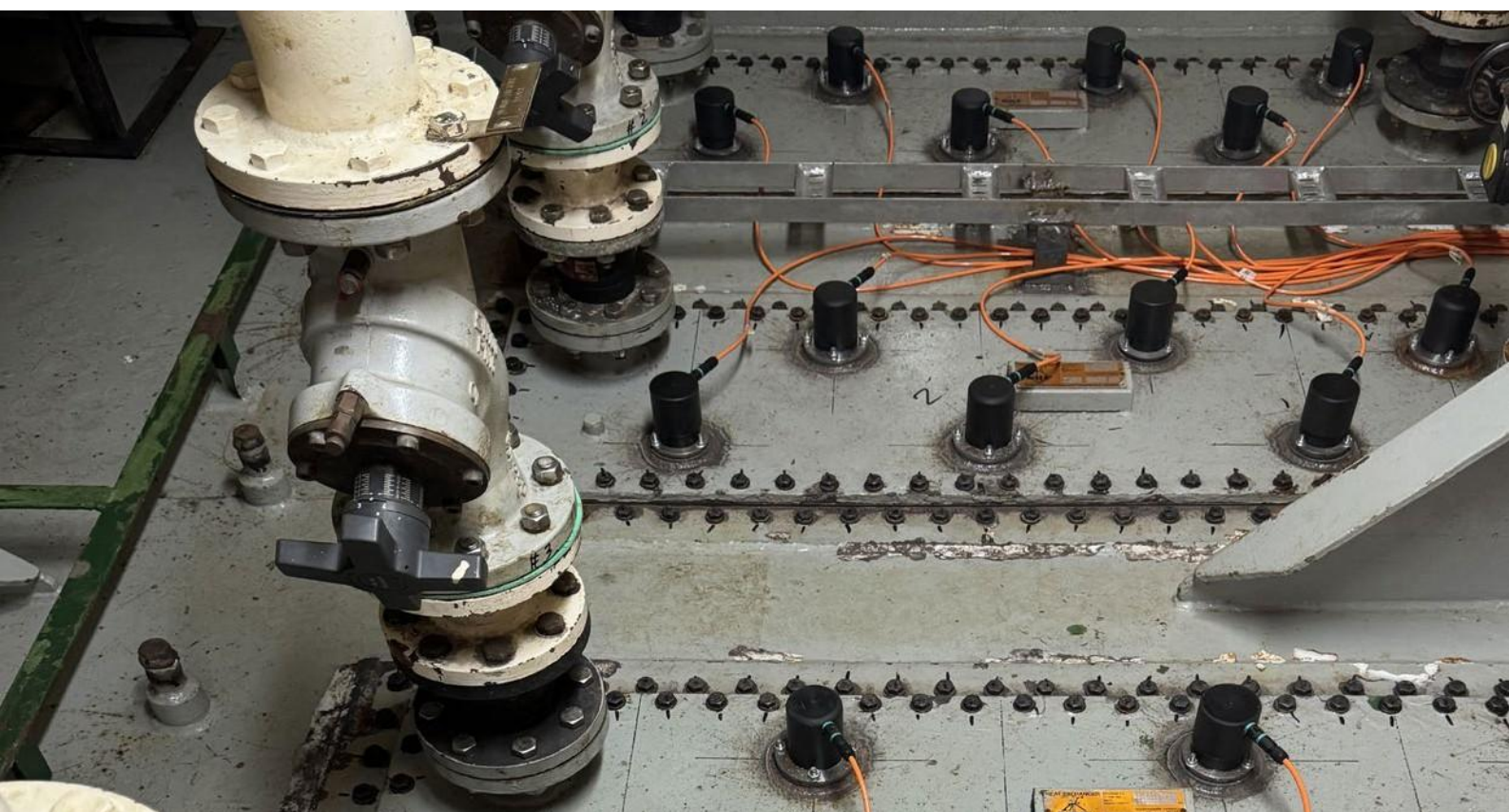
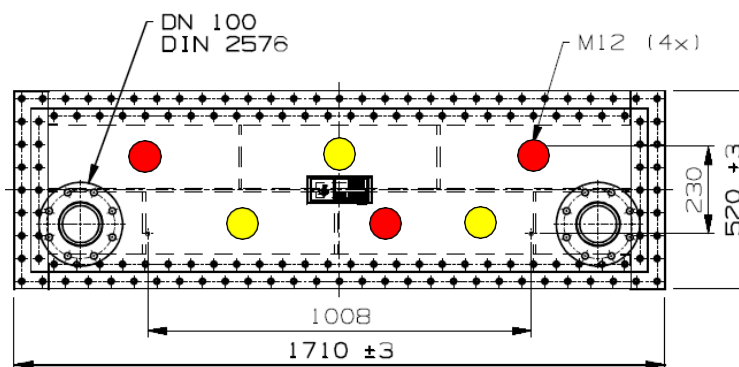
### TD-locations Jumbo Vision

Serial plate tag might have to be removed

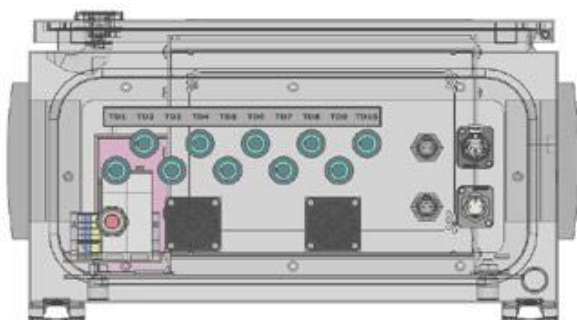
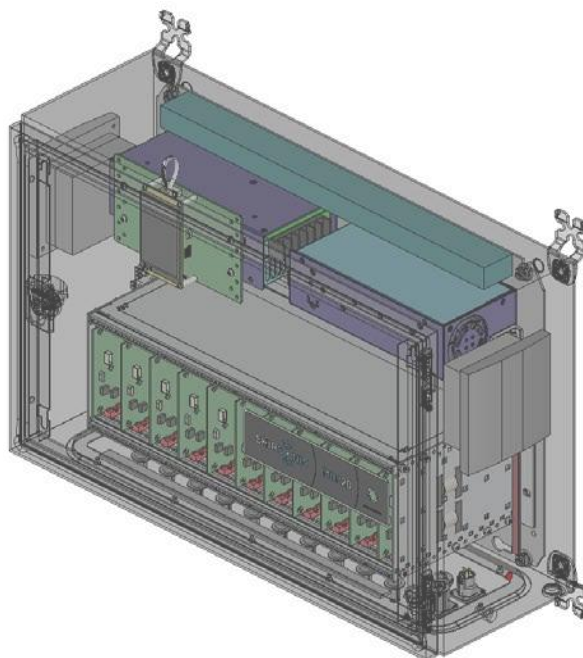
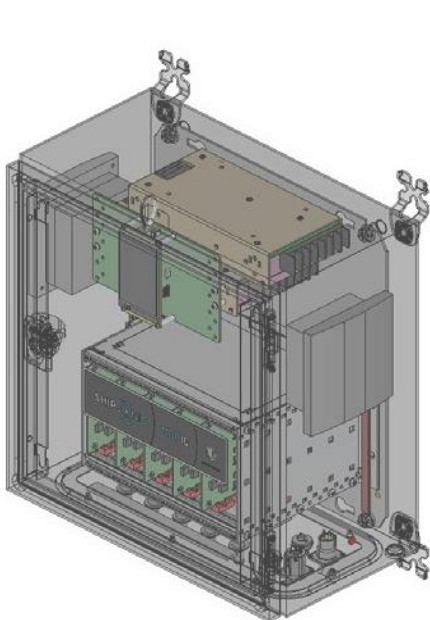
Transducer 80 Watt



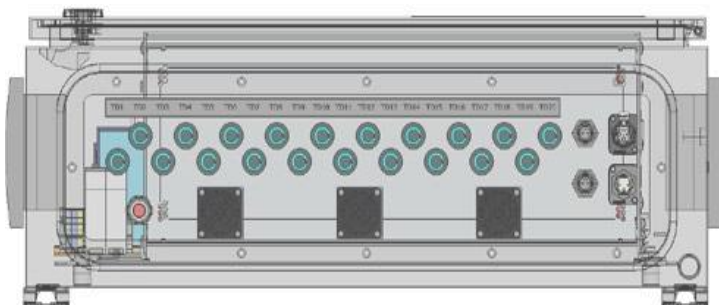
Transducer 100 Watt



## DRAWINGS



**MDP10**



**MDP20**